I-69 EVANSVILLE TO INDIANAPOLIS

Tier 2 Studies

Survey of Karst Features Report

Section 4, US 231 to SR 37

Contains Confidential Information

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Prepared for

Federal Highway Administration and
Indiana Department of Transportation

Executive Summary

This study was conducted to support the I-69 Tier 2, Section 4 Environmental Impact Statement (EIS) and to address items 1 through 4 of the 1993 Memorandum of Understanding (MOU). The Indiana Department of Transportation (INDOT), the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and U.S. Fish and Wildlife Service (USFWS) entered into the MOU to define guidelines for the development of transportation projects in karst areas and minimize the impact of construction projects in these areas. This study was prepared by Hydrogeology Incorporated of Bloomington, Indiana.

The scope of this study included identification and mapping of visible karst features within the I-69 Section 4 corridor, including field verification of previously reported or mapped karst features. In addition, groundwater flowpaths for karst features have been identified for evaluation of potential highway impacts and avoidance/minimization considerations.

Section 4 Karst Setting

The Section 4 Survey of Karst Features covers the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. This section of I-69 extends from near the intersection of US 231 and State Road 45/58 near Scotland, IN to State Road 37 (SR 37) near its intersection with Victor Pike southwest of Bloomington, IN.

Karst Areas

Three distinct areas of karst geology were identified within the study area. These areas are described below.

Taylor Ridge to SR 54

Taylor Ridge to SR 54 Karst extends from Taylor Ridge southwest of Koleen to SR 54. The ridges in this area are mostly sandstone and the valleys are limestone. The sandstone cap rock limits sinkhole development on the ridges. Some recharge occurs along fractures in the sandstone ridges but most of the recharge occurs in swallets and joints in the dry run valleys where limestone units outcrop. In most of this area the Big Clifty sandstone is found on the ridges and springs are developed in the underlying Beech Creek limestone. This area is typical of the Crawford Upland Physiographic Region.

SR 54 to Harmony Road

SR 54 to Harmony Road Karst extends from SR 54 to Harmony Road south of Stanford, Indiana. Sinkhole development occurs on the ridges, primarily in the eastern portion. Sinkhole development is limited to the eastern portion because karst-developing limestone beds dip to the southwest which decreases the surface expression of karst features. Karst features develop in limestones of the Blue River and Sanders Group. Swallets and sinking streams provide the majority of recharge to springs. This area is part of the Crawford Upland Physiographic Region.

Harmony Road to SR 37

Harmony Road to SR 37 Karst extends from Harmony Road to SR 37 intersection southwest of Bloomington. The karst in this area is exemplified by ridges and valleys that are comprised of limestones of the Blue River and Sanders Group. Sinkhole and swallet development occurs in the cap rock on the ridges and in drainages. The features act as recharge areas during rain events. This recharge provides the water for the springs located in the valleys. This area is typical of the Mitchell Plain physiography.

Non-Karst Areas

The non-karst portion of the Section 4 corridor extends from US-231 to the Taylor Ridge area. Historical data and field checks for karst features were conducted in this area with the identification of no karst features.

Physiography

Section 4 is divided into the Mitchell Plain and Crawford Upland Physiographic Regions. The mutual boundary of the Crawford Upland and Mitchell Plain is irregular, following the rugged escarpment of clastic beds overlying the limestones.

The Crawford Upland portion of Section 4 extends from US 231 to Harmony Road. The Crawford Upland is underlain by the upper Mississippian West Baden and Stephensport Groups. These two groups are composed of beds of shale, sandstones and limestone. The presence of these more silici-clastic rocks makes the Crawford Upland more resistant to dissolution. The silici-clastic rocks line the ridges forming a rugged topography with considerable relief (320 ft from SR 45/58 to between the ridges and the valleys. The valleys are generally formed in the Beech Creek Limestone, which is the major hydrogeologic unit in the area.

The Mitchell Plain portion of Section 4 extends from Harmony Road to SR 37. The Mitchell Plain contains most of the karst features in Indiana and in the Section 4 corridor. The carbonate bedrock units of the Blue River Group, consisting of the St. Louis and Ste. Genevieve

Limestones are the primary karst forming geologic units. The thinly bedded, highly jointed, nature of the St. Louis, Ste. Genevieve and Paoli Limestones makes them more prone to karst development. The Harrodsburg and Salem limestone of the Sanders Group and the Paoli limestone of the Blue River Group also develop karst features in the Mitchell Plain.

Bedrock Characteristics

Depth to bedrock is shallow (0-12 ft) on the ridges and deeper in the valleys (8-15 ft). Water infiltrates into the limestone bedrock along bedding planes, fractures and joints; dissolving and widening those areas which results in an irregular bedrock surface which is referred to as epikarst.

Soil Characteristics

Soil section on the ridges is as follows:
Organic Soil (0-1 ft)
Mineral Soil (1-12 ft)
Soil section in valleys is as follows:
Organic Soil (0-1 ft)
Mineral Soil (1-15 ft)

Organic soils may be thicker in areas of alluvial sedimentation. Additionally, soil thickness estimates are general values for the area and not based on specific soil sampling.

Land Use

Land use in Section 4 consists primarily of forested and agricultural land, with limited residential and commercially developed areas. Within the Section 4 corridor there are 4,803 acres of upland habitat, which amount to 64% of the corridor area. There are 2,164 acres under agricultural uses, which amount to 29% of the corridor area. Wetland acres (42) and open water acres (94) amount to about one percent of Section 4 corridor. Residential, commercial and other developed land uses occupy the remaining 6% of the corridor area.

Mining

Mining operations in the Section 4 Study area include limestone quarrying for both dimension and aggregate stone. The active limestone quarries present in the vicinity of the study area include Victor Oolitic and Independent Limestone. Several small abandoned quarries are located in the vicinity of Tramway Road and Victor Pike. According to the Indiana Geological Survey (IGS) abandoned coal mining operations are reported for the Koleen area, which have been identified as very old, small, and abandoned shallow surface and slope excavations. None of

these operations' remnants were identified in the field by the Project Team. The Project Team in consultation with IDNR Division of Reclamation has determined that these were small volume, short lived mines used mainly for consumption by the landowners. Some location data available from IGS and IDNR has not been field verified by these Agencies. Based on the results of field reconnaissance, and coordination with IDNR and IGS, these excavations have, apparently become overgrown and non-discernable due to their shallow nature.

Water Supply

Groundwater and surface water are both used as potable water sources in the Section 4 study area. Groundwater wells are used abundantly throughout Section 4 and springs are also used as a potable water supply for individual landowners. Public water supplies in the study area include:

- City of Bloomington Utilities (Bloomington)
- Van Buren Water (Southwester Monroe County)
- Eastern Heights Water (Greene County)
- Eastern Water (Greene County)
- Ellis Water (Greene County).

Hydrogeologic Units

US 231 to Taylor Ridge

The springs in this area discharge from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

Taylor Ridge to SR 54

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the West Baden, and Stephensport Groups. The Beech Creek Limestone is the major hydrogeologic unit with the Haney and Beaver Bend Limestones serving as minor hydrogeologic units.

SR 54 to Harmony Road

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones. The Indian Creek Beds serve as an impermeable unit and is important in directing groundwater flow. Water moving vertically from permeable units (Paoli Limestone) encounters the impermeable unit (Indian Creek Beds) and will then flow horizontally along hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of discharge features.

Harmony Road to SR 37

Recharge to springs generally comes from sinkholes located at the tops and flanks of the ridges. The major hydrogeologic units are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, and Ste. Genevieve Limestones. The Indian Creek Beds and Lost River Chert Bed both serve as impermeable units and are important in directing groundwater flow. Water moving vertically from permeable units encounters the impermeable units and will then flow horizontally along hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of discharge features.

Methodology

The study methodology was developed, and the study was conducted to ensure the project's adherence to the objectives of the 1993 Karst MOU (in italics below) in the following manner:

Research available public and private sources for information relative to karst features:

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey (IGS), Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. In addition, the information included in the 1994 Karst Features in the Bloomington to Evansville Highway Report and associated data was reviewed. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

During the study, coordination was maintained among the Project Team to review and exchange new information discovered by other project related studies. These included ongoing studies

regarding caves as potential Indiana bat habitat, as well as karst studies and other field evaluations being conducted for the I-69 corridor within adjacent sections and within Section 4. This included cross referencing all previous mapping collected with the field investigations and the IGS cave entrance surveys conducted in support of the Project Team's Section 7 Consultation with USFWS for this project.

Field check karst and cave features that appear from the first task and identify any additional karst features:

Field checks were conducted to verify and map previously recorded karst features along the length of the Section 4 corridor. In addition, a field reconnaissance was conducted to determine the presence of, and map previously unrecorded visible karst features within the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area and surface water drainage patterns of the area:

Drainage areas, drainage patterns, and land use specifically related to the karst features were determined and mapped. Additionally, dye tracing tests were conducted on karst features within the karst study area in order to determine and map the subsurface flow from recharge features (caves, sinkholes, swallets, and sinking/losing streams) to discharge features (springs and gaining streams) and establish groundwater flow patterns within the study area.

Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be requested to review and comment on the findings at the early coordination phase of project development:

The project team has conducted ongoing coordination with the agencies signatory to the Karst MOU (signatory agencies), including a karst study progress update meeting for the agencies during the development of this report. This meeting and other coordination has addressed comments and questions raised by INDR, IDEM, and USFWS as well as other review agencies to date.

Indiana Department of Transportation, using the input from Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will begin to formulate appropriate measures to offset unavoidable impacts to the karst features:

The project team will determine the appropriate measures to offset unavoidable impacts to karst features through coordination with the signatory agencies and any other appropriate review agencies. Any future agency concerns or questions relating to the findings or recommendations presented in this report, or any other karst related issues will be addressed by the project team through ongoing coordination relative to addressing the Karst MOU.

Results

The Section 4 Karst study produced the following results:

Karst Mapping

- Three distinct areas of karst were investigated over the 27-mile length of the Section 4 corridor
- Mapped karst features relevant to the corridor:
  - 63 caves, 14 within the corridor
  - 993 sinkholes, 305 within the corridor
  - 62 swallets, 19 within the corridor
  - 15 sinking streams, 6 within the corridor
  - 331 springs, 103 within the corridor
- Land use and drainage areas for karst features were determined
- Sixty-three (63) caves were identified. The scope of this project required only surface description of caves, not detailed surveying and exploration. Features were described as caves if it appeared to the field surveyor that the feature was large enough to enter and explore. It is possible that some of these features have a very limited extent of passage (conduit) large enough for human exploration.
- Ten areas of importance were identified (Cave, Cave, Cave, Cave, Cave, Spring, Cave, Cave, the SR 37 Interchange and Tramway Road Karst Area) based on hydrogeologic, geologic, engineering, and cultural reasons

- Water chemistry differences were observed between springs designated karst and non-karst

- Pollutant load estimates for pre and post construction

- Potential measures to offset impacts to karst include alternative drainage, mitigation/treatment, and operations and maintenance measures.

Dye Tracing

- A total of 39 dye tracing tests were conducted. The results of these tests show 47 groundwater flowpaths

- 9 groundwater flowpaths were shown to cross the Section 4 corridor

- The length of groundwater flowpaths varies greatly within Section 4 (340 ft to 21,774 ft). The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway. The average length was just over one mile

- Over 250 dye tracing sampling locations were established, and over 7,000 samples were analyzed

- Groundwater flow was characterized based on the dye tracing tests. The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point

- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point

- Cave, Cave, Cave, Cave, Cave, and Cave have all been hydrogeologically linked to the Section 4 corridor

- When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points.

Surveys of Section 4 Caves

Six sites were sampled to determine the presence of cave invertebrates. Sampling was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling.

A reconnaissance was conducted of all known caves within five miles of the Section 4 corridor. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat (*Myotis sodalis*) and make recommendations regarding further, more detailed investigations for bats that were to be conducted later by teams of biologists. There are 315 known caves located within five miles of the Section 4 corridor. Of these caves, 226 were judged by cave investigators to be potential Indiana bat hibernacula. Two-hundred and seven (207) of these caves were inspected to determine whether they are potential hibernacula. In addition, 41 caves were visited that were not part of the originally identified caves; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Access was denied to five sites, and 14 caves could not be located. As a result, 59 caves were recommended for intensive investigations as Indiana bat winter hibernacula.

Summary and Conclusions

Karst resources in the Section 4 study area have been impacted to a limited extent during historical and recent development within Monroe and Greene Counties. Due to the relatively undisturbed nature of Section 4 karst resources, appropriate areas outside of the Section 4 corridor were determined to be necessary to catalogue all relevant karst features. The project consisted of karst feature mapping and characterization, groundwater tracing of relevant karst features, and to determine the hydrogeology characteristics of the Section 4 corridor.

All karst features, and karst geology in general cannot be avoided within the Section 4 corridor; however, individual karst features can be avoided. Therefore, the focus of the alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features, alternative drainage, mitigation/treatment, and operation and maintenance measures.

The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point. Four dye traces demonstrated flowpaths to multiple discharge points from a single injection point. Eight groundwater flowpaths were shown to cross the Section 4 alignment. The length of groundwater flowpaths varies greatly (340 ft to over 20,000 ft) in length. The longer

flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway.

Cave, Cave, Cave, Cave, Cave, and Cave have been hydrogeologically linked to the Section 4 corridor.

Spring discharge within the study area varies greatly, due to the hydrogeologic nature of the spring and flow conditions (i.e. high or low flow). The spring discharges range from less than 0.1 gpm to 1,000 gpm. Spring discharges were estimated by field hydrogeologist and were not gauged. Water chemistry for karst and non-karst springs was analyzed and compared. The karst springs had lower pH, higher conductivity and higher calcium concentration than the non-karst springs.

Hydrogeologic characterization by area is as follows:

- Taylor Ridge to SR 54: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances are long (up to 4 miles), and subsequently had long travel times (1-3 weeks). Groundwater generally flowed west/southwest (along dip) and/or southeast/northwest (along strike)

- SR 54 to Harmony Road: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances were long (up to 3 miles), and subsequently had longer travel times (1-6 weeks). Groundwater generally flowed west/southwest (along dip) and/or southeast/northwest (along strike)

- Harmony Road to SR 37: Recharge to springs generally enters the karst system through sinkholes located at the tops and flanks of the ridges. Groundwater travel distance in this area were shorter (up to 3,000 ft), and subsequently had relatively short travel times, generally under three days.

Areas of Importance

Cave

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 4-1434, 4-1525, and 4-1524), four of which receive direct run-off from the Section 4 corridor. The drainage area associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) crosses into the Section 4 corridor. It should be noted that the affected drainage areas are linked

to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

The entrance to Cave is located approximately miles north of the corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. The drainage area associated with 4-0037 crosses into the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with swallet 4-0037. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made such that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is not located within the Section 4 corridor. This cave will not be directly impacted by highway construction. The Section 4 Alternatives are located approximately miles from the cave. However, dye tracing tests revealed that recharge to Cave is derived in part from four swallets (4-0166, 4-0173, 4-0175, and 4-1504) which receive run-off from the Section 4 corridor. Three other recharge features (4-0174, 4-0203, and 4-0204), which were not dye traced, are potentially hydrogeologically linked to Cave. The drainage area associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) crosses into the Section 4 corridor. The Section 4 Alternatives are on a common alignment in the vicinity of the above-noted features, and all Alternatives will impact the features and associated drainage areas in the same manner. Construction in this area could impact the recharge to Cave. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special

consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is located approximately south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to a spring, which is presumably connected to Cave based on best available data, is derived in part from a sinking stream (4-0661) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave and the associated spring. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with sinking stream 4-0661. Due to the relationship between the proposed road and existing topography, it is not anticipated that highway derived runoff would be directed toward sinking stream 4-0661. Special planning should be conducted, where appropriate and practicable, to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

Cave

Cave is located approximately south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from a swallet (4-1035) which does receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment, predominately down-gradient of swallet 4-1035 in this area. The Alternatives will impact the drainage area of swallet 4-1035 in a similar manner and therefore have the same potential to affect the cave spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Spring

Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. The spring will not be directly impacted by highway construction. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-1228) in a drainage east of

Spring within the Section 4 corridor. It is likely that the area downstream of sinking stream 4-1228 acts as a sinking stream during high flow periods and also provides recharge to Spring. Sinking stream 4-1228 and the potential losing stream reach down gradient from it would receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Spring. The Section 4 Alternatives area on a common alignment in this area and will unavoidably cross sinking stream 4-1228. They will not encroach upon the drainage area of sinking stream 4-1228. The Alternatives will cross sinking stream 4-1228 in a similar manner and therefore have the same potential to affect the spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

Cave

Cave is not located within the Section 4 corridor. The cave will not be directly impacted by highway construction. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. Cave is located southeast of Cave and lies between it and the input features for the dye traces. The Section 4 Alternatives are about a half-mile south of the cave location and share a common alignment in this area. All Alternatives would result in the same impact upon the drainage areas of potential Cave recharge features located within the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicates probability that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario the water could pass out of and back into the limestone one or more times. The majority of the recharge to the cave is derived from more proximal features. Therefore, it is not anticipated that the project will cause a material degradation of the cave spring's water quality or quantity.

Cave

Cave is located approximately south of the Section 4 corridor. Cave has been mapped and the cave passage trends toward the Section 4 corridor. The mapped extent of this cave terminates outside the Section 4 corridor, over 1,000 feet south of the Section 4 Alternatives. Dye tracing tests revealed that recharge to Cave is derived in part from a sinking stream (4-1271) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same impacts along the northern edge of the drainage area of sinking stream 4-1271. Where appropriate and practicable,

special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special consideration should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

SR 37 Interchange

Dye tracing tests reveal the northeastern side of SR 37 near its intersection with Victor Pike to be part of the recharge area for one significant spring (4-1501). The southwestern side of SR 37 near its intersection with Victor Pike is a concern from an engineering standpoint due to the high density of karst features. The bedrock is likely highly fractured and could pose unique design and construction issues. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. Additionally, the construction of SR 37 and surrounding development has already altered the land surface and drainage patterns. Sinkholes have been filled and altered which could be problematic during construction. Drainages and conduits have also been altered which present problems in studying the hydrogeology. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same encroachment within the recharge area along the northeastern side of SR 37 near Victor Pike. Special planning, where appropriate and practicable, should be conducted to insure that highway derived runoff within the drainage area of sinkhole 4-1496 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special planning should be conducted so that construction does not sever this recharge feature by sedimentation or impervious cover.

Tramway Road Karst Area

This area is located within the corridor, north of Tramway Road and west of Victor Pike. Dye tracing tests reveal short isolated groundwater systems and the karst features do not provide recharge to any significant springs. This area will need additional engineering measures to account for the high density of karst features and the highly fractured bedrock. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. The instability of the bedrock was highlighted by a sinkhole collapse documented by the project team. This collapsed occurred on the edge of a sinkhole (4-0133) identified during field mapping. The review did not identify that an alternative outside the corridor would provide substantial karst impact and/or roadway stability benefits compared to alternatives within the corridor. The Section 4 Alternatives utilize three alignments in this area and would affect a similar overall number of features. The Preferred Alternative (Alternative 2) as well as Alternatives 3 and 4 minimize impacts to higher infiltration features and minimize anticipated stability concerns in the area by cresting the hill north of Tramway Road on its east side, approximately 30 feet lower in elevation in comparison to Alternative 1.

General Environmental Concerns

- Karst groundwater systems can transport sediment and contaminants virtually unimpeded into cave and spring systems. Dye tracing studies of the groundwater systems within the Section 4 corridor identify the potential for highway related contamination in locations removed from the source. The average distance between dye injection and detection was just over one mile

- Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides is common. If contaminants enter the karst system the location for establishing a response could be difficult to predict.

General Engineering Concerns

- Collapse of filled (naturally and otherwise) sinkholes and cave passages can compromise adjacent and overlying structures. These failures can occur without surface expression prior to collapse. There are sinkholes within the Section 4 corridor that have been filled by natural and man-made processes

- Impervious surfaces, such as roads, alter the natural patterns of run-off and infiltration. Concentrated and redirected runoff into open sinkholes or over sinkholes without surface expression can result in sinkhole collapse. Unlined retention or detention structures can increase the localized hydraulic head, which could result in collapse of adjacent sinkholes. Alteration of surface run-off can also increase erosion which can effectively sever recharge features by sedimentation

- Impervious surfaces, such as roads, can sever recharge features. This can result in decrease spring discharges and alteration of habitat for any biological communities within the karst system

- The karst landscape is an ever evolving landscape. Karst features can change rapidly with subsequent opening and infilling of sinkholes, caves and swallets as well as increase and decrease in spring discharges

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted low-salt/no spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

- The drainage design for I-69 should provide for proper energy dissipation devices at the culvert and storm sewer system outlet locations to prevent erosion to existing channels. Energy dissipater devices include such items as scour holes, riprap linings and stilling basins. Design of energy dissipater devices and ditch linings should be based on INDOT's Drainage Design Manual

- Run-off from the roadway should have as much natural treatment as is possible. It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching potential karst recharge features

- The roadway construction, when possible, should be planned to maintain the drainage to karst recharge features

- Utilization of lined ditches to the outfall discharge points are recommended within the karst areas designed to prevent erosion. Water flow within the roadway ditches will need an analysis for lining requirements. Culvert outlets should be designed to discharge water to at grade terrain. This design will reduce erosion scour and sediment transport into the karst and other environments. Design of ditches and culverts should be based on INDOT's Drainage Design Manual. This will reduce soil erosion through karst features that could compromise the integrity of the roadway

- A spill response plan should be established with response equipment readily available during and after road construction. Karst groundwater systems have the potential for high groundwater flow velocities, which makes quick response to any spill a necessity. Drainage and runoff control mechanisms should be in place to prevent contaminants from entering the karst system. In the event that contaminants enter the karst system, use of response or mitigation measures at discharge points may be necessary

- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

Best Management Practices

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted no-salt/spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

- The drainage design for I-69 should provide for proper energy dissipation devices at the culvert and storm sewer system outlet locations to prevent erosion to existing channels. Energy dissipater devices include such items as scour holes, riprap linings and stilling basins. Design of energy dissipater devices and ditch linings should be based on INDOT's Drainage Design Manual

- Run-off from the roadway should have as much natural treatment as is possible. It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching potential karst recharge features

- The roadway construction, when possible, should be planned to maintain the drainage to karst recharge features

- Utilization of lined ditches to the outfall discharge points are recommended within the karst areas designed to prevent erosion. Water flow within the roadway ditches will need an analysis for lining requirements. Culvert outlets should be designed to discharge water to at grade terrain. This design will reduce erosion scour and sediment transport into the karst and other environments. Design of ditches and culverts should be based on INDOT's Drainage Design Manual. This will reduce soil erosion through karst features that could compromise the integrity of the roadway

- A spill response plan should be established with response equipment readily available during and after road construction. Karst groundwater systems have the potential for high groundwater flow velocities, which makes quick response to any spill a necessity. Drainage and runoff control mechanisms should be in place to prevent contaminants from entering the karst system. In the event that contaminants enter the karst system, use of response or mitigation measures at discharge points may be necessary

- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

Glossary of Relevant Terms
I -69 Tier 2 Section 4

General Terms

Corridor
The I-69 Tier 2 Section 4 corridor is a generally 2,000 ft wide area that begins near US 231 near Scotland, Indiana and extends northeast 27 miles to SR 37 just southwest of Bloomington, Indiana.

Karst Study Area
The Section 4 Karst Study Area includes the 27-mile long Section 4 corridor and appropriate areas outside of the corridor to encompass karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Section 5
The I-69 Section 5 corridor is a 2,000-ft wide area centered on State Route 37 (SR 37) beginning at the north terminus of the Section 4 corridor southwest of Bloomington in Monroe County, Indiana, and extending to just south of Martinsville in Morgan County, Indiana. The Section 5 Karst Study Area included both the I-69 Tier 1 and Tier 2 karst data that was determined to be relevant to Section 5, and extended from south of Section 5 north along SR 37 to roughly Chambers Pike.

Section 3
The I-69 Section 3 corridor is a generally 2,000-ft wide area, which begins just north of the proposed US 50 interchange, east of Washington, travels in a north by northeasterly direction along the east side of Elnora and turns east by northeasterly to the south Section 4 corridor terminus east of US 231, near Naval Surface Warfare Center (NSWC) - Crane Division.

Karst/Geologic Terms

Baseflow
The part of a stream discharge that is not attributable to direct runoff from precipitation or snow-melt. Baseflow is sustained by groundwater discharge (AGI Glossary, 2005, 5th edition).

Carbonate Rocks
Sedimentary rocks that contain large amount of carbonate (CO_3) such as limestone and dolomite.

Cave
A natural underground opening in rock that is large enough for human entry and exploration of an appreciable distance.

Cave System
An assemblage of karst features, which contain multiple passages, recharge areas and springs that may or may not be related.

Dip
The direction of the slope of geologic formations.

Discharge Feature
An opening in the bedrock and/or soil that allows water to flow from the subsurface onto the land surface. Examples of these features are springs, gaining streams, and in some instances caves.

Dye Detection/Dye Positive
A water or charcoal sample that contains fluorescent dye. This is a specific result in that it is a spring sample or stream crossing sample with no preexisting upstream source of fluorescent dye.

Dye Trace Test
Fluorescent dye was injected into recharge features with existing flow from surface sources or with supplemental flow from a tanker. All known springs in the area were then sampled for water and with charcoal samplers and analyzed for the presence of dye.

Epikarst
The upper portion of the soluble rock that has been highly weathered due to the dissolution of the carbonate rock by carbon dioxide from precipitation and acids dissolved from the organic zones in the soil. The area contains many fissures and enlarged fractures and joints. The epikarst can store water and transmit it to the saturated zone especially during wet periods.

Groundwater Flowpath
See Karst Flowpath.

Guano
Biological waste, often a reference to bat droppings.

High Infiltration Recharge Feature
A surface area where water and materials can move unimpeded to the subsurface.

ISCO Sampler
A commercial water sampler that can take 24 consecutive water samples over desired time intervals. ISCO samplers can be set at 1 hour intervals to take samples for a complete day. The continuous water sampling gives a more accurate time of travel and better idea of how long the dye pulse is discharging at the spring. Data obtained is useful in establishing mitigation plans.

Karst
A terrain with distinctive hydrology and landforms arising from a combination of high rock solubility, well developed secondary permeability and rock structure. The hydrology is usually manifested in internal drainage along solutionally enlarged passageways in the subsurface rock.

Karst Conduit
An underground solutionally enlarged opening, sometimes tubular in shape that is carrying or has carried water at some time. The opening may be too small for human entry but potentially accessible to smaller biota. Inward or outward airflow is a common attribute and can indicate connection to larger volume karst systems.

Karst Flowpath
Groundwater flow through a karst conduit within a karst groundwater system, also described as the distance and direction water travels from recharge to discharge.

Karst Valley
A valley in a karst terrain that is under-drained by sinkholes in the valley bottom. The sinkholes are often aligned along major joints, fractures or other structural features that determine the direction of the valley axis.

Losing Stream
In hydrology the common term is influent stream. This type of stream has the water table below the surface of the stream thus water seeps through the stream bottom due to the vertical gradient.

Low Infiltration Recharge Feature
A surface area where water and material movement to the subsurface is impeded by rock, soil, or other material.

Medium Infiltration Recharge Feature
A surface area where water and materials are impeded but still move relatively easily to the subsurface.

Non-specific Dye Positive/Dye Detection
A water or charcoal sample that contains fluorescent dye that has been attributed to an upstream source.

Recharge Area
The land surface that contributes water to a particular karst feature.

Recharge Feature
A surface area that channels water to the karst groundwater system. Examples of such features relevant to this report are sinkholes, swallets, sinking streams and in some situations caves.

Relevant Karst
The portion of karst within the 27-mile length of Section 4 corridor and associated areas outside of the corridor; that has been demonstrated to have corridor-derived water passing through it; or is linked by logical inference based on the best available geographic, geologic, and hydrologic data, including the Tier 2 investigation. It does not include areas outside the corridor that contribute water to the corridor.

Sampling Station
Sampling stations for this project consisted of a charcoal packet anchored in an area of active spring or stream flow. Water samples were taken when the charcoal packets were placed and each time the charcoal packets were changed. GPS locations were taken and the stations flagged with the spring identification number.

Silici-clastic
Sedimentary rock rich in quartz and other silicate minerals.

Sinking Stream
A surface stream that flows entirely into the subsurface with no noticeable swallet.

Sinkhole
A natural occurring bowl shaped feature that collects water from areas near the sinkhole. The water can infiltrate to the subsurface through openings at the sinkhole bottom and/or through the soil if openings do not occur. Collapse of sinkholes is common and can result in steeper irregular depressions.

Spring
An area where water from a karst groundwater system discharges to the surface.

Strike
The line perpendicular to the dip of geologic formations.

Swallet
The area where a stream sinks into the subsurface or an opening in the bottom of a sinkhole. The term swallet can be used interchangeably with the term swallowhole.

Land Use Terms

Agricultural
Includes all land such as pastures, row crops that are considered agricultural operations.

Nonresidential/industrial
Commercial and industrial complexes and other developed areas, excluding housing and developed uses such as churches and graveyards.

Public Lands
Land available for public use such as schools, libraries and hospitals.

Quarry
In Section 4 unless otherwise designated, the term quarry refers to currently active or abandoned limestone extraction sites.

Undeveloped Land
For the purposes of this report this term indicates wetlands and forested areas including state owned lands.

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1.0 INTRODUCTION

1.1 Purpose and Scope

This report has been prepared in conjunction with the I-69 Tier 2 Environmental Impact Statement (EIS) for Section 4, from US 231 near Scotland in Greene County to SR 37 near Bloomington in Monroe County. This report documents reviews of karst information relevant to the Section 4 corridor, field checks of previously recorded karst features, field investigations to identify previously unrecorded karst features, dye tracing of karst features, and recommendations for karst feature avoidance, impact minimization, and mitigation of unavoidable impacts. The Survey of Karst Features study methodology was developed and conducted to insure the project is consistent with the objectives of the 1993 Memorandum of Understanding delineating guidelines for the construction of transportation projects in karst regions of the state (Karst MOU) (**Appendix A**) between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM), and the U.S. Fish and Wildlife Service (USFWS). The first four items identified in the Karst MOU are addressed by this report in the following manner:

Research available public and private sources for information relative to karst features:

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey, Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. This data included the 1994 Karst Features in the Bloomington to Evansville Highway Report (USDOT, 1996) and associated data. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

During the study, coordination was maintained among the Project Team to review and exchange new information discovered by other project related studies. These included ongoing studies regarding caves as potential Indiana bat habitat, as well as karst studies and other field evaluations being conducted for the I-69 corridor within adjacent sections and within section 4. This included cross referencing all previous mapping collected with the field investigations and the IGS cave entrance surveys conducted in support of the Project Team's Section 7 Consultation with the USFWS for this project.

Field check karst and cave features that appear from the first task and identify any additional karst features:

Field checks were conducted to verify and map previously recorded karst features along the length of the Section 4 corridor. In addition, a field reconnaissance was conducted to determine the presence of, and map previously unrecorded karst features within the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area and surface water drainage patterns of the area:

Drainage areas, drainage patterns, and land use specifically related to the karst features were determined and mapped. Additionally, dye tracing tests were conducted on karst features within the karst study area in order to determine and map the subsurface flow from recharge features (caves, sinkholes, swallets, and sinking streams) to discharge features (springs and gaining streams) and establish groundwater flow patterns within the study area.

Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be requested to review and comment on the findings at the early coordination phase of project development:

The project team has conducted ongoing coordination with the agencies signatory to the Karst MOU (signatory agencies), including a karst study progress update meeting for the agencies during the development of this report. This meeting and other coordination has addressed comments and questions raised by INDR, IDEM, and USFWS as well as other review agencies to date. In addition, this draft report will be distributed to the signatory agencies and other appropriate review agencies for their review and comments prior to development of the DEIS.

Indiana Department of Transportation, using the input from Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will begin to formulate appropriate measures to offset unavoidable impacts to the karst features:

The project team will determine the appropriate measures to offset unavoidable impacts to karst features through coordination with the signatory agencies and any other appropriate review agencies. Any future agency concerns or questions relating to the findings or recommendations presented in this report, or any other karst related issues will be addressed by the project team through ongoing coordination relative to addressing the Karst MOU.

1.2 Study Area

The Section 4 corridor, which is the section of the I-69 corridor from US 231 to SR 37, is approximately twenty-seven miles in length (**Figure 1**). Section 4 begins in Greene County at the US 231 intersection with SR 45/58 near Scotland and proceeds northeasterly to Monroe County, ending at SR 37 southwest of Bloomington, just north of the SR 37 intersection with Victor Pike. The Section 4 corridor, as defined in the I-69 Evansville to Indianapolis Tier 1 Record of Decision (ROD), is predominantly 2,000 ft in width, with the following exceptions. Beginning at approximately Greene CR 1260 E near Hobbieville, the corridor gradually widens (to the north) to approximately 5,500 ft (between Carmichael Road and Carter Road) and then tapers back to the 2,000 ft width just west of Breeden Road in Monroe County. Additionally, in the Tier 1 study three "notches" were cut out of the corridor to add further buffer for resources known, based on Tier 1 information, to be located near the corridor. North of Carter Road, and east of the Monroe/Greene County Line, the corridor was notched to provide further buffer for the area associated with the Virginia Iron Works. South of the Evans Road/Evans Lane intersection in Monroe County, and south of the Koontz/Rockport Road intersection the corridor was notched to provide further buffer to karst resources. The karst study area included the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. For this study, relevant karst is the portion of karst within the 27-mile length of Section 4 corridor and associated areas outside of the corridor; that has been demonstrated to have corridor-derived water passing through it; or is linked by logical inference based on the best available geographic, geologic, and hydrologic data, including the Tier 2 investigation. It does not include areas outside the corridor that contribute water to the corridor.

The karst geology in the Section 4 karst study area is divided into the following three areas which are shown on **Figure 2**:

- Taylor Ridge to SR 54
- SR 54 to Harmony Road
- Harmony Road to SR 37.

The portion of the corridor without karst geology is shown on **Figure 2** and covers the following area:

- US 231 to Taylor Ridge.

1.3 Land Use

Land use in Section 4 consists primarily of forested and agricultural land, with limited residential and commercially developed areas (**Figure 3**). Within the Section 4 corridor there are 4,803 acres of upland habitat, which amount to 64% of the corridor area. There are 2,164 acres under agricultural uses, which amount to 29% of the corridor area. Wetland acres (42) and open water acres (94) amount to about one percent of Section 4 corridor. Residential, commercial and other developed land uses occupy the remaining 6% of the corridor area.

1.4 Physiographic Setting

Section 4 is divided into the Mitchell Plain and Crawford Upland Physiographic Regions (**Figure 4**). The mutual boundary of the Crawford Upland and Mitchell Plain is irregular, following the rugged escarpment of silici-clastic beds overlying limestone beds.

The Crawford Upland portion of Section 4 extends from US 231 to Harmony Road. The Crawford Upland is underlain by the upper Mississippian West Baden and Stephensport Groups. These two groups are composed of beds of shale, sandstones and limestone. The presence of these more silici-clastic rocks makes the Crawford Upland more resistant to dissolution. The silici-clastic rocks line the ridges forming a rugged topography with considerable relief (320 ft from SR45/58 to between the ridges and the valleys. The valleys are generally formed in the Beech Creek Limestone, which is the major hydrogeologic unit in the area.

The Mitchell Plain portion of Section 4 extends from Harmony Road to SR 37. The Mitchell Plain contains most of the karst features in Indiana and in the Section 4 corridor. The carbonate bedrock units of the Blue River Group, consisting of the St. Louis and Ste. Genevieve Limestones are the primary karst forming geologic units. The thinly bedded, highly jointed, nature of the St. Louis, Ste. Genevieve and Paoli Limestones makes them more prone to karst development. The Harrodsburg and Salem limestone of the Sanders Group and the Paoli Limestone of the Blue River Group also develop karst features in the Mitchell Plain.

1.5 Geologic Setting

The Section 4 study area is located within the Eastern Flank of the structural Illinois Basin. The bedrock dips to the southwest at approximately 30 ft per mile with local variations from 10 to 50 ft per mile. The Mount Carmel Fault lies approximately five miles east of SR 37 and there are no demonstrated faults within the karst study area.

The bedrock's structural strike, measured perpendicular to its dip, is northwest to southeast, with local variations. The bedrock is relatively shallow in the study area with thin soil sections on the ridges and thicker soil sections in the valleys. Older to younger bedrock is exposed from

northeast to southwest across the Section 4 corridor. The stratigraphic column relevant to Section 4 is illustrated in **Table 1**. The Mississippian Age carbonate bedrock units highlighted in **Table 1** are the source of karst development in Section 4.

1.5.1 US 231 to Taylor Ridge

Lower Pennsylvanian rocks that contain sandstone, shales, and interbedded coal layers are predominant. No karst forming rocks are exposed in this area.

1.5.2 Taylor Ridge to SR 54

Upper Mississippian rocks that contain inter-bedded limestone, sandstone and shale are predominant. The ridges are mostly sandstone and the valleys are limestone. The sandstone cap rock limits sinkhole development on the ridges. In this area the Big Clifty Sandstone is found on the ridges and the Beech Creek Limestone is exposed in the valleys.

1.5.3 SR 54 to Harmony Road

Upper Mississippian rocks that contain inter-bedded limestone, sandstone and shale are predominant. Recharge to springs is generally from swallets/sinking streams located in dry runs, with some minor contributions from the few sinkholes located in this area. The major karst forming units in this area are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones.

1.5.4 Harmony Road to SR 37

Lower Mississippian rocks that contain inter-bedded limestone and shales are predominant. This area is characterized by limestone ridges and valleys. Sinkhole and swallet development occurs in the cap rock on the ridges and in drainages. Recharge to springs in this area is generally from sinkholes located at the tops of ridges and to a lesser extent swallets in drainages. The major karst forming units in this area are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, Ste. Genevieve, and Paoli Limestones.

1.5.5 Mining Operations

Mining operations in the Section 4 study area include limestone quarrying for both dimension and aggregate stone. The active limestone quarries present in the vicinity of the study area include Victor Oolitic and Independent Limestone. Several small abandoned quarries are located in the vicinity of Tramway Road and Victor Pike. According to the IGS, abandoned coal mining operations are reported in the vicinity of Koleen. These mines have been characterized as very old, small, and abandoned shallow surface and slope excavations. No remnants of these

operations were identified in the field by the Project Team. The Project Team, in consultation with IDNR Division of Reclamation, has determined that these were small volume, short-lived mines used mainly for consumption by landowners. Some location data available from IGS and IDNR has not been field verified by these Agencies. Based on the results of field reconnaissance and coordination with IDNR and IGS, these excavations have apparently become overgrown and non-discernable due to their shallow nature.

Table 1: Section 4 Relevant Bedrock Units

System	Series	Group	Formation	Sub-Formation
Mississippian	Upper	Stephensport	Glen Dean Limestone	
			Hardinsburg Formation	
			Haney Limestone	
			Big Clifty	Indian Springs Shale
			Beech Creek Limestone	
		West Baden	Elwren Formation	
			Reelsville Limestone	
			Sample Formation	
			Beaver Bend Limestone	
			Bethel Formation	
	Lower	Blue River Group	Paoli Limestone	Downeys Bluff Member
				Yankeytown Member
				Shelterville Member
				Popcorn Member
			Ste. Genevieve Limestone	Byrantsville Breccia Bed
				Levias Member (Indian Creek Beds)
				Spar Mountain Member
				Fredonia Member
				Lost River Chert Bed
			St. Louis Limestone	
		Sanders Group	Salem Limestone	
			Harrodsburg Limestone	
			Ramp Creek Formation	
		Borden	Borden Formation	

Karst Forming Units
Confining Units
(Modified from Shaver et al, 1986)

1.6 Hydrogeologic Setting

1.6.1 Water Supply

Groundwater and surface water are used as potable water sources in the Section 4 study area. Groundwater wells are common throughout Section 4. Springs are also used as a water supply. Public water supplies in the study area include:

- City of Bloomington Utilities (Bloomington)
- Van Buren Water (Southwester Monroe County)
- Eastern Heights Water (Greene County)
- Eastern Water (Greene County)
- Ellis Water (Greene County).

1.6.2 Karst Groundwater

Carbonate rocks are prone to dissolution when contacted by infiltrating water. The partial pressure of carbon dioxide in the atmosphere is approximately $10^{-3.5}$ atmospheres. This carbon dioxide is absorbed into rainwater, which makes the rainwater slightly acidic with a pH of approximately 5.6. Anthropogenic sources such as industrial emissions can create other acids (hydrochloric, nitric, and sulfuric) that can lower the pH of rain below 5.6. Rainwater infiltrates through the soil zone which may contain additional carbon dioxide and other acid forming compounds. Organic acids may also contribute to the lower pH of the infiltrating water, but carbonic acid is the major source of acidity. Additional absorption of carbon dioxide and other acid forming compounds can lower the pH of the infiltrating water to 4 in extreme situations.

Acidic water infiltrates into the bedrock along bedding planes, fractures and joints; dissolving and widening those areas. Karst formed in this manner is referred to as epikarst and exhibits a shallow zone of enhanced secondary permeability. Secondary permeability of this nature creates the major pathways for groundwater flow in karst areas. The pathways receive recharge from sinkholes, swallets, sinking streams, caves, and infiltration through soil.

1.6.3 Section 4 Hydrogeologic Units

US 231 to Taylor Ridge

Springs in this area discharge water from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

Taylor Ridge to SR 54

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the West Baden, and Stephensport Groups. The Beech Creek Limestone is the major hydrogeologic unit with the Haney and Beaver Bend Limestones serving as minor hydrogeologic units.

SR 54 to Harmony Road

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones. The Indian Creek Beds serve as an impermeable unit and are important in directing groundwater flow. Water moving vertically from permeable units (Paoli Limestone) encounters the impermeable unit (Indian Creek Beds) and will then flow horizontally along a hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of recharge features.

Harmony Road to SR 37

Recharge to springs generally comes from sinkholes located at the tops and flanks of the ridges. The major hydrogeologic units are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, and Ste. Genevieve Limestones. The Indian Creek Beds and Lost River Chert Bed both serve as impermeable units and are important in directing groundwater flow. Water moving vertically from permeable units encounters the impermeable units and will then flow horizontally along a hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of recharge features.

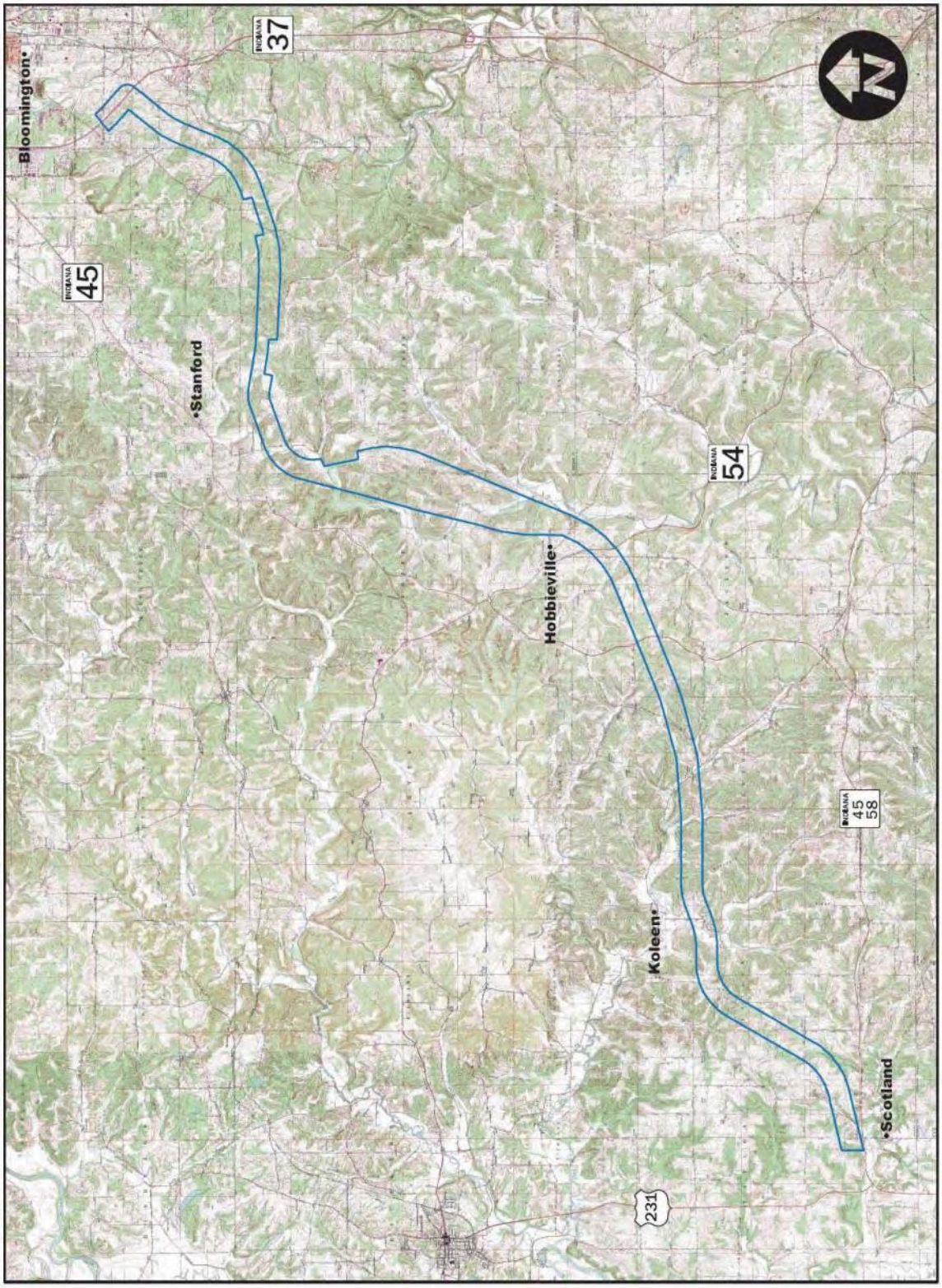


Figure 1: Section 4 Corridor and Karst Study Area
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4

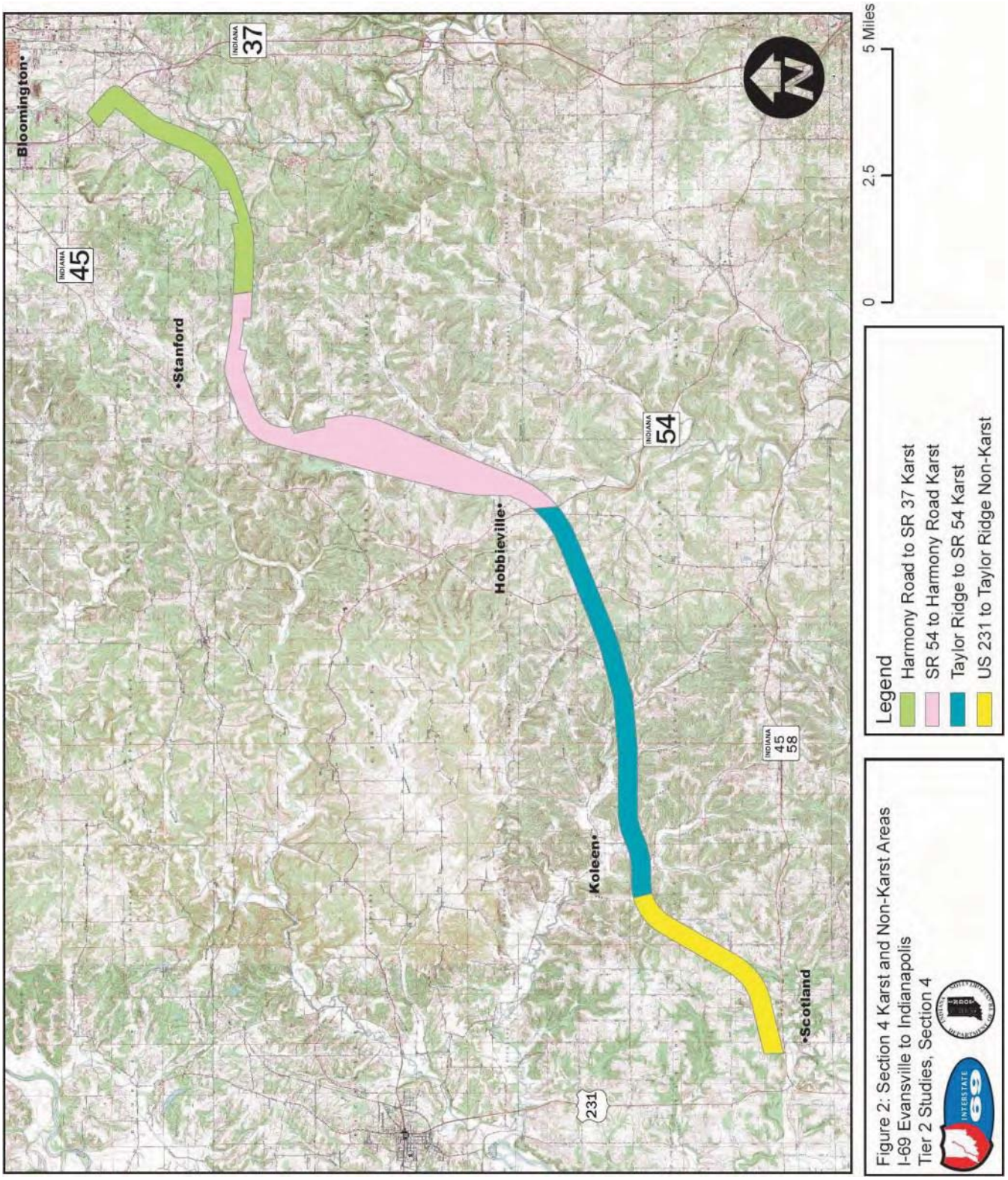
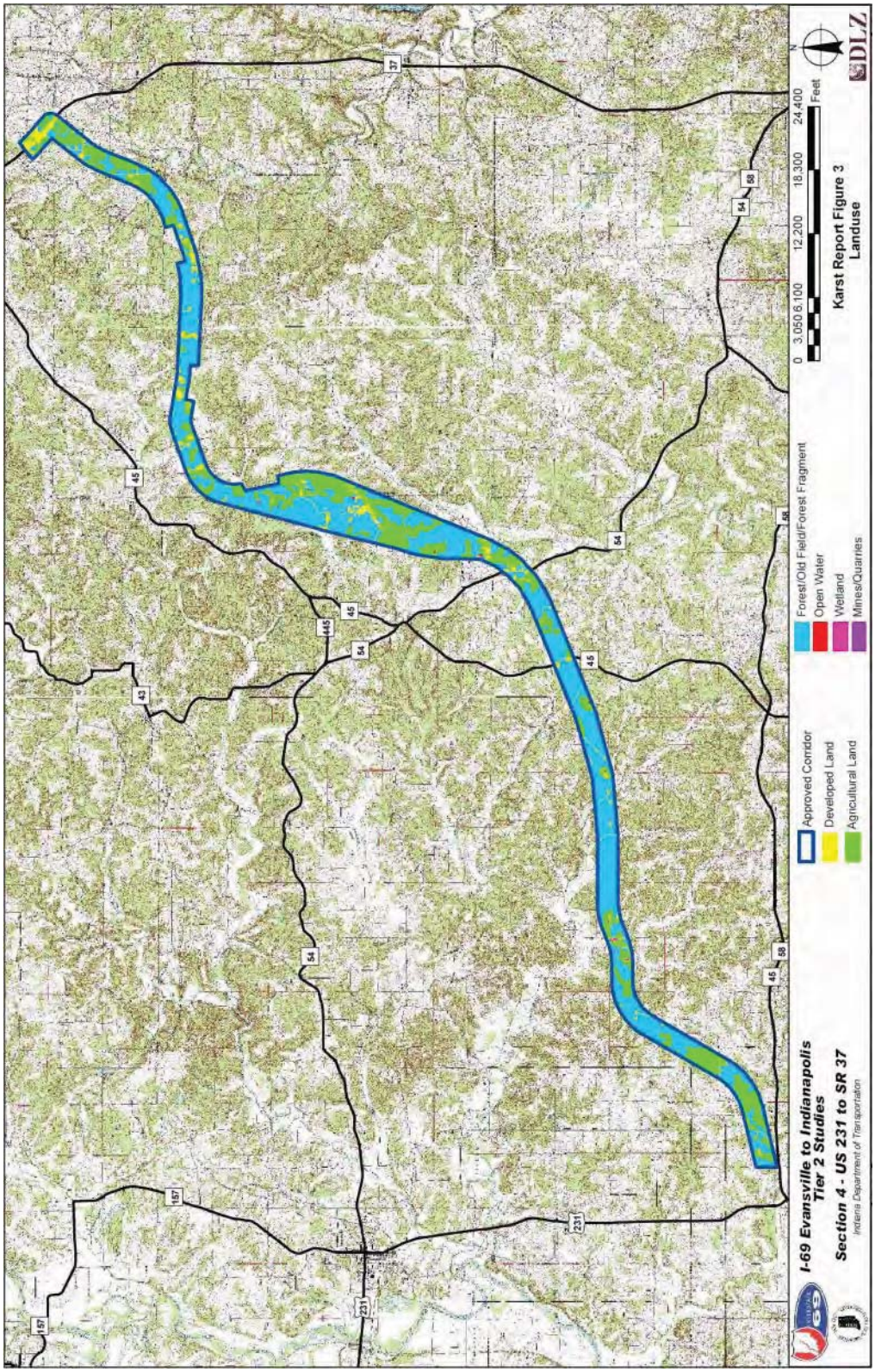


Figure 2: Section 4 Karst and Non-Karst Areas
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4


I-69 Evansville to Indianapolis
Tier 2 Studies
Section 4 - US 231 to SR 37
Indiana Department of Transportation
Approved Corridor
Developed Land
Agricultural Land
Forest/Old Field/Forest Fragment
Open Water
Wetland
Mines/Quarries
0 3,050 6,100 12,200 18,300 24,400
Feet
Karst Report Figure 3
Landuse
DLZ

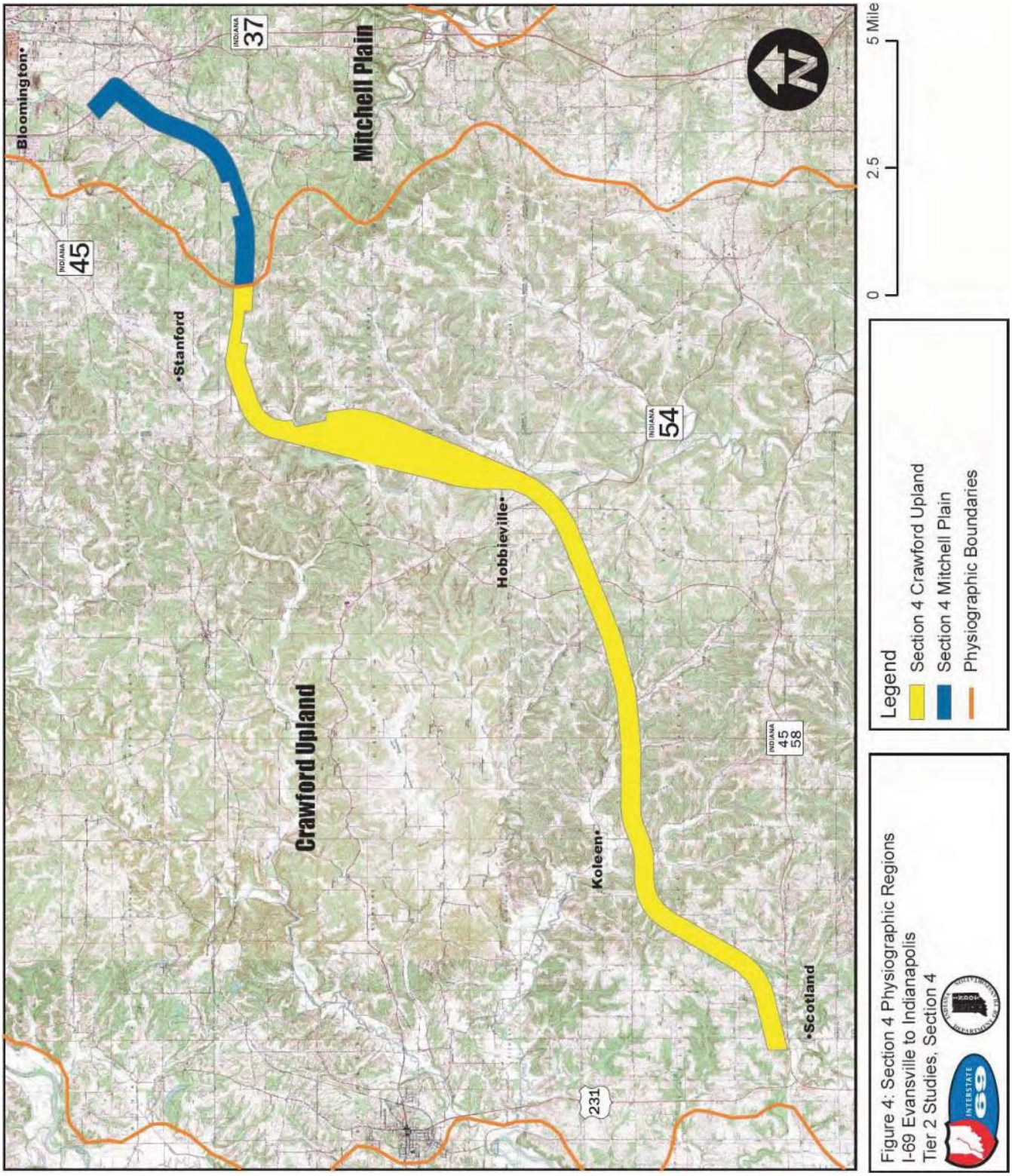


Figure 4: Section 4 Physiographic Regions
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4

2.0 METHODOLOGY

The Survey of Karst Features study methodology was developed and conducted to ensure the project is consistent with the objectives of the 1993 Karst Memorandum of Understanding (MOU) (**Appendix A**) between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM), and the U.S. Fish and Wildlife Service (USFWS). Analysis of the water chemistry of several karst and non-karst springs was conducted at the suggestion of the USEPA.

2.1 Public and Private Karst Resources

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey, Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. This included the 1994 Karst Features in the Bloomington to Evansville Highway Report and associated data. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

2.2 Karst Feature Identification

A complete field reconnaissance was conducted to check previously mapped karst features and determine the presence of unrecorded visible karst features within the 27-mile length of the Section 4 corridor and potentially associated karst features outside of the corridor. Unidentified underground karst features are likely to be present within the project area. Dye tracing was conducted in order to determine groundwater flow patterns in the area. However, identifying the exact location of the subsurface features associated with this flow cannot be accomplished without invasive ground disturbance (e.g., excavation). Accordingly, otherwise unidentified subsurface karst features associated with observed surface features and underground flow paths were not identified in the karst survey methodology. The Karst MOU was developed with the understanding that it is possible that previously unknown subsurface karst features will be unearthed during construction and the MOU establishes procedures to be followed to address this potential. Under the Karst MOU, if during construction unknown features are identified, the MOU signatory agencies will be contacted and an agreement regarding the proposed treatment of the feature reached prior to work continuing in that specific area of the project.

Aerial photographs and topographic maps were also consulted prior to and during field work to assist in the locating karst features. Once in the field, teams (consisting of 2 to 6 people) walked

approximately 50ft wide transects to locate karst features. When karst features were located, they were given a unique field identification number (i.e. 4-0001) and were flagged with that number, described on a field form (**Appendix B**), located with a GPS (with sub-meter accuracy) unit, and photographed. Multiple visits were made to many areas including reconnaissance during leaf off periods of reduced vegetation and with varying surface/ground water conditions. The features identified were categorized in the following manner.

2.2.1 Recharge Features

A recharge feature is an area that channels water to karst groundwater systems. These features have an associated surface drainage area (recharge area), from which surface water is collected, and directed into the subsurface. In this study recharge features were categorized by their estimated infiltration capacity and divided with the following distinctions:

- High Infiltration - any recharge feature in which water and materials can be conducted unimpeded to the subsurface

- Medium Infiltration - any recharge feature in which transport to the subsurface of water and materials are impeded by material (rock, soil, other), but still possesses moderate infiltration potential

- Low Infiltration - any recharge feature in which water and materials are impeded by material (rock, soil, other) and possess a low infiltration potential.

The following are considered recharge features:

- Sinkholes

- Swallets

- Sinking Streams

- Caves (in some cases).

2.2.2 Discharge Features

Discharge features are openings in the bedrock and/or soil that allow water to flow from the subsurface onto the land surface. These features vary greatly in physical size and flow rate within the Section 4 study area.

The following are examples of discharge features:

- Springs
- Caves (in some cases)
- Gaining Streams
- Sinkholes (in rare cases where the sinkhole is below the water table).

2.2.3 Drainage Area

The drainage area for each karst feature was calculated by incorporating USGS 1/3 arc second Digital Elevation Model Dataset (10 meter resolution) for the study area into an ArcHydro GIS model. The drainage model calculates the up-gradient drainage area for each karst recharge feature. The drainage area is based on their point location from field reconnaissance.

2.2.4 Land Use

The land use for each karst feature was determined using the National Land Cover Dataset (NLCD, 2001 data) which is cooperative project between the USGS and the USEPA. The NLCD is based on 30-meter Landsat thematic mapper (TM) data.

2.3 Dye Tracing Methodology

Dye tracing tests were conducted on karst features within the study area in order to determine and map the subsurface flow from recharge features to discharge features. The criteria for the selection of dye injection and sampling sites were determined in the following manner:

- Based on data collected in the field, recharge features were determined to have high, medium or low infiltration potential. Features with a high infiltration potential are the most suitable dye injection points due to the relatively unimpeded access to the subsurface. Using features with low infiltration potential as injection sites increases the likelihood for injected dye to be impeded by subsurface sumps (fractures, soil, and organic matter). Injection sites were also selected based on their proximity to the Section 4 corridor and if drainage from the Section 4 corridor would contribute runoff to the associated feature

- A sampling network was determined that consisted of all discharge features relevant to the injection point. Sampling sites were also established where streams relevant to the

injection feature were crossed by existing roadways. Such stream crossings are appropriate as streams receive base-flow which could contain the injected dye

- Background samples prior to the dye injection were collected and analyzed for all sampling sites to check for pre-existing fluorescence

- ISCO automated water samplers were installed at springs with the high potential for dye positives

- The appropriate fluorescent dye was chosen from four different dyes (Fluorescein (Uranine), Rhodamine WT, Eosine, and Phloxine B). Dye selection was based on presence of fluorescence in background samples and other ongoing dye traces in the vicinity of injection point. All of the dyes used are environmentally safe in the amounts used for these studies (Smart, 1984)

- Dye was introduced to selected recharge features under natural flow or supplemental flow (the feature was flushed with potable water that was brought to the feature via water tanker). When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points

- All water and activated charcoal samples collected were analyzed using Karst Project Team guidelines (See Section 2.4).

2.3.1 Dye Tracing Program

2.3.1.1 Background Fluorescence

When dye traces are performed in developed areas, there is the potential for background levels of fluorescence in the local groundwater and streams. Sources of background fluorescence include the common use of Fluorescein (Uranine) and Rhodamine WT for sewer and drain pipe tracing by municipalities and local residents. Additional sources of background fluorescence include automotive coolants which are known to contain Fluorescein and Rhodamine WT. Only two previous dye tracing tests were known to have been conducted in the Section 4 Karst Study Area. The absence of known previous dye tracing tests decreases the likelihood of background fluorescence. In order to determine the presence of any background fluorescence, water and charcoal samples are collected and analyzed prior to dye injection.

2.3.1.2 Sampling Stations

Dye tracing sampling stations were established and the presence of background fluorescence was determined for each sampling station. Sampling stations were selected from discharge features identified during the course of the field reconnaissance. The sampling stations were identified in the manner described in Section 2.2. Prior to dye tracing tests the following steps were performed for relevant sampling stations:

- Collection of grab water sample
- Placement of activated charcoal samplers
- Collection of activated charcoal samplers after 1 week
- Placement of ISCO automatic water samplers if appropriate
- Analysis of background water and charcoal samples.

Use of ISCO automated water samplers allows for collection of continuous water samples at any sampling interval, the most common being 1 to 4 hour intervals. The use of ISCO samplers allows for more detailed breakthrough or arrival data of dye, which can be useful when establishing mitigation plans.

The dynamic nature of karst groundwater systems makes it highly likely that spring discharges have changed since the feature was initially documented. During high flow conditions there is the likelihood for ephemeral springs to be flowing which could have been dry during field reconnaissance. In order to assure all possible discharge points were located prior to dye injection the relevant areas were re-examined prior to dye injection for the presence of ephemeral springs. In the event that previously undocumented springs were found they were documented in the manner described in Section 2.2 and established as sampling stations in the manner described above.

2.3.1.3 Dye Injections

The dye tracing program was designed to trace groundwater flowpaths from karst features relevant to the Section 4 corridor. The dye introductions were selected with the following criteria:

- Relevance to the study area, i.e. the feature is within the study corridor or would receive run-off directly from the corridor

- Proximity to areas of importance, i.e. prominent caves and springs
- Size of the feature's drainage area
- The feature's infiltration capacity. Features with high infiltration capacity are more critical for roadway planning, and more suitable for dye tracing than low infiltration capacity recharge features.

2.4 Dye Trace Field and Laboratory Procedures

Quality Assurance/ Quality Control (**Appendix C**)

The following field sampling protocols are implemented to insure accuracy and reproducibility of dye tracing results:

- Collection of field duplicates, water and charcoal
- Collection of field blanks, water and charcoal.

The following lab sampling protocols are implemented to insure accuracy and reproducibility of dye tracing results:

- Testing of all sampling containers, amber bottles (water) polypro jars (charcoal)
- Daily fluorospectrophotometer calibration as per the manufacturers recommendations
- Daily standard analysis for all dyes in use
- Analysis of field blanks and field duplicates.

Dye positives must meet the following criteria

- Fluorescence peak must fall in the accepted range for the dye in question
- Fluorescence peak must have typical fluorescence shape
- Fluorescence peak must be 10 times the concentration of background fluorescence

- Fluorescence peak must be 3 times the detection limit of the machine or 9 times the signal to noise ratio.

2.5 Pollutant Load Estimates

2.5.1 Pollutant Loads from Highway and Right-of-Way

The pollutant loads were calculated for each karst feature within the right-of-way (ROW) but outside the construction limits of the I-69 preferred alternative. All features inside the construction limits are assumed to be filled and capped. Therefore pollutant loading for those features will be zero. Any springs inside the construction limits will be provided with a "spring box" as well as drainage culvert to perpetuate the natural flow of the stream discharge.

Pollutant loads were calculated for pre and post construction conditions. The calculation procedures are based upon models developed to predict pollutant loads without field measurements presented in a Federal Highway Administration (FHWA) training course. The first part of the model calculates pollutant load estimates, developed in the late 1970's using field data from monitoring programs in various states. The second part estimates the pollutant concentrations and compares them to water quality standards. The third part estimates the pollutant loads in the "background", or what occurs before the highway is built. This methodology is included in Appendix N of this document.

Since the construction phasing of Section 4 is not yet determined, during-construction load estimates will not be performed. As part of the construction and construction oversight, strict adherence to the erosion control measures is essential. Runoff and sediment control are to be performed during construction in accordance with the Erosion and Sediment Control plans developed in compliance with the Indiana Handbook for Erosion Control in Developing Areas (Division of Soil Conservation, Indiana Department of Natural Resources). According to the "Results of MOU-Related Karst Studies for Indiana State Road 37, Lawrence County, Indiana (1992-1995)" (EarthTech, 1997), there were elevated levels of Total Suspended Solids (TSS) and Total Recoverable Metals (TRM) to the subsurface associated with the during-construction activities for the SR 37 project. These levels returned to pre-construction conditions about two years after construction. This pattern is anticipated for the I-69 construction.

2.6 Review of IDNR Water Well Data

In their comment letter dated August 3, 2007 on the Section 4 Draft Karst Report the USEPA suggested that IDNR Division of Water water well database should be included in this study to document local water tables and to determine the flow conditions under which the dye traces were conducted.

Because karst groundwater is moving through conduits and flow paths may intersect within a given karst formation, there may be little correlation between the "water table" as measured in wells and a karst conduit flow system in the vicinity. Many assumptions would need to be made regarding well connectivity to and influence from a karst conduit system versus the consolidated formation system, as well as the status of the seasonal influence on these water levels across the wide ranging timeframe of the IDNR well dataset. The undissolved rock (in which wells are typically placed) usually has several orders of magnitude less hydraulic conductivity than does the turbulent flow regime in the karst conduits; and therefore, response times are quite different. These factors limit the usefulness of IDNR water well data for the analyses recommended. The data were reviewed on May 24, 2010 to identify references to karst voids, for assessment of major structural issues. Two references were found. One reference related to a well in Section 5 (the information will be passed along to Section 5). The well log for well No. 213669, located near the , indicates a "crevice" from 20 to 23 ft. Based on their knowledge of the area as well as terminology commonly used by drillers, the karst specialists feel that crevice is likely a fracture, and probably not a serious concern. The data may be reviewed and compared to geotechnical boring data utilized for final design of the project. Water well locations and logs in the vicinity of the Section 4 corridor are depicted in **Appendix L**.

3.0 RESULTS

This section summarizes the results of the karst feature mapping and evaluation, dye tracing, and recharge area delineation.

Karst is an ever-evolving landscape. Karst features can change rapidly and the field descriptions included in this report are accurate for the time the features were identified in the field. Subsequent opening or infilling of sinkholes, caves, conduits, and swallets is likely as are increases and/or decreases in spring discharges.

3.1 Karst Features

Karst features include caves, sinkholes, swallets, sinking streams, springs, and others. In accordance with the Karst MOU, the location, type area, and significant characteristics of karst features were researched, field checked, and documented. To evaluate these features relative to the corridor and potential alignments, these features were incorporated into a GIS database. Previously unrecorded karst features within the 27-mile length of corridor and potentially associated features outside of the corridor were included in the GIS database. The complete field mapping database can be found in **Appendix D** and the corresponding feature photographs are included in **Appendix I**. Drainage area (**Appendix E**) and land use (**Appendix F**) for appropriate karst features are included in the summary data tables for each feature type.

3.1.1 Caves

Reviews of the existing data obtained (see Section 2.1 Public and Private Karst Resources) and field mapping identified the locations of 63 caves within the study area. The entrances to fourteen of these caves are located within the corridor. Four caves located outside of the corridor have been linked to the corridor via dye tracing tests. All cave entrances located within the corridor were included in the development of alignment alternatives. Caves are identified as bedrock openings large enough for entry by a human. Many are blocked by infilling with sediments, collapsed bedrock, and waste materials. These caves include all those previously located for I-69 investigations and others that were investigated by Indiana Geological Survey and the Winter Action Area surveys for the endangered Indiana bat. The project team coordinated and shared this information during the time of the surveys, and information gathered during the course of these other surveys is included in the cave descriptions. A complete cave list with descriptions can be seen in **Appendix D - Table 2** and cave locations can be seen in **Figures 5, 6**, and **7**.

3.1.1.1 Named Caves

Cave

Cave was field located and is reported as 4-0749. This cave is located within an 11 ft diameter 30 ft deep sinkhole. It is also known as Cave. The vertical pit drops approximately 30 ft and leads to several hundred feet of cave passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was field located and is reported as 4-1427. The cave entrance is located miles east of the corridor boundary, and across . The entrance is a small vertical pit, about 20 ft deep, into a horizontal cave draining to the west to a collapsed spring along Little Indian Creek. The cave extends eastward under the ridge for an unknown length bearing a karst flowpath. This cave has a vertical range of approximately 50 ft passing downward from the Paoli Limestone into the Ste. Genevieve Limestone. Topography, limited recharge, and hydrogeologic range of this cave preclude connectivity with the corridor. The cave has a large drainage channel feeding it from the hill to the north and is categorized as a recharge feature. The drainage to this cave is located outside of the corridor and is not connected via surface drainage.

Cave was harp trapped in the fall of 2004 and a winter survey was conducted in 2005 as a part of an associated study of the Winter Action Area for the endangered Indiana bat. No Indiana bats were captured there during fall harp trapping or observed during the winter survey.

Suggested Abatement

This cave is located on the opposite side of from the Section 4 corridor. serves as a groundwater drain making it unlikely groundwater would flow from the corridor Cave. Additionally, the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was field located and is reported as 4-1527. The entrance to the cave is not located within the corridor. Cave is developed in the Beech Creek Limestone and would have a stratigraphic vertical extent of about 35 ft. Dye tracing tests (1 & 2, Clifty Chapel, Flick 1 and Flick 2 Traces) indicated the system is approximately 20,000 ft long with 200 ft of vertical relief. The cave has a 500 gpm spring flowing out of the entrance and is categorized as a discharge feature. Cave was not harp trapped in the fall 2004 or part of the winter 2005 survey for the endangered Indiana bat. Cave has been considered a hibernaculum for the Indiana bat by USFWS. However, IDNR surveys have found a decreasing population. The last count in 2005 was down to zero Indiana bats from a 1995 maximum population of 28.

Suggested Abatement

Cave is not located within the corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 1434, 4-1525, and 4-1524), four of which receive direct run-off from the corridor (**Figure 8**). The drainage areas associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) cross into the corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave was field located and is reported as 4-1665. The entrance is located within the corridor, and the cave was identified for avoidance during alternative development. The entrance located on an upper slope is 7 ft wide and 3 ft high. This cave extends a distance of approximately 150 ft. The cave entrance extends downward from the surface and is categorized as a recharge feature. The cave is sediment filled and stream abandoned, with a vertical extent of about 25 ft in the St. Louis Limestone. No Indiana bats were trapped or observed in Cave

during the Winter Action Area surveys. Two unidentified Myotis bats were observed during the winter survey, but could not be examined for differentiation.

Suggested Abatement
The entrance to Cave is located within the corridor and was avoided during alignment development. Surface drainage from the roadway to this feature should have as much natural treatment as possible and the mapped cave passage should be considered during construction planning (**Figure 9**). It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching this feature. Also, where appropriate and practicable special consideration should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave was not located during fieldwork for this study. This suspect cave location was also researched and looked for by the IGS during the Winter Action Area surveys, and was not located by IGS either. Discussion with the IGS suggests the cave location data is inaccurate for Cave, and that the actual location of the cave is likely outside of the study area. However, the previously documented location within the corridor was identified for avoidance during alternative development.

Suggested Abatement
No abatement recommended.

Cave

Cave was previously documented and identified during field reconnaissance. It is included in the database as 4-0405. The cave is located approximately ft east of the corridor boundary and within the general area that was excluded from the corridor due concerns related to the historic site. This cave entrance was corroborated by Indiana Geological Survey's cave reconnaissance as the entrance associated with the name Cave. It is located near, but not connected with lying one half mile to the east. The cave is located in a sinkhole with exposed bedrock and is categorized as a recharge feature. At the time of field description there was outward air movement at the entrance to the cave, which can be an indication of connection to a larger cave system. Cave entrance lies approximately 40 ft above the flood plain of Little Indian Creek, opposite from the corridor. The small opening through the Paoli Limestone could not be penetrated far, but any cave associated with is opening would extend eastward below the ridge, or westward immediately to the floodplain of Indian Creek. Any cave associated with this opening would have a vertical extent limited to approximately 50 ft extending through the Paoli Limestone and upper third of the Ste. Genevieve Limestone. This cave has no hydrological connectivity with the corridor.

Suggested Abatement
The drainage to this cave is located outside of the corridor. Additionally, the vertical extent of this cave is limited by the geology. No abatement measures are deemed necessary for this feature.

Cave

Cave entrance was field located and assigned 4-0061. Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. Swallet 4-0037 derives a portion of its recharge from the Section 4 corridor. The entrance to the Cave is a small opening about 2 ft square. This drops down into a larger conduit that curves around to the right and the flowpath discharges through a large spring approximately 20 ft wide and 5 ft high at the highest point. The flow volume from swallet 4-0037 is relatively low. To the left, upstream, the cave has a surveyed length of 2,600 ft ending, as a cave, to a small rise pool. This cave has a vertical range of approximately 40 ft extending through the lower one-third of the Ste. Genevieve Limestone, between the entrance and the rise pool. Several small conduits gather recharge from nearby sinkhole ponds. The flowpath extending beyond the rise pool has been dye traced from an input point 4,000 ft to the northeast, and lying below a pit inside of Cave (Conner, 2006). Cave and Cave are generally considered as separate caves, however their physical and hydrological interconnections informally provide for the consideration of and Cave System. Related information is found in the description of Cave in this Section. Cave was fall harp trapped and winter surveyed as part of the Winter Action Area surveys. Cave receives most of its recharge from recharge features a mile to the north in an area overlying Cave, and structurally up dip. Topographically there is a divide between Cave and the corridor lying to the south. Flowpath potential may extend downward from the Paoli Limestone to the lower Ste. Genevieve Limestone.

Suggested Abatement
Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave was field located and assigned 4-0282. The opening to this cave is located outside of the corridor. A 200 gpm spring flows out of the entrance of the cave, and is categorized as a discharge feature. Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from

four swallets (4-0166, 4-0173, 4-0175, 4-1504) which receive run-off from the Section 4 corridor (**Figure 11**). Three other recharge features (4-0174, 4-0203, and 4-0204), which were not dye traced, are potentially hydrogeologically linked to the cave. The surface drainage areas associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) cross into the Section 4 corridor. The spring outlet of Cave is inundated by ponding behind a stone damn built by the landowner for water withdrawal purposes. This precludes ingress for the Indiana bat and other terrestrial fauna.

Suggested Abatement
Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave
Cave is a suspect location that was not located during fieldwork. Indiana Geological Survey cave data indicates this cave is located at UTM (feet) coordinate of X= , Y= , which is located outside of the corridor. Communication with the landowner suggests this cave was filled with soil to prevent livestock from entering or falling into the cave. The Beech Creek Limestone is present below the upper ridge at this location. Any soil filled cave at this location would have a limited vertical extent of approximately 20 ft.

Suggested Abatement
Although the location of Cave was not definitively identified, the suspected location is located outside of the corridor and would not receive surface drainage from the corridor. No abatement is recommended for this feature.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-0674. The cave has a vertical pit entrance and is categorized as a recharge feature. Historical information indicates the pit entrance leads to a cave system approximately 400 ft long. However, dye tracing in the area suggests the system potentially associated with this cave receives underground drainage from as far away as 3,000 ft (See Section 3.2.2, Wright Road Trace).

Suggested Abatement
Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to spring 4-0678 is derived in part from a sinking stream 4-0661

which receives surface drainage from the corridor (**Figure 12**). Based on cave mapping of Cave, spring 4-0678 is the likely discharge point for groundwater flow from the cave. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover. Cave was fall harp trapped and winter surveyed finding no Indiana bats.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-0943. The cave entrance is located outside of the corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet (4-1035). Swallet 4-1035 derives a portion of its recharge from the Section 4 corridor. The cave has a 3 ft by 3 ft entrance that leads to a cave system approximately 1,000 ft in length. It is located south of the corridor and just west of . The cave has an approximately 30 gpm spring flowing out of the entrance and is categorized as a discharge feature. The 3 by 3 ft entrance is fitted with a length of corrugated pipe to capture water from this spring which floods to the ceiling after storms. Several hundred feet of small water pipe extends into the accessible conduit to reach a low water capture pool. The pipe appears to be no longer in use. Exploration and surveying has pushed beyond two “bathtub” obstacles to survey approximately 1,000 ft extending westward and southward away from the corridor. Approximately another 350 ft of conduit is reported to have been explored. This cave ranges vertically for approximately 50 ft through the lower St. Louis Limestone.

Suggested Abatement

Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is a spring outlet previously documented and located during fieldwork and identified as 4-1743. It is located within the corridor and just east of . The mapped cave is known to extend approximately 150 ft through the St. Louis Limestone, with a vertical extent of 10 ft or less. This cave location was identified for avoidance during alternative development. A spring flows out of the entrance at approximately 15 to 20 gpm and the cave is

categorized as a discharge feature. The cave was included in the Winter Action Area surveys for the endangered Indiana bat. No bats were trapped during the fall of 2004. During the winter survey attempts to enter the cave found frost shattered collapse at the entrance. Inside approximately 10 ft the conduit is approximately 18 inches in diameter. A spring harp trapping during 2005 also captured no bats.

Suggested Abatement

The entrance to Cave is located within the corridor and was avoided during alignment development. Suitable dye injection locations for this cave were located southwest of the intersection of and . However, this karst area is avoided by a cut-out in the corridor that will prevent construction on or drainage to the potential recharge area for Cave. There are several large high infiltration sinkholes in this area and for that reason it was identified for avoidance during alternative development (**Figure 14**). Limited drainage to the cave is presumably derived from the corridor although the majority of drainage is most likely derived from outside the corridor. The location of the drainage in relation to the cave entrance suggests the cave system trends from the entrance to the northwest, although the mapped cave passage trends west and south. Construction planning in this area should consider the cave entrance and the potential for cave passage to the east, northwest and southwest of the cave entrance. Also, special consideration should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-1674. The cave has a 10 gpm spring flowing out of the entrance and is categorized as a discharge feature. The cave entrance is located outside of the corridor and drainage to this cave is located outside of the corridor. The cave passage extends away from the corridor to the southwest for approximately 2,000 ft.

Suggested Abatement

This cave is located on the opposite side of from the Section 4 corridor. serves as a groundwater drain making it unlikely groundwater would flow from the corridor to Cave. Additionally, the cave passage extends away from the corridor and the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-0382. The cave entrance is located approximately ft south of the corridor boundary within an . The cave entrance is 2 ft by 2 ft and is partially obstructed by limestone quarry blocks. The cave is categorized as a discharge feature with a less than 1 gpm spring flowing out of the cave entrance. The cave extends as a narrow stream

abandoned conduit for approximately 200 feet where it connects to a larger room complex developed in the Popcorn Sandstone Bed. A lower conduit accessed in the back of the room extends eastward and northward into the ridge for an unknown distance. This cave has a vertical extent of approximately 50 ft, with recharge in the Paoli Limestone and Popcorn Sandstone Bed, and extends downward through one third of the thickness of the Ste. Genevieve Limestone. The downstream segment would be expected to discharge to the west within several hundred ft into Little Indian Creek based on the immediately local geology and hydrogeology. The Cave was fall trapped and winter surveyed as part of the Winter Action Area Surveys with no Indiana bats trapped or observed.

Suggested Abatement

The entrance to Cave is located outside of the corridor. There is a small (<0.5 gpm) spring below the cave entrance but the cave passage does not have flowing water. Due to the lack for flowing water it was determined the cave would not be a suitable sampling location for dye tracing tests. The source of the spring below the entrance is likely the result of soil drainage through the quarry walls where the entrance is located. The only area of concern with this cave is the possibility of encountering a cave passage during roadway construction. The cave passage is known to be approximately 200 feet with an unknown length of cave passage beyond that. The cave passage trends to the northeast towards the corridor. Encountering unmapped portions of this cave is a possibility and should be considered during roadway planning and construction. The use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor was recommended by the USEPA. Such methods are unlikely to yield definitive results in this karst setting. The clay rich soils developed above the bedrock and also the significant thickness of bedrock between the cave and the ground surface would hinder a geophysical study.

Cave

Cave was previously documented and located during fieldwork. Its entrance is identified in this report as 4-0058. Cave has a surveyed length of 23,760 ft. It is hydrologically connected to nearby Cave via a 4,000 ft dye trace connecting them. Cave has three active flowpaths. The spring entrance to the includes approximately 3,500 ft of passage. Recharge to the cave is derived from the area north and west of the cave entrance. This main flowpath passes below the Indiana bat hibernaculum identified by USFWS and surveyed by IDNR. The second flowpath extends from a drainage divide near the to a pit to the northeast, just south of . This system has several cutoffs where its water is carried downward to enter the third flowpath. The third flowpath is entered at the base of the pit. Upstream it continues north of . Downstream it is not passable, but was dye traced to Cave. The interconnectivity between and Caves allows water from to enter but not the opposite. Cave does not receive water from the corridor and corridor water does not pass through the Indiana bat hibernacula in Cave.

Cave was fall harp trapped as part of the Winter Action Area surveys, and was winter surveyed by IDNR as part of their biennial census counts.

Suggested Abatement
Previous dye tracing tests show that groundwater flows from Cave to Caves. Cave served as a monitoring point for the Cave Trace and there was no dye detection at Cave. These two traces suggest that it is highly unlikely that Cave would receive run-off from the corridor. Additionally, the drainage to this cave is located outside of the corridor. No abatement measures are deemed necessary for this feature.

Cave
was previously documented and located during fieldwork. It is identified in this report as 4-1518. Cave is located outside of the corridor and was identified for avoidance during alternative development. The cave is developed in the Beech Creek Limestone and is limited to 35 ft stratigraphic extent. The cave has two distinct springs flowing out of separate openings and is categorized as a discharge feature. The combined flow of these springs at high flow is approximately 500 gpm. Cave was fall harp trapped and winter surveyed finding no Indiana bats.

Suggested Abatement
Cave is not located within the Section 4 corridor. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. The probable flowpath for the Cave dye traces cross the potential recharge area for Cave (**Figure 15**). No dye positives were recovered at Cave. However, the groundwater flow direction determined from the Cave dye traces indicates groundwater flows from the corridor towards Cave.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-0279. The cave has a 10 foot wide by 3 ft high entrance that leads to a cave system approximately 600 ft long. The cave passage extends downward from the surface and is categorized as a recharge feature. However, the high location of the entrance on the hillside would limit the amount of drainage to the cave entrance. Dye tracing tests (Trace 1) indicate that recharge to the cave is derived from the corridor. Cave was fall harp trapped and winter surveyed for the Indiana bat. A female Indiana bat was harp trapped swarming at the entrance in autumn 2004. The winter survey found no Indiana bats inside. Because of its location along the corridor this cave was trapped and surveyed a second time the following year finding no Indiana bats.

Suggested Abatement

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to spring 4-1274 located 500 ft southwest and 40 ft lower in elevation than the cave entrance, is derived in part from sinking stream 4-1271 and 4-172 which receive surface drainage from the corridor (**Figure 16**). Cave lies between 4-1271 and spring 4-1274 and it is likely that Cave receives recharge from sinking stream 4-1271. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-1271 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever 4-1271 by sedimentation or impervious cover. Additionally, the mapped cave passage for Cave trends toward the corridor. The possibility of encountering unmapped portions of the cave passage during roadway construction exists and should be considered during roadway planning in this area.

Cave

Cave was not definitively located during the course of fieldwork. Four caves (4-0071, 4-0831, 4-0775, and 4-0735) were found in the vicinity of the Indiana Geological Survey reported location of Cave; however none were definitively determined to be Cave. The cave location data from the IGS corresponds to 4-0842, which is described for this study as a soil plugged sinkhole. It is possible that this is the feature previously reported as Cave and that the opening has become smaller due to sedimentation. This suspect location is outside of the corridor, approximately 1,000 ft south of the corridor boundary. The local terrain is developed on the St. Louis Limestone and any such cave in this area would likely have had a vertical extent of 50 ft or less.

Suggested Abatement

Although Cave was not definitively identified, its suspected location is located outside the corridor and does not receive surface drainage from the corridor. No abatement recommended for this feature.

Cave

Cave was previously documented and is located approximately east of the corridor and across Indian Creek. The cave was located during field reconnaissance and is identified in the database as 4-1306. The entrance to the cave is approximately 10 ft wide and 5 ft high. This spring features multiple discharges to the floodplain with an estimated discharge of 1,000 gpm during high flow. This surveyed cave extends eastward, into the ridge for 4,640 ft where the ceiling drops to the static water depth of approximately 18 inches, but the conduit continues for an unknown extent. This cave floods entirely to the ceiling during storm cycles. The vertical extent of the cave is approximately 40 ft. The probable source of recharge to this cave is karst features to the northeast of the cave entrance. is recognized by

USFWS as a hibernaculum for the endangered Indiana bat. A recent IDNR survey identified a population of 119 hibernating Indiana bats. Topography, limited recharge, and the channel of Indian Creek preclude any hydrological connection between Cave and the corridor.

Suggested Abatement
This cave is located on the opposite side of Indian Creek from the Section 4 corridor. Indian Creek serves as a groundwater drain making it unlikely groundwater would flow from the corridor to Cave. Additionally, the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-1057. The entrance to the cave is 15 ft by 6 ft wide and extends 10 ft visibly from the surface.

Suggested Abatement
The entrance to Cave is located outside of the corridor and is not connected via surface drainage except under extreme high flow conditions (**Figure 17**). There is a channel located to the north and separated by a surface divide which does receive surface drainage from the corridor. Under extreme high flow conditions water can overflow this channel and enter Cave. Measures should be taken to address the high flow conditions that can result in drainage from the corridor entering Cave. Increasing the height and width of the bank separating the low flow channel and high flow channel of would prevent water from the corridor from entering the cave entrance.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-1303. The entrance to the cave is 15 ft by 15 ft and extends downward from the surface. Cave and the associated adjacent spring discharge to the floodplain of Little Indian Creek and are located approximately miles east of the corridor boundary and are separated from the corridor by a south trending valley. The known cave has been surveyed for a distance of 2,283 ft to the northeast below the slope flanking Little Indian Creek. The cave has a reported surveyed height of 52 ft. This is in agreement with a recharge feature into the Paoli Limestone and a karst flowpath extending downward through the upper one-third of the Ste. Genevieve Limestone. A dye trace was completed in effort to determine if there is a hydrological connection between the corridor and Cave but no connection was identified.
Cave is in the Winter Action Area and was harp trapped in the fall of 2004 finding no endangered Indiana bats. An effort was made to make a winter survey, but access into the cave

was not granted. Further consultation with USFWS Bloomington Field Office (BFO) determined that this cave is not likely a hibernaculum for Indiana bats.

Suggested Abatement
The entrance and recharge area for Cave are located outside of the corridor. The entrance is not connected via surface drainage and there is no indication of subsurface connection with the corridor. No abatement measures are deemed necessary for this feature.

Cave
Cave was not definitively located during fieldwork. The suspected location lies outside of the corridor, approximately ft north of the corridor boundary at UTM (feet) coordinate of X , Y . One cave (4-0020) is located ft east and ft south of the suspected location. Several large sinkholes were identified within ft of this area and it is possible that one of these features might have had a cave opening at some point that is currently filled with sediment. This suspect location was also reviewed by the Indiana Geological Survey as part of the Winter Action Area surveys, with no cave opening identified.

Suggested Abatement
Although the location of Cave was not definitively identified, its suspected location is in an area with a high density of karst features (**Figure 18**). Dye tracing tests in this area (See Section 3.2.2, Koontz Duval Trace) suggest that there is a large underground system in this area. The possibility of encountering unmapped cave passage during roadway construction exists and should be considered during roadway planning in this area. As previously noted, the use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor are unlikely to yield definitive results due to clay rich soils developed over the bedrock and a significant thickness of bedrock between the cave and the ground surface.

Cave
Cave (IGS designation) was identified during field reconnaissance within the corridor just west of and south of . This feature was identified as 4-0089 in this report. This cave was included in the Winter Action Area survey. Fall harp trapping and winter surveys during 2005 as a part of an associated study identified no Indiana bats at this location. The survey team found the opening to extend downward vertically only a short distance into the St. Louis Limestone a short distance where further ingress is prevented by soil and rock.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave (**Figure 19**) is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where

appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave (IGS designation, also known as Cave) was identified during field reconnaissance as a new cave located outside of the corridor, approximately ft south of the corridor boundary in Greene County, just west of . This feature is identified as 4-1479 and has a 5 ft by 3 ft opening to the Beech Creek Limestone. At the time of field description there was outward air movement at the entrance to the cave, which can be an indication of connection to a larger cave system. The Winter Action Area team fall trapped and then made a winter survey into this cave extending approximately 150 ft. No Indiana bats were found.

Suggested Abatement
The recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

3.1.1.2 Unnamed Caves

Previously unnamed caves were identified during the course of field mapping. These caves can also be seen in **Figures 5, 6,** and **7** and in **Appendix D - Table 2**.

4-0020
This cave has a 2 ft diameter entrance and is located within a sinkhole. It appears to have passage leading away from the entrance. This cave is possibly Cave although it was not possible to definitively identify it as such.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The cave in a high density of other karst features that suggests there could be a large karst system present in this area. The possibility of encountering unmapped cave passages during roadway construction exists and should be considered during roadway planning in this area.

4-0047
This cave has an entrance 2.5 ft by 5.5 ft. The entrance drops 12 ft into a small room. There is a solutional entrance in the floor of the small room. This feature is located within a sinkhole.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0071
This cave has an entrance 2.5 ft in diameter and the passage visibly extends 3.5 ft from the entrance. The entrance is located within a 30 ft diameter sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0115
This cave has an entrance 4 ft by 2ft and the passage visibly extends 3 ft from the entrance.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0123
This cave has an entrance 6 ft by 4ft and the passage visibly extends 8 ft from the entrance. The entrance was moving cold air at the time of field location, which can be an indication of connection to a large volume cave system. Several areas of soil collapse were also observed around the entrance.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0135
This cave has an entrance 2 ft in diameter and the passage visibly extends 3 ft from the entrance. The entrance is located within a 30 ft diameter 15 ft deep sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0238
This cave entrance is located within 9 ft diameter 7 ft deep sinkhole. There is a cave (4-0254) with spring flow out of the passage, located 500 ft to the north and approximately 140 ft vertically lower than 4-0238. This could indicate the presence of a large karst system within the ridge that 4-0238 could be connected to.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0254
This cave has an entrance 4 ft by 1.5 ft. A small spring discharges below the entrance. The spring is ephemeral in nature and was not flowing at the time of field location but was observed to be flowing on subsequent visits to the location. The feature is a dye recovery location for Evans Road Trace 2. The length of this cave system based on the distance from dye injection at 4-0362 to detection at 4-0254 would be 2,818 ft.

Suggested Abatement
The entrance to this cave and the associated recharge feature (4-0362) are located outside of the corridor and are not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0255
This cave has a vertical entrance 3 ft in diameter that drops vertically 15 ft. The vertical entrance leads to passage that trends south into the ridge to an unknown distance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0283
This cave has a vertical entrance 3.5 ft by 1.5 ft that drops vertically 5 ft. The entrance moves significant quantities of air. There is a cave (4-0287) with spring flow out of the passage, located

80 ft to the northwest from 4-0283. Airflow from the entrance of 4-0283 and proximity to cave 4-0287 could indicate the presence of a large volume of cave passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement recommended.

4-0287
This cave has an entrance 10 ft by 2.5 ft and the passage visibly extends 10 ft from the entrance. A 1 gpm spring discharges below the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The probable recharge area for this cave is located northwest from the cave entrance, part of which would be within the corridor. The Section 4 Alternatives are not anticipated to impact the drainage areas of the suspected recharge features. Therefore no abatement is recommended.

4-0298
This cave has an entrance 3 ft by 2 ft and the passage visibly extends 3 ft from the entrance. There was no spring flow at the time of field location although reeds and ponded water indicate this feature does have intermittent spring flow.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement recommended.

4-0370
This cave is located within a 19 ft diameter 4 ft deep dual depression sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0511
This cave has an entrance 3 ft by 1.5 ft and the passage visibly extends 4 ft from the entrance. It is located above a spring. The entrance was moving significant air when field located, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0695
This cave is reported to be over 300 ft long. At the time of field identification the entrance was filled in with gravel.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0706
This cave has a 5 ft by 8 ft entrance that visibly extends 20 ft. It is located on a ridge above a 100 gpm spring (4-0707). There are loose rocks and breakdown that would prevent further ingress just inside the cave entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0735
This cave has a 10 ft deep vertical entrance and what appears to be horizontal passage leading away from vertical entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0741
This cave is located within a 13 ft by 3 ft wide 6 ft deep sinkholes. The entrance was moving air at the time of field location, which can be an indication of connection to a large volume cave system. It is very close to Cave and may overly passage to the Cave.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0775
This cave has an entrance 2.5 ft by 2 ft and the passage visibly extends 15 ft from the entrance. The entrance is developed on a solutionally enlarged joint and a 1 gpm spring flows from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. It is doubtful this cave is connected to the corridor via groundwater flow, although dye tracing tests would be required to determine this.

4-0778
This cave has an entrance 1.5 ft in diameter and extends visibly 6 ft from the entrance. At the time of field location the entrance was moving fair amounts of air, which can be an indication of significant passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0780
This cave has an entrance 10 ft by 5 ft and the passage visibly extends 20 ft from the entrance. A 6 gpm spring flows out of the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The probable recharge area for this cave is located northwest from the cave entrance, part of which could receive surface drainage from the corridor. The Section 4 Alternatives are not anticipated to impact the drainage areas of the suspected recharge features. Therefore no abatement is recommended.

4-0831
This cave has a 7 ft diameter entrance. This cave was a dye recovery location for Victor Oolitic Trace 3. The length of this cave system based on the distance from dye injection at 4-0807 to detection at 4-0831 would be 661 ft.

Suggested Abatement
The entrance to this cave is located outside of the corridor although dye tracing tests revealed it is connected via surface drainage to 4-0807 and groundwater flow from 4-0807 to 4-0831. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-0807 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0875
This cave has an entrance 2 ft in diameter. The entrance is located within an 11 ft by 4 ft wide 6 ft deep sinkhole.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0918
This cave has an entrance 2.5 ft in diameter. The entrance is vertical and drops visibly 5 ft.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0977
This cave has an entrance 2 ft in diameter that drops visibly 40 ft downward from the entrance. At the time of field location this feature was blowing warm air. This feature overlies known passage area of Cave. It is probable that this feature would provide a connection to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0978
This cave has an entrance that is 2.5 ft by 1.5 ft. The entrance drops 20 ft into a small room. At the time of field location the entrance was moving air. This feature overlies known passage of Cave. It is probable that this feature would provide entrance to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1039
This cave has an entrance 4 ft by 3 ft and the passage visibly extends 5 ft from the entrance. The entrance was sucking air at the time field location, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1108
This cave has an entrance that is 4 ft in diameter and the passage visibly extends 15 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1112
This cave has an entrance that is 4.5 ft in diameter and the passage visibly extends 20 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1131
This cave has an entrance 3 ft in diameter and the passage visibly extends 10 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1198
This cave has an entrance 12 ft by 3 ft. A 300 gpm spring flows out of the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1230
This cave has a 2 ft diameter entrance and a 3 gpm spring flowing from the entrance. At the time of field location the opening was moving air, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1231
This cave has an entrance 2 ft by 1 ft. At the time of field location cold air was blowing out of the entrance, which can be an indication of connection to a large volume cave system. There was guano present around the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1367
This cave has an entrance 3 ft in diameter and the passage visibly extends 15 ft vertically downward from the entrance. This feature is located in a drainage and was exposed during a rain event. The entrance to this feature is located 400 ft north of Cave and there is a strong possibility these two features are related.

Suggested Abatement
The entrance to this cave is located outside of the corridor but is connected via surface drainage. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1431
This feature is a cave with the entrance obstructed by breakdown. There is a significant quantity of air blowing from breakdown in the spring alcove, which can be an indication of connection to a large volume cave system. A 25 gpm spring flows out of the entrance. This feature is a dye recovery location for Kermit Inman Trace 1. Based on the results from that trace the cave system associated with this feature would be 739 ft in length.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Dye tracing tests show this cave also receives recharge from within the corridor. Where appropriate and practicable, special planning should be conducted to insure recharge to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover. The possibility of encountering unmapped cave passages during roadway construction exists and should be considered during roadway planning in this area. As previously noted, the use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor are unlikely to yield definitive results due to clay rich soils developed over the bedrock and a significant thickness of bedrock between the cave and the ground surface.

4-1441
This feature is a cave that the land owner stated was filled in.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1470
This cave has an entrance 10 ft by 6 ft and the passage visibly extends 8 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1475
This cave has an entrance 3 ft in diameter and the passage visibly extends 30 ft vertically downward from the entrance. The landowner states that the entrance pit leads to more passage. This cave is in the vicinity of three dye injection locations that had dye recoveries at
Cave. Additional dye tracing studies would be needed to determine if this cave is connected to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1479
This cave has an entrance 3 ft by 5 ft and the passage visibly extends 20 ft from the entrance. There is a significant quantity of air blowing out the entrance, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1522
This cave has an entrance 2 ft by 1 ft and the passage visibly extends 5 ft from the entrance. At the time of field location there was a significant quantity of air blowing out the entrance and steam was present, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. No recharge features could be identified for this feature. It is recommended that the entrance of this feature be avoided.

4-1624
This cave has an entrance 3 ft in diameter.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1665
This cave has an entrance 7 ft by 2.5 ft.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

3.1.2 Sinkholes

Field mapping identified the locations of 993 sinkholes within the karst study area. Of these, 305 are located within the corridor. Sinkholes were defined by infiltration capacities of high, medium, or low. A complete sinkhole list with descriptions can be seen in **Appendix D - Table 3** and sinkhole locations can be seen in **Figures 20, 21**, and **22**.

3.1.3 Swallets

Field mapping identified the locations of 62 swallets within the karst study area. Of these, 19 are located within the corridor. A complete swallet list with descriptions can be seen in **Appendix D - Table 4** and swallet locations can be seen in **Figures 23, 24**, and **25**.

3.1.4 Sinking Streams

Field mapping identified the locations of 15 sinking streams within the karst study area. Six (6) of these are located within the corridor. A complete sinking stream list with descriptions can be seen in **Appendix D - Table 5** and sinking stream locations can be seen in **Figures 26, 27**, and **28**.

3.1.5 Springs

Field mapping identified the locations of 331 springs within the karst study area. Of these, 103 are located within the corridor. A complete list with descriptions can be seen in **Appendix D - Table 6** and conduit locations can be seen in **Figures 29, 30,** and **31**.

Spring
Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-

1228) in a drainage located within the Section 4 corridor (**Figure 32**). During high flow periods water overflows 4-1228. It is likely in these conditions that the area downstream of 4-1228 acts as a losing stream and provides recharge to Spring. The feature 4-1228 and the potential losing down gradient from it would receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Spring. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

3.1.5.1 Spring Water Chemistry

The water chemisty of karst and non-karst springs was compared to determine chemical differences in the two spring types.

Methodology

Water was collected from five karst and five non-karst springs. The water was analyzed for major cations, major anions, specific conductance, temperature, and pH (**Appendix G-1**). After the samples were analyzed, the cation/anion data were plotted on tri-linear and stiff diagrams, and pH vs. conductivity plots for comparison. Additionally, the PHREEQC computer model was utilized to determine the saturation index of calcite and dolomite carbonate minerals.

The following karst springs were analyzed:

-
- Spring
- Spring
-
- 4-0067.

The following non-karst springs were analyzed:

- 4-1077
- 4-1081

- 4-1083
- 4-1084
- 4-1092.

Trilinear Diagrams

A trilinear diagram is a method for comparing the water chemistry of multiple water samples. The lower left triangle in the diagram is the plot for the major cations (Ca, Mg, Na+K). The triangle on the lower right is the plot for the major anions (HCO3, SO4, Cl). The cations and anions for each water sample were plotted in the cation/anion triangles and then projected on the diamond above to determine the water type classification (for example, Ca-HCO3). The karst and non-karst spring samples were plotted on a trilinear diagram (**Appendix G-2**). The karst springs are predominantly Ca-HCO3. The non-karst springs fall into the "no dominant type" category for cations and are predominantly HCO3 water with regard to anions.

The two outliers on the trilinear diagrams were and 4-10092. had higher concentrations of sulfate than the other karst springs. The high concentration of sulfate could be the result of agricultural activities in the recharge area for the spring or groundwater flow through gypsum bedrock. Spring 4-1092 also differs from the other non-karst springs, with higher concentrations of both Mg and Cl. This spring is located near Scotland, IN where the geology consists of Pennsylvanian aged inter-bedded coals and shales. This geology could potentially cause the difference in water chemistry seen at this spring.

Conductivity vs. pH

A plot of conductivity vs. pH was also used to compare the karst and non-karst springs (**Appendix G-3**). The pH for the karst springs ranged 6.75 to 7.65, with most above 7. The non-karst springs ranged from 4.26-6.38, with most below 6. The conductivity for the karst springs was higher on average, ranging from 160.2 to 661 µs/cm. The non-karst springs ranged 93-195.2 µs/cm.

Stiff Diagram

Stiff diagrams are another method to compare water chemistry. On a Stiff diagram the major cations (Na, Ca, Mg) and major anions (Cl, HCO3, SO4) are plotted on an area graph (**Appendix G-4**). As determined with the Trilinear Diagrams, the karst spring samples are Ca-HCO3 water and the non-karst spring samples had no predominant cation and were predominantly HCO3 water with regard to anions.

Saturation Index

The saturation index (SI) of a particular mineral in water is used to determine if that water will dissolve or precipitate that mineral. For example, water with a SI of 1.0 for calcite will precipitate calcite, while water with a calcite SI of -5.0 will dissolve calcite. For this study the SI for calcite and dolomite were compared for each karst and non-karst spring (**Appendix G-5**). The karst springs' calcite SI varied from 0.05 to -1.9. Non-karst springs were more under saturated with values from -2.51 to -5.14 (**Appendix G-6**). The karst spring dolomite SI ranged from -0.69 to -4.16. The non-karst springs were again more under saturated with SI from -5.15 to -10.3 (**Appendix G-6**). For both calcite and dolomite, Spring is more under saturated than the other karst springs. This is a reasonable finding as Spring discharges at the contact between the Beech Creek Limestone and Big Clifty Sandstone, and undoubtedly receives some recharge from the non-karst Big Clifty.

Conclusions

The purpose of the water chemistry study was to verify the karst or non-karst nature of springs located within Section 4. The springs deemed karst and non-karst had consistent differences in their water chemistry, which are summarized below:

Water Classification

- Karst: Ca-HCO3
- Non-karst: No dominant type/HCO3.

As expected the karst springs are classified as Ca-HCO3. As the carbonate bedrock (CaCO3) is dissolved, Ca is released into solution and CO3 reacts with free H+ to form HCO3. The non-karst springs fall into the "no dominant type" category for cations and are predominantly HCO3 waters with regard to anions.

pH

- Karst: ranged from 6.75 to 7.65 with most over 7
- Non-karst: ranged from 4.26 to 6.38 with most under 6.

The determined differences in pH are typical for karst and non-karst springs. As groundwater dissolves carbonate bedrock, the free H+ molecules combine with CO3 to form HCO3. As the free H+ reacts to form HCO3, there is less H+ in solution and the pH increases. The pH values for karst waters are typically around 7.

Conductivity

- Karst: ranged from 160.2 to 661 µs/cm
- Non-karst: ranged from 93-195.2 µs/cm

Carbonate bedrock is more readily dissolved than sandstones and shales. As a result, water that flows through carbonate bedrock tends to have high conductivity. The karst springs flow from carbonate bedrock while the non-karst springs flow from mostly sandstone and shales, which explains the difference in conductivity.

Saturation Index

- Karst: Calcite SI from 0.05 to -1.9, Dolomite SI from -0.69 to -4.16
- Non-Karst: Calcite SI from -2.51 to -5.14, Dolomite SI from -5.15 to -10.3.

With respect to calcite, the karst springs are either oversaturated or closer to equilibrium than the non-karst springs. Oversaturation or near equilibrium is expected for water flowing through carbonate bedrock. Under saturation is expected for water flowing through non-carbonate bedrock. With respect to dolomite, the karst springs are closer to equilibrium than the non-karst springs. The carbonate bedrock in the study area does contain some dolomite which explains the difference in SI with respect to dolomite for the karst and non-karst springs.

3.2 Dye Tracing Results

3.2.1 Previous Dye Tracing Tests

Two previous dye traces were conducted in the Cave area and are depicted in **Figure 33.**

3.2.2 Current Dye Tracing Tests

A total of 39 dye tracing tests were conducted in the Section 4 study area which resulted in 47 groundwater flowpaths (**Figures 34, 35,** and **36**). The dye tracing tests were designed to determine groundwater flowpaths from relevant karst features within the Section 4 study area. The summary of dye tracing tests can be seen in **Appendix H - Table 7**. Straight-line dye trace maps and a discussion of breakthrough curve data can be seen in **Appendix H**. The following are summaries of the dye tracing tests conducted as part of this study.

4/5 Interchange Trace 1

On July 11, 2005 at 0915 hours, 0.53 gallons of Eosine liquid dye was injected into sinkhole 4-1505, which is located within the corridor. 4-1505 has an 8.32 acre drainage area with 6.54 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 4000 gallons of potable water. First dye detection (water and charcoal samples) for this trace occurred at spring 4-1457, on July 15, 2005 at 1030 hours. This spring is located within the corridor. Eosine was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location was 485 ft which equates to a groundwater velocity of 120 ft/day. Dye was not detected at any other sampling locations.

4/5 Interchange Trace 2

On January 2, 2006 at 0940 hours, 1 gallon of Rhodamine WT dye was injected into sinkhole 4-1600, which is located within the corridor. 4-1600 has a 0.52 acre drainage area with 0.52 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. No water was pumped into this feature due to precipitation events the morning and afternoon of January 2, 2006. First dye detection for this trace occurred at Bolin Bridge sampling station, on January 4, 2006 at 1542 hours. Dye was also detected at spring 4-1530 on January 5, 2005 at 1212 hours. This spring located within the corridor and is upstream of the Bolin Bridge sampling station and was determined to be the source of the Rhodamine WT. Rhodamine WT was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location (4-1530) was 989 ft which equates to a groundwater velocity of 440 ft/day. Dye was not detected at any other sampling locations.

4/5 Interchange Trace 3

On January 26, 2006 at 0945 hours, 0.11 gallons of Fluorescein (Uranine) dye was injected into sinkhole 4-1496, which is located outside the Section 4 corridor. 4-1496 has a 0.16 acre drainage area with no drainage coming from the corridor. Although drainage to 4-1496 is located outside of the corridor, the drainage to 4-1496 will most likely be within the footprint of the Section 4/5 interchange. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 2,000 gallons of potable water. An ISCO automated water sampler was installed at spring 4-1501. First dye detection (ISCO water sample) for this trace occurred at 4-1501, on January 26, 2006 at 1708 hours. This spring is located outside of the corridor. Fluorescein was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location was 3,993 ft which equates to a groundwater velocity of 13,690 ft/day. The breakthrough curve data for 4-1501 can be seen in **Appendix G-3B**. Dye was not detected at any other sampling locations.

Trace 1

On May 5, 2009 at 1130 hours, 1 gallon of Fluorescein liquid dye was injected into sinking stream 4-1434, which is located within the corridor. 4-1434 has a 237.2 acre drainage area with 25.7 of those acres coming from the corridor. This feature was receiving approximately 3 gpm natural recharge at the time of injection. The first dye detection (water sample) for this trace occurred at Cave (4-1527), on May 14, 2009 at 0558 hours. Cave is located outside of the corridor. Fluorescein was detected in water and charcoal samples for this trace. The straight line distance from injection location to detection location was 21,774 ft which equates to a groundwater velocity of 28,298 ft/day. After the injection approximately 4 inches of rain fell in the area over the next 24 hours. This resulted in extreme high flow conditions for this trace.

The second dye detection (water & charcoal samples) for this trace occurred at stream crossing A-5, on May 15, 2009 at 0926 hours. The straight line distance from injection location to detection location was 6,407 ft which equates to a groundwater velocity of 3,348 ft/day. This location is downstream of the injection site and following injection there was approximately 4 inches of precipitation. It is probable that during this rain event water and any dye remaining at the surface overflowed the injection site and resulted in this downstream detection.

Trace 2

On June 29, 2009 at 1040 hours, 1 gallon of Eosine liquid dye was injected into sinking stream 4-1432, which is located within the corridor. 4-1432 has a 297.2 acre drainage area with 281.5 of those acres coming from the corridor. This feature was receiving approximately 1 gpm natural recharge at the time of injection. The first dye detection (water sample) for this trace occurred at spring Cave (4-1527), on July 15, 2009 at 1115 hours. Cave is located outside of the corridor. Eosine was detected in both water and charcoal samples. The straight line distance from injection location to detection location was 21,318 ft which equates to a groundwater velocity of 1,330 ft/day. Dye was not detected at any other sampling locations.

Clifty Chapel Trace

On December 29, 2005 at 1500 hours, 0.75 gallons of Fluorescein liquid dye was injected into sinking stream 4-1240, which is outside of the corridor but receives surface drainage from the corridor. 4-1240 has a 65.99 acre drainage area with 52.88 of those acres coming from the corridor. This feature is located in drainage, and at the time of injection was receiving approximately 15-20 gpm of natural recharge. First dye detection (water and charcoal samples) occurred at Cave (4-1527), on January 2, 2005 at 1320 hours. Cave is located outside of the corridor. The straight line distance from injection location to detection location was 20,000 ft which equates to a groundwater velocity of 4,370 ft/day. Dye was not detected at any other sampling locations.

Clifty Road Trace
On January 4, 2010 at 0850 hours, 1 gallon of Fluorescein liquid dye was mixed with 25 gallons of potable water and injected into sinking stream 4-0685. Sinking stream 4-0685 is located inside the corridor. At the time of injection approximately 2 gpm of natural flow was sinking. The first dye detection (water sample) for this trace occurred at spring 4-1526, on January 5, 2009 at 0852 hours. Fluorescein was detected at 4-1526 in water and charcoal samples. The straight line distance from injection location to detection location was 1,367 ft which equates to a groundwater velocity of 998 ft/day. Dye was not detected at any other sampling locations.

Cooper Cemetery Trace 1
On June 10th, 2005 at 1630 hours, 0.53 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1227, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (water and charcoal samples) occurred on June 13, 2005 at 1055 hours at springs 4-1190 and 4-1191. These features are located within 30 ft of each other and are outside of the corridor. The straight-line travel distance from injection to discharge is 4,065 ft, which equates to a groundwater velocity of 1,478.2 ft/day. The flowpath for this dye trace crosses the corridor. Dye was not detected at any other sampling locations.

Cooper Cemetery Trace 2
On December 14, 2005 at 1100 hours, 0.26 gallons of Rhodamine WT was injected in swallet 4-1222, which is located within the corridor. 4-1222 has an 18.86 acre drainage area all of which is located within the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (water and charcoal samples) occurred at springs 4-1190 and 4-1191 on December 20, 2005 at 1130 hours. These features are located within 30 ft of each other and are outside of the corridor. The straight line distance from injection location to detection location is 1,735 ft, which equates to a groundwater velocity of 289.2 ft/day. Dye was not detected at any other sampling locations.

Dempshar Trace
On January 16, 2006 at 1545 hours 1.2 gallons of Fluorescein dye was injected in swallet 4-0521. 4-0521 has a 124.85 acre drainage area with 38.77 of those acres coming from the corridor. This feature was receiving 40 gpm of natural recharge at the time of injection. 4-0512 is located outside of the corridor but receives surface drainage from the corridor. First detection occurred on January 17, 2006 at 1233 hours at Dye 40 which is a bridge crossing on Little Indian Creek. Dye was detected in water and charcoal samples at this location. The straight line distance from injection location to detection location is 11,677 ft which equates to a groundwater velocity of 14,012 ft/day. Dye was also detected on January 19, 2006 at 1119 hours at Dye 41 which is a bridge crossing on Indian Creek. Dye was detected in water and charcoal samples at this location. The straight line distance from injection location to detection location is 13,463 ft which equates to a groundwater velocity of 4,823 ft/day. No springs were positive for

Fluorescein dye which indicated that groundwater is discharging via base flow into Indian Creek and Little Indian Creek. Upstream sampling locations (Dye 42, 43, 44) had no detection, which helps to define the length of Indian Creek and Little Indian Creek where flow from this injection is being discharged to Indian Creek and Little Indian Creek. Fluorescein dye was also detected at downstream sampling stations Dye 36 and Dye 50. Due to the upstream presence of dye it is not possible to determine if the dye positives at these locations were due to base flow into Indian Creek or surface flow along Indian Creek. All dye recovery locations are outside of the corridor.

Evans Road Trace 1

On September 8, 2005 at 1145 hours, 0.53 gallons of Eosine dye was injected in swallet 4-1504, which is outside of the corridor but receives surface drainage from the corridor. 4-1504 has a 25.01 acre drainage area with 4.39 of those acres coming from the corridor. This feature is located in drainage, and at the time of injection was not receiving any natural recharge. Due to lack of natural recharge into the feature, the 0.53 gallons of Eosine dye was flushed with 4,700 gallons of water. Eosine was detected at 4-0282 better known as Cave, in water and charcoal samples, on September 26, 2005 at 1520 hours. Cave is located outside of the corridor. The straight-line distance from injection at 4-1503 to detection at 4-0282 is 12,034 ft, which equates to a groundwater velocity of 663.9 ft/day. The flowpath for this dye trace crosses the corridor. Dye was also detected at Dye 02 which is downstream of 4-0282.

Evans Road Trace 2

On September 15, 2005 at 1050 hours, 0.53 gallons of Fluorescein (Uranine) dye was injected into feature 4-0362, which is located outside of the corridor and does not receive surface drainage from the corridor. This feature is a sinkhole and at the time of injection was not receiving any natural recharge. Due to the lack of natural recharge, the Fluorescein was flushed with 4,000 gallons of potable water. Fluorescein was detected in water and charcoal samples at cave 4-0254 on September 28, 2005, at 1354 hours. 4-0254 is located outside of the corridor. The straight line distance from injection point to detection point is 2,818 ft which equates to a groundwater velocity of 214.7 ft/day. Dye was also detected at Dye 01 which is downstream of 4-0254.

Evans Road Trace 3

On October 11, 2005 at 1700 hours, 0.40 gallons of Rhodamine WT dye was injected into swallet 4-0175, which is located within the corridor. 4-0175 has a 28.70 acre drainage area with 22.99 of those acres coming from the corridor. This feature is in a dry run and was receiving no natural recharge at the time of injection. Due to the lack of natural recharge, the dye was flushed with 2,000 gallons of potable water. Rhodamine detection (visual, and in water and charcoal samples) occurred at 4-0282 better known as Cave on November 10, 2005 at 1600 hours. Cave is located outside of the corridor. The straight line distance from injection location to detection location is 10,000 ft which equates to a groundwater velocity of

334.3 ft/day. The flowpath for this dye trace crosses the corridor. Dye was also detected at Dye 02 which is downstream of 4-0282.

Flick Trace 1
On December 16, 2005 at 1140 hours, 1 gallon of Eosine liquid dye was injected in sinking stream 4-1525, which is located within the corridor. 4-1525 has a 97.90 acre drainage area with 35.78 of those acres coming from the corridor. This feature was receiving 30-40 gpm of natural recharge at the time of injection. Eosine from this trace was detected in both water and charcoal samples at Cave (4-1527) on December 29, 2005 at 1307 hours. Cave is located outside of the corridor. Straight line distance from injection location to detection location is 19,500 ft which equates to a groundwater velocity of 1,495.2 ft/day. Dye was not detected at any other sampling locations.

Flick Trace 2
On December 16, 2005 at 1730 hours, 1 gallon of Rhodamine WT liquid dye was injected in sinking stream 4-1526, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 10 gpm of natural recharge at the time of injection. Rhodamine WT from this trace was detected in water and charcoal samples at Cave (4-1527) on December 29, 2005 at 1307 hours. Cave is located outside of the corridor. Straight line distance from injection location to detection location is 21,000 ft which equates to a groundwater velocity of 1,641.7 ft/day. The flowpath for this dye trace crosses the corridor. Dye was not detected at any other sampling locations.

Freeman Trace 1
On December 21, 2005 at 1000 hours, 0.08 gallons of Fluorescein (Uranine) liquid dye was injected into sinkhole 4-0421, which is located within the corridor. 4-0421 has a 0.08 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of recharge the dye was flushed with 2,750 gallons of potable water. Fluorescein from this trace was detected visually, and in water and charcoal samples at spring 4-1520 on December 23, 2005 at 1052 hours. This spring is located within the corridor. The straight line distance from injection location to detection location is 1,373 ft, which equates to a groundwater velocity of 686.5 ft/day. Dye was not detected at any other sampling locations.

Freeman Trace 2
On December 21, 2005 at 1030 hours, 0.08 gallons of Rhodamine WT was injected into sinkhole 4-0114, which is located within the corridor. 4-0114 has a 0.02 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of recharge the dye was flushed with 2,750 gallons of potable water. Rhodamine from this trace was detected in water and charcoal samples at spring 4-1520 on December 23, 2005 at 1052 hours. This spring is located within the corridor. The straight line distance from injection

location to detection location is 1,112 ft, which equates to a groundwater velocity of 556.0 ft/day. Dye was not detected at any other sampling locations.

Freeman Trace 3

On April 27, 2009 at 1115 hours, 1 liter of Phloxine B liquid dye was injected into sinkhole 4-0134, which is located within the corridor. 4-0134 has a 5.6 acre drainage area all within the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 1,500 gallons of potable water. The first dye detection (water sample) for this trace occurred at spring 4-1136, on April 27, 2009 at 2132 hours. Phloxine B was detected at this spring in water samples. The straight line distance from injection location to detection location was 1,811 ft which equates to a groundwater velocity of 4,227 ft/day. Dye was not detected at any other sampling locations.

Cave Trace

On July 21, 2009 at 1130 hours, 0.5 gallons of Fluorescein liquid dye was injected into swallet 4-0037, which is located outside the corridor. 4-0037 has a 407.2 acre drainage area with 77 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 2,500 gallons of potable water. The first dye detection (water sample) for this trace occurred at Cave (4-0061), on July 22, 2009 at 0721 hours. Fluorescein was detected in a single water sample at Cave. The straight line distance from injection location to detection location was 2,550 ft which equates to a groundwater velocity of 3,083 ft/day.

After injection of the dye on July 21 a rain event of approximately 4 inches occurred. This would be considered extreme high flow conditions. It is likely that under most flow conditions water entering 4-0037 does not travel to Cave. However, in high flow conditions like those that occurred after injection it is possible for water to travel from 4-0037 to Cave. Additionally, the large volume of water flowing into the Cave system at the time of trace likely diluted the Fluorescein dye and resulted in the single detection.

The second dye detection (water & charcoal samples) for this trace occurred at 4-1023, on July 23, 2009 at 0850 hours. The straight line distance from injection location to detection location was 4,000 ft which equates to a groundwater velocity of 2,118 ft/day.

The third dye detection (water & charcoal samples) for this trace occurred at 4-1023, on July 23, 2009 at 0850 hours. The straight line distance from injection location to detection location was 2,520 ft which equates to a groundwater velocity of 1,293 ft/day.

Cave Trace 1

On August 10, 2009 at 0955 hours, three pounds of Eosine powder dye was mixed with 600 gallons potable water and injected into swallet 4-0173, which is located within the corridor. 4-

0173 has a 340.9 acre drainage area with 175.5 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0282), on October 9, 2009 at 1430 hours. Eosine was detected at Cave in water and charcoal samples. The straight line distance from injection location to detection location was 10,500 ft which equates to a groundwater velocity of 360 ft/day. Dye was not detected at any other sampling locations.

Cave Trace 2

On August 4, 2009 at 1230 hours, 1 gallon of Fluorescein liquid dye was injected into swallet 4-0166 and flushed with 400 gallons potable water. 4-0166 is located within the corridor and has a 717.8 acre drainage area with 502.9 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0282), on September 27, 2009 at 0530 hours. Eosine was detected at Cave in water and charcoal samples. The straight line distance from injection location to detection location was 11,660 ft which equates to a groundwater velocity of 513 ft/day. Dye was not detected at any other sampling locations.

Hobbieville Trace

On August 23, 2009 at 0930 hours, 1 gallon of Fluorescein liquid dye was injected into sinking stream 4-1424 which is located within the corridor. 4-1424 has a 7,133.7 acre drainage area with 1,084.7 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 350 gallons of potable water. The first dye detection (water sample) for this trace occurred at stream crossing HV-5 on October 13, 2009 at 0949 hours. The straight line distance from injection location to detection location was 2,479 ft which equates to a groundwater velocity of 124 ft/day. HV-4 is located down gradient in the same drainage from 4-1424. This suggests water sinking in the streambed at 4-1424 re-emerges down gradient.

The second dye detection (water & charcoal samples) for this trace occurred at stream crossing HV-1, on October 13, 2009 at 1000 hours. The straight line distance from injection location to detection location was 2,849 ft which equates to a groundwater velocity of 142 ft/day.

The third dye detection (water & charcoal samples) for this trace occurred at 4-1298, on October 16, 2009 at 0830 hours. The straight line distance from injection location to detection location was 3,584 ft which equates to a groundwater velocity of 156 ft/day. It must be noted that spring 4-1298 is a wet weather spring and was not flowing during background sampling. It therefore cannot be consider a definitive detection. However, the detection of dye downstream at HV-1 supports the detection at 4-1298

Kermit Inman Trace
On October 13, 2005 at 1715 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected into sinkhole 4-1403, which is located within the corridor. 4-1403 has a 0.04 acre drainage area all of which is within the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge, 2,000 gallons of potable water was flushed with the dye. Fluorescein detection occurred at two locations for this trace. The first dye detection occurred at spring 4-1431 on October 17, 2005 at 0951 hours. This spring is within the corridor. The straight line distance from injection location to detection location is 739 ft, which equates to a groundwater velocity 201.5 ft/day. Dye was detected in both water and charcoal samples at this location. The second dye detection occurred at spring 4-1405 on October 24, 2005 at 1430 hours. This spring is located within the corridor. The straight line distance from injection location to detection location is 1,400 ft, which equates to a groundwater velocity 128.7 ft/day. Dye was detected in both water and charcoal samples at this location. Dye was not detected at any other sampling locations.

Koontz Duvall Trace 1
On August 2, 2005 at 0915 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected in sinkhole 4-1517, which is located within the corridor. 4-1517 has a 0.04 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of natural recharge the dye was flushed with 4,000 gallons of potable water. The presence of the dye was not detected after one week of sampling. Due to the lack of any dye detection, an additional 0.26 gallons of Fluorescein (Uranine) and 6,000 gallons of water were injected into 4-1517 on August 9, 2005 at 1050 hours. During recovery of the field sampling network on August 15, 2005 at 1130, a Fluorescein visual was observed at spring 4-1528. This spring is located within the corridor. The straight-line travel distance from injection to detection point is 3,360 ft, which equates to a groundwater velocity of 256.8 ft/day. Dye was also detected in water and charcoal samples. Dye was not detected at any other sampling locations.

Lama Trace
On August 4, 2009 at 1020 hours, 0.5 gallons of Eosine liquid dye was injected into sinking stream 4-0269 and flushed with 4,800 gallons potable water, which is located outside the corridor. 4-0269 has a 540 acre drainage area with 227.2 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at spring 4-1513, on August 9, 2009 at 1123 hours. Eosine was detected at 4-1513 in water and charcoal samples. The straight line distance from injection location to detection location was 3,100 ft which equates to a groundwater velocity of 626 ft/day. Dye was not detected at any other sampling locations.

Mt. Zion Church Trace 1
On November 15, 2005 at 1715 hours, 0.53 gallons of Rhodamine WT liquid dye was injected into swallet 4-1656, which is located within the corridor. 4-1656 has a 0.08 acre drainage area all of which is within the corridor. This feature was receiving 15-20 gpm of natural recharge at the

time of injection. Rhodamine WT detection occurred at two locations for this trace. The first dye detection (water and charcoal samples) occurred at spring 4-1631 on November 21, 2005 at 1417 hours. The straight line distance from injection location to detection location is 3,840 ft, which equates to a groundwater velocity 635.6 ft/day. The second dye detection in both water and charcoal samples occurred at feature 4-1023 on November 30, 2005 at 1023 hours. The straight line distance from injection location to detection location is 5,164 ft, which equates to a groundwater velocity 347.2 ft/day. Both dye detection locations were outside of the corridor. Dye was not detected at any other sampling locations.

Mt. Zion Church Trace 2

On November 15, 2005 at 1100 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1030, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. First dye detection (water and charcoal samples) occurred on November 21, 2005 at 1450 hours at 4-0971 (Cave). Cave is located outside of the corridor. The straight-line travel distance from injection to detection is 3,230 ft, which equates to a groundwater velocity of 527.3 ft/day. Dye was not detected at any other sampling locations.

Cave Trace

On October 7, 2009 at 1030 hours, 0.5 gallons of Eosine liquid dye was injected into swallet 4-1035, which is located outside the corridor. There was no natural recharge to this feature and the dye was therefore flushed with 2,000 gallons potable water. 4-1035 has a 17.57 acre drainage area with 15.98 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0943), on October 8, 2009 at 0715 hours. The straight line distance from injection location to detection location was 3,974 ft which equates to a groundwater velocity of 10,900 ft/day. Dye was not detected at any other sampling locations.

R400 Trace

On August 26, 2009 at 1045 hours, 0.5 gallons of Eosine liquid dye was injected into sinking streams 4-1272 and flushed with 150 gallons potable water, which is located outside the corridor. 4-1272 has a 194.4 acre drainage area with 158.2 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at spring 4-1274, on August 27, 2009 at 1000 hours. Eosine was detected at 4-1274 in water and charcoal samples. The straight line distance from injection location to detection location was 482 ft which equates to a groundwater velocity of 498 ft/day. Dye was not detected at any other sampling locations.

Spring Trace

On June 10th, 2005 at 1630 hours, 0.53 gallons of Rhodamine WT dye was injected in sinking stream 4-1228, which is located within the corridor. 4-1228 has a 133.83 acre drainage area with 11.96 of those acres coming from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (visual) occurred at Spring (4-

1516) on June 19, 2005 at 1311 hours. Spring is located within the corridor. The straight line travel distance from injection location to detection location is 5,870 ft, which equates to a groundwater velocity of 1,498.7 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Cave Trace

On August 30, 2005 at 1245 hours, 0.40 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1271, which is outside of the corridor but receives surface drainage from the corridor. 4-1271 has a 29.98 acre drainage area with 29.96 of those acres coming from the corridor. This feature was receiving 10 gpm of natural recharge at the time of injection. Visual detection occurred at spring 4-1274 on September 1, 2005 at 1000 hours. This spring is located outside of the corridor. The straight-line travel distance from injection to discharge is 1,649 ft, which equates to a groundwater velocity of 879.5 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Smith Trace

On December 29, 2005 at 1050 hours 0.5 lbs of Phloxine B powder dye was mixed with 5 gallons of water and injected into feature 4-1275, which is located within the corridor. 4-1275 has a 33.25 acre drainage area with 24.24 of those acres coming from the corridor. This feature is a swallet and was receiving 10 gpm of natural recharge at the time of injection. Phloxine B was first detected (water and charcoal samples) at spring 4-1276 on December 30, 2005 at 1440 hours. This spring is located outside of the corridor. The straight-line distance from injection point to detection point is 360 ft, which equates to a groundwater velocity of 320 ft/day. Dye was detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Trace 1

On August 18, 2005 at 1030 hours, 0.26 gallons of Rhodamine WT dye was injected in cave 4-1057, also known as is located outside of the corridor. During low flow conditions it has a 0.08 acre drainage area with no contribution from the corridor. In extreme high flow conditions it has a 226.11 acre drainage with 6.67 of those acres coming from the corridor. 4-1057 was not receiving any natural recharge at the time of injection. Due to lack of natural recharge the 0.26 gallons of Rhodamine WT was flushed with 4,000 gallons of potable water. The first dye detection (water and charcoal samples) occurred on September 6, 2005 at 1115 hours at spring 4-0394. This spring is located outside of the corridor. The straight-line distance from injection at 4-1057 to detection at 4-0394 is 6,465 ft which equates to a groundwater velocity of 38.86 ft/day. Dye was not detected at any other sampling locations.

Valhalla Trace 1
On June 12, 2005 at 1216 hours, 0.53 gallons of Rhodamine WT dye was injected in swallet 4-0701, which is located within the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. An ISCO automated water sampler was installed at feature 4-1195. The first dye detection (water and charcoal samples) occurred at spring 4-1195 at 2045 hours on June12th, 2005. This spring is located outside of the corridor. The straight-line distance from injection at 4-0701 to detection at 4-1195 is 4,050 ft, which equates to a groundwater velocity of 12,150.0 ft/day. The flowpath for this dye trace crosses the corridor. The breakthrough curve data for 4-1195 can be seen in **Appendix G-24B**. The sharp leading edge of the breakthrough curve indicates conduit flow from the injection site. The trailing edge of the breakthrough curve is a broader curve, which indicates that the discharge point is also receiving diffusive flow. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 1
On May 12, 2005 at 1030 hours, 0.13 gallons of Fluorescein (Uranine) dye was injected in swallet 4-0731, which is outside of the corridor but receives surface drainage from corridor. 4-0731 has a 29.94 acre drainage area with 3.63 of those acres coming from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. An ISCO automated water sampler was installed at feature 4-1055. The first dye detection (visual, water and charcoal samples) occurred at spring 4-1055 at 1430 hours on May 12, 2005. This spring is located outside of the corridor. The straight-line distance from injection at 4-0731 to detection at 4-1055 is 1,466 ft, which equates to a groundwater velocity of 11,728.0 ft/day. The breakthrough curve data for 4-1055 can be seen in **Appendix G-25B**. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 2
On July 21, 2005 at 0920 hours, 0.53 gallons of Rhodamine WT dye was injected in sinkhole 4-0716, which is located within the corridor. 4-0716 has a 3.68 acre drainage area with 1.98 of those acres coming from the corridor. This feature was not receiving any natural recharge at the time of injection. Due to lack of recharge the 0.53 gallons of Rhodamine WT was flushed with 4,000 gallons of potable water. The first dye detection occurred on July 22nd, 2005 at 0930 hours. This was a visual detection reported by a landowner downstream of 4-1510. Feature 4-1510 was visited at 1045 hours on July 22, 2005 and the presence of Rhodamine WT dye was visually confirmed. 4-1510 is located inside the corridor. The straight line distance from injection at 4-0716 to detection at 4-1510 is 1,692 ft, which equates to a groundwater velocity of 1,624.3 ft/day. This flowpath crosses the corridor. Dye was detected visually and in water and charcoal samples at 4-1055. Dye was also detected in feature 4-0720. 4-0720 is located outside of the corridor. First dye detection at 4-0720 occurred on August 4, 2005 at 1124 hours. The straight line distance from injection at 4-0716 to detection at 4-1510 is 1,692 ft, which equates to a groundwater velocity of 1,624.3/day. The straight line distance from injection at 4-0716 to

detection at 4-0720 is 1,092 ft, which equates to a groundwater velocity of 77.5 ft/day. Dye was also detected in water and charcoal samples. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 3
On May 14, 2005 at 1300 hours, 0.13 gallons of Rhodamine WT dye was injected in swallet 4-0807, which is outside of the corridor but receives surface drainage from the corridor. 4-0807 has a 34.37 acre drainage area with 16.07 of those acres coming from the corridor. This feature was receiving 40gpm of natural recharge at the time of injection. The first dye detection (visual) occurred at spring 4-0831 on May 14, 2005 at 1315 hours. 4-0831 is located outside of the corridor. The straight-line distance from injection at 4-0807 to detection at 4-0830 is 781ft, which equates to a groundwater velocity 63,456 ft/day. Dye was detected visually and in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Wright Road Trace 1
On October 23, 2005 at 1045 hours, 0.26 gallons of Rhodamine WT was injected in swallet 4-0661, which is outside of the corridor but receives surface drainage from the corridor. 4-0661 has a 133.83 acre drainage area with 10.95 of those acres coming from the corridor. This feature was receiving 2 gpm of natural recharge at the time of injection. The first dye detection (visual) for this trace occurred at feature 4-0678 on October 29, 2005 at 1100 hours. 4-0678 is located outside of the corridor. This feature is the discharge point for water that flows through Cave. The straight line distance from injection location to detection location is 3,540 ft, which equates to a groundwater velocity of 599 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

3.3 Summary of Dye Tracing Tests

- A total of 39 dye tracing tests were conducted. The results of these tests show 47 groundwater flowpaths
- 9 groundwater flowpaths were shown to cross the Section 4 corridor
- The length of groundwater flowpaths varies greatly within Section 4 (340 ft to 21,774 ft). The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway
- Over 250 dye tracing sampling locations were established, and over 7000 samples were analyzed

- Groundwater flow was characterized based on the dye tracing tests. The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point

- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point

- Cave, Cave, Cave, Cave, Cave, and Cave have all been hydrogeologically linked to the Section 4 corridor

- When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points.

4.0 SURVEYS OF SECTION 4 CAVES

Six cave sites within and in proximity to the Section 4 corridor were sampled to determine the presence of invertebrates: Cave, Spring, Spring 4-1195, Cave, Cave and Spring 4-1501. Sites were selected based on hydrologic connections to the corridor confirmed by dye tracing. Sampling for this study was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling. Fourteen species with the ecological classification of troglobite or stygobite (obligate subterranean animals) and two species that are not obligate subterranean animals were found.

Table 2: Section 4 Cave Fauna

Species	Location	Listing Status
Sphalloplana weingartneri (Weingartner's cave flatworm)	Cave	IDNR Watch List
Pseudocandona jeanneli (Jeannel's groundwater ostracod)	Cave	IDNR Endangered
Caecidotea stygia (Northern cave isopod)	Cave	
Crangonyx packardi (Packard's groundwater amphipod)	Cave	IDNR Watch List
Crangonyx indianensis (Indiana cave amphipod)	Cave	IDNR Watch List
Conotyla bollmani (Bollman's cave millipede)	Cave	IDNR Watch List
Phanetta subterranea (Subterranean sheet-web spider)	Cave	
Porrhomma cavernicola (Cavernicolous sheet-web spider)	Cave	
Pseudosinella fonsa (Fountain cave springtail)	Cave	IDNR Threatened
Arrhopalites undescribed species (cave springtail)	Cave	IDNR Endangered Candidate
Pseudanophthalmus undescribed species (Ray's cave beetle)	Cave	IDNR Endangered

Table 2: Section 4 Cave Fauna		
Species	**Location**	**Listing Status**
Batrisodes krekeleri (Krekeler's cave ant beetle)	Cave	IDNR Endangered
Spelobia tenebrarum (Cave dung-fly)	Cave	
Sinella alata (Indiana cave springtail)	Cave	IDNR Watch List
Pseudosinella collina (Hilly springtail)*	Cave	IDNR Rare
Myotis sodalis (Indiana bat)*	Cave	USFWS Endangered

* Not obligate subterranean species

The entire known range of the cave springtail is a single cave located approximately one-half mile north of the Section 4 corridor in Greene County. The Ray's cave beetle is known only from three caves including one site in the proposed I-69 project area. Refer to **Appendix K** for documentation of the survey of Section 4 cave fauna.

A reconnaissance was conducted of all known caves within five miles of the Section 4 corridor. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat (*Myotis sodalis*) and make recommendations regarding further, more detailed investigations for bats that were to be conducted later by teams of biologists. There are 315 known caves located within five miles of the Section 4 corridor. Of these caves, 226 were judged by cave investigators to be potential Indiana bat hibernacula. Two-hundred and seven (207) of these caves were inspected to determine whether they are potential hibernacula. In addition, 41 caves were visited that were not part of the originally identified caves; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Access was denied to five sites, and 14 caves could not be located. As a result, 59 caves were recommended for intensive investigations as Indiana bat winter hibernacula. Refer to **Appendix M** for documentation of the cave reconnaissance for Indiana bat hibernacula. Results of the Indiana bat surveys can be found in the reports titled: *Surveys for Indiana Bats in Caves in Greene and Monroe Counties, Indiana* (BHE 2005), *Autumn, Winter, and Spring Habitat for the Indiana Bat (Myotis sodalis) Within the Crawford Upland and Mitchell Plain From Scotland to Bloomington, Indiana* (ESI, 2005), *Autumn 2005 and Winter 2006 Habitat for the Indiana Bat (Myotis sodalis) within the Crawford Upland and Mitchell Plain from Scotland to Bloomington* (ESI, 2006) and *Surveys for Indiana bats in Caves in Greene and Monroe Counties, Indiana* (BHE, 2006).

5.0 ANNUAL POLLUTANT LOAD ESTIMATES

The Karst Memorandum of Understanding (MOU) dated 1993 between INDOT, IDNR, IDEM, and the USFWS delineates guidelines for construction of transportation projects in karst regions of the state. As part of the I-69 project, the USEPA has also been invited to participate in the MOU activities review process. The MOU signatory agencies and the USEPA have been informed that Steps 1-4 of the Karst MOU will be followed as part of the National

Environmental Policy Act (NEPA) study for Sections 4 and 5 of the I-69 project. Step 2 of the Karst MOU states the following "….Calculations of estimates of annual pollutant loads from the highway and drainage within the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan…."

This section summarizes key points from the research gathered as part of the karst pollutant loading estimations for the Tier 2 EIS of I-69 Section 4 in Greene and Monroe Counties. It also discusses the attempts made and limitations to compute the pollutant loadings as a desk top exercise, or without actual field sampling, using a Federal Highway Administration (FHWA) published process.

INDOT's Previous Karst Study on SR 37

In April 1996, Earth Tech prepared "Results of MOU-Related Karst Studies for Indiana State Road 37, Lawrence County, Indiana (1992-1995)" for INDOT. This document described the Karst MOU and documented the results of the BMP's used both during and after construction. The project was to reconstruct SR 37 from a two-lane highway to four-lane divided between SR 60 (Mitchell) to US 50 (Bedford). In general, INDOT used the following steps to fulfill the Karst MOU:

1. Survey all karst features directly or indirectly affected by the project
2. Delineate sub-surface drainage routes using dye-tracing.
3. Install drainage structures (Best Management Practices (BMPs)) such as settlement basins, peat filters and rock filters to all karst features within the right-of-way. The size and type of each BMP was estimated based on the drainage area and type of karst feature. By all indication, the choice of the BMP was an estimation with the understanding that monitoring of the BMP is essential to assure its effectiveness.
4. Collect samples of runoff at the BMP's both during and after construction and test for pollutants (e.g. lead, zinc, copper, etc.). These samples were collected during six storm events between February 1993 and August 1995. The concentrations of pollutants were compared to Indiana's Water Quality Standards for aquatic life and drinking water.
5. Observe the BMP effectiveness at conveying stormwater during rain events. Most BMPs proved effective, although some need to be enlarged or their drainage basins enlarged to assure water was not going to pond onto the roadway.

The study concluded that less than 2 years after construction, the pollutant concentrations in the runoff were reduced to what one would expect prior to construction. As long as the filter systems operate as designed, no long term effects to karst features is expected.

In the short term (within two years after construction), high levels of Total Suspended Solids (TSS) and Total Recoverable Metals (TRM) (copper, lead, zinc, etc.) were found. This was likely due to the fact the BMPs were installed prior to earthwork and grading activities. Therefore, even though the BMP filters and normal erosion control measures were monitored, the filters were typically found to be clogged. The study does not give a recommendation on how to remediate this.

Kentucky's Previous Karst Study on I-69 at Mammoth Cave

As part of the literature research conducted, a report completed by the Kentucky Transportation Center, "Evaluation of Methods to Protect Water Quality in Karst Areas: Phase I" was reviewed. This study, done for the Kentucky Transportation Cabinet in October 2003, analyzed pollutant loads to karst features near an interchange of I-65 and an entrance to Mammoth Cave. The procedures detailed in the study match those of Indiana's Earth Tech report. Field samples were collected to find the pollutant concentrations and those values compared to national standards. Their findings were highway runoff pollutant loadings were minimal. Additional phases of the research report were to study other karst features throughout the state, and report a methodology that could be used for loading calculations and BMP design. One of the authors was contacted to check the status of additional phases to the study; however none have been completed at this time.

Karst Features to Analyze

The karst survey identified almost 1,500 karst features in the karst study area. About 450 features are located within the 2,000' wide corridor of Section 4, 106 inside the proposed right-of-way for Preferred Alternative 2 under the Initial design criteria and 87 for the Low Cost design criteria. The drainage areas for all these features were estimated in **Appendix N** of this report. It was assumed that any karst feature inside the construction limits would be capped, so its pollutant load estimate is zero. A karst feature had to be outside the construction limits yet inside the proposed right-of-way to be eligible for analysis. The number of features that fit this criterion for the initial criteria is 22 and for the low cost criteria is 20.

The first step was to identify an approximate station along the I-69 centerline for a feature. Using this station, the karst feature was then identified on a plan and profile drawing. Using the profile, the approximate limits of the right-of-way drainage area was estimated (i.e. runoff area). These limits were determined by beginning at the feature and going "uphill" along the profile until a crest or culvert was reached (whichever came first).

The calculation of the pollutant loadings into the karst features required some assumptions; primarily when delineating how much of the proposed right-of-way would drain into the karst

feature. Three main assumptions were made, all likely erring on the side of a higher pollutant loading than what will realistically occur after construction:

1. It was assumed that the entire right-of-way width would drain into the karst feature. In many cases, this is highly unlikely. For instance, if a karst feature is located on the backslope of a ditch along the southbound lane, there is no guarantee that highway run off from the median or ditch along the northbound lane would drain to the karst feature on the other side of the road. More often than not, the road acts as a barrier, preventing runoff from being conveyed from one ditch to the other. The only exception would be if a cross culvert or median drain would convey drainage to a karst basin.
2. Also, where multiple karst features are located within the same right-of-way drainage area, the pollutant loading calculation for each feature assumed no run off would drain into the other features. In all likelihood, the karst features would share the runoff volumes.
3. Finally, the roadside and median ditches are designed for conveyance and outlet into streams and creeks, not into karst features such as sinkholes or swallets. Therefore, it is reasonable to assume runoff may not find its way to a feature, instead traveling along the ditch grades and culverts as designed and constructed. The pollutant loading calculation assumed the entire right-of-way would drain into the karst feature, and not be conveyed elsewhere.

FHWA Highway Runoff Water Quality Training Course

FHWA conducted a class on water quality and storm water runoff from highways. Section 8 of this workshop dealt with models and studies that have been developed to predict pollutant loads without field measurements. The first part of the model calculates pollutant load estimates, developed in the late 1970's using field data from monitoring programs in various states. The second part estimates the pollutant concentrations and compares them to water quality standards. The third part estimates the pollutant loads in the "background", or what occurs before the highway is built. This methodology is included in **Appendix N** of this document.

Part 1: Pollutant Loadings from Highway Runoff

In order to estimate the pollutant loading from the highway runoff, the length of the road that would drain into the karst feature must be estimated. This was found by plotting the karst feature's station on a profile view, and then measuring upgrade from the feature to the nearest crest or cross culvert, whichever came first. The pollutant loading calculation assumes the *entire* highway right-of-way along this length would drain into the karst feature. This is unlikely, given

the three drainage ditches (two roadside and the median) are not designed to convey drainage to karst features. For instance, if a karst feature is located inside the roadside ditch along the southbound lanes, there is no guarantee (and in fact is very unlikely) that cross culverts would be installed to convey drainage from the other roadside ditch and the median under the road to the karst feature.

The model estimates the pollutant loading by first determining the load of total solids. Once that load is found, regression equations are used to determine the load for other various pollutants (lead, copper, zinc, etc.). The theory behind this is solids act as "carriers" for other pollutants, so the higher the solids the higher the metals and other pollutants. The estimated pollutant load prior to the rain event is calculated using the daily traffic estimate. It is assumed that the road has not been washed of pollutants in 20 days, which the study's analysis determined to be an adequate length of time for an accurate initial load estimate. The initial pollutant load is then modified to account for the runoff rate. This rate was calculated using National Oceanic and Atmospheric Administration (NOAA) data for the 1-year/1-hour, 2-year/24-hour and 5-year/24-hour rain frequencies. The rate also takes into account the drainage control on the highway, in this case, open median and ditches, and the length of highway within the drainage basin of the particular karst feature. The I-69 project was considered a Type III roadway, which is indicative of a rural highway with paved shoulders which uses grassy ditch conveyance for the surface runoff.

Once the runoff and rain data is taken into account, the pollutant loading of total solids at each karst feature was calculated. Regression models are then used to determine the pollutant load (pounds) for other pollutants. For karst features with very small drainage areas, some of the regression equations produce values in the negative. It should be assumed, for these cases, the load is zero. Table 1 in Exhibits 1-6 are included in **Appendix N** which displays the pollutant mass loadings for reach of the three rain events for both the Initial and Low Cost design criteria.

Part 2: Pollutant Concentrations from Highway Runoff

The pollutant loadings calculated in Part 1 can then be modified into concentrations. The loadings are divided by the volume of rain water (for a particular rain event) inside the right-of-way that would drain into the karst feature. Table 2 in Exhibits 1-6 in **Appendix N** shows the results of the pollutant concentration estimates (for each rain event using the Initial and Low Cost design criteria).

Concentrations of pollutants are then compared to Indiana's Water Quality Standards for aquatic life and drinking water. These standards are from Indiana Administrative Code (327 IAC 2-1-6) and assume a hardness of 250 mg/L. The four pollutants that are exceeded the most often are lead, total nitrogen, cadmium and mercury. **Table 3** and **Table 4** below summarize the results for those four pollutants for each rain event analyzed. The more intense the rain event, the more

wash-off of the highway will result and the less settling of solids in the ditches, hence the 1-year/1-hour event shows more pollutants exceeding the water quality standards. The FHWA course materials state that caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive equation was developed.

Table 3. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Preferred Alternative 2 - Initial Design Criteria[1]

Initial Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**
1year-1hour	15	22	22	22	0.033 (40532)	0.523 (41608)	0.053 (41608)	0.107 (41608)
2year-24hours	0	22	11	14	--	0.189 (41608)	0.020 (41608)	0.041 (41608)
5year-24hours	0	22	7	13	--	0.155 (41608)	0.016 (41608)	0.033 (41608)

Table 4. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Preferred Alternative 2 - Low Cost Design Criteria

Low Cost Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**
1year-1hour	17	20	20	21	0.168 (40620)	0.840 (40620)	0.043 (40132)	0.079 (40132)
2year-24hours	8	20	9	14	0.050 (40620)	0.257 (40620)	0.016 (40132)	0.030 (40132)
5year-24hours	4	20	8	9	0.044 (40620)	0.224 (40620)	0.013 (40132)	0.025 (40132)

Part 3: Pollutant Loadings from Karst Drainage Area (Prior to Highway Construction)

This section calculates how much pollutant would enter a water way upstream of the highway discharge. For this study, this is taken as the pre-construction calculation, or what is currently entering the karst feature prior to the highway's construction. Using the drainage area of each karst feature and the NOAA rainfall data, a runoff volume inside the drainage basin is calculated. The FHWA Water Quality Manual provides mean concentrations levels for certain pollutants, which are used with the runoff volume to determine the pollutant load. Some of the pollutants analyzed in Parts 1 and 2 were not included in this analysis because runoff concentrations were not provided. These concentrations are based on urban land uses, which is typically much higher than pollutant concentrations from rural areas. When comparing these pre-construction pollutant concentrations, three pollutants are shown to exceed the lowest of Indiana's water quality

[1] The lowest of the three Water Quality Standards listed in the IAC is 0.01 mg/L for lead, 0.01 mg/L for total nitrogen, 0.0023 mg/L for cadmium and 0.00014 mg/L for mercury.

standards: lead, total nitrogen and mercury. These are the same three that exceeded standards most often when looking at the highway runoff. Table 3 in Exhibits 1-6 in Appendix N lists the estimated pollutant mass loads for the pre-construction condition for each of the three rain events analyzed.

6.0 POTENTIAL MEASURES TO MINIMIZE IMPACTS TO KARST AREAS

A primary objective of the 1993 Memorandum of Understanding (MOU) is to minimize the effects of highway construction and operation on karst resources. The four preferred strategies to achieve this objective are listed below in order of priority and/or effectiveness. The strategies are avoidance, alternative drainage, mitigation/treatment and operation and maintenance.

6.1 Avoidance

Avoidance is the best strategy for minimizing karst resource impacts associated with highway construction and operation. Within Section 4, I-69 would be constructed on primarily undeveloped land. The proposed corridor does not follow an existing highway that could be improved to interstate standards. Therefore, the careful planning of the highway alignment is the best opportunity to avoid and minimize impacts to karst resources. Not all karst features can be avoided. Areas within the Section 4 corridor that need to be prioritized for avoidance and minimization are discussed in Section 7.4, Areas of Importance. Features that cannot be avoided will be addressed via alternative drainage and mitigation/treatment, or other appropriate measures.

6.2 Alternative Drainage

Alternative drainage is listed in the Karst MOU as the second most important strategy for minimizing karst resource impacts associated with highway construction and operation. Collection and management of highway runoff is an important consideration during the development of the roadway design. Dye tracing of Section 4 shows that, in some cases, flowpaths are as long as 4 miles from the dye injection point. Redirecting highway runoff is a concern due to the fact that directing highway runoff away from karst recharge features is not always a viable option within this study area. Additionally, redirecting run-off from karst features can negatively affect aquatic species within the karst system by decreasing the quantity of water entering the system. In some areas, Section 4 has karst features distributed across the corridor which would preclude diverting runoff from the highway away from karst features. This is especially true of the eastern part of Section 4. Identifying areas to divert runoff away from karst features may be easier to implement in the western part of Section 4 due to the different geology there.

6.3 Mitigation/Treatment

The third suggested measure in the Karst MOU is mitigation and treatment such as implementation of peat and sand filters, gravel filters, vegetative buffers, and lined spill or runoff containment structures. These structures could be constructed in appropriate locations along the highway to detain and/or treat highway runoff prior to discharge. Monitoring will be required to assure that the drainage discharged from these structures has minimal impact on karst features. Additional karst mitigation measures such as use of geosynthetic reinforced soils, void grouting, compaction grouting, concrete caps, reinforced bridging slabs, deep foundations etc., could be considered concurrently with drainage treatment alternatives so as not to impede drainage in recharge areas.

6.4 Operation and Maintenance

- Examination of the areas that receive runoff from the highway to detect soil piping or opening of buried karst features

- Implementation of no-mowing and no-spray zones to increase vegetative groundcover, to filter roadway runoff prior to leaving the right-of-way

- Routine maintenance and inspection of treatment/containment structures to check the capacity, integrity, and operational efficiency of the structure

- Improved technology should be used to update, maintain, and alter any treatment and containment structures when deemed necessary.

Figure 5 through Figure 40 have been removed from this document for confidentiality reasons related to karst.

7.0 SUMMARY AND CONCLUSIONS

The Section 4 Karst Study Area includes the 27-mile long Section 4 corridor and appropriate areas outside of the corridor, to encompass karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. Karst resources in the Section 4 karst study area have been impacted during historical and recent development within Monroe and Greene Counties. Deforestation, row crop production, livestock grazing, and other drainage modification activities have had long term impacts on many of the recharge features and springs, primarily through increased sediment loads. Other human activity has also impacted these features hydraulically in some cases. Ridge top and slope land use modifications have periodically increased the short term addition of sediment to these caves that have very long term affects. Sinkhole filling with trash, hazardous materials, and animal carcasses has resulted in impacts to cave biota, sedimentation, and water quality.

This survey of karst features consisted of karst feature mapping and characterization, groundwater dye tracing of relevant karst features, and determination of the hydrogeologic characteristics of the Section 4 corridor. Due to the location and distribution of observed karst features and their potential connectivity to features outside of the corridor, it was determined that it was necessary to catalogue all relevant karst features in appropriate areas outside of the Section 4 Corridor.

All karst features and karst geology in general cannot be avoided by activities associated with the construction of an interstate highway within the Section 4 corridor; however, individual karst features can be avoided. Therefore, the focus of the alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features, alternative drainage, mitigation/treatment, and operation and maintenance measures.

7.1 Karst Features Mapping and Identification

This study identified the following karst features within the karst study area:

- 63 caves, 14 within the corridor
- 993 sinkholes, 305 within the corridor
- 62 swallets, 19 within the corridor
- 15 sinking streams, 6 within the corridor

- 331 springs, 103 within the corridor

7.2 Dye Tracing

Dye tracing tests characterized groundwater flowpaths in the following manner:

- 39 dye injections resulted in 47 distinct groundwater flowpaths
- 9 dye traces demonstrated groundwater flowpaths that cross the corridor
- The karst groundwater flowpaths in Section 4 tend to be discrete in that recharge features discharge to a single point.
- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point.
- The length of groundwater flowpaths varies greatly (340 ft to just over 20,000 ft) in length. The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway.
- Cave, Cave, Cave, Cave, Cave, and Cave: have been hydrogeologically linked through dye tracing to the Section 4 corridor.

7.3 Karst Springs

Spring discharges within the study area varies greatly, due to the hydrogeologic nature of the springs and particular hydrologic conditions (i.e. high or low flow). The spring discharges range from less than 0.1 gpm to over 1000 gpm. Spring discharges were estimated by a field hydrogeologist and were not measured with gauging equipment. Water chemistry for karst and non-karst springs were analyzed and compared. The karst springs had lower pH, higher conductivity and high calcium concentration than the non-karst springs.

Characterization of springs by hydrogeologic unit is as follows:

- US 231 to Taylor Ridge: The springs in this area discharge from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

- Taylor Ridge to SR 54: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances are up to 4 miles, with travel times ranging from 4 days to 3 weeks. Groundwater generally flows west/southwest (along dip) and/or southeast/northwest (along strike).

- SR 54 to Harmony Road: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances were up to 3 miles, and had travel times ranging from 1 to 6 weeks. Groundwater generally flows west/southwest (along dip) and/or southeast/northwest (along strike).

- Harmony Road to SR 37: Recharge to springs generally enters the karst system through sinkholes located at the tops and flanks of the ridges. Groundwater travel distances in this area were up to 3,000 ft, and had relatively short travel times, generally less than three days.

Based on dye tracing results two regional hydrogeologic no-flow boundaries were identified.

- SR 45 Ridge

- Kirksville Ridge

These two areas are topographic ridges and are depicted in **Figure 37**. The SR 45 Ridge is considered a hydrogeologic boundary for the following reasons:

- Groundwater flowpaths from recharge features on the west side of the SR 45 Ridge did not flow east across the ridge.

- Groundwater flowpaths from recharge features on the east side of the SR 45 Ridge did not flow west across the ridge.

The Kirksville Ridge is considered a hydrogeologic boundary for the following reasons:

- Groundwater flowpaths from recharge features on the west side of the Kirksville Ridge did not flow east across the ridge.

- Groundwater flowpaths from recharge features on the east side of the Kirksville Ridge did not flow west across the ridge.

7.4 Areas of Importance

7.4.1 Cave

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 4-1434, 4-1525, and 4-1524), four of which receive direct run-off from the Section 4 corridor. The drainage area associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) crosses into the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.2 Cave

The entrance to Cave is located approximately 0.6 miles north of the corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. The drainage area associated with 4-0037 crosses into the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with swallet 4-0037. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made such that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.3 Cave

Cave is not located within the Section 4 corridor. This cave will not be directly impacted by highway construction. The Section 4 Alternatives are located approximately miles from the cave. However, dye tracing tests revealed that recharge to Cave is derived in part from four swallets (4-0166, 4-0173, 4-0175, and 4-1504) which receive run-off from the Section 4 corridor. Three other recharge features (4-0174, 4-0203, and 4-0204), which

were not dye traced, are potentially hydrogeologically linked to Cave. The drainage area associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) crosses into the Section 4 corridor. The Section 4 Alternatives are on a common alignment in the vicinity of the above-noted features, and all Alternatives will impact the features and associated drainage areas in the same manner. Construction in this area could impact the recharge to Cave. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.4 Cave

Cave is located approximately feet south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to a spring, which is presumably connected to Cave based on best available data, is derived in part from a sinking stream (4-0661) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave and the associated spring. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with sinking stream 4-0661. Due to the relationship between the proposed road and existing topography, it is not anticipated that highway derived runoff would be directed toward sinking stream 4-0661. Special planning should be conducted, where appropriate and practicable, to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration,, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.5 Cave

Cave is located approximately feet south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from a swallet (4-1035) which does receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment, predominately down-gradient of swallet 4-1035 in this area. The Alternatives will impact the drainage area of swallet 4-1035 in a similar manner and therefore have the same potential to affect the cave spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where

appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.6 Spring

Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. The spring will not be directly impacted by highway construction. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-1228) in a drainage east of Spring within the Section 4 corridor. It is likely that the area downstream of sinking stream 4-1228 acts as a sinking stream during high flow periods and also provides recharge to Spring. Sinking stream 4-1228 and the potential losing stream reach down gradient from it would receive run-off from the Section 4 Corridor. Construction in this area could impact the recharge to Spring. The Section 4 Alternatives are on a common alignment in this area and will unavoidably cross sinking stream 4-1228. They will not encroach upon the drainage area of sinking stream 4-1228. The Alternatives will cross sinking stream 4-1228 in a similar manner and therefore have the same potential to affect the spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

7.4.7 Cave

Cave is not located within the Section 4 corridor. The cave will not be directly impacted by highway construction. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. Cave is located ft southeast of Cave and lies between it and the input features for the dye traces. The Section 4 Alternatives are about a half-mile south of the cave location and share a common alignment in this area. All Alternatives would result in the same impact upon the drainage areas of potential Cave recharge features located within the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicates probability that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario the water could pass out of and back into the limestone one or more times. The majority of the recharge to the cave is derived from more proximal features. Therefore, it is not anticipated that the project will cause a material degradation of the cave spring's water quality or quantity.

7.4.8 Cave

Cave is located approximately feet south of the Section 4 corridor. Cave has been mapped and the cave passage trends toward the Section 4 corridor. The mapped extent of this cave terminates outside the Section 4 corridor, over feet south of the Section 4 Alternatives. Dye tracing tests revealed that recharge to Cave is derived in part from a sinking stream (4-1271) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same impacts along the northern edge of the drainage area of sinking stream 4-1271. Where appropriate and practicable, special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special consideration should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.9 SR 37 Interchange

Dye tracing tests reveal the northeastern side of SR 37 near its intersection with Victor Pike to be part of the recharge area for one significant spring (4-1501). The southwestern side of SR 37 near its intersection with Victor Pike is a concern from an engineering standpoint due to the high density of karst features. The bedrock is likely highly fractured and could pose unique design and construction issues. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. Additionally, the construction of SR 37 and surrounding development has already altered the land surface and drainage patterns. Sinkholes have been filled and altered which could be problematic during construction. Drainages and conduits have also been altered which present problems in studying the hydrogeology. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same encroachment within the recharge area along the northeastern side of SR 37 near Victor Pike. Special planning, where appropriate and practicable, should be conducted to insure that highway derived runoff within the drainage area of sinkhole 4-1496 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special planning should be conducted so that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.10 Tramway Road Karst Area

This area is located within the corridor, north of Tramway Road and west of Victor Pike. Dye tracing tests reveal short isolated groundwater systems and the karst features do not provide recharge to any significant springs. Dye tracing did not identify a potential hydrologic link to nearby quarries, suggesting that quarrying in the area has not contributed to sinkhole

development. This area will need additional engineering measures to account for the high density of karst features and the highly fractured bedrock. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. The instability of the bedrock was highlighted by a sinkhole collapse documented by the project team. This collapsed occurred on the edge of a sinkhole (4-0133) identified during field mapping. The review did not identify that an alternative outside the corridor would provide substantial karst impact and/or roadway stability benefits compared to alternatives within the corridor. The Section 4 Alternatives utilize three alignments in this area and would affect a similar overall number of features. The Preferred Alternative (Alternative 2) as well as Alternatives 3 and 4 minimize impacts to higher infiltration features and minimize anticipated stability concerns in the area by cresting the hill north of Tramway Road on its east side, approximately 30 feet lower in elevation in comparison to Alternative 1.

7.5 General Environmental Concerns

- Karst groundwater systems can transport sediment and contaminants virtually unimpeded into cave and spring systems. Dye tracing studies show the groundwater systems within the Section 4 corridor have the potential to impact areas a long distance (up to 4 miles) from the source

- Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides is common. If contaminants enter the karst system the location for establishing a response could be difficult to predict.

7.6 General Engineering Concerns

- Collapse of filled (naturally and otherwise) sinkholes and cave passages can compromise adjacent and overlying structures. These failures can occur without surface expression prior to collapse. There are sinkholes within the Section 4 corridor that have been filled by natural and man-made processes

- Impervious surfaces, such as roads, alter the natural patterns of run-off and infiltration. Concentrated and redirected runoff into open sinkholes or over sinkholes without surface expression can result in sinkhole collapse. Unlined retention or detention structures can increase the localized head, which could result in collapse of adjacent sinkholes. Alteration of surface run-off can also increase erosion which can effectively sever recharge features by sedimentation

- Impervious surfaces, such as roads, can sever recharge features by covering or filling. This can result in decrease spring discharges and alteration of habitat for any biological communities within the karst system

- The karst landscape is an ever evolving landscape. Karst features can change rapidly with subsequent opening and infilling of sinkholes, caves and swallets as well as increase and decrease in spring discharges.

8.0 Recommendations

8.1 Best Management Practices

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted low-salt/no spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

- The drainage design for I-69 should provide for proper energy dissipation devices at the culvert and storm sewer system outlet locations to prevent erosion to existing channels. Energy dissipater devices include such items as scour holes, riprap linings and stilling basins. Design of energy dissipater devices and ditch linings should be based on INDOT's Drainage Design Manual

- Run-off from the roadway should have as much natural treatment as is possible. It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching potential karst recharge features

- The roadway construction, when possible, should be planned to maintain the drainage to karst recharge features

- Utilization of lined ditches to the outfall discharge points are recommended within the karst areas designed to prevent erosion. Water flow within the roadway ditches will need an analysis for lining requirements. Culvert outlets should be designed to discharge water to at grade terrain. This design will reduce erosion scour and sediment transport into the karst and other environments. Design of ditches and culverts should be based on INDOT's Drainage Design Manual. This will reduce soil erosion through karst features that could compromise the integrity of the roadway

- A spill response plan should be established with response equipment readily available during and after road construction. Karst groundwater systems have the potential for high groundwater flow velocities, which makes quick response to any spill a necessity. Drainage and runoff control mechanisms should be in place to prevent contaminants from entering the karst system. In the event that contaminants enter the karst system, use of response or mitigation measures at discharge points may be necessary

- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

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APPENDIX A – KARST MOU

Memorandum of Understanding

(Retyped of original text 3/14/2007)

This Memorandum of Understanding is made and entered into this thirteenth day of October, 1993, between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM) and the U.S. Fish and Wildlife Service (USFWS) for the purpose of delineating guidelines for construction of transportation projects in karst regions of the State.

Whereas, INDOT, IDNR, IDEM and the USFWS wish to cooperate in the identification, study and treatment of drainage in karst regions related to the construction of transportation projects and

Whereas, INDOT, IDNR, IDEM and the USFWS accept responsibility to ensure the transportation needs of Indiana are met in an environmentally sensitive manner that protects the habitat of all species and

Whereas, design and construction practices must protect ground water quality, public health and safety, and the environment.

Whereas, the Indiana Department of Natural Resources will conform to the terms and conditions within this MOU for their transportation projects. Likewise, it will be IDNR's responsibility to provide standard biological review for projects in the karst region.

Therefore, in consideration of the terms and conditions set forth herein the INDOT, IDNR, IDEM and USFWS agree as follows:

1. INDOT in cooperation with the IDNR, IDEM and USFWS shall determine the location of sinkholes, caves, underground streams, and other related karst features and their relationship prior to proposed alterations or construction in karst regions of the state, a consultant with expertise in karst geology/hydrology may assist in the identification and characterization of the karst features. The choice of the consultant retained by INDOT will be subject to the review of IDNR, USFWS and IDEM.

2. Tasks to accomplish this work will include:

   Research public and private information sources for information relative to karst features.

   Conduct field check karst and cave features that appear from the first task and identify any additional karst features.

   Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area

and surface water drainage patterns of the area. Calculations of estimates of annual pollutant loads from the highway and drainage with the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan.

That report will be used as a tool to assist in determining the proposed highway alignment. The intent of INDOT is to avoid karst areas and use alternate drainage where possible.

3. IDNR, IDEM and USFWS will be requested to review and comment on the findings at the early coordination phase of project development.

4. INDOT, using the input from IDNR, IDEM and USFWS will begin to formulate appropriate measures to offset unavoidable impacts to the karst features. It is understood by all parties that some of the methods proposed at this time will be generic and could be applied throughout the length of the corridor. Other methods may be specific to a particular cave or karst feature. Some of the approaches may require additional investigations to determine their necessity and/or their feasibility. A revised draft report will be prepared by INDOT's consultant and provided to the IDNR, IDEM and the USFWS as part of the design review process.

5. Drainage entering from beyond the right-of-way will be treated according to the same process as drainage generated by the project.

6. As the project progresses further into the design phase, the IDNR, IDEM and USFWS will be invited and will attend field checks and meetings dealing with efforts to negate or minimize adverse impacts.

7. Hazardous materials traps (HMT's) will be constructed at storm water outfalls and other locations that will protect karst features from spill contamination.

8. INDOT agrees to develop a monitoring and maintenance plan for the affected karst features. IDNR, IDEM and USFWS will be provided an opportunity to review this plan. The establishment of water quality and a point at which a standard is established for remediation will be a part of each monitoring plan. The results of the monitoring will be submitted to IDNR, USFWS and IDEM on a regular basis.

9. A low salt and no spray strategy will be developed for each future project. A signing strategy for these items will also be developed for each project.

10. Prior to acceptance of the final design plans an agreement will be developed which will set out t6he appropriate and practicable measures to offset unavoidable impacts to karst features. This agreement will be signed by the Department Director of IDNR, the Commissioner of the IDEM, the Commissioner of INDOT and the Supervisor of the USFWS Bloomington, Indiana Field Office. The agreement will become a part of

the contract documents for the project, will be discussed at the pre-construction conference and will be on file at the office of the project administrator.

11. INDOT will assure that the terms of the agreement will be completed with all safeguards given to the karst area. Special provisions, which are binding provisions that are a part of the contract, will be included outlining the precautions to be taken. Construction and design strategies for handling karst features will be discussed with the contractor(s) and project administrator during the pre-construction conference. Project administrator shall ensure that the contractor is following the new erosion control standards that meet Rule 5 of 327 IAC 13 and any special precautions outlined in the design plans that the sinkhole treatment is being handled correctly. The erosion control plan must be available at the project administrator's office. An emergency response plan will be made a part of the contract documents. In addition, the contract documents will contain a strategy for signing to alert the public to the fact that all types of spills are potentially hazardous to the karst environment. For INDOT, this plan would be procedure 20 of the Field Operations Manual dated 6/24/1992. [Currently in the Construction Activities Environmental Manual].

12. The location and nature of the sinkholes and drainage schematic will be provided to the IDEM. They will provide the information to the appropriate local authorities and the Hazmat teams. An emergency response plan will be followed. This constitutes procedure 20. Included in this information is an understanding that all types of spills are potentially hazardous to karst regions.

13. IDNR, IDEM and USFWS personnel will monitor construction and maintenance to the agreed upon terms, as deemed necessary.

14. If during construction it is found that the mitigation agreement must be altered, all of the agencies will be contacted and agreement reached prior to work continuing in that specific area of the project. In order to not unduly delay projects, a two working days response time is needed from the resource agencies.

15. Treatments will be maintained during construction by means of a visual inspection on a weekly basis or after every rain. Corrective action will be taken as needed.

16. If after the above procedure is followed and a state/federal endangered/threatened species is found during construction, work in that area of the project will stop. The IDNR and USFWS will be immediately notified. The IDNR and USFWS will promptly investigate the situation, advise the project administrator and assume responsibility for protecting the endangered species and taking the appropriate action.

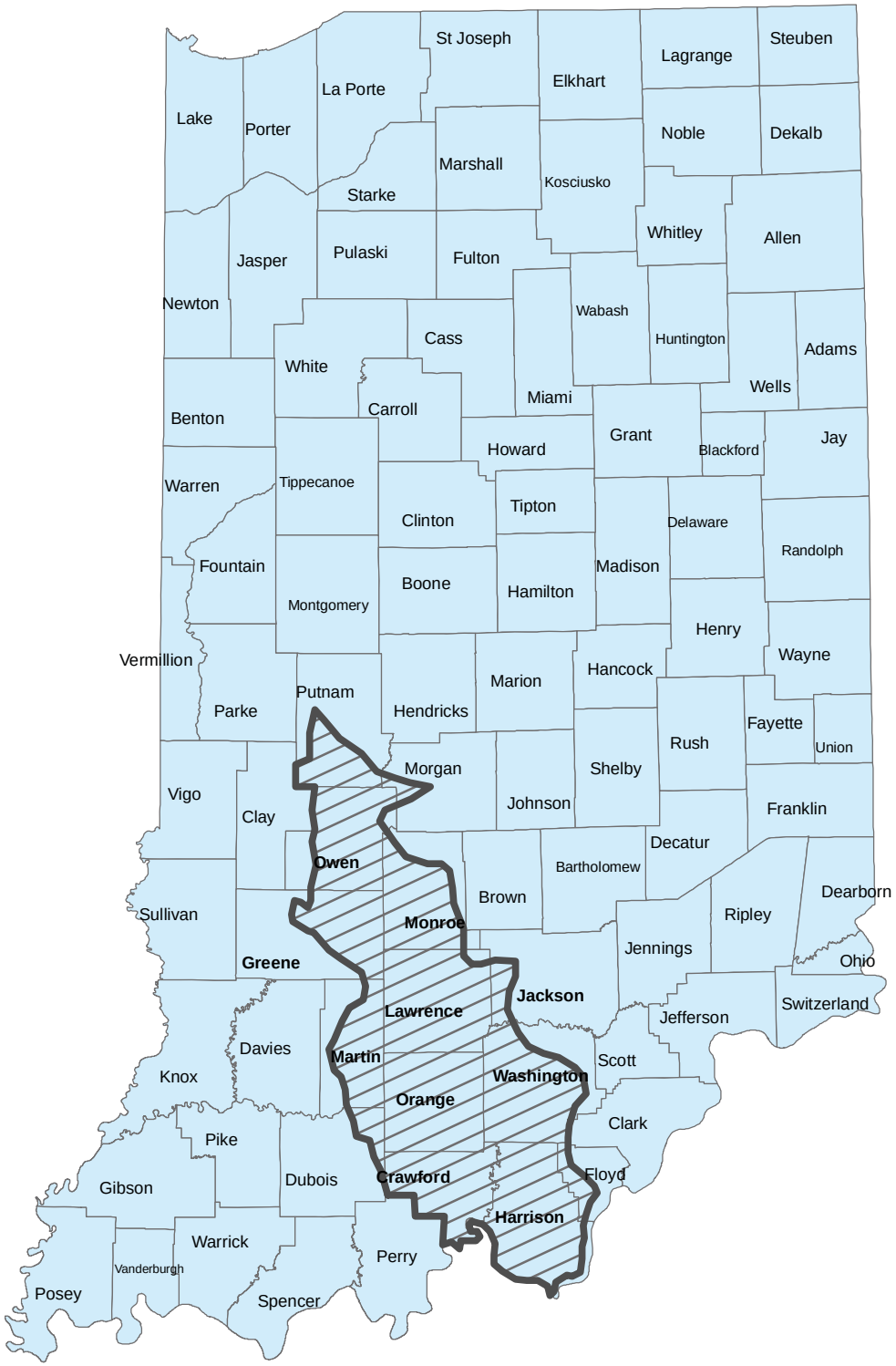
17. This document will be reviewed annually or more frequently at the request of any of the foregoing agencies.

MR. FREDERICK C. P'POOL, COMMISSIONER
INDIANA DEPARTMENT OF TRANSPORTATION

MR. PATRICK R. RALSTON, DIRECTOR
INDIANA DEPARTMENT OF NATURAL RESOURCES

MS. KATHY PROSSER, COMMISSIONER
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

MR. DAVID C HUDAK, FIELD SUPERVISOR, BLOOMINGTON FIELD OFFICE
U. S. FISH AND WILDLIFE SERVICE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Vermillion
Hancock
Marion
Putnam
Parke
Hendricks
Fayette
Rush
Union
Morgan
Shelby
Vigo
Johnson
Franklin
Clay
Decatur
Owen
Bartholomew
Brown
Dearborn
Sullivan
Monroe
Ripley
Jennings
Greene
Ohio
Jackson
Switzerland
Lawrence
Jefferson
Davies
Martin
Scott
Knox
Washington
Orange
Clark
Pike
Dubois
Crawford
Floyd
Gibson
Harrison
Warrick
Perry
Vanderburgh
Posey
Spencer
Potential Karst Features Region

APPENDIX B – KARST FEATURE FORM

hydrogeology inc.

1211 S Walnut St
Bloomington, IN 47401

Observed by:

Karst Feature Form

Feature ID:		County:	
Date:	Time:	USGS Quadrangle	
Picture #:	Township:	Section:	Range:

Location

Quarter Sections:	Elevation (ft)
UTM (10m) North:	UTM (10m) East:

Feature Description

Feature Type:	Topography:	Rock Type/Unit:
Length:	Width:	Depth:
Catchment Area: <1 <5 <10 <20 <30 <40 <50 <75 <100	Infiltration: low med high	Infill: soil org trash Bedrock: yes no
Opening:	Airflow:	Spring Discharge:

Notes:

Feature Types

C	Cave	MB	Manmade feature in bedrock
SC	Solution cavity	SW	Swallow hole
SF	Solution-enlarged fracture(s)	SH	Sinkhole
F	Fault	CD	Non-karst closed depression
SP	Spring	Z	Zone, clustered or aligned features

Figure 3.1: Karst feature field form

APPENDIX C – Dye Tracing Field and Lab QAQC

hydrogeology inc.
1211 S Walnut St
Bloomington, IN 47401

FIELD AND LABORATORY PROCEDURES FOR COLLECTION/ANALYSIS OF WATER AND CHARCOAL SAMPLES FOR THE PRESENCE OF FLUORESCENT DYES

December 19, 2005

Dr. Noel C. Krothe, RPG
President
Hydrogeology Inc.

Introduction

This document describes the standard field and laboratory operating procedures used by Hydrogeology Inc. for the analysis of water and charcoal samples for the presence of fluorescent dyes. In some situations these procedures are altered, and are noted as such in the lab results.

Fluorescent Dyes

Fluorescein
Common Name: Uranine HS (Fluorescein)
Chemical Name: Acid Yellow 73

Rhodamine WT
Common Name: Rhodmaine WT
Chemical Name: None

Eosine
Common Name: Eosine, Eosin
Chemical Name: Acid Red 87

Procedures

Description of Samplers

Water and charcoal samples are collected and analyzed at all sampling locations.

Water Samples

Water samples are collected in Cincinnati Container brand amber round bottles. Amber bottles are used in order to decrease UV exposure. Samples are refrigerated immediately upon return from collection.

Water Sample Collection

All water sampler collected are analyzed for the presence of fluorescent dye. Water samples are collected at springs, stream crossings and in wells. Water samples collected at springs are collected at the mouth of the spring and in the area with the highest flow. Water samples from wells are collected using a detected disposable plastic bailer. Typically the bailer is hung above water and lowered into the well to retrieve the sample. If the bailer is suspended below the water level the bailer is retrieved and emptied and then lowered again to obtain a fresh water sample. Water samples are collected at various frequencies, but at a minimum of once per week. Typically, ISCO automated water samplers are used to collect water samples at frequencies of as often as every fifteen. The information gained from using automated samplers is useful for establishing a dye breakthrough curve.

Charcoal Samplers

Charcoal samples are constructed using fiberglass screen. The screen is formed into approximately 2 inch by 4 inch pouches. The pouches are filled with approximately 4-5

grams of Calgon Carbon Corporation activated charcoal. Prior to being placed in the field all charcoal packets are washed in de-ionized water. The charcoal packets are placed in plastic containers and rinsed with de-ionized water until the packets are completely submerged. The charcoals are then agitated for approximately 2 minutes and then allowed to sit for fifteen minutes. This process is repeated three times. The charcoals are then placed in Parkway Plastic 4oz polypro jars and are used that day.

Charcoal Sample Collection

Charcoal samplers are attached to various items including bricks, stones, trees, and other stationary items. Charcoal samplers are attached with heavy duty rope and/or wire. If possible the charcoal is completely submerged and placed in the area with the fastest flow. When samplers are placed in a well, the charcoal packet is suspended on heavy duty rope with several weights attached to ensure the packet is completely submerged.. When charcoal samples are collected they are collected in Parkway Plastic 4oz polypro jars. If there is sufficient flow the charcoal is rinsed in the source water prior to being placed in the container. Samples are placed in a freezer immediately upon return from collection.

Charcoal Sample Elution

After collection the charcoal packets are rinsed in de-ionized to remove all excess sediment and particulates that can interfere with analysis. Once the charcoal is properly rinsed the packet is cut and the contents are dumped back into the original plastic sampling container. The charcoal container is then filled with eluting solution which is composed of 5 parts isopropyl alcohol, 3 parts de-ionized water, and 2 parts aqueous ammonia. The samples are allowed to sit for approximately 2 hours in the elutant.

Analysis on the Shimadzu RF-5301

The Shimadzu RF-5301 spectrofluorophotometer is used for samples analysis. This is a synchronous scanning model and is controlled by a MPC ClientPro desktop computer. Our Shimadzu RF-5301 is operated and maintained in accordance with the manufacturer's recommendations. Shimadzu Scientific Instrument technicians were responsible for installation and training for use of the RF-5301 to Hydrogeology Inc personal.

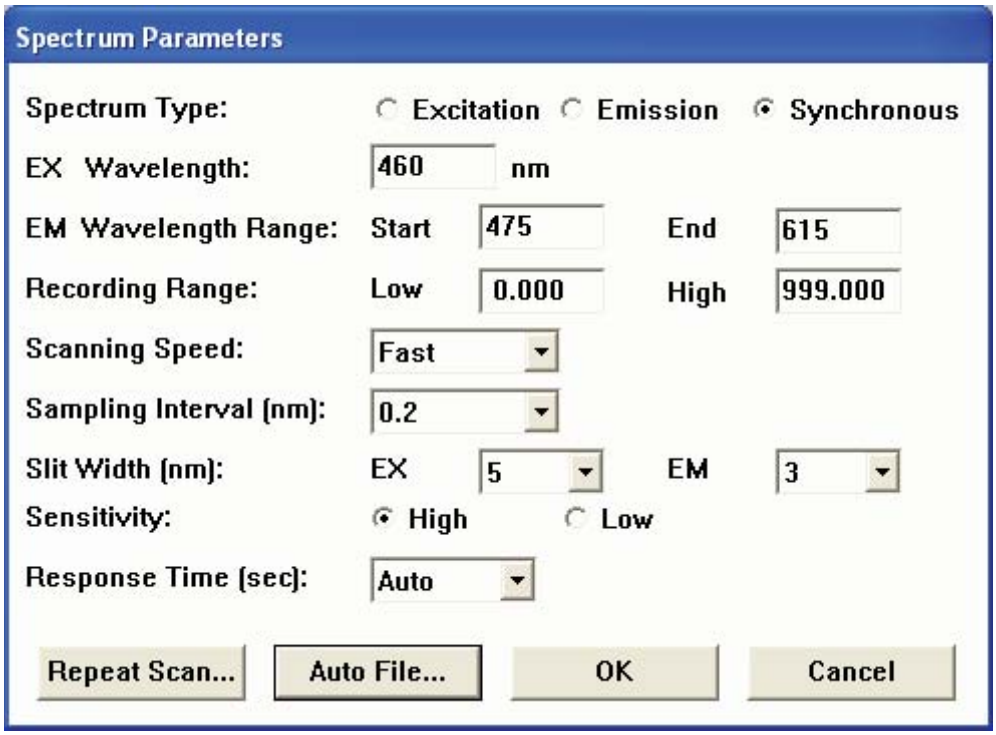
Charcoal Sample Analysis

After two hours of elutriating approximately 4 ml of the elutant is poured into a disposable polyethylene cuvette. These cuvettes are designed for fluorometric analysis and are clear on all four sides. The cuvettes have a spectral range of 340 to 800mm. The cuvette is then placed in the Shimadzu RF-5301 and run at the following settings.

Table 1: Typical excitation and emission slit widths for dye analysis

Dye and matrix	Excitation (EX)	Emission (EM)
Fluorescein in water	5	5
Fluorescein in elutant	5	3
Rhodamine WT in water	5	5
Rhodamine WT in elutant	5	3
Eosine in water	5	5
Eosine in elutant	5	3

Figure 1: Typical instrument settings for elutant analysis



After analysis the cuvettes are discarded. If the sample has no detected dye it is disposed of. If the sample reveals a dye positive the samples is placed in a freezer for possible further analysis.

Water Sample Analysis

Approximately 4 ml of the each water sample is poured into a disposable polyethylene cuvette. These cuvettes are designed for fluorometric analysis. . The cuvettes have a spectral range of 340 to 800mm. The cuvette is then placed in the Shimadzu RF-5301 and run at the following settings.

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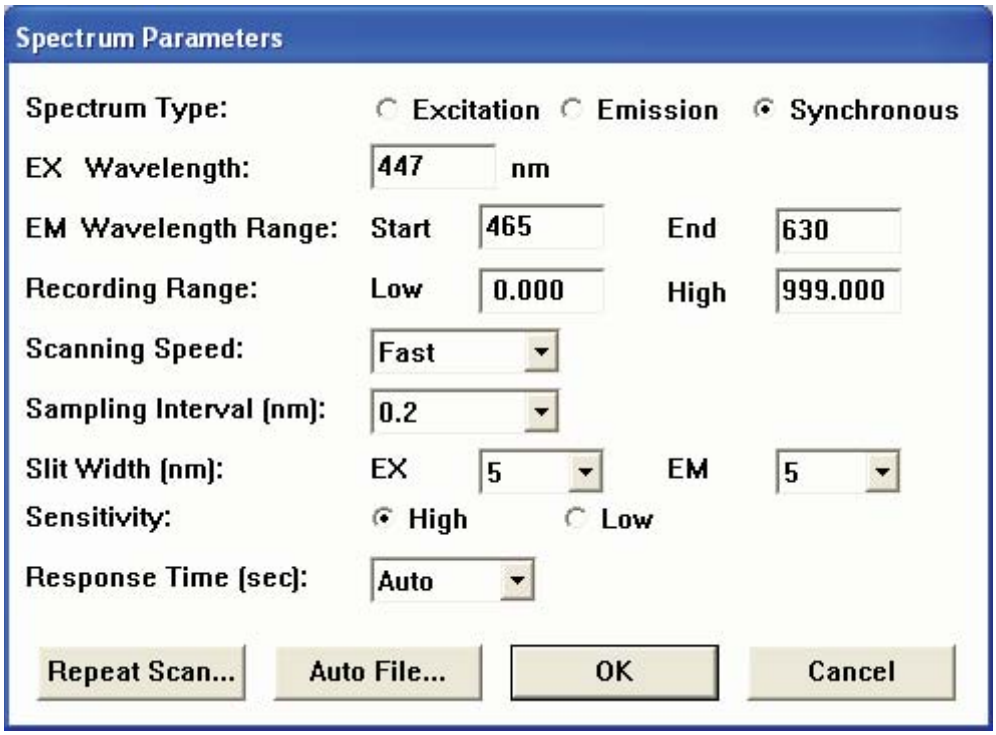
Rhodamine WT in elutant	5	3
Eosine in water	5	5
Eosine in elutant	5	3

Figure 2: Typical instrument settings for water analysis



After analysis the cuvettes are discarded. If the sample has no detected dye it is disposed of. If the sample reveals a dye positive the samples is placed in a refrigerator for possible further analysis.

Quantification

The magnitudes of fluorescent peaks for all dyes used are determined using a series of dye standards. Dye concentrations are calculated based on the height of the fluorescence peak. Dye standards are run on a daily basis for all dyes used. The following are the dye standards run on a daily basis:

1. Fluorescein in water at concentrations of 0.1 & .01 ppb
2. Fluorescein in elutant at concentrations of 0.1 & .01 ppb
3. Rhodamine WT in water at concentrations of 0.1 & .01 ppb
4. Rhodamine WT in elutant at concentrations of 0.1 & .01 ppb

5. Eosine in water at concentrations of 0.1 & .01 ppb
6. Eosine in elutant at concentrations of 0.1 & .01 ppb

Quality Control

Laboratory water and elutant and water blanks are run prior to after all lab sessions. Additionally, charcoal packets are allowed to soak in de-ionized water for 1 hr, then elutriated for two hours, and then analyzed.

Determination of Positive Dye Hits

The fluorescent emission wavelength ranges for all the dyes used have been established and are listed in Table 2 (add table). The following criteria are used to determine a dye positive in water and elutant samples:

1. There must be at least one peak at the sampling location within the accepted emission spectrum range for Fluorescein, Rhodamine WT, and Eosine
2. The peak must be indicative of fluorescence, meaning a sharp narrow peak indicative of Fluorescein, Rhodamine WT, and Eosine as opposed to broad peaks not associated with these dyes.
3. If any background fluorescence existed at the sample station the new peak must be 10 times the background level
4. The peak must have a concentration of three times the detection limit of the machine.

Table 2: Established fluorescent ranges

Dye and matrix	Range
Eosine in Water	532 to 540
Eosine in Elutant	530 to 540
Fluorescein in Water	504 to 511
Fluorescein in Elutant	510 to 515.6
Rhodamine WT in Water	562 to 568
Rhodamine WT in Elutant	569 to 575

Breakthrough Curve Data

The most accurate way to design a dye trace test is to use an continuous water sampler at the spring or spring that are the most likely major discharge point for the dye injection. The sampler can be programmed to collect water samples on a continuous interval. The most common procedure is to set the sampler at a one hour interval until the dye is detected. The water samples are then analyzed for the concentration of dye and plotted versus time. The first detection of dye indicates the approximate travel time from the injection point of the dye to the discharging spring. Samples following first detection are analyzed for concentration. The highest concentration is the peak of the graph. All samples from the first detection are analyzed and plotted until the dye can not be detected. This produces a concentration versus time curve which gives not only the time

of arrival but also how long it will take for the dye pulse to move through the system. The time of arrival and the duration of the peak will differ at different flow regimes. If a minimum flow time is desired then high flow conditions are necessary. The break through curve can be important to mitigation.

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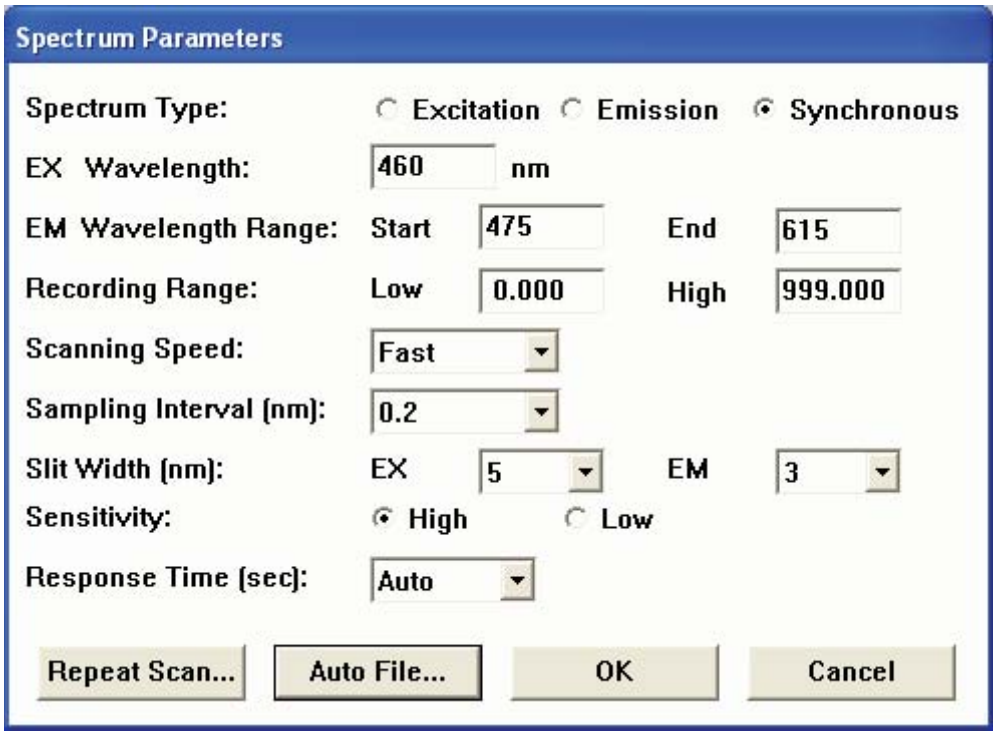

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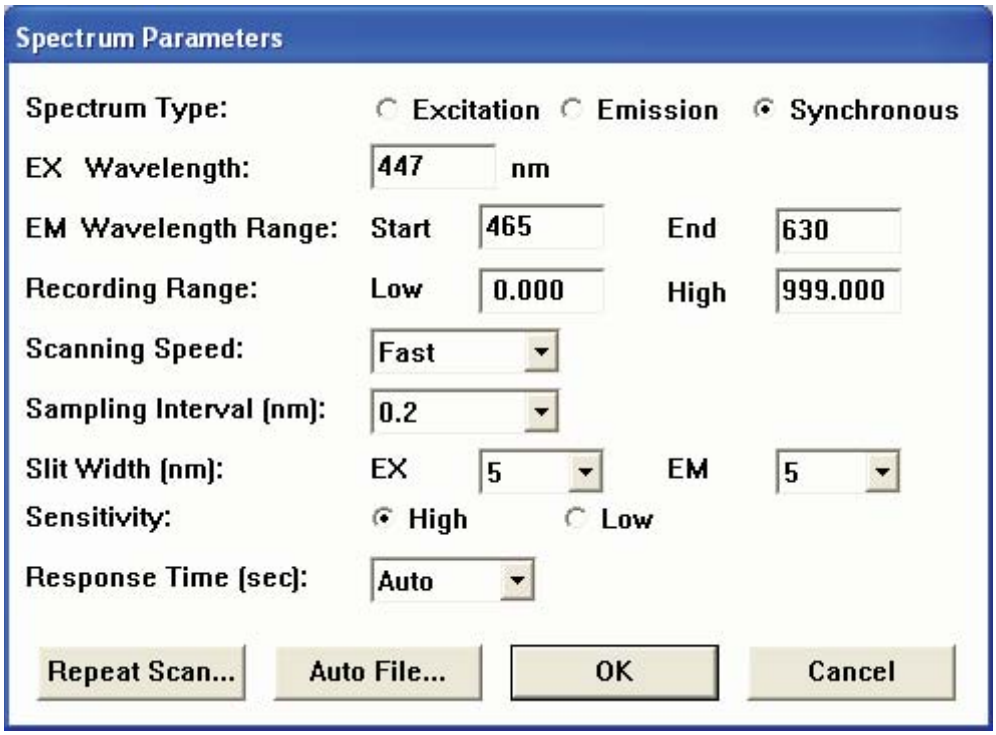

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APPENDIX D – KARST FEATURE FIELD DATABASE

Table 2 has been removed for confidentiality reasons related to karst.

Table 3 has been removed for confidentiality reasons related to karst.

Table 4 has been removed for confidentiality reasons related to karst.

Table 5 has been removed for confidentiality reasons related to karst.

Table 6 has been removed for confidentiality reasons related to karst.

APPENDIX E – KARST FEATURE DRAINAGE AREA

able E-1: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40001	970.11	0.24	
40002	242.30	0.06	
40004	242.38	0.06	
40005	807.97	0.20	
40006	646.24	0.16	
40007	80.91	0.02	
40008	323.37	0.08	
40009	565.33	0.14	
40010	80.82	0.02	
40011	970.11	0.24	
40012	242.30	0.06	
40016	80.82	0.02	
40017	80.74	0.02	
40018	565.25	0.14	
40019	161.73	0.04	
40020	888.70	0.22	
40021	242.21	0.06	
40022	7189.53	1.78	
40023	242.38	0.06	
40024	485.10	0.12	
40025	80.91	0.02	
40026	1938.88	0.48	
40027	80.82	0.02	
40028	80.74	0.02	
40029	80.74	0.02	
40030	888.45	0.22	
40031	242.30	0.06	
40032	646.16	0.16	
40033	323.12	0.08	
40034	323.12	0.08	
40036	80.74	0.02	
40037	161.48	0.04	
40038	484.68	0.12	
40039	323.04	0.08	
40040	646.07	0.16	
40041	888.37	0.22	
40042	161.48	0.04	
40043	403.86	0.10	
40044	80.74	0.02	
40045	80.82	0.02	
40046	484.60	0.12	
40047	80.82	0.02	
40048	323.12	0.08	
40049	3958.17	0.98	
40050	161.48	0.04	
40051	19063.46	4.71	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40052	403.77	0.10	
40053	969.02	0.24	
40054	1211.82	0.30	
40055	80.74	0.02	
40056	10662.61	2.63	
40057	1211.41	0.30	
40058	242.30	0.06	
40061	1292.14	0.32	
40062	726.81	0.18	
40063	1615.35	0.40	
40064	403.86	0.10	
40065	80.82	0.02	
40066	1130.67	0.28	
40068	2342.57	0.58	
40069	1373.05	0.34	
40070	80.74	0.02	
40071	80.74	0.02	
40072	888.54	0.22	
40073	16559.49	4.09	
40074	80.82	0.02	
40076	80.74	0.02	
40080	807.71	0.20	
40081	323.04	0.08	
40082	242.38	0.06	
40084	323.04	0.08	
40086	888.29	0.22	
40087	3392.25	0.84	
40088	1212.41	0.30	
40089	1050.68	0.26	
40090	161.48	0.04	
40091	323.04	0.08	
40092	888.62	0.22	
40093	161.56	0.04	
40094	17367.71	4.29	
40095	80.74	0.02	
40096	2180.68	0.54	
40097	1049.93	0.26	
40099	969.27	0.24	
40100	727.06	0.18	
40101	242.30	0.06	
40103	242.21	0.06	
40104	80.74	0.02	
40105	80.74	0.02	
40106	242.55	0.06	
40107	242.30	0.06	
40108	646.24	0.16	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40109	403.86	0.10	
40110	161.64	0.04	
40111	727.06	0.18	
40112	80.74	0.02	
40113	726.98	0.18	
40114	80.74	0.02	
40115	80.74	0.02	
40117	323.12	0.08	
40119	80.74	0.02	
40121	323.04	0.08	
40123	484.60	0.12	
40125	403.94	0.10	
40127	1776.91	0.44	
40129	242.30	0.06	
40130	161.48	0.04	
40131	565.33	0.14	
40132	2746.85	0.68	
40133	1453.87	0.36	
40134	2261.84	0.56	
40135	403.77	0.10	
40136	1050.51	0.26	
40137	242.30	0.06	
40138	80.82	0.02	
40139	242.38	0.06	
40140	161.56	0.04	
40141	80.74	0.02	
40142	161.64	0.04	
40143	646.07	0.16	
40144	161.56	0.04	
40145	161.56	0.04	
40146	807.97	0.20	
40147	323.04	0.08	
40148	565.92	0.14	
40149	80.91	0.02	
40151	485.10	0.12	
40152	403.86	0.10	
40153	403.94	0.10	
40154	323.12	0.08	
40155	17367.46	4.29	
40157	242.21	0.06	
40158	11874.35	2.93	
40159	565.42	0.14	
40160	80.82	0.02	
40161	484.60	0.12	
40162	403.86	0.10	
40163	646.24	0.16	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40167	403.77	0.10	
40168	1292.39	0.32	
40169	403.86	0.10	
40170	161.56	0.04	
40171	726.98	0.18	
40172	403.77	0.10	
40172	565.33	0.14	
40177	646.24	0.16	
40178	1130.83	0.28	
40179	80.74	0.02	
40182	484.60	0.12	
40183	3068.71	0.76	
40184	888.45	0.22	
40185	80.74	0.02	
40186	242.30	0.06	
40187	323.20	0.08	
40188	3795.61	0.94	
40189	323.04	0.08	
40190	565.92	0.14	
40191	5655.18	1.40	
40192	888.54	0.22	
40193	161.48	0.04	
40194	1130.75	0.28	
40195	1292.65	0.32	
40196	565.33	0.14	
40198	323.04	0.08	
40199	403.77	0.10	
40200	807.97	0.20	
40201	1050.10	0.26	
40202	11631.71	2.87	
40205	484.68	0.12	
40206	484.60	0.12	
40207	161.56	0.04	
40208	2908.58	0.72	
40209	403.77	0.10	
40210	1292.14	0.32	
40211	4362.36	1.08	
40212	80.74	0.02	
40213	565.33	0.14	
40215	1292.14	0.32	
40216	161.56	0.04	
40217	161.48	0.04	
40221	888.54	0.22	
40222	403.77	0.10	
40223	2099.77	0.52	
40224	242.30	0.06	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40225	484.68	0.12	
40226	1454.12	0.36	
40227	727.56	0.18	
40228	80.74	0.02	
40229	242.30	0.06	
40230	888.29	0.22	
40231	565.33	0.14	
40232	1131.00	0.28	
40233	1938.80	0.48	
40234	161.48	0.04	
40235	323.12	0.08	
40236	242.30	0.06	
40237	1049.85	0.26	
40238	1939.30	0.48	
40239	4765.64	1.18	
40240	323.04	0.08	
40241	161.56	0.04	
40242	242.30	0.06	
40243	403.94	0.10	
40244	1534.44	0.38	
40245	565.50	0.14	
40246	161.56	0.04	
40247	646.07	0.16	
40248	403.86	0.10	
40249	161.73	0.04	
40250	80.74	0.02	
40251	1372.88	0.34	
40252	323.04	0.08	
40255	646.07	0.16	
40256	80.74	0.02	
40257	323.12	0.08	
40258	242.38	0.06	
40260	565.33	0.14	
40261	403.77	0.10	
40272	80.74	0.02	
40273	1211.32	0.30	
40274	1211.41	0.30	
40275	2261.25	0.56	
40276	161.56	0.04	
40277	888.62	0.22	
40278	161.48	0.04	
40279	646.16	0.16	
40283	565.50	0.14	
40284	80.74	0.02	
40285	646.24	0.16	
40286	807.71	0.20	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40288	242.30	0.06	
40290	1373.13	0.34	
40291	484.76	0.12	
40292	1373.30	0.34	
40293	969.44	0.24	
40295	404.19	0.10	
40296	1695.92	0.42	
40297	1534.44	0.38	
40299	807.55	0.20	
40362	6704.35	1.66	
40363	807.71	0.20	
40365	403.86	0.10	
40366	323.04	0.08	
40367	161.48	0.04	
40368	403.94	0.10	
40369	80.82	0.02	
40370	403.94	0.10	
40371	888.45	0.22	
40373	727.14	0.18	
40374	2665.28	0.66	
40375	1455.21	0.36	
40376	161.56	0.04	
40377	2342.16	0.58	
40378	80.82	0.02	
40379	161.56	0.04	
40380	242.30	0.06	
40381	242.38	0.06	
40382	242.30	0.06	
40383	888.62	0.22	
40384	1130.58	0.28	
40385	80.74	0.02	
40386	888.45	0.22	
40387	242.30	0.06	
40388	323.04	0.08	
40389	322.95	0.08	
40390	242.38	0.06	
40391	242.38	0.06	
40392	242.21	0.06	
40393	565.33	0.14	
40395	242.30	0.06	
40396	969.27	0.24	
40397	565.25	0.14	
40398	888.29	0.22	
40399	726.98	0.18	
40400	1454.04	0.36	
40401	1050.10	0.26	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40403	2503.63	0.62	
40404	80.74	0.02	
40405	2342.07	0.58	
40406	646.07	0.16	
40408	242.30	0.06	
40409	484.60	0.12	
40410	807.63	0.20	
40411	80.74	0.02	
40412	1130.75	0.28	
40413	1453.95	0.36	
40414	16236.54	4.01	
40415	161.64	0.04	
40416	1696.59	0.42	
40420	969.27	0.24	
40421	323.04	0.08	
40422	242.55	0.06	
40423	323.12	0.08	
40425	565.42	0.14	
40426	80.74	0.02	
40427	161.48	0.04	
40432	888.62	0.22	
40433	1453.95	0.36	
40434	80.74	0.02	
40435	80.82	0.02	
40436	323.12	0.08	
40437	1050.26	0.26	
40438	161.56	0.04	
40439	161.56	0.04	
40440	161.64	0.04	
40441	242.38	0.06	
40442	80.82	0.02	
40443	161.64	0.04	
40444	80.74	0.02	
40445	80.82	0.02	
40446	242.47	0.06	
40447	484.68	0.12	
40448	242.47	0.06	
40449	161.56	0.04	
40450	565.42	0.14	
40451	323.04	0.08	
40452	726.98	0.18	
40453	888.45	0.22	
40454	80.74	0.02	
40455	1534.69	0.38	
40456	726.81	0.18	
40457	969.27	0.24	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40458	726.98	0.18	
40459	80.91	0.02	
40460	161.73	0.04	
40461	484.60	0.12	
40462	484.51	0.12	
40463	969.19	0.24	
40464	888.45	0.22	
40465	726.81	0.18	
40466	101617.80	25.11	
40467	484.68	0.12	
40469	565.33	0.14	
40470	242.30	0.06	
40471	242.38	0.06	
40473	242.47	0.06	
40474	1049.85	0.26	
40475	80.91	0.02	
40476	80.82	0.02	
40477	1050.18	0.26	
40478	242.21	0.06	
40479	1938.38	0.48	
40480	403.86	0.10	
40481	565.50	0.14	
40482	565.50	0.14	
40483	807.55	0.20	
40484	80.74	0.02	
40485	565.42	0.14	
40486	565.42	0.14	
40487	242.30	0.06	
40488	726.89	0.18	
40489	646.07	0.16	
40500	969.36	0.24	
40501	807.63	0.20	
40502	1293.48	0.32	
40506	1857.39	0.46	
40507	888.62	0.22	
40508	161.64	0.04	
40510	2746.52	0.68	
40511	726.98	0.18	
40512	1211.49	0.30	
40514	323.04	0.08	
40515	726.98	0.18	
40516	242.21	0.06	
40520	484.60	0.12	
40523	1049.85	0.26	
40524	403.77	0.10	
40525	80.82	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40530	5493.11	1.36	
40531	323.37	0.08	
40532	726.98	0.18	
40533	161.48	0.04	
40535	323.04	0.08	
40536	80.74	0.02	
40537	80.82	0.02	
40538	242.30	0.06	
40539	80.74	0.02	
40540	161.48	0.04	
40541	484.68	0.12	
40542	888.45	0.22	
40543	484.60	0.12	
40544	1211.57	0.30	
40545	80.74	0.02	
40546	1050.01	0.26	
40547	242.47	0.06	
40548	403.86	0.10	
40549	161.48	0.04	
40550	403.77	0.10	
40551	161.56	0.04	
40552	80.74	0.02	
40553	242.30	0.06	
40554	80.82	0.02	
40555	80.74	0.02	
40556	484.60	0.12	
40557	3715.79	0.92	
40558	403.86	0.10	
40559	726.98	0.18	
40560	323.04	0.08	
40561	161.56	0.04	
40561	1131.00	0.28	
40562	242.30	0.06	
40563	1050.18	0.26	
40564	161.48	0.04	
40565	323.12	0.08	
40566	323.12	0.08	
40567	323.04	0.08	
40568	484.60	0.12	
40569	323.20	0.08	
40570	565.42	0.14	
40572	969.11	0.24	
40573	57998.68	14.33	
40574	80.82	0.02	
40575	403.94	0.10	
40576	80.74	0.02	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40577	404.02	0.10	
40578	242.30	0.06	
40579	242.30	0.06	
40580	727.56	0.18	
40581	1454.04	0.36	
40583	242.38	0.06	
40584	726.98	0.18	
40585	403.86	0.10	
40586	161.48	0.04	
40587	726.98	0.18	
40588	161.64	0.04	
40589	646.74	0.16	
40590	161.48	0.04	
40591	80.74	0.02	
40592	4442.77	1.10	
40593	242.55	0.06	
40595	484.51	0.12	
40596	323.12	0.08	
40597	323.12	0.08	
40598	808.13	0.20	
40599	80.74	0.02	
40600	2988.31	0.74	
40601	80.74	0.02	
40602	80.74	0.02	
40603	404.02	0.10	
40604	242.38	0.06	
40605	323.12	0.08	
40606	161.48	0.04	
40607	242.30	0.06	
40608	242.30	0.06	
40609	484.68	0.12	
40610	161.56	0.04	
40611	484.68	0.12	
40612	161.56	0.04	
40613	323.04	0.08	
40614	565.42	0.14	
40615	1050.01	0.26	
40616	161.56	0.04	
40617	1292.23	0.32	
40619	484.60	0.12	
40620	646.74	0.16	
40621	484.51	0.12	
40622	242.30	0.06	
40623	80.74	0.02	
40624	888.54	0.22	
40625	323.12	0.08	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40626	161.56	0.04	
40627	323.04	0.08	
40628	242.21	0.06	
40629	242.21	0.06	
40630	161.48	0.04	
40631	80.74	0.02	
40632	1292.31	0.32	
40633	323.12	0.08	
40634	80.74	0.02	
40635	565.33	0.14	
40636	242.21	0.06	
40637	80.74	0.02	
40638	484.51	0.12	
40640	80.74	0.02	
40641	242.30	0.06	
40642	161.56	0.04	
40643	242.38	0.06	
40645	242.30	0.06	
40646	726.98	0.18	
40647	403.94	0.10	
40649	888.54	0.22	
40650	161.48	0.04	
40651	1049.85	0.26	
40652	1049.85	0.26	
40653	484.60	0.12	
40654	323.12	0.08	
40655	1130.67	0.28	
40656	80.74	0.02	
40658	484.60	0.12	
40659	80.74	0.02	
40660	80.82	0.02	
40664	807.80	0.20	
40667	80.82	0.02	
40668	403.94	0.10	
40670	565.33	0.14	
40671	565.25	0.14	
40672	80.82	0.02	
40673	323.12	0.08	
40674	1130.92	0.28	
40675	1211.57	0.30	
40676	565.25	0.14	
40677	403.77	0.10	
40680	403.77	0.10	
40681	403.86	0.10	
40682	323.20	0.08	
40683	6946.82	1.72	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40685	161.56	0.04	
40689	161.48	0.04	
40690	161.48	0.04	
40692	80.74	0.02	
40693	80.74	0.02	
40694	323.12	0.08	
40695	484.68	0.12	
40698	242.21	0.06	
40703	80.74	0.02	
40706	80.82	0.02	
40708	242.30	0.06	
40709	161.48	0.04	
40710	80.74	0.02	
40711	888.45	0.22	
40712	161.56	0.04	
40713	484.68	0.12	
40714	323.04	0.08	
40715	323.12	0.08	
40716	14909.02	3.68	
40717	404.19	0.10	
40718	1211.66	0.30	
40719	323.04	0.08	
40721	726.98	0.18	
40722	565.33	0.14	
40723	242.30	0.06	
40724	565.33	0.14	
40725	646.07	0.16	
40726	161.48	0.04	
40727	323.12	0.08	
40728	173994.13	42.99	
40729	80.74	0.02	
40730	242.30	0.06	
40731	888.54	0.22	
40732	80.74	0.02	
40733	484.85	0.12	
40734	161.48	0.04	
40735	80.82	0.02	
40736	242.38	0.06	
40737	484.60	0.12	
40738	888.37	0.22	
40739	161.48	0.04	
40740	4685.23	1.16	
40741	242.30	0.06	
40742	484.93	0.12	
40746	323.04	0.08	
40747	80.74	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40749	161.56	0.04	
40750	242.30	0.06	
40751	807.88	0.20	
40752	80.91	0.02	
40753	242.30	0.06	
40754	161.56	0.04	
40755	242.21	0.06	
40756	565.58	0.14	
40757	1211.74	0.30	
40758	565.50	0.14	
40759	242.30	0.06	
40760	242.21	0.06	
40763	80.82	0.02	
40764	161.56	0.04	
40765	646.16	0.16	
40766	80.82	0.02	
40767	80.82	0.02	
40768	242.30	0.06	
40769	80.82	0.02	
40770	484.60	0.12	
40771	323.12	0.08	
40772	161.64	0.04	
40773	565.33	0.14	
40774	161.56	0.04	
40777	565.33	0.14	
40778	13327.88	3.29	
40779	403.86	0.10	
40783	242.38	0.06	
40784	80.74	0.02	
40786	484.68	0.12	
40787	80.82	0.02	
40789	215513.05	53.25	
40790	403.86	0.10	
40791	161.56	0.04	
40792	80.74	0.02	
40793	403.77	0.10	
40795	484.93	0.12	
40796	323.04	0.08	
40797	242.47	0.06	
40798	323.37	0.08	
40801	565.92	0.14	
40802	403.86	0.10	
40803	80.82	0.02	
40804	80.74	0.02	
40805	2342.74	0.58	
40809	565.33	0.14	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40818	242.30	0.06	
40819	80.74	0.02	
40820	242.30	0.06	
40821	323.12	0.08	
40822	484.60	0.12	
40823	404.19	0.10	
40824	161.56	0.04	
40825	242.30	0.06	
40826	242.30	0.06	
40827	80.74	0.02	
40828	80.74	0.02	
40829	80.74	0.02	
40831	646.74	0.16	
40832	484.60	0.12	
40833	323.04	0.08	
40834	646.24	0.16	
40835	323.04	0.08	
40836	80.74	0.02	
40837	646.07	0.16	
40838	2180.85	0.54	
40840	484.68	0.12	
40841	80.91	0.02	
40842	242.38	0.06	
40844	80.82	0.02	
40847	403.86	0.10	
40848	1130.58	0.28	
40849	242.38	0.06	
40850	484.51	0.12	
40851	80.82	0.02	
40852	242.55	0.06	
40856	7027.64	1.74	
40857	323.04	0.08	
40858	726.81	0.18	
40859	323.12	0.08	
40860	80.91	0.02	
40861	323.37	0.08	
40862	161.48	0.04	
40863	646.24	0.16	
40864	80.74	0.02	
40865	807.63	0.20	
40869	888.45	0.22	
40870	646.24	0.16	
40872	1453.62	0.36	
40873	323.20	0.08	
40874	1130.58	0.28	
40875	2181.68	0.54	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40876	80.82	0.02	
40877	403.77	0.10	
40880	242.30	0.06	
40888	323.12	0.08	
40889	323.12	0.08	
40892	28353.02	7.01	
40893	888.54	0.22	
40894	1696.34	0.42	
40895	1777.07	0.44	
40896	807.71	0.20	
40897	323.12	0.08	
40898	403.77	0.10	
40899	888.37	0.22	
40900	80.74	0.02	
40901	242.21	0.06	
40902	484.68	0.12	
40903	161.56	0.04	
40904	242.38	0.06	
40906	80.82	0.02	
40907	1534.86	0.38	
40909	726.81	0.18	
40912	242.30	0.06	
40913	403.86	0.10	
40914	646.16	0.16	
40915	484.60	0.12	
40916	565.42	0.14	
40917	565.42	0.14	
40918	484.60	0.12	
40920	323.12	0.08	
40922	80.74	0.02	
40923	403.86	0.10	
40924	9693.25	2.40	
40926	969.27	0.24	
40927	888.37	0.22	
40928	565.33	0.14	
40930	80.82	0.02	
40931	1372.88	0.34	
40932	322.95	0.08	
40933	161.48	0.04	
40934	242.38	0.06	
40936	1615.43	0.40	
40937	485.01	0.12	
40938	161.56	0.04	
40939	80.74	0.02	
40940	403.77	0.10	
40941	85704.88	21.18	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40942	565.75	0.14	
40947	2019.37	0.50	
40948	80.74	0.02	
40949	1292.23	0.32	
40950	322.95	0.08	
40951	646.74	0.16	
40952	242.38	0.06	
40954	808.38	0.20	
40955	161.48	0.04	
40956	161.73	0.04	
40957	646.24	0.16	
40959	646.16	0.16	
40960	242.47	0.06	
40961	970.03	0.24	
40962	27140.53	6.71	
40963	807.63	0.20	
40964	6623.53	1.64	
40966	1131.00	0.28	
40967	242.21	0.06	
40968	161.64	0.04	
40969	727.40	0.18	
40970	242.38	0.06	
40972	80.74	0.02	
40973	80.82	0.02	
40974	807.71	0.20	
40975	484.68	0.12	
40976	646.24	0.16	
40977	565.33	0.14	
40978	646.24	0.16	
40979	80.74	0.02	
40980	1938.72	0.48	
40981	484.68	0.12	
40982	646.16	0.16	
40983	6865.49	1.70	
40984	565.33	0.14	
40985	484.76	0.12	
40986	2100.86	0.52	
40987	3473.32	0.86	
40988	161.56	0.04	
40989	3150.04	0.78	
40990	5008.02	1.24	
40991	3231.03	0.80	
40992	1292.23	0.32	
40993	80.74	0.02	
40994	80.74	0.02	
40995	80.82	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40996	242.21	0.06	
40997	80.91	0.02	
40998	565.50	0.14	
40999	565.33	0.14	
41000	807.88	0.20	
41001	1049.85	0.26	
41002	1534.86	0.38	
41003	1211.41	0.30	
41004	1534.78	0.38	
41005	2261.67	0.56	
41006	403.94	0.10	
41007	3554.40	0.88	
41008	807.63	0.20	
41009	1131.75	0.28	
41010	323.12	0.08	
41011	1292.14	0.32	
41012	161.56	0.04	
41013	565.25	0.14	
41014	80.82	0.02	
41015	1697.59	0.42	
41016	485.01	0.12	
41017	1292.23	0.32	
41018	323.12	0.08	
41019	888.96	0.22	
41021	484.51	0.12	
41022	323.12	0.08	
41025	403.77	0.10	
41026	80.74	0.02	
41027	161.56	0.04	
41029	807.88	0.20	
41032	80.82	0.02	
41033	403.94	0.10	
41034	565.50	0.14	
41036	80.74	0.02	
41039	1130.83	0.28	
41041	323.12	0.08	
41042	242.30	0.06	
41043	323.20	0.08	
41057	323.04	0.08	low flow
41057	915042.17	226.11	high flow
41058	5411.96	1.34	
41059	161.56	0.04	
41063	969.11	0.24	
41072	242.21	0.06	
41101	484.60	0.12	
41102	1131.50	0.28	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41103	80.74	0.02	
41104	80.74	0.02	
41105	1292.14	0.32	
41106	726.98	0.18	
41108	323.04	0.08	
41109	323.12	0.08	
41111	565.42	0.14	
41112	565.25	0.14	
41117	1776.65	0.44	
41120	1857.48	0.46	
41121	242.30	0.06	
41122	646.07	0.16	
41123	2665.36	0.66	
41124	242.47	0.06	
41125	403.77	0.10	
41126	80.82	0.02	
41127	807.63	0.20	
41128	80.74	0.02	
41130	23021.47	5.69	
41131	3553.98	0.88	
41132	726.89	0.18	
41133	242.38	0.06	
41134	161.56	0.04	
41135	80.74	0.02	
41137	646.07	0.16	
41138	565.67	0.14	
41142	242.38	0.06	
41144	484.60	0.12	
41156	2261.50	0.56	
41159	808.47	0.20	
41160	80.74	0.02	
41161	80.91	0.02	
41162	242.21	0.06	
41163	242.21	0.06	
41164	646.24	0.16	
41165	403.94	0.10	
41166	323.12	0.08	
41167	646.16	0.16	
41168	484.76	0.12	
41169	80.74	0.02	
41170	1211.66	0.30	
41171	16559.49	4.09	
41172	1373.22	0.34	
41173	484.68	0.12	
41174	403.77	0.10	
41175	403.77	0.10	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41176	161.48	0.04	
41177	161.64	0.04	
41178	484.68	0.12	
41179	403.94	0.10	
41180	80.74	0.02	
41181	403.77	0.10	
41182	726.98	0.18	
41183	161.48	0.04	
41184	1615.60	0.40	
41185	888.70	0.22	
41199	807.80	0.20	
41210	80.82	0.02	
41212	161.64	0.04	
41231	593790.37	146.73	
41238	888.37	0.22	
41239	2342.24	0.58	
41261	1534.86	0.38	
41268	807.63	0.20	
41270	565.50	0.14	
41277	161.48	0.04	
41278	807.63	0.20	
41279	969.36	0.24	
41280	1131.00	0.28	
41281	2504.05	0.62	
41282	1050.18	0.26	
41283	161.56	0.04	
41284	1292.23	0.32	
41285	1615.35	0.40	
41286	565.50	0.14	
41287	161.48	0.04	
41288	2100.11	0.52	
41289	726.81	0.18	
41299	1211.32	0.30	
41300	323.04	0.08	
41301	323.12	0.08	
41367	845250.09	208.86	
41401	2100.61	0.52	
41402	404.02	0.10	
41403	161.48	0.04	
41404	161.48	0.04	
41406	161.64	0.04	
41407	242.30	0.06	
41408	565.42	0.14	
41415	969.27	0.24	
41416	888.54	0.22	
41417	727.06	0.18	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41419	969.19	0.24	
41420	161.56	0.04	
41425	6058.53	1.50	
41426	80.91	0.02	
41427	1130.83	0.28	
41428	969.36	0.24	
41429	323.04	0.08	
41430	646.32	0.16	
41433	80.82	0.02	
41435	726.98	0.18	
41436	242.30	0.06	
41437	14297.49	3.53	
41438	646.74	0.16	
41439	807.55	0.20	
41440	646.16	0.16	
41441	322.95	0.08	
41442	726.98	0.18	
41443	5896.47	1.46	
41444	403.86	0.10	
41445	80.82	0.02	
41446	1453.62	0.36	
41447	970.11	0.24	
41448	969.11	0.24	
41449	808.05	0.20	
41450	242.38	0.06	
41451	807.97	0.20	
41452	161.56	0.04	
41453	10581.53	2.61	
41454	646.41	0.16	
41455	565.33	0.14	
41459	80.91	0.02	
41460	80.74	0.02	
41461	242.30	0.06	
41462	565.33	0.14	
41463	484.60	0.12	
41464	323.12	0.08	
41465	484.60	0.12	
41466	889.29	0.22	
41467	161.64	0.04	
41468	1373.22	0.34	
41469	323.04	0.08	
41470	161.48	0.04	
41471	242.21	0.06	
41472	969.94	0.24	
41473	807.55	0.20	
41474	484.51	0.12	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41475	2423.90	0.60	
41478	161.48	0.04	
41479	807.80	0.20	
41493	242.30	0.06	
41494	161.64	0.04	
41495	807.63	0.20	
41496	646.16	0.16	
41497	1454.04	0.36	
41505	33684.49	8.32	
41515	565.25	0.14	
41517	80.74	0.02	
41522	727.48	0.18	
41600	2100.19	0.52	
41601	322.95	0.08	
41602	242.30	0.06	
41603	1211.74	0.30	
41604	1211.74	0.30	
41605	1211.74	0.30	
41606	403.94	0.10	
41607	403.86	0.10	
41608	888.45	0.22	
41609	242.38	0.06	
41610	1049.85	0.26	
41611	888.96	0.22	
41612	403.86	0.10	
41613	727.06	0.18	
41614	726.98	0.18	
41615	565.92	0.14	
41616	565.33	0.14	
41617	1130.83	0.28	
41618	969.36	0.24	
41619	646.74	0.16	
41620	485.10	0.12	
41621	485.10	0.12	
41622	726.81	0.18	
41623	242.21	0.06	
41624	66560.18	16.45	
41625	161.48	0.04	
41626	161.56	0.04	
41627	13327.55	3.29	
41628	80.74	0.02	
41629	80.74	0.02	
41630	403.94	0.10	
41633	242.38	0.06	
41634	646.07	0.16	
41635	10904.65	2.69	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41637	59451.47	14.69	
41638	1858.23	0.46	
41639	726.89	0.18	
41640	565.33	0.14	
41641	484.60	0.12	
41642	323.12	0.08	
41643	80.74	0.02	
41644	565.33	0.14	
41645	322.95	0.08	
41646	161.64	0.04	
41647	84331.83	20.84	
41648	1211.66	0.30	
41649	484.51	0.12	
41650	80.74	0.02	
41651	2019.12	0.50	
41652	1859.32	0.46	
41653	1130.67	0.28	
41654	80.82	0.02	
41655	80.74	0.02	
41656	323.12	0.08	
41657	80.82	0.02	
41658	80.82	0.02	
41659	242.55	0.06	
41660	969.11	0.24	
41661	484.51	0.12	
41662	242.30	0.06	
41663	242.38	0.06	
41664	726.98	0.18	
41665	807.55	0.20	
41666	1211.41	0.30	
41667	404.19	0.10	
41668	1050.77	0.26	
41669	80.82	0.02	
41670	484.68	0.12	
41671	403.86	0.10	
41672	969.11	0.24	
41673	1212.41	0.30	
41700	2584.79	0.64	
41701	726.89	0.18	
41702	2342.57	0.58	
41703	1212.58	0.30	
41704	2423.40	0.60	
41705	1049.93	0.26	
41706	807.63	0.20	
41707	6382.74	1.58	
41708	484.76	0.12	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41709	1292.06	0.32	
41710	2746.35	0.68	
41711	484.60	0.12	
41714	403.94	0.10	
41715	1615.60	0.40	
41716	403.86	0.10	
41720	80.74	0.02	
41721	646.66	0.16	
41722	565.33	0.14	
41725	484.68	0.12	
41728	242.21	0.06	
41729	323.12	0.08	
41730	484.93	0.12	
41731	323.12	0.08	
41733	484.76	0.12	
41734	80.74	0.02	
41735	323.12	0.08	
41736	80.82	0.02	
41749	565.33	0.14	
41750	80.82	0.02	
41752	484.68	0.12	
40037	164803.77	40.72	
40166	290474.34	71.78	
40173	137966.73	34.09	
40174	519394.80	128.34	
40175	116157.93	28.70	
40180	379490.48	93.77	
40181	347906.18	85.97	
40203	102506.67	25.33	
40204	85463.34	21.12	
40219	76656.62	18.94	
40220	969.27	0.24	
40253	206222.83	50.96	
40259	242.38	0.06	
40269	218501.03	53.99	
40289	646.24	0.16	
40294	323.12	0.08	
40364	1938.13	0.48	
40417	3311.77	0.82	
40419	510427.44	126.13	
40430	1373.22	0.34	
40468	100567.96	24.85	
40472	197824.73	48.88	
40490	108645.52	26.85	
40521	505261.33	124.85	
40522	323.12	0.08	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40657	242.55	0.06	
40701	89420.92	22.10	
40731	137262.51	33.92	
40743	105332.08	26.03	
40744	80.74	0.02	
40745	403.94	0.10	
40748	646.07	0.16	
40761	1211.41	0.30	
40785	82795.80	20.46	
40800	79161.42	19.56	
40806	2261.42	0.56	
40807	323.04	0.08	
40808	565.42	0.14	
40881	161.56	0.04	
40910	646.07	0.16	
40911	323.04	0.08	
40935	5896.97	1.46	
40958	167773.37	41.46	
40965	8642.82	2.14	
41030	157757.34	38.98	
41031	78434.36	19.38	
41035	161.56	0.04	
41100	808.47	0.20	
41113	19467.57	4.81	
41114	148791.40	36.77	
41115	627234.87	154.99	
41143	565.50	0.14	
41145	888.45	0.22	
41222	76334.75	18.86	
41226	128920.98	31.86	
41227	324803.90	80.26	
41228	541609.97	133.83	
41232	447260.89	110.52	
41367	845250.09	208.86	
41421	969.27	0.24	
41456	726.98	0.18	
41504	101214.03	25.01	
41531	267612.51	66.13	

APPENDIX F – KARST FEATURE LAND USE

Table F-1: Section 4 Corridor and Karst Feature Land Use

Section 4 Corridor

ACRES	LANDUSE
4.8039	Water
4.2344	Developed Land
9.2956	Developed Land
4281.7792	Upland Habitat
57.1281	Upland Habitat
0.6568	Upland Habitat
1780.6349	Agricultural Land
1370.7780	Agricultural Land
5.6567	Wetland Habitat
0.4448	Wetland Habitat

Karst Features

ID	ACRES	LANDUSE
40001	0.13	Agricultural Land
40001	0.11	Agricultural Land
40002	0.02	Agricultural Land
40002	0.04	Agricultural Land
40004	0.01	Agricultural Land
40004	0.05	Agricultural Land
40005	0.07	Upland Habitat
40005	0.00	Agricultural Land
40005	0.13	Agricultural Land
40006	0.09	Upland Habitat
40006	0.01	Agricultural Land
40006	0.07	Agricultural Land
40007	0.02	Upland Habitat
40008	0.08	Upland Habitat
40008	0.00	Agricultural Land
40009	0.12	Upland Habitat
40009	0.02	Agricultural Land
40010	0.02	Agricultural Land
40011	0.13	Agricultural Land
40011	0.11	Agricultural Land
40012	0.02	Agricultural Land
40012	0.04	Agricultural Land
40016	0.00	Upland Habitat
40016	0.02	Agricultural Land
40017	0.02	Upland Habitat
40018	0.14	Upland Habitat
40019	0.04	Upland Habitat
40020	0.22	Upland Habitat
40021	0.06	Upland Habitat
40022	1.78	Upland Habitat
40023	0.06	Upland Habitat

ID	ACRES	LANDUSE
40024	0.12	Upland Habitat
40025	0.02	Upland Habitat
40026	0.48	Upland Habitat
40027	0.02	Agricultural Land
40028	0.02	Upland Habitat
40028	0.00	Agricultural Land
40029	0.02	Upland Habitat
40029	0.00	Agricultural Land
40030	0.14	Upland Habitat
40030	0.08	Upland Habitat
40031	0.06	Upland Habitat
40032	0.16	Upland Habitat
40033	0.06	Upland Habitat
40033	0.02	Upland Habitat
40034	0.08	Upland Habitat
40036	0.00	Upland Habitat
40036	0.02	Agricultural Land
40037	0.04	Agricultural Land
40038	0.12	Upland Habitat
40039	0.08	Upland Habitat
40040	0.16	Upland Habitat
40041	0.22	Upland Habitat
40042	0.04	Upland Habitat
40043	0.10	Upland Habitat
40044	0.02	Upland Habitat
40045	0.02	Upland Habitat
40046	0.12	Upland Habitat
40047	0.02	Upland Habitat
40048	0.08	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40049	0.80	Upland Habitat
40049	0.14	Agricultural Land
40049	0.04	Agricultural Land
40050	0.04	Upland Habitat
40051	3.33	Upland Habitat
40051	1.19	Agricultural Land
40051	0.19	Agricultural Land
40052	0.10	Upland Habitat
40053	0.12	Upland Habitat
40053	0.12	Agricultural Land
40054	0.28	Upland Habitat
40054	0.02	Agricultural Land
40055	0.02	Upland Habitat
40056	2.19	Upland Habitat
40056	0.44	Agricultural Land
40057	0.16	Upland Habitat
40057	0.14	Agricultural Land
40058	0.06	Upland Habitat
40058	0.00	Agricultural Land
40061	0.32	Agricultural Land
40062	0.18	Agricultural Land
40063	0.40	Agricultural Land
40064	0.03	Upland Habitat
40064	0.07	Agricultural Land
40065	0.02	Agricultural Land
40066	0.14	Upland Habitat
40066	0.07	Agricultural Land
40066	0.07	Agricultural Land
40068	0.58	Agricultural Land
40069	0.11	Upland Habitat
40069	0.20	Agricultural Land
40069	0.03	Agricultural Land
40070	0.02	Upland Habitat
40071	0.02	Upland Habitat
40072	0.05	Upland Habitat
40072	0.16	Agricultural Land
40073	3.74	Agricultural Land
40073	0.35	Agricultural Land
40074	0.02	Agricultural Land
40076	0.02	Agricultural Land
40080	0.16	Agricultural Land
40080	0.04	Agricultural Land
40081	0.08	Agricultural Land
40082	0.06	Agricultural Land

ID	ACRES	LANDUSE
40084	0.05	Agricultural Land
40084	0.03	Agricultural Land
40086	0.00	Developed Land
40086	0.13	Upland Habitat
40086	0.07	Agricultural Land
40086	0.02	Agricultural Land
40087	0.84	Agricultural Land
40088	0.30	Agricultural Land
40089	0.26	Agricultural Land
40090	0.00	Agricultural Land
40090	0.04	Agricultural Land
40091	0.07	Agricultural Land
40091	0.01	Agricultural Land
40092	0.22	Agricultural Land
40093	0.04	Agricultural Land
40094	0.24	Upland Habitat
40094	0.56	Agricultural Land
40094	3.48	Agricultural Land
40095	0.02	Agricultural Land
40096	0.54	Agricultural Land
40097	0.23	Agricultural Land
40097	0.03	Agricultural Land
40099	0.15	Agricultural Land
40099	0.09	Agricultural Land
40100	0.09	Agricultural Land
40100	0.09	Agricultural Land
40101	0.06	Agricultural Land
40103	0.06	Agricultural Land
40104	0.02	Agricultural Land
40105	0.02	Agricultural Land
40106	0.06	Agricultural Land
40107	0.06	Agricultural Land
40108	0.15	Agricultural Land
40108	0.01	Agricultural Land
40109	0.10	Agricultural Land
40110	0.04	Agricultural Land
40111	0.18	Agricultural Land
40112	0.02	Agricultural Land
40113	0.18	Agricultural Land
40114	0.02	Agricultural Land
40115	0.02	Agricultural Land
40117	0.08	Agricultural Land
40119	0.02	Agricultural Land
40121	0.08	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40123	0.12	Agricultural Land
40125	0.10	Agricultural Land
40127	0.44	Agricultural Land
40129	0.06	Agricultural Land
40130	0.01	Agricultural Land
40130	0.03	Agricultural Land
40131	0.13	Agricultural Land
40131	0.01	Agricultural Land
40132	0.62	Agricultural Land
40132	0.06	Agricultural Land
40133	0.19	Agricultural Land
40133	0.17	Agricultural Land
40134	0.50	Agricultural Land
40134	0.06	Agricultural Land
40135	0.09	Agricultural Land
40135	0.01	Agricultural Land
40136	0.21	Agricultural Land
40136	0.05	Agricultural Land
40137	0.06	Agricultural Land
40138	0.02	Agricultural Land
40139	0.04	Agricultural Land
40139	0.02	Agricultural Land
40140	0.03	Agricultural Land
40140	0.01	Agricultural Land
40141	0.02	Agricultural Land
40142	0.04	Agricultural Land
40143	0.12	Upland Habitat
40143	0.04	Agricultural Land
40144	0.04	Agricultural Land
40145	0.04	Agricultural Land
40146	0.20	Agricultural Land
40147	0.04	Agricultural Land
40147	0.04	Agricultural Land
40148	0.13	Agricultural Land
40148	0.01	Agricultural Land
40149	0.02	Agricultural Land
40151	0.09	Agricultural Land
40151	0.03	Agricultural Land
40152	0.02	Agricultural Land
40152	0.08	Agricultural Land
40153	0.10	Agricultural Land
40154	0.08	Agricultural Land
40155	0.06	Upland Habitat
40155	1.28	Agricultural Land
40155	2.96	Agricultural Land

ID	ACRES	LANDUSE
40157	0.06	Agricultural Land
40158	2.93	Agricultural Land
40159	0.14	Agricultural Land
40160	0.02	Agricultural Land
40161	0.12	Agricultural Land
40162	0.10	Agricultural Land
40163	0.16	Agricultural Land
40167	0.10	Upland Habitat
40168	0.32	Upland Habitat
40169	0.10	Agricultural Land
40170	0.04	Agricultural Land
40171	0.18	Upland Habitat
40172	0.24	Upland Habitat
40177	0.16	Upland Habitat
40178	0.23	Upland Habitat
40178	0.05	Agricultural Land
40179	0.02	Upland Habitat
40182	0.12	Upland Habitat
40183	0.71	Upland Habitat
40183	0.05	Agricultural Land
40184	0.22	Upland Habitat
40184	0.00	Agricultural Land
40185	0.02	Upland Habitat
40186	0.06	Upland Habitat
40187	0.08	Upland Habitat
40188	0.56	Upland Habitat
40188	0.38	Agricultural Land
40189	0.08	Upland Habitat
40190	0.14	Upland Habitat
40191	0.94	Upland Habitat
40191	0.45	Agricultural Land
40192	0.22	Upland Habitat
40193	0.04	Upland Habitat
40194	0.28	Upland Habitat
40195	0.32	Upland Habitat
40196	0.14	Upland Habitat
40198	0.08	Upland Habitat
40199	0.10	Upland Habitat
40200	0.20	Upland Habitat
40201	0.26	Upland Habitat
40202	2.39	Upland Habitat
40202	0.48	Agricultural Land
40205	0.07	Upland Habitat
40205	0.05	Upland Habitat
40206	0.12	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40207	0.01	Agricultural Land
40207	0.03	Agricultural Land
40208	0.57	Upland Habitat
40208	0.02	Upland Habitat
40208	0.11	Agricultural Land
40208	0.01	Agricultural Land
40209	0.08	Upland Habitat
40209	0.02	Agricultural Land
40210	0.17	Upland Habitat
40210	0.15	Agricultural Land
40211	0.87	Upland Habitat
40211	0.20	Agricultural Land
40212	0.02	Upland Habitat
40213	0.14	Upland Habitat
40215	0.20	Upland Habitat
40215	0.10	Agricultural Land
40215	0.02	Agricultural Land
40216	0.03	Upland Habitat
40216	0.01	Agricultural Land
40217	0.04	Agricultural Land
40221	0.16	Upland Habitat
40221	0.00	Agricultural Land
40221	0.05	Agricultural Land
40222	0.10	Agricultural Land
40223	0.25	Upland Habitat
40223	0.27	Agricultural Land
40224	0.00	Upland Habitat
40224	0.06	Agricultural Land
40225	0.03	Upland Habitat
40225	0.07	Agricultural Land
40225	0.01	Agricultural Land
40226	0.36	Upland Habitat
40227	0.18	Upland Habitat
40228	0.02	Upland Habitat
40229	0.06	Upland Habitat
40230	0.22	Upland Habitat
40231	0.14	Upland Habitat
40232	0.14	Upland Habitat
40232	0.02	Agricultural Land
40232	0.11	Agricultural Land
40233	0.48	Upland Habitat
40234	0.04	Upland Habitat
40235	0.08	Upland Habitat
40236	0.06	Upland Habitat

ID	ACRES	LANDUSE
40237	0.26	Upland Habitat
40237	0.00	Agricultural Land
40238	0.47	Upland Habitat
40238	0.00	Agricultural Land
40239	0.20	Upland Habitat
40239	0.49	Agricultural Land
40239	0.49	Agricultural Land
40240	0.08	Upland Habitat
40241	0.04	Upland Habitat
40242	0.06	Upland Habitat
40243	0.10	Upland Habitat
40244	0.37	Upland Habitat
40244	0.01	Agricultural Land
40245	0.14	Upland Habitat
40246	0.04	Upland Habitat
40247	0.14	Upland Habitat
40247	0.02	Agricultural Land
40248	0.10	Upland Habitat
40249	0.04	Upland Habitat
40250	0.01	Upland Habitat
40250	0.01	Agricultural Land
40251	0.22	Upland Habitat
40251	0.12	Agricultural Land
40252	0.08	Upland Habitat
40255	0.16	Upland Habitat
40256	0.02	Upland Habitat
40257	0.04	Upland Habitat
40257	0.04	Agricultural Land
40258	0.06	Agricultural Land
40260	0.14	Upland Habitat
40261	0.07	Upland Habitat
40261	0.03	Agricultural Land
40272	0.02	Agricultural Land
40273	0.21	Upland Habitat
40273	0.09	Agricultural Land
40274	0.23	Upland Habitat
40274	0.07	Agricultural Land
40275	0.30	Agricultural Land
40275	0.26	Agricultural Land
40276	0.04	Agricultural Land
40277	0.22	Agricultural Land
40278	0.04	Agricultural Land
40279	0.06	Upland Habitat
40279	0.10	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40283	0.13	Upland Habitat
40283	0.01	Agricultural Land
40284	0.02	Upland Habitat
40285	0.16	Upland Habitat
40286	0.20	Upland Habitat
40288	0.02	Agricultural Land
40288	0.04	Agricultural Land
40289	0.12	Agricultural Land
40289	0.04	Agricultural Land
40290	0.29	Upland Habitat
40290	0.05	Agricultural Land
40291	0.12	Upland Habitat
40292	0.31	Upland Habitat
40292	0.03	Agricultural Land
40293	0.13	Upland Habitat
40293	0.09	Agricultural Land
40293	0.02	Agricultural Land
40295	0.10	Upland Habitat
40296	0.37	Upland Habitat
40296	0.04	Agricultural Land
40297	0.37	Upland Habitat
40297	0.00	Agricultural Land
40299	0.20	Upland Habitat
40362	1.42	Agricultural Land
40362	0.24	Agricultural Land
40363	0.20	Upland Habitat
40365	0.09	Upland Habitat
40365	0.01	Agricultural Land
40366	0.08	Upland Habitat
40367	0.04	Upland Habitat
40368	0.07	Upland Habitat
40368	0.03	Agricultural Land
40369	0.02	Upland Habitat
40370	0.10	Upland Habitat
40371	0.16	Upland Habitat
40371	0.06	Agricultural Land
40373	0.01	Upland Habitat
40373	0.17	Agricultural Land
40374	0.33	Upland Habitat
40374	0.33	Agricultural Land
40375	0.31	Upland Habitat
40375	0.05	Agricultural Land
40376	0.04	Upland Habitat
40377	0.45	Upland Habitat
40377	0.13	Agricultural Land

ID	ACRES	LANDUSE
40378	0.02	Upland Habitat
40379	0.04	Upland Habitat
40380	0.06	Agricultural Land
40381	0.06	Upland Habitat
40382	0.06	Upland Habitat
40383	0.20	Upland Habitat
40383	0.02	Agricultural Land
40384	0.28	Upland Habitat
40385	0.02	Upland Habitat
40386	0.22	Upland Habitat
40387	0.06	Upland Habitat
40387	0.00	Agricultural Land
40388	0.08	Upland Habitat
40389	0.08	Upland Habitat
40390	0.06	Upland Habitat
40391	0.06	Upland Habitat
40392	0.06	Upland Habitat
40393	0.14	Upland Habitat
40395	0.06	Upland Habitat
40396	0.11	Upland Habitat
40396	0.13	Agricultural Land
40397	0.14	Upland Habitat
40398	0.22	Upland Habitat
40399	0.12	Upland Habitat
40399	0.06	Agricultural Land
40400	0.36	Upland Habitat
40400	0.00	Agricultural Land
40401	0.26	Upland Habitat
40403	0.30	Upland Habitat
40403	0.32	Agricultural Land
40404	0.02	Upland Habitat
40405	0.58	Upland Habitat
40406	0.16	Upland Habitat
40408	0.06	Upland Habitat
40409	0.12	Upland Habitat
40410	0.18	Upland Habitat
40410	0.02	Agricultural Land
40411	0.02	Upland Habitat
40412	0.28	Upland Habitat
40413	0.36	Upland Habitat
40414	4.01	Upland Habitat
40415	0.04	Upland Habitat
40416	0.37	Upland Habitat
40416	0.02	Agricultural Land
40416	0.02	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40420	0.24	Upland Habitat
40421	0.07	Upland Habitat
40421	0.01	Agricultural Land
40422	0.06	Upland Habitat
40423	0.08	Upland Habitat
40425	0.06	Upland Habitat
40425	0.08	Agricultural Land
40426	0.02	Upland Habitat
40427	0.04	Agricultural Land
40430	0.05	Upland Habitat
40430	0.29	Agricultural Land
40432	0.20	Upland Habitat
40432	0.01	Agricultural Land
40433	0.29	Upland Habitat
40433	0.07	Agricultural Land
40434	0.02	Agricultural Land
40435	0.02	Agricultural Land
40436	0.04	Upland Habitat
40436	0.04	Agricultural Land
40437	0.12	Upland Habitat
40437	0.00	Upland Habitat
40437	0.14	Agricultural Land
40438	0.04	Upland Habitat
40439	0.04	Upland Habitat
40440	0.04	Agricultural Land
40441	0.06	Agricultural Land
40442	0.02	Agricultural Land
40443	0.04	Agricultural Land
40444	0.02	Agricultural Land
40445	0.02	Agricultural Land
40446	0.06	Agricultural Land
40447	0.05	Upland Habitat
40447	0.07	Agricultural Land
40448	0.03	Upland Habitat
40448	0.02	Upland Habitat
40448	0.00	Agricultural Land
40449	0.01	Upland Habitat
40449	0.03	Agricultural Land
40450	0.14	Agricultural Land
40451	0.08	Agricultural Land
40452	0.09	Upland Habitat
40452	0.09	Agricultural Land
40453	0.07	Upland Habitat
40453	0.15	Agricultural Land

ID	ACRES	LANDUSE
40454	0.02	Agricultural Land
40455	0.18	Agricultural Land
40455	0.20	Agricultural Land
40456	0.18	Upland Habitat
40457	0.24	Upland Habitat
40458	0.18	Upland Habitat
40459	0.00	Upland Habitat
40459	0.02	Agricultural Land
40460	0.02	Upland Habitat
40460	0.02	Agricultural Land
40461	0.09	Upland Habitat
40461	0.03	Agricultural Land
40462	0.12	Upland Habitat
40463	0.24	Upland Habitat
40464	0.22	Upland Habitat
40465	0.13	Upland Habitat
40465	0.05	Agricultural Land
40466	18.25	Upland Habitat
40466	0.87	Agricultural Land
40466	5.99	Agricultural Land
40467	0.10	Upland Habitat
40467	0.02	Agricultural Land
40469	0.14	Upland Habitat
40470	0.06	Upland Habitat
40471	0.05	Upland Habitat
40471	0.01	Agricultural Land
40473	0.06	Upland Habitat
40473	0.00	Agricultural Land
40474	0.26	Upland Habitat
40475	0.02	Upland Habitat
40476	0.02	Upland Habitat
40477	0.10	Upland Habitat
40477	0.15	Agricultural Land
40477	0.01	Agricultural Land
40478	0.06	Upland Habitat
40479	0.48	Upland Habitat
40480	0.10	Upland Habitat
40481	0.14	Upland Habitat
40482	0.14	Upland Habitat
40483	0.20	Upland Habitat
40484	0.02	Upland Habitat
40485	0.14	Upland Habitat
40486	0.14	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40487	0.05	Upland Habitat
40487	0.01	Agricultural Land
40488	0.13	Upland Habitat
40488	0.05	Agricultural Land
40489	0.07	Upland Habitat
40489	0.09	Agricultural Land
40500	0.24	Upland Habitat
40501	0.20	Upland Habitat
40502	0.29	Upland Habitat
40502	0.03	Wetland Habitat
40506	0.46	Upland Habitat
40507	0.22	Upland Habitat
40508	0.01	Upland Habitat
40508	0.03	Agricultural Land
40510	0.68	Upland Habitat
40511	0.18	Upland Habitat
40512	0.30	Upland Habitat
40514	0.08	Upland Habitat
40515	0.18	Upland Habitat
40516	0.06	Upland Habitat
40520	0.11	Upland Habitat
40520	0.01	Agricultural Land
40523	0.25	Upland Habitat
40523	0.01	Agricultural Land
40524	0.10	Upland Habitat
40525	0.02	Upland Habitat
40530	0.04	Upland Habitat
40530	0.70	Agricultural Land
40530	0.61	Agricultural Land
40531	0.06	Upland Habitat
40531	0.02	Agricultural Land
40532	0.05	Upland Habitat
40532	0.12	Agricultural Land
40533	0.03	Upland Habitat
40533	0.01	Agricultural Land
40535	0.08	Upland Habitat
40535	0.00	Agricultural Land
40536	0.02	Agricultural Land
40537	0.02	Upland Habitat
40538	0.06	Upland Habitat
40539	0.02	Upland Habitat
40540	0.04	Upland Habitat
40541	0.12	Upland Habitat
40542	0.15	Upland Habitat
40542	0.07	Agricultural Land

ID	ACRES	LANDUSE
40543	0.12	Upland Habitat
40544	0.30	Upland Habitat
40545	0.02	Upland Habitat
40546	0.26	Upland Habitat
40547	0.06	Upland Habitat
40548	0.05	Upland Habitat
40548	0.04	Agricultural Land
40549	0.03	Upland Habitat
40549	0.01	Agricultural Land
40550	0.03	Upland Habitat
40550	0.07	Agricultural Land
40551	0.04	Upland Habitat
40552	0.02	Upland Habitat
40553	0.03	Upland Habitat
40553	0.03	Agricultural Land
40554	0.01	Upland Habitat
40554	0.01	Agricultural Land
40555	0.02	Agricultural Land
40556	0.12	Agricultural Land
40557	0.17	Upland Habitat
40557	0.75	Agricultural Land
40558	0.10	Agricultural Land
40559	0.02	Upland Habitat
40559	0.04	Upland Habitat
40559	0.12	Agricultural Land
40560	0.00	Upland Habitat
40560	0.08	Agricultural Land
40561	0.32	Agricultural Land
40562	0.06	Agricultural Land
40563	0.14	Upland Habitat
40563	0.12	Agricultural Land
40564	0.04	Agricultural Land
40565	0.06	Upland Habitat
40565	0.02	Agricultural Land
40566	0.02	Upland Habitat
40566	0.06	Agricultural Land
40567	0.04	Upland Habitat
40567	0.04	Agricultural Land
40568	0.07	Upland Habitat
40568	0.05	Agricultural Land
40569	0.08	Agricultural Land
40570	0.06	Upland Habitat
40570	0.08	Agricultural Land
40572	0.16	Upland Habitat
40572	0.08	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40573	6.72	Upland Habitat
40573	5.77	Agricultural Land
40573	1.85	Agricultural Land
40574	0.02	Upland Habitat
40575	0.05	Upland Habitat
40575	0.05	Agricultural Land
40576	0.01	Upland Habitat
40576	0.01	Agricultural Land
40576	0.01	Agricultural Land
40577	0.10	Upland Habitat
40578	0.03	Upland Habitat
40578	0.03	Agricultural Land
40579	0.06	Upland Habitat
40580	0.16	Upland Habitat
40580	0.02	Agricultural Land
40581	0.36	Agricultural Land
40581	0.00	Agricultural Land
40583	0.06	Upland Habitat
40584	0.09	Upland Habitat
40584	0.09	Agricultural Land
40584	0.00	Agricultural Land
40585	0.06	Upland Habitat
40585	0.04	Agricultural Land
40586	0.02	Upland Habitat
40586	0.02	Agricultural Land
40587	0.13	Upland Habitat
40587	0.05	Agricultural Land
40588	0.04	Upland Habitat
40589	0.15	Upland Habitat
40589	0.01	Agricultural Land
40590	0.04	Upland Habitat
40591	0.02	Agricultural Land
40592	0.05	Agricultural Land
40592	1.05	Agricultural Land
40593	0.00	Upland Habitat
40593	0.06	Agricultural Land
40595	0.12	Agricultural Land
40596	0.04	Upland Habitat
40596	0.04	Agricultural Land
40597	0.00	Upland Habitat
40597	0.04	Agricultural Land
40597	0.04	Agricultural Land
40598	0.20	Agricultural Land
40599	0.02	Agricultural Land

ID	ACRES	LANDUSE
40600	0.49	Upland Habitat
40600	0.05	Agricultural Land
40600	0.20	Agricultural Land
40601	0.02	Upland Habitat
40601	0.00	Agricultural Land
40602	0.02	Upland Habitat
40603	0.10	Upland Habitat
40604	0.03	Upland Habitat
40604	0.03	Agricultural Land
40605	0.03	Upland Habitat
40605	0.05	Agricultural Land
40606	0.03	Upland Habitat
40606	0.01	Agricultural Land
40607	0.06	Upland Habitat
40608	0.06	Upland Habitat
40609	0.12	Upland Habitat
40610	0.04	Upland Habitat
40611	0.12	Upland Habitat
40612	0.04	Upland Habitat
40613	0.08	Upland Habitat
40614	0.14	Upland Habitat
40615	0.26	Upland Habitat
40616	0.04	Upland Habitat
40617	0.25	Upland Habitat
40617	0.07	Upland Habitat
40619	0.05	Upland Habitat
40619	0.07	Upland Habitat
40620	0.11	Upland Habitat
40620	0.05	Upland Habitat
40621	0.12	Upland Habitat
40622	0.06	Upland Habitat
40623	0.02	Upland Habitat
40624	0.19	Upland Habitat
40624	0.03	Agricultural Land
40625	0.08	Upland Habitat
40626	0.04	Upland Habitat
40627	0.08	Upland Habitat
40628	0.06	Upland Habitat
40629	0.06	Upland Habitat
40630	0.04	Upland Habitat
40631	0.00	Upland Habitat
40631	0.02	Agricultural Land
40632	0.24	Upland Habitat
40632	0.07	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40633	0.02	Upland Habitat
40633	0.06	Agricultural Land
40634	0.02	Upland Habitat
40634	0.00	Agricultural Land
40635	0.12	Upland Habitat
40635	0.02	Agricultural Land
40636	0.06	Upland Habitat
40637	0.02	Upland Habitat
40638	0.12	Upland Habitat
40640	0.02	Upland Habitat
40641	0.06	Upland Habitat
40642	0.04	Upland Habitat
40643	0.06	Upland Habitat
40645	0.06	Upland Habitat
40646	0.18	Upland Habitat
40647	0.10	Upland Habitat
40649	0.18	Upland Habitat
40649	0.04	Agricultural Land
40650	0.04	Upland Habitat
40651	0.22	Upland Habitat
40651	0.04	Agricultural Land
40652	0.22	Upland Habitat
40652	0.04	Agricultural Land
40653	0.07	Upland Habitat
40653	0.05	Agricultural Land
40654	0.08	Upland Habitat
40655	0.28	Agricultural Land
40656	0.02	Agricultural Land
40658	0.07	Upland Habitat
40658	0.05	Agricultural Land
40659	0.01	Upland Habitat
40659	0.01	Agricultural Land
40660	0.02	Upland Habitat
40664	0.20	Upland Habitat
40667	0.02	Upland Habitat
40668	0.06	Upland Habitat
40668	0.01	Upland Habitat
40668	0.03	Agricultural Land
40670	0.14	Upland Habitat
40671	0.14	Upland Habitat
40672	0.02	Upland Habitat
40673	0.08	Upland Habitat
40674	0.28	Upland Habitat
40675	0.30	Upland Habitat
40676	0.14	Upland Habitat

ID	ACRES	LANDUSE
40677	0.10	Upland Habitat
40680	0.10	Upland Habitat
40681	0.10	Upland Habitat
40682	0.08	Upland Habitat
40683	1.59	Upland Habitat
40683	0.06	Agricultural Land
40683	0.07	Agricultural Land
40685	0.04	Upland Habitat
40689	0.02	Upland Habitat
40689	0.02	Agricultural Land
40690	0.02	Upland Habitat
40690	0.02	Agricultural Land
40692	0.02	Upland Habitat
40693	0.02	Agricultural Land
40694	0.08	Upland Habitat
40695	0.12	Upland Habitat
40695	0.00	Agricultural Land
40698	0.06	Upland Habitat
40703	0.02	Upland Habitat
40706	0.02	Upland Habitat
40708	0.06	Upland Habitat
40709	0.04	Upland Habitat
40710	0.02	Upland Habitat
40711	0.15	Upland Habitat
40711	0.07	Agricultural Land
40712	0.04	Upland Habitat
40713	0.12	Upland Habitat
40714	0.08	Upland Habitat
40715	0.08	Upland Habitat
40716	0.44	Agricultural Land
40716	0.02	Agricultural Land
40717	0.07	Agricultural Land
40717	0.03	Agricultural Land
40718	0.12	Upland Habitat
40718	0.12	Agricultural Land
40718	0.06	Agricultural Land
40719	0.05	Upland Habitat
40719	0.03	Agricultural Land
40721	0.05	Upland Habitat
40721	0.06	Agricultural Land
40721	0.07	Agricultural Land
40722	0.07	Upland Habitat
40722	0.07	Agricultural Land
40722	0.00	Agricultural Land
40723	0.06	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40724	0.14	Agricultural Land
40725	0.04	Upland Habitat
40725	0.12	Agricultural Land
40726	0.04	Agricultural Land
40727	0.01	Upland Habitat
40727	0.05	Agricultural Land
40727	0.02	Agricultural Land
40728	22.72	Upland Habitat
40728	12.06	Agricultural Land
40728	8.22	Agricultural Land
40729	0.02	Agricultural Land
40730	0.05	Agricultural Land
40730	0.01	Agricultural Land
40731	0.20	Agricultural Land
40731	0.02	Agricultural Land
40732	0.02	Upland Habitat
40733	0.10	Upland Habitat
40733	0.02	Agricultural Land
40734	0.04	Upland Habitat
40735	0.02	Upland Habitat
40736	0.06	Upland Habitat
40737	0.12	Upland Habitat
40738	0.22	Upland Habitat
40739	0.04	Agricultural Land
40740	0.16	Upland Habitat
40740	0.48	Agricultural Land
40740	0.52	Agricultural Land
40741	0.06	Agricultural Land
40742	0.12	Agricultural Land
40746	0.08	Upland Habitat
40747	0.02	Upland Habitat
40749	0.04	Agricultural Land
40750	0.05	Upland Habitat
40750	0.01	Agricultural Land
40751	0.03	Upland Habitat
40751	0.08	Agricultural Land
40751	0.09	Agricultural Land
40752	0.02	Upland Habitat
40752	0.00	Agricultural Land
40753	0.06	Upland Habitat
40753	0.00	Agricultural Land
40754	0.00	Upland Habitat
40754	0.04	Agricultural Land
40755	0.04	Upland Habitat
40755	0.02	Agricultural Land

ID	ACRES	LANDUSE
40756	0.07	Upland Habitat
40756	0.07	Agricultural Land
40757	0.19	Upland Habitat
40757	0.11	Agricultural Land
40758	0.14	Upland Habitat
40759	0.05	Upland Habitat
40759	0.01	Agricultural Land
40759	0.00	Agricultural Land
40760	0.04	Upland Habitat
40760	0.02	Agricultural Land
40763	0.01	Upland Habitat
40763	0.01	Agricultural Land
40764	0.04	Upland Habitat
40765	0.04	Upland Habitat
40765	0.12	Agricultural Land
40766	0.02	Upland Habitat
40767	0.02	Agricultural Land
40768	0.06	Agricultural Land
40769	0.02	Agricultural Land
40770	0.08	Upland Habitat
40770	0.04	Agricultural Land
40771	0.02	Upland Habitat
40771	0.06	Agricultural Land
40772	0.02	Upland Habitat
40772	0.02	Agricultural Land
40773	0.14	Upland Habitat
40774	0.04	Upland Habitat
40777	0.14	Upland Habitat
40778	1.86	Upland Habitat
40778	0.68	Agricultural Land
40778	0.75	Agricultural Land
40779	0.09	Upland Habitat
40779	0.01	Agricultural Land
40783	0.06	Upland Habitat
40784	0.02	Upland Habitat
40786	0.07	Upland Habitat
40786	0.05	Agricultural Land
40787	0.02	Agricultural Land
40789	23.93	Upland Habitat
40789	13.99	Agricultural Land
40789	15.33	Agricultural Land
40790	0.10	Upland Habitat
40791	0.04	Agricultural Land
40792	0.02	Upland Habitat
40793	0.10	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40795	0.06	Upland Habitat
40795	0.06	Agricultural Land
40796	0.08	Agricultural Land
40797	0.06	Upland Habitat
40798	0.08	Upland Habitat
40801	0.02	Upland Habitat
40801	0.07	Agricultural Land
40801	0.05	Agricultural Land
40802	0.00	Upland Habitat
40802	0.07	Agricultural Land
40802	0.03	Agricultural Land
40803	0.02	Agricultural Land
40804	0.01	Upland Habitat
40804	0.01	Agricultural Land
40805	0.55	Agricultural Land
40805	0.03	Agricultural Land
40809	0.14	Upland Habitat
40818	0.02	Upland Habitat
40818	0.04	Agricultural Land
40819	0.02	Agricultural Land
40820	0.06	Agricultural Land
40821	0.04	Upland Habitat
40821	0.04	Agricultural Land
40822	0.00	Agricultural Land
40822	0.12	Agricultural Land
40823	0.00	Agricultural Land
40823	0.10	Agricultural Land
40824	0.02	Agricultural Land
40824	0.02	Agricultural Land
40825	0.02	Agricultural Land
40825	0.04	Agricultural Land
40826	0.04	Agricultural Land
40826	0.02	Agricultural Land
40827	0.02	Agricultural Land
40828	0.02	Agricultural Land
40829	0.02	Agricultural Land
40831	0.10	Upland Habitat
40831	0.01	Agricultural Land
40831	0.05	Agricultural Land
40832	0.12	Upland Habitat
40833	0.08	Upland Habitat
40834	0.15	Upland Habitat
40834	0.01	Agricultural Land
40835	0.08	Agricultural Land
40836	0.02	Agricultural Land

ID	ACRES	LANDUSE
40837	0.09	Agricultural Land
40837	0.07	Agricultural Land
40838	0.42	Agricultural Land
40838	0.12	Agricultural Land
40840	0.10	Agricultural Land
40840	0.02	Agricultural Land
40841	0.02	Agricultural Land
40842	0.06	Upland Habitat
40844	0.02	Agricultural Land
40847	0.03	Upland Habitat
40847	0.07	Upland Habitat
40848	0.28	Upland Habitat
40849	0.06	Agricultural Land
40850	0.12	Agricultural Land
40851	0.02	Agricultural Land
40852	0.00	Upland Habitat
40852	0.06	Agricultural Land
40856	0.19	Upland Habitat
40856	1.12	Agricultural Land
40856	0.42	Agricultural Land
40857	0.08	Upland Habitat
40858	0.04	Upland Habitat
40858	0.06	Agricultural Land
40858	0.08	Agricultural Land
40859	0.08	Agricultural Land
40860	0.02	Agricultural Land
40861	0.08	Agricultural Land
40862	0.04	Agricultural Land
40863	0.02	Upland Habitat
40863	0.07	Agricultural Land
40863	0.07	Agricultural Land
40864	0.02	Agricultural Land
40865	0.01	Upland Habitat
40865	0.19	Agricultural Land
40869	0.10	Upland Habitat
40869	0.12	Agricultural Land
40870	0.13	Upland Habitat
40870	0.02	Agricultural Land
40870	0.01	Agricultural Land
40872	0.26	Upland Habitat
40872	0.10	Agricultural Land
40873	0.08	Agricultural Land
40873	0.00	Agricultural Land
40874	0.27	Upland Habitat
40874	0.01	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40875	0.54	Upland Habitat
40876	0.02	Agricultural Land
40877	0.10	Upland Habitat
40880	0.06	Agricultural Land
40888	0.08	Agricultural Land
40889	0.03	Upland Habitat
40889	0.05	Agricultural Land
40892	6.92	Upland Habitat
40892	0.08	Agricultural Land
40893	0.22	Upland Habitat
40894	0.42	Upland Habitat
40895	0.42	Upland Habitat
40895	0.01	Agricultural Land
40896	0.20	Upland Habitat
40897	0.08	Upland Habitat
40898	0.10	Upland Habitat
40899	0.22	Upland Habitat
40900	0.02	Upland Habitat
40901	0.06	Upland Habitat
40902	0.12	Upland Habitat
40903	0.04	Upland Habitat
40904	0.05	Upland Habitat
40904	0.01	Agricultural Land
40904	0.00	Agricultural Land
40906	0.02	Upland Habitat
40906	0.00	Agricultural Land
40907	0.38	Upland Habitat
40909	0.18	Upland Habitat
40912	0.06	Upland Habitat
40913	0.10	Upland Habitat
40914	0.06	Upland Habitat
40914	0.10	Upland Habitat
40915	0.11	Upland Habitat
40915	0.01	Agricultural Land
40916	0.10	Upland Habitat
40916	0.04	Upland Habitat
40917	0.10	Upland Habitat
40917	0.04	Upland Habitat
40918	0.04	Upland Habitat
40918	0.08	Upland Habitat
40920	0.08	Upland Habitat
40922	0.02	Upland Habitat
40923	0.02	Upland Habitat
40923	0.08	Agricultural Land
40923	0.01	Agricultural Land

ID	ACRES	LANDUSE
40924	1.65	Upland Habitat
40924	0.69	Agricultural Land
40924	0.06	Agricultural Land
40926	0.24	Upland Habitat
40927	0.22	Upland Habitat
40928	0.14	Upland Habitat
40930	0.02	Upland Habitat
40931	0.34	Upland Habitat
40932	0.08	Upland Habitat
40933	0.04	Upland Habitat
40934	0.06	Upland Habitat
40936	0.40	Upland Habitat
40937	0.12	Upland Habitat
40938	0.04	Upland Habitat
40939	0.02	Upland Habitat
40940	0.10	Upland Habitat
40941	19.61	Upland Habitat
40941	0.95	Agricultural Land
40941	0.61	Agricultural Land
40942	0.14	Upland Habitat
40947	0.50	Agricultural Land
40948	0.02	Upland Habitat
40949	0.32	Upland Habitat
40950	0.08	Upland Habitat
40951	0.16	Upland Habitat
40952	0.06	Upland Habitat
40954	0.20	Upland Habitat
40955	0.04	Upland Habitat
40956	0.04	Upland Habitat
40957	0.16	Upland Habitat
40959	0.13	Upland Habitat
40959	0.03	Agricultural Land
40960	0.03	Upland Habitat
40960	0.03	Agricultural Land
40961	0.24	Agricultural Land
40962	1.93	Upland Habitat
40962	3.45	Agricultural Land
40962	1.32	Agricultural Land
40963	0.17	Agricultural Land
40963	0.03	Agricultural Land
40964	0.12	Upland Habitat
40964	0.54	Agricultural Land
40964	0.98	Agricultural Land
40966	0.28	Agricultural Land
40967	0.06	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40968	0.04	Agricultural Land
40969	0.18	Agricultural Land
40970	0.06	Agricultural Land
40972	0.02	Upland Habitat
40973	0.02	Upland Habitat
40974	0.20	Upland Habitat
40975	0.12	Upland Habitat
40976	0.16	Upland Habitat
40977	0.14	Upland Habitat
40978	0.16	Upland Habitat
40979	0.02	Upland Habitat
40980	0.48	Upland Habitat
40981	0.12	Upland Habitat
40982	0.16	Upland Habitat
40983	1.70	Upland Habitat
40984	0.06	Agricultural Land
40984	0.08	Agricultural Land
40985	0.01	Upland Habitat
40985	0.11	Agricultural Land
40986	0.41	Upland Habitat
40986	0.11	Agricultural Land
40987	0.44	Upland Habitat
40987	0.41	Agricultural Land
40988	0.04	Agricultural Land
40989	0.04	Upland Habitat
40989	0.74	Agricultural Land
40990	0.55	Upland Habitat
40990	0.69	Agricultural Land
40991	0.74	Upland Habitat
40991	0.05	Agricultural Land
40992	0.17	Upland Habitat
40992	0.14	Agricultural Land
40993	0.02	Upland Habitat
40994	0.02	Upland Habitat
40995	0.02	Upland Habitat
40996	0.06	Upland Habitat
40997	0.02	Upland Habitat
40998	0.14	Upland Habitat
40999	0.14	Upland Habitat
41000	0.20	Upland Habitat
41001	0.20	Upland Habitat
41001	0.06	Agricultural Land
41002	0.01	Upland Habitat
41002	0.16	Agricultural Land
41002	0.21	Agricultural Land

ID	ACRES	LANDUSE
41003	0.26	Upland Habitat
41003	0.04	Agricultural Land
41004	0.07	Upland Habitat
41004	0.28	Agricultural Land
41004	0.03	Agricultural Land
41005	0.12	Upland Habitat
41005	0.36	Agricultural Land
41005	0.08	Agricultural Land
41006	0.10	Upland Habitat
41007	0.67	Upland Habitat
41007	0.21	Agricultural Land
41008	0.20	Upland Habitat
41009	0.23	Upland Habitat
41009	0.05	Agricultural Land
41010	0.08	Upland Habitat
41011	0.25	Upland Habitat
41011	0.07	Agricultural Land
41012	0.04	Upland Habitat
41013	0.14	Upland Habitat
41014	0.02	Upland Habitat
41015	0.41	Upland Habitat
41015	0.01	Agricultural Land
41016	0.12	Upland Habitat
41017	0.32	Upland Habitat
41018	0.08	Upland Habitat
41019	0.14	Upland Habitat
41019	0.08	Agricultural Land
41021	0.12	Upland Habitat
41022	0.08	Upland Habitat
41025	0.10	Upland Habitat
41026	0.02	Upland Habitat
41027	0.04	Upland Habitat
41029	0.12	Upland Habitat
41029	0.07	Agricultural Land
41029	0.01	Agricultural Land
41032	0.02	Upland Habitat
41033	0.10	Upland Habitat
41034	0.14	Upland Habitat
41036	0.02	Upland Habitat
41039	0.24	Upland Habitat
41039	0.03	Upland Habitat
41039	0.02	Agricultural Land
41041	0.08	Upland Habitat
41042	0.06	Upland Habitat
41043	0.08	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41057	0.08	Upland Habitat
41057	166.51	Upland Habitat
41057	1.33	Upland Habitat
41057	42.42	Agricultural Land
41057	15.85	Agricultural Land
41058	1.34	Upland Habitat
41059	0.04	Upland Habitat
41063	0.24	Upland Habitat
41072	0.06	Upland Habitat
41101	0.12	Upland Habitat
41102	0.28	Upland Habitat
41103	0.02	Upland Habitat
41103	0.00	Agricultural Land
41104	0.02	Upland Habitat
41105	0.32	Upland Habitat
41106	0.18	Upland Habitat
41108	0.08	Upland Habitat
41109	0.08	Upland Habitat
41111	0.14	Upland Habitat
41112	0.14	Upland Habitat
41117	0.22	Upland Habitat
41117	0.12	Agricultural Land
41117	0.09	Agricultural Land
41120	0.17	Upland Habitat
41120	0.04	Agricultural Land
41120	0.26	Agricultural Land
41121	0.00	Upland Habitat
41121	0.06	Agricultural Land
41122	0.00	Upland Habitat
41122	0.16	Agricultural Land
41123	0.17	Upland Habitat
41123	0.05	Agricultural Land
41123	0.43	Agricultural Land
41124	0.06	Agricultural Land
41125	0.10	Agricultural Land
41126	0.02	Upland Habitat
41126	0.00	Agricultural Land
41127	0.20	Upland Habitat
41128	0.01	Upland Habitat
41128	0.01	Agricultural Land
41130	4.56	Upland Habitat
41130	0.01	Upland Habitat
41130	1.12	Agricultural Land

ID	ACRES	LANDUSE
41131	0.79	Upland Habitat
41131	0.02	Agricultural Land
41131	0.06	Agricultural Land
41132	0.09	Upland Habitat
41132	0.09	Agricultural Land
41133	0.06	Agricultural Land
41134	0.04	Agricultural Land
41135	0.02	Agricultural Land
41137	0.15	Upland Habitat
41137	0.01	Agricultural Land
41138	0.13	Upland Habitat
41138	0.01	Agricultural Land
41142	0.06	Agricultural Land
41144	0.12	Upland Habitat
41156	0.36	Developed Land
41156	0.05	Upland Habitat
41156	0.15	Agricultural Land
41159	0.10	Developed Land
41159	0.10	Agricultural Land
41160	0.02	Agricultural Land
41161	0.02	Agricultural Land
41162	0.02	Agricultural Land
41162	0.04	Agricultural Land
41163	0.05	Agricultural Land
41163	0.01	Agricultural Land
41164	0.09	Agricultural Land
41164	0.07	Agricultural Land
41165	0.07	Agricultural Land
41165	0.03	Agricultural Land
41166	0.01	Agricultural Land
41166	0.07	Agricultural Land
41167	0.08	Developed Land
41167	0.06	Upland Habitat
41167	0.03	Agricultural Land
41168	0.12	Agricultural Land
41169	0.01	Agricultural Land
41169	0.01	Agricultural Land
41170	0.15	Developed Land
41170	0.15	Agricultural Land
41171	1.52	Developed Land
41171	0.01	Upland Habitat
41171	2.56	Agricultural Land
41172	0.06	Upland Habitat
41172	0.28	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41173	0.12	Agricultural Land
41174	0.04	Upland Habitat
41174	0.06	Agricultural Land
41175	0.10	Agricultural Land
41176	0.00	Upland Habitat
41176	0.04	Agricultural Land
41177	0.04	Agricultural Land
41178	0.09	Upland Habitat
41178	0.03	Agricultural Land
41179	0.08	Upland Habitat
41179	0.01	Agricultural Land
41179	0.01	Agricultural Land
41180	0.02	Upland Habitat
41181	0.05	Upland Habitat
41181	0.05	Agricultural Land
41182	0.15	Upland Habitat
41182	0.03	Agricultural Land
41183	0.00	Upland Habitat
41183	0.04	Agricultural Land
41184	0.07	Upland Habitat
41184	0.30	Agricultural Land
41184	0.03	Agricultural Land
41185	0.02	Developed Land
41185	0.08	Developed Land
41185	0.01	Agricultural Land
41185	0.10	Agricultural Land
41199	0.20	Upland Habitat
41210	0.02	Upland Habitat
41212	0.04	Upland Habitat
41231	141.48	Upland Habitat
41231	4.86	Upland Habitat
41231	0.22	Upland Habitat
41231	0.16	Agricultural Land
41238	0.22	Upland Habitat
41239	0.58	Upland Habitat
41261	0.11	Upland Habitat
41261	0.27	Agricultural Land
41268	0.20	Upland Habitat
41270	0.14	Upland Habitat
41277	0.04	Agricultural Land
41278	0.07	Upland Habitat
41278	0.13	Agricultural Land
41279	0.24	Upland Habitat
41280	0.28	Upland Habitat

ID	ACRES	LANDUSE
41281	0.34	Upland Habitat
41281	0.17	Agricultural Land
41281	0.11	Agricultural Land
41282	0.14	Upland Habitat
41282	0.12	Agricultural Land
41283	0.03	Upland Habitat
41283	0.00	Agricultural Land
41284	0.32	Upland Habitat
41285	0.40	Upland Habitat
41286	0.14	Upland Habitat
41287	0.04	Upland Habitat
41288	0.52	Upland Habitat
41289	0.14	Upland Habitat
41289	0.04	Agricultural Land
41299	0.30	Upland Habitat
41300	0.08	Upland Habitat
41301	0.08	Upland Habitat
41303	0.02	Upland Habitat
41367	150.00	Upland Habitat
41367	1.33	Upland Habitat
41367	42.16	Agricultural Land
41367	15.37	Agricultural Land
41401	0.52	Agricultural Land
41402	0.10	Agricultural Land
41403	0.04	Agricultural Land
41404	0.04	Agricultural Land
41406	0.04	Agricultural Land
41407	0.05	Agricultural Land
41407	0.01	Agricultural Land
41408	0.14	Agricultural Land
41415	0.24	Upland Habitat
41416	0.22	Upland Habitat
41417	0.18	Upland Habitat
41419	0.24	Upland Habitat
41420	0.04	Upland Habitat
41425	1.50	Upland Habitat
41426	0.02	Upland Habitat
41427	0.28	Upland Habitat
41428	0.24	Upland Habitat
41429	0.08	Upland Habitat
41430	0.09	Upland Habitat
41430	0.07	Agricultural Land
41433	0.02	Upland Habitat
41435	0.18	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41436	0.04	Upland Habitat
41436	0.02	Agricultural Land
41437	1.24	Upland Habitat
41437	1.06	Agricultural Land
41437	1.23	Agricultural Land
41438	0.01	Upland Habitat
41438	0.15	Agricultural Land
41439	0.20	Agricultural Land
41440	0.01	Upland Habitat
41440	0.08	Agricultural Land
41440	0.07	Agricultural Land
41441	0.08	Upland Habitat
41442	0.11	Upland Habitat
41442	0.06	Agricultural Land
41443	0.49	Upland Habitat
41443	0.50	Agricultural Land
41443	0.47	Agricultural Land
41444	0.07	Upland Habitat
41444	0.03	Agricultural Land
41445	0.02	Upland Habitat
41446	0.36	Agricultural Land
41447	0.13	Agricultural Land
41447	0.11	Agricultural Land
41448	0.24	Agricultural Land
41449	0.07	Upland Habitat
41449	0.03	Agricultural Land
41449	0.10	Agricultural Land
41450	0.01	Agricultural Land
41450	0.05	Agricultural Land
41451	0.07	Upland Habitat
41451	0.00	Agricultural Land
41451	0.13	Agricultural Land
41452	0.00	Agricultural Land
41452	0.04	Agricultural Land
41453	1.14	Upland Habitat
41453	0.65	Agricultural Land
41453	0.82	Agricultural Land
41454	0.16	Agricultural Land
41455	0.14	Agricultural Land
41459	0.02	Upland Habitat
41460	0.02	Upland Habitat
41461	0.06	Upland Habitat
41462	0.12	Upland Habitat
41462	0.02	Agricultural Land

ID	ACRES	LANDUSE
41463	0.12	Upland Habitat
41464	0.04	Upland Habitat
41464	0.04	Agricultural Land
41465	0.02	Upland Habitat
41465	0.04	Agricultural Land
41465	0.06	Agricultural Land
41466	0.20	Agricultural Land
41466	0.02	Agricultural Land
41467	0.04	Agricultural Land
41468	0.15	Upland Habitat
41468	0.17	Agricultural Land
41468	0.02	Agricultural Land
41469	0.08	Agricultural Land
41470	0.04	Upland Habitat
41471	0.06	Upland Habitat
41472	0.24	Upland Habitat
41473	0.20	Upland Habitat
41474	0.12	Upland Habitat
41475	0.60	Upland Habitat
41478	0.00	Upland Habitat
41478	0.00	Agricultural Land
41478	0.03	Agricultural Land
41479	0.20	Upland Habitat
41493	0.06	Agricultural Land
41494	0.00	Upland Habitat
41494	0.04	Agricultural Land
41495	0.09	Developed Land
41495	0.11	Agricultural Land
41496	0.05	Developed Land
41496	0.11	Agricultural Land
41497	0.36	Agricultural Land
41505	3.85	Developed Land
41505	0.12	Upland Habitat
41505	0.79	Agricultural Land
41505	3.55	Agricultural Land
41515	0.00	Upland Habitat
41515	0.07	Agricultural Land
41515	0.07	Agricultural Land
41517	0.02	Upland Habitat
41522	0.02	Upland Habitat
41522	0.15	Agricultural Land
41600	0.22	Agricultural Land
41600	0.29	Agricultural Land
41601	0.08	Upland Habitat
41601	0.00	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41602	0.06	Upland Habitat
41602	0.00	Agricultural Land
41603	0.19	Upland Habitat
41603	0.11	Agricultural Land
41604	0.19	Upland Habitat
41604	0.11	Agricultural Land
41605	0.19	Upland Habitat
41605	0.11	Agricultural Land
41606	0.04	Agricultural Land
41606	0.06	Agricultural Land
41607	0.10	Agricultural Land
41608	0.02	Upland Habitat
41608	0.04	Agricultural Land
41608	0.17	Agricultural Land
41609	0.03	Agricultural Land
41609	0.03	Agricultural Land
41610	0.26	Agricultural Land
41611	0.07	Upland Habitat
41611	0.03	Agricultural Land
41611	0.12	Agricultural Land
41612	0.06	Upland Habitat
41612	0.04	Agricultural Land
41613	0.14	Upland Habitat
41613	0.04	Agricultural Land
41614	0.03	Upland Habitat
41614	0.04	Agricultural Land
41614	0.11	Agricultural Land
41615	0.05	Upland Habitat
41615	0.09	Agricultural Land
41616	0.09	Upland Habitat
41616	0.05	Agricultural Land
41617	0.21	Agricultural Land
41617	0.07	Agricultural Land
41618	0.20	Agricultural Land
41618	0.04	Agricultural Land
41619	0.07	Upland Habitat
41619	0.09	Agricultural Land
41620	0.10	Upland Habitat
41620	0.02	Agricultural Land
41621	0.10	Upland Habitat
41621	0.02	Agricultural Land
41622	0.13	Upland Habitat
41622	0.05	Agricultural Land
41623	0.06	Upland Habitat

ID	ACRES	LANDUSE
41624	1.15	Upland Habitat
41624	12.36	Agricultural Land
41624	2.94	Agricultural Land
41625	0.04	Agricultural Land
41626	0.04	Agricultural Land
41627	3.07	Agricultural Land
41627	0.22	Agricultural Land
41628	0.02	Agricultural Land
41629	0.02	Upland Habitat
41630	0.02	Developed Land
41630	0.08	Agricultural Land
41633	0.06	Agricultural Land
41634	0.08	Upland Habitat
41634	0.07	Upland Habitat
41634	0.02	Agricultural Land
41635	0.43	Upland Habitat
41635	2.07	Agricultural Land
41635	0.19	Agricultural Land
41637	5.06	Upland Habitat
41637	6.97	Agricultural Land
41637	2.66	Agricultural Land
41638	0.46	Upland Habitat
41639	0.18	Upland Habitat
41640	0.14	Upland Habitat
41641	0.12	Upland Habitat
41642	0.08	Upland Habitat
41643	0.02	Upland Habitat
41644	0.09	Upland Habitat
41644	0.05	Agricultural Land
41645	0.08	Upland Habitat
41646	0.04	Agricultural Land
41647	16.69	Upland Habitat
41647	3.96	Agricultural Land
41647	0.20	Agricultural Land
41648	0.30	Upland Habitat
41649	0.12	Upland Habitat
41650	0.02	Upland Habitat
41651	0.50	Upland Habitat
41652	0.46	Upland Habitat
41653	0.28	Upland Habitat
41654	0.02	Upland Habitat
41655	0.02	Upland Habitat
41656	0.08	Upland Habitat
41657	0.02	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41658	0.02	Upland Habitat
41659	0.06	Upland Habitat
41660	0.24	Upland Habitat
41661	0.12	Upland Habitat
41662	0.06	Upland Habitat
41663	0.06	Upland Habitat
41664	0.18	Upland Habitat
41665	0.20	Upland Habitat
41666	0.10	Upland Habitat
41666	0.20	Agricultural Land
41667	0.10	Upland Habitat
41668	0.26	Upland Habitat
41669	0.01	Upland Habitat
41669	0.01	Agricultural Land
41670	0.12	Upland Habitat
41671	0.08	Agricultural Land
41671	0.02	Agricultural Land
41672	0.24	Upland Habitat
41673	0.30	Upland Habitat
41700	0.06	Developed Land
41700	0.33	Agricultural Land
41700	0.25	Agricultural Land
41701	0.02	Developed Land
41701	0.07	Upland Habitat
41701	0.09	Agricultural Land
41702	0.15	Upland Habitat
41702	0.42	Agricultural Land
41702	0.00	Agricultural Land
41703	0.17	Upland Habitat
41703	0.07	Agricultural Land
41703	0.07	Agricultural Land
41704	0.49	Agricultural Land
41704	0.11	Agricultural Land
41705	0.19	Upland Habitat
41705	0.07	Agricultural Land
41706	0.20	Upland Habitat
41707	1.58	Upland Habitat
41708	0.12	Upland Habitat
41709	0.31	Upland Habitat
41709	0.01	Agricultural Land
41710	0.68	Upland Habitat
41711	0.12	Upland Habitat
41714	0.00	Developed Land
41714	0.01	Upland Habitat
41714	0.07	Agricultural Land
41714	0.01	Agricultural Land

ID	ACRES	LANDUSE
41715	0.21	Developed Land
41715	0.18	Agricultural Land
41716	0.00	Developed Land
41716	0.06	Agricultural Land
41716	0.03	Agricultural Land
41720	0.02	Agricultural Land
41721	0.05	Upland Habitat
41721	0.11	Agricultural Land
41722	0.11	Upland Habitat
41722	0.02	Agricultural Land
41722	0.01	Agricultural Land
41725	0.12	Agricultural Land
41728	0.05	Upland Habitat
41728	0.01	Agricultural Land
41728	0.00	Agricultural Land
41729	0.02	Upland Habitat
41729	0.06	Agricultural Land
41730	0.12	Agricultural Land
41731	0.02	Upland Habitat
41731	0.05	Agricultural Land
41731	0.01	Agricultural Land
41733	0.09	Upland Habitat
41733	0.03	Agricultural Land
41734	0.00	Upland Habitat
41734	0.02	Agricultural Land
41735	0.06	Upland Habitat
41735	0.02	Agricultural Land
41736	0.02	Agricultural Land
41749	0.14	Upland Habitat
41750	0.02	Upland Habitat
41752	0.12	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
40098	19.96	Developed Land
40098	0.89	Developed Land
40098	18.30	Developed Land
40098	79.03	Upland Habitat
40098	0.22	Upland Habitat
40098	213.18	Agricultural Land
40098	115.28	Agricultural Land
40098	0.44	Wetland Habitat
40166	56.57	Upland Habitat
40166	12.53	Agricultural Land
40166	2.68	Agricultural Land
40173	24.74	Upland Habitat
40173	1.07	Upland Habitat
40173	7.15	Agricultural Land
40173	1.14	Agricultural Land
40174	94.84	Upland Habitat
40174	28.18	Agricultural Land
40174	5.33	Agricultural Land
40175	24.84	Upland Habitat
40175	3.22	Agricultural Land
40175	0.65	Agricultural Land
40180	34.13	Upland Habitat
40180	35.25	Agricultural Land
40180	24.40	Agricultural Land
40181	20.76	Upland Habitat
40181	45.48	Agricultural Land
40181	19.73	Agricultural Land
40203	21.98	Upland Habitat
40203	2.94	Agricultural Land
40203	0.41	Agricultural Land
40204	18.95	Upland Habitat
40204	2.03	Agricultural Land
40204	0.13	Agricultural Land
40219	0.22	Water
40219	7.75	Upland Habitat
40219	7.22	Agricultural Land
40219	3.76	Agricultural Land
40220	0.17	Upland Habitat
40220	0.01	Agricultural Land
40220	0.06	Agricultural Land
40253	21.28	Upland Habitat
40253	23.13	Agricultural Land
40253	6.55	Agricultural Land
40259	0.06	Upland Habitat

Swal2

NAME	ACRES	LAND USE
40269	17.89	Upland Habitat
40269	6.78	Agricultural Land
40269	29.32	Agricultural Land
40294	0.06	Upland Habitat
40294	0.02	Agricultural Land
40364	0.32	Upland Habitat
40364	0.16	Agricultural Land
40417	0.69	Upland Habitat
40417	0.10	Agricultural Land
40417	0.03	Agricultural Land
40419	0.22	Water
40419	0.03	Developed Land
40419	0.17	Developed Land
40419	79.71	Upland Habitat
40419	25.49	Agricultural Land
40419	20.50	Agricultural Land
40468	18.02	Upland Habitat
40468	0.84	Agricultural Land
40468	5.99	Agricultural Land
40472	25.40	Upland Habitat
40472	0.22	Upland Habitat
40472	0.22	Upland Habitat
40472	13.24	Agricultural Land
40472	9.80	Agricultural Land
40490	19.51	Upland Habitat
40490	1.34	Agricultural Land
40490	5.99	Agricultural Land
40521	1.11	Water
40521	28.04	Upland Habitat
40521	89.21	Agricultural Land
40521	6.49	Agricultural Land
40522	0.04	Upland Habitat
40522	0.04	Agricultural Land
40526	15.86	Upland Habitat
40526	21.39	Agricultural Land
40526	24.57	Agricultural Land
40657	0.03	Agricultural Land
40657	0.03	Agricultural Land
40661	126.85	Upland Habitat
40661	2.26	Upland Habitat
40661	4.40	Agricultural Land
40661	0.32	Agricultural Land
40701	17.51	Upland Habitat
40701	4.33	Agricultural Land
40701	0.25	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
40702	20.70	Upland Habitat
40702	1.70	Upland Habitat
40702	1.31	Agricultural Land
40702	4.19	Agricultural Land
40743	13.07	Upland Habitat
40743	7.81	Agricultural Land
40743	5.15	Agricultural Land
40744	0.02	Agricultural Land
40745	0.01	Upland Habitat
40745	0.09	Agricultural Land
40748	0.16	Upland Habitat
40761	0.30	Upland Habitat
40785	3.41	Upland Habitat
40785	0.44	Upland Habitat
40785	12.86	Agricultural Land
40785	3.74	Agricultural Land
40800	14.14	Upland Habitat
40800	5.11	Agricultural Land
40800	0.31	Agricultural Land
40806	0.22	Agricultural Land
40806	0.34	Agricultural Land
40807	0.04	Agricultural Land
40807	0.04	Agricultural Land
40808	0.12	Upland Habitat
40808	0.02	Agricultural Land
40881	0.03	Upland Habitat
40881	0.01	Agricultural Land
40910	0.16	Upland Habitat
40911	0.08	Upland Habitat
40935	1.07	Upland Habitat
40935	0.33	Agricultural Land
40935	0.06	Agricultural Land
40958	18.05	Upland Habitat
40958	16.75	Agricultural Land
40958	6.66	Agricultural Land
40965	0.13	Upland Habitat
40965	0.82	Agricultural Land
40965	1.19	Agricultural Land
41030	33.05	Upland Habitat
41030	5.11	Agricultural Land
41030	0.83	Agricultural Land
41031	17.34	Upland Habitat
41031	2.04	Agricultural Land
41035	0.04	Upland Habitat
41100	0.20	Upland Habitat

Swal2

NAME	ACRES	LAND USE
41113	4.37	Upland Habitat
41113	0.44	Agricultural Land
41114	28.22	Upland Habitat
41114	0.88	Agricultural Land
41114	7.66	Agricultural Land
41115	94.32	Upland Habitat
41115	44.09	Agricultural Land
41115	16.59	Agricultural Land
41143	0.12	Upland Habitat
41143	0.02	Agricultural Land
41145	0.06	Upland Habitat
41145	0.16	Agricultural Land
41158	7.39	Developed Land
41158	2.35	Developed Land
41158	3.04	Upland Habitat
41158	11.88	Agricultural Land
41158	5.68	Agricultural Land
41222	18.86	Upland Habitat
41226	31.86	Upland Habitat
41227	72.41	Upland Habitat
41227	4.10	Agricultural Land
41227	3.75	Agricultural Land
41228	118.59	Upland Habitat
41228	8.92	Agricultural Land
41228	6.32	Agricultural Land
41232	105.27	Upland Habitat
41232	4.86	Upland Habitat
41232	0.22	Upland Habitat
41232	0.16	Agricultural Land
41240	54.43	Upland Habitat
41240	1.11	Upland Habitat
41240	10.45	Agricultural Land
41271	13.63	Upland Habitat
41271	2.06	Agricultural Land
41271	14.29	Agricultural Land
41272	14.95	Upland Habitat
41272	1.91	Agricultural Land
41272	2.58	Agricultural Land
41275	29.94	Upland Habitat
41275	3.24	Upland Habitat
41275	0.07	Agricultural Land
41367	150.00	Upland Habitat
41367	1.33	Upland Habitat
41367	42.16	Agricultural Land
41367	15.37	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
41418	1.90	Upland Habitat
41421	0.17	Upland Habitat
41421	0.07	Agricultural Land
41424	0.22	Water
41424	0.48	Developed Land
41424	352.65	Upland Habitat
41424	1.56	Upland Habitat
41424	97.40	Agricultural Land
41424	261.07	Agricultural Land
41432	13.07	Upland Habitat
41432	1.89	Upland Habitat
41432	0.18	Upland Habitat
41432	9.17	Agricultural Land
41432	5.42	Agricultural Land
41434	18.23	Upland Habitat
41434	0.44	Upland Habitat
41434	3.46	Agricultural Land
41434	1.65	Agricultural Land
41456	0.03	Upland Habitat
41456	0.04	Agricultural Land
41456	0.11	Agricultural Land
41504	22.24	Upland Habitat
41504	2.31	Agricultural Land
41504	0.46	Agricultural Land
41524	22.12	Upland Habitat
41524	1.28	Agricultural Land
41524	0.37	Agricultural Land
41525	1.78	Water
41525	61.91	Upland Habitat
41525	4.72	Upland Habitat
41525	0.22	Upland Habitat
41525	28.38	Agricultural Land
41525	0.89	Agricultural Land
41531	20.64	Upland Habitat
41531	42.42	Agricultural Land
41531	3.07	Agricultural Land

APPENDIX G – Spring Water Chemistry

Figure G-1 has been removed for confidentiality reasons related to karst.

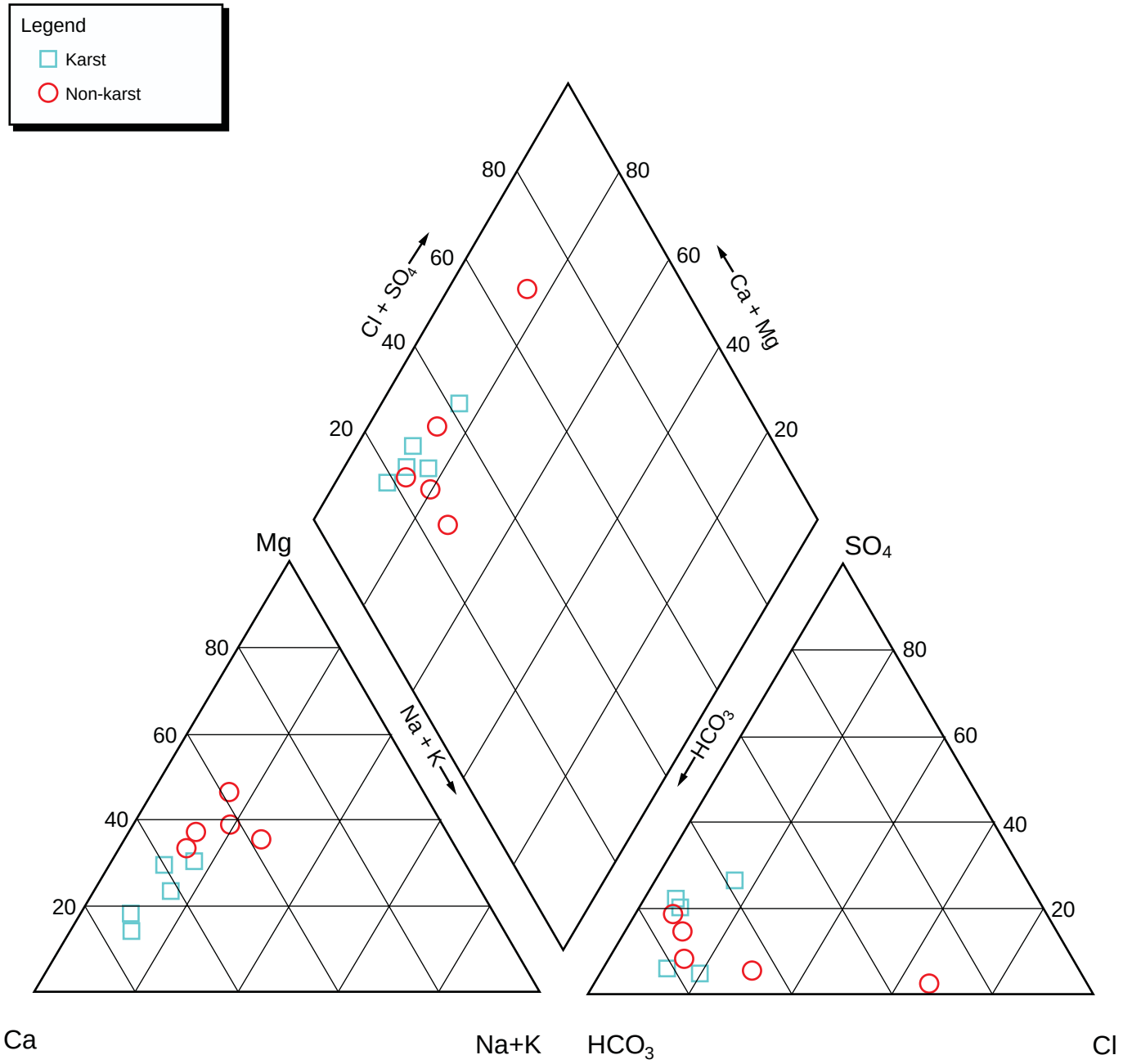

Figure G-2: Trilinear diagram for karst and non-karst springs

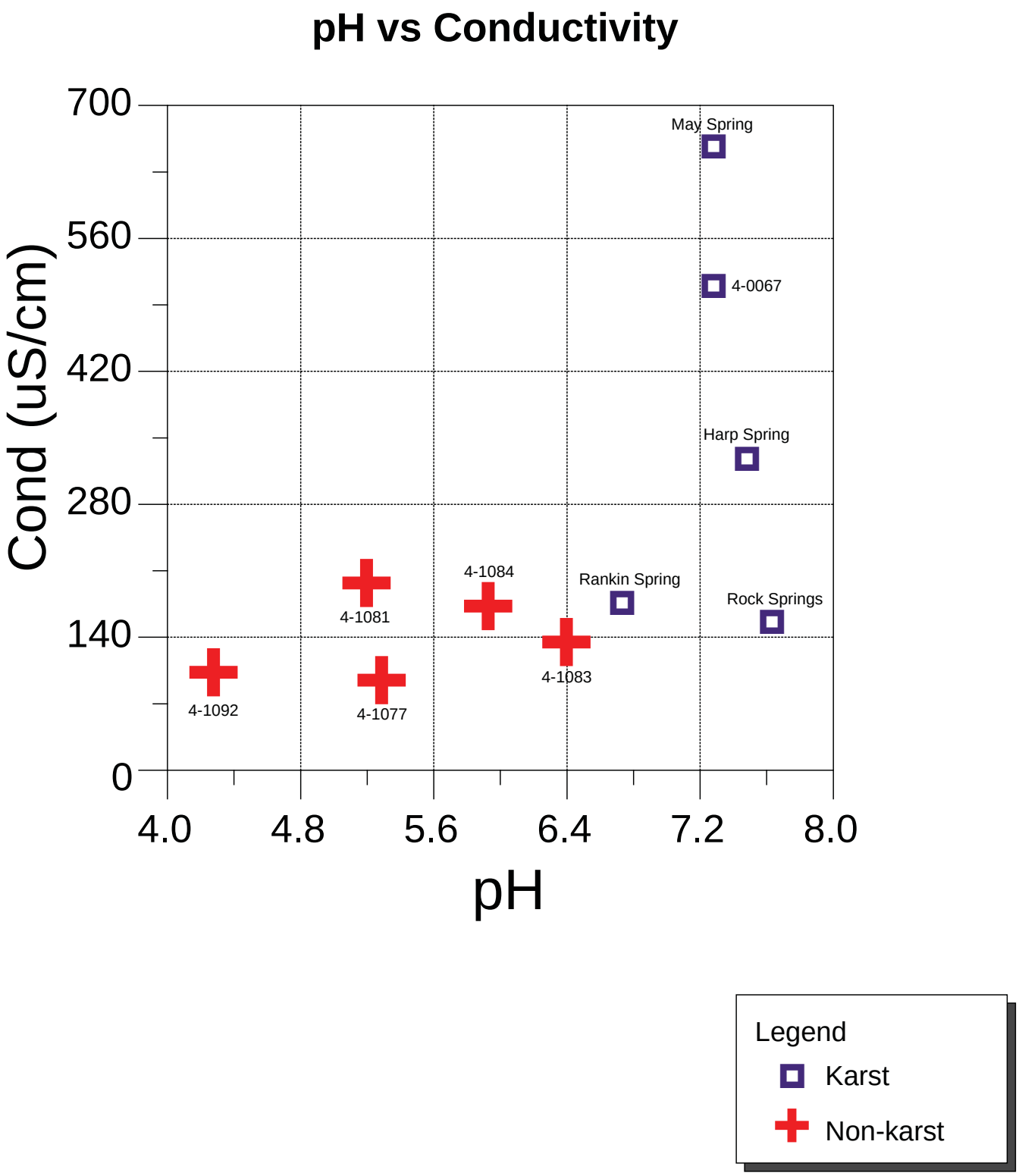

Figure G-3: pH vs conductivity for karst and non-karst springs

Figure G-4 has been removed for confidentiality reasons related to karst.

Figure G-5 has been removed for confidentiality reasons related to karst.

Figure G-6 has been removed for confidentiality reasons related to karst.

Figure G-7 has been removed for confidentiality reasons related to karst.

APPENDIX H – Dye Tracing Summary Figures

Figure H-1 has been removed for confidentiality reasons related to karst.

Figure H-2 has been removed for confidentiality reasons related to karst.

Figure H-3 has been removed for confidentiality reasons related to karst.

Figure H-3B has been removed for confidentiality reasons related to karst.

Figure H-4 has been removed for confidentiality reasons related to karst.

Figure H-5 has been removed for confidentiality reasons related to karst.

Figure H-6 has been removed for confidentiality reasons related to karst.

Figure H-7 has been removed for confidentiality reasons related to karst.

Figure H-8 has been removed for confidentiality reasons related to karst.

Figure H-9 has been removed for confidentiality reasons related to karst.

Figure H-10 has been removed for confidentiality reasons related to karst.

Figure H-11 has been removed for confidentiality reasons related to karst.

Figure H-12 has been removed for confidentiality reasons related to karst.

Figure H-13 has been removed for confidentiality reasons related to karst.

Figure H-14 has been removed for confidentiality reasons related to karst.

Figure H-15 has been removed for confidentiality reasons related to karst.

Figure H-16 has been removed for confidentiality reasons related to karst.

Figure H-17 has been removed for confidentiality reasons related to karst.

Figure H-18 has been removed for confidentiality reasons related to karst.

Figure H-19 has been removed for confidentiality reasons related to karst.

Figure H-20 has been removed for confidentiality reasons related to karst.

Figure H-21 has been removed for confidentiality reasons related to karst.

Figure H-22 has been removed for confidentiality reasons related to karst.

Figure H-23 has been removed for confidentiality reasons related to karst.

Figure H-24 has been removed for confidentiality reasons related to karst.

Figure H-25 has been removed for confidentiality reasons related to karst.

Figure H-26 has been removed for confidentiality reasons related to karst.

Figure H-27 has been removed for confidentiality reasons related to karst.

Figure H-28 has been removed for confidentiality reasons related to karst.

Figure H-29 has been removed for confidentiality reasons related to karst.

Figure H-30 has been removed for confidentiality reasons related to karst.

Figure H-31 has been removed for confidentiality reasons related to karst.

Figure H-32 has been removed for confidentiality reasons related to karst.

Figure H-33 has been removed for confidentiality reasons related to karst.

Figure H-34 has been removed for confidentiality reasons related to karst.

Figure H-34B has been removed for confidentiality reasons related to karst.

Figure H-35 has been removed for confidentiality reasons related to karst.

Figure H-35B has been removed for confidentiality reasons related to karst.

Figure H-36 has been removed for confidentiality reasons related to karst.

Figure H-37 has been removed for confidentiality reasons related to karst.

Figure H-38 has been removed for confidentiality reasons related to karst.

Table 7 has been removed for confidentiality reasons related to karst.

APPENDIX I – KARST FEATURE PHOTOGRAPHS

All karst feature photographs have been removed for confidentiality reasons related to karst.

APPENDIX J – KARST FEATURES / DEIS ALTERNATIVES MAPPING AND IMPACT TABLE

Figure J-1 has been removed for confidentiality reasons related to karst.

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40003	Spring	0-1 gpm			X	X	X	X	X	X
40006	Sinkhole	High	X	X	X	X	X	X	X	X
40007	Sinkhole	Medium	X	X	X	X	X	X	X	X
40008	Sinkhole	Low	X	X	X	X	X	X	X	X
40009	Sinkhole	Low	X	X	X	X	X	X	X	X
40010	Sinkhole	Low	X	X	X	X	X	X	X	X
40068	Sinkhole	Medium	X	X	X	X	X	X	X	X
40069	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
40084	Sinkhole	Low			X	X	X	X	X	X
40085	Spring	0-1 gpm			X	X	X	X	X	X
40087	Sinkhole	Medium	X	X						
40092	Sinkhole	Low			X	X	X	X	X	X
40094	Sinkhole	High				X		X		X
40095	Sinkhole	Low	X	X						
40096	Sinkhole	High	X	X						
40097	Sinkhole	Medium			X	X	X	X	X	X
40098	Sinking Stream	High			X	X	X	X	X	X
40099	Sinkhole	Low			X	X	X	X	X	X
40100	Sinkhole	Low			X	X	X	X	X	X
40103	Sinkhole	High			X	X	X	X	X	X
40105	Sinkhole	Low				X				X
40106	Sinkhole	Medium			X	X	X	X	X	X
40107	Sinkhole	Medium				X	X	X		X
40109	Sinkhole	Medium			X	X	X	X	X	X
40110	Sinkhole	Low				X				X
40111	Sinkhole	Medium			X	X	X	X	X	X
40113	Sinkhole	Low			X	X	X	X	X	X
40129	Sinkhole	Low				X				X
40130	Sinkhole	Medium			X	X			X	X
40131	Sinkhole	Medium			X	X			X	X
40132	Sinkhole	Medium			X	X			X	X
40140	Sinkhole	Low				X				X
40142	Sinkhole	Low	X	X						
40164	Spring	0-1 gpm				X		X		X
40168	Sinkhole	High	X	X	X	X	X	X	X	X
40171	Sinkhole	High	X		X		X		X	
40173	Swallet	High	X	X	X	X	X	X	X	X
40182	Sinkhole	Medium	X	X	X	X	X	X	X	X

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40183	Sinkhole	Medium	X	X	X	X	X	X	X	X
40204	Swallet	High	X		X		X		X	
40215	Sinkhole	Medium	X	X	X	X	X	X	X	X
40217	Sinkhole	Medium	X	X	X	X	X	X	X	X
40286	Sinkhole	Medium				X		X		
40293	Sinkhole	Low	X	X	X	X	X	X	X	X
40372	Spring	0-1 gpm	X	X	X	X	X	X	X	X
40381	Sinkhole	High	X	X	X	X	X	X	X	X
40410	Sinkhole	Medium			X	X	X	X		
40411	Sinkhole	Medium	X	X					X	X
40412	Sinkhole	Low	X	X					X	X
40414	Sinkhole	Medium	X	X	X	X	X	X	X	X
40422	Sinkhole	Medium		X						
40423	Sinkhole	Low	X	X						
40428	Spring	2-10 gpm				X		X		X
40429	Spring	0-1 gpm				X		X		X
40430	Swallet	Medium			X	X	X	X	X	X
40432	Sinkhole	Low	X	X						
40433	Sinkhole	High	X	X						
40434	Sinkhole	Medium	X	X						
40435	Sinkhole	Medium	X	X						
40437	Sinkhole	High		X						
40448	Sinkhole	Low	X	X						
40500	Sinkhole	Medium		X						
40509	Spring	2-10 gpm			X	X	X	X		
40514	Sinkhole	Low		X						X
40515	Sinkhole	Low	X	X					X	X
40530	Sinkhole	Low					X	X		
40532	Sinkhole	Medium			X	X			X	X
40533	Sinkhole	High			X	X			X	X
40535	Sinkhole	Low	X	X						
40536	Sinkhole	High	X	X						
40538	Sinkhole	Medium	X	X						
40539	Sinkhole	High	X	X						
40540	Sinkhole	Low		X						
40541	Sinkhole	Low	X	X						
40544	Sinkhole	High		X						
40546	Sinkhole	Medium		X						

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40547	Sinkhole	High	X	X						
40548	Sinkhole	High	X	X						
40549	Sinkhole	High		X						
40550	Sinkhole	High	X	X						
40551	Sinkhole	Low	X	X						
40552	Sinkhole	Medium	X	X						
40553	Sinkhole	Low	X	X						
40554	Sinkhole	Medium	X	X						
40555	Sinkhole	Low	X	X						
40556	Sinkhole	High	X	X						
40557	Sinkhole	High	X	X						
40558	Sinkhole	Low	X	X						
40620	Sinkhole	Low			X	X			X	X
40621	Sinkhole	Medium			X	X			X	X
40622	Sinkhole	Low	X	X	X	X			X	X
40623	Sinkhole	Low	X	X		X				X
40624	Sinkhole	Medium	X	X		X				X
40625	Sinkhole	Low	X	X						
40626	Sinkhole	Low	X	X						
40627	Sinkhole	Low	X	X						
40628	Sinkhole	Low	X	X						
40629	Sinkhole	Low	X	X						
40630	Sinkhole	Medium	X	X						
40631	Sinkhole	Low	X	X	X	X			X	X
40632	Sinkhole	Low			X	X			X	X
40633	Sinkhole	Low			X	X			X	X
40634	Sinkhole	Low	X	X	X	X			X	X
40635	Sinkhole	Medium			X	X			X	X
40640	Sinkhole	Low						X		
40641	Sinkhole	High					X	X		
40642	Sinkhole	High					X	X		
40643	Sinkhole	High					X	X		
40658	Sinkhole	Medium					X	X		
40659	Sinkhole	Medium					X	X		
40708	Sinkhole	Medium					X	X		
40709	Sinkhole	Medium					X	X		
40710	Sinkhole	High					X	X		
40711	Sinkhole	High					X	X		

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40712	Sinkhole	Low					X	X		
40713	Sinkhole	Low						X		
40714	Sinkhole	Low					X	X		
40715	Sinkhole	Low					X	X		
40786	Sinkhole	High	X	X	X	X			X	X
40813	Spring	2-10 gpm	X	X						
40814	Spring	11-100 gpm	X	X						
40908	Spring	0-1 gpm			X	X			X	X
41020	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41027	Sinkhole	Low	X	X	X	X	X	X	X	X
41037	Spring	0-1 gpm		X		X		X		X
41038	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41065	Spring	2-10 gpm	X	X					X	X
41066	Spring	2-10 gpm		X						
41073	Spring	0-1 gpm	X	X					X	X
41099	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41151	Spring	2-10 gpm					X	X		
41152	Spring	0-1 gpm						X		
41188	Spring	0-1 gpm		X		X		X		X
41196	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41200	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41202	Spring	0-1 gpm		X		X		X		X
41215	Spring	2-10 gpm	X	X					X	X
41216	Spring	2-10 gpm	X	X					X	X
41222	Swallet	High	X	X	X	X	X	X	X	X
41238	Sinkhole	High	X	X	X	X	X	X	X	X
41239	Sinkhole	Medium	X	X	X	X	X	X	X	X
41301	Sinkhole	Medium	X	X					X	X
41424	Sinking Stream	High			X	X			X	X
41430	Sinkhole	Low	X	X			X	X		
41432	Sinking Stream	High	X	X	X	X	X	X	X	X
41437	Sinkhole	Medium	X	X	X	X	X	X	X	X
41445	Sinkhole Zone	Medium	X	X						
41455	Sinkhole	High	X	X	X	X	X	X	X	X
41456	Swallet	High	X	X	X	X	X	X	X	X
41457	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41458	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41459	Sinkhole	Low	X	X	X	X	X	X	X	X

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
41460	Sinkhole	Medium	X	X	X	X	X	X	X	X
41461	Sinkhole	Low	X	X	X	X	X	X	X	X
41462	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
41463	Sinkhole	High	X	X	X	X	X	X	X	X
41464	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
41465	Sinkhole	Medium	X	X		X		X		X
41466	Sinkhole	Low	X	X	X	X	X	X	X	X
41483	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41512	Spring	0-1 gpm		X		X		X		X
41520	Spring	2-10 gpm			X	X	X	X	X	X
41521	Spring	2-10 gpm	X	X						
41529	Spring	2-10 gpm	X	X						
41530	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41603	Sinkhole	Low	X	X	X	X	X	X	X	X
41604	Sinkhole	Low	X	X	X	X	X	X	X	X
41605	Sinkhole	Medium	X	X	X	X	X	X	X	X
41608	Sinkhole	Low				X		X		X
41614	Sinkhole	Medium	X	X	X	X	X	X	X	X
41700	Sinkhole	High	X	X	X	X	X	X	X	X
41711	Sinkhole	Medium	X	X	X	X	X	X	X	X
41714	Sinkhole	High	X	X	X	X	X	X	X	X
41715	Sinkhole	High	X	X	X	X	X	X	X	X
41744	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41756	Spring	0-1 gpm		X		X		X		X
41757	Spring	0-1 gpm		X		X		X		X
41758	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41759	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41760	Spring	0-1 gpm		X		X		X		X
Total Features Impacted			**107**	**121**	**87**	**106**	**87**	**102**	**93**	**112**

APPENDIX K – SURVEY OF SECTION 4 CAVE FAUNA

Pesi 123.08

Interstate 69 Evansville to Indianapolis Tier 2 Studies: Section 4 Cave Fauna

FINAL REPORT

21 December 2006

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INTERSTATE 69 EVANSVILLE TO INDIANAPOLIS
TIER 2 STUDIES: SECTION 4 CAVE FAUNA

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Abstract

Six sites were sampled for cave invertebrates within and in proximity to Section 4 of the proposed I-69 Evansville to Indianapolis in Greene and Monroe counties:

and

Sites were selected based on hydrologic connections to the corridor, identified through dye tracing studies conducted as a part of this project to address the Memorandum of Understanding (MOU) between the Indiana Department of Transportation (INDOT), Indiana Department of Natural Resources (IDNR), Indiana Department of Environmental Management (IDEM) and US Fish and Wildlife Service (USFWS). Sampling for this study was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling. Fourteen species with the ecological classification of troglobite or stygobite (obligate subterranean animal) were found:

Species	Location	Listing Status
Sphalloplana weingartneri (Weingartner's cave flatworm)		IDNR Watch List
Pseudocandona jeanneli (Jeannel's groundwater ostracod)		IDNR Endangered
Caecidotea stygia (Northern cave isopod)		
Crangonyx packardi (Packard's groundwater amphipod)		IDNR Watch List
Crangonyx indianensis (Indiana cave amphipod)		IDNR Watch List
Conotyla bollmani (Bollman's cave millipede)		IDNR Watch List
Phanetta subterranea (Subterranean sheet-web spider)		
Porrhomma cavernicola (Cavernicolous sheet-web spider)		
Pseudosinella fonsa (Fountain cave springtail)		IDNR Threatened
Arrhopalites undescribed species (Ashcraft cave springtail)		IDNR Endangered Candidate
Pseudanophthalmus undescribed species (Ray's cave beetle)		IDNR Endangered
Batrisodes krekeleri (Krekeler's cave ant beetle)		IDNR Endangered
Spelobia tenebrarum (Cave dung-fly)		
Sinella alata (Indiana cave springtail)		IDNR Watch List

In addition to the fauna with Listing Status described above, the following two species were found, and although not obligate subterranean animals, are also species of concern:

Species	Location	Listing Status
Pseudosinella collina (Hilly springtail)		IDNR Rare
Myotis sodalis (Indiana bat)		USFWS Endangered

The entire known range of the Ashcraft cave springtail is a single cave in the proposed I-69 project area. The Ray's cave beetle is known only from three caves including one site in the proposed I-69 project area.

Key words – Indiana, cave fauna, troglobite, *Pseudanophthalmus*, *Arrhopalites*

1.0 Introduction

This study is part of the Tier 2 Environmental Impact Statements for the proposed I-69 from Evansville to Indianapolis, Indiana. Six sites identified in the Section 4 Karst Report were selected for cave invertebrate surveys based on their hydrological connections to the proposed I-69 corridor, identified during dye tracing studies for the project. Lewis and Associates LLC was subcontracted by Environmental Solutions and Innovations, Inc. to complete a cave invertebrate inventory for INDOT and FHWA. The six caves included both flowing springs and drier openings, which provided opportunities for sampling.

2.0 Study Area

2.1 Location –

Section 4 of the proposed I-69 corridor (Section 4) begins at US 231 in southeastern Greene County north of SR 58 near the northwest corner of Naval Support Activity Crane. It proceeds northeast into Monroe County and ends at SR 37 near Victor Pike south of Bloomington. The total length of Section 4 in Greene and Monroe counties is approximately 27 miles (Figure 1).

Three sites were selected for study in Greene County: and an unnamed spring designated as These sites were located in the vicinity of the town of Koleen. Three sites were selected for study in Monroe County: and The Monroe County sampling sites were south or southwest of Bloomington. Six additional springs and caves were sampled, each located within or associated with the above sampling sites, and included

and Specific descriptions of the sampling sites and other associated springs and caves within each sampling site are included in the results. Figure 2 and Table 1 provide locations of sampling sites. Appendix C contains photographs of sites. Appendix D contains maps of caves sampled.

2.2 Physiography –

The project area is in the Crawford Upland Section of the Shawnee Hills Natural Region and the Mitchell Plain Section of the Highland Rim Natural Region in southwest Indiana (Homoya et al. 1985). An overview of the caves and karst of the area was presented by Powell (1961). The Crawford Upland Section is characterized by rugged hills with sandstone cliffs and rockhouses, and well-drained acid silt loam soils. The majority of natural communities are upland forest types, although a few sandstone and limestone glades, gravel washes, and barrens are known. To the east, the Mitchell Plain Section is characterized by relatively low relief and marked by sinkholes and extensive cave systems developed in Mississippian age limestone bedrock (Homoya et al. 1985). Upland forest types are common although swamps, flatwoods, and barrens are present. Examples of medium and high gradient streams with rocky bottoms in this area include Indian, Clear, and Popcorn creeks.

2.3 Review of literature –

The first biological survey of caves in the vicinity of the project area was conducted by Blatchley (1897), during a five-week trip through the south-central karst in a horse drawn spring-wagon. Blatchley started at in Crawford County, then continued north through Orange, Lawrence, Monroe, and Owen counties. In Monroe County he visited Mayfield's, , , , and caves.

Since Blatchley's time most of the names have changed due to taxonomic works, collectively the following assemblage of obligate subterranean species was noted: isopod *Caecidotea stygia*, amphipod *Crangonyx gracilis* (=*C. packardi*), crayfish *Cambarus pellucidus* (=*Orconectes inermis*), millipede *Conotyla bollmani*, springtail *Degeeria cavernarum* (either *Sinella cavernarum* or *S. alata*), cave beetle *Anophthalmus tenuis* (=*Pseudanophthalmus* spp.), and fly *Limosina tenebrarum* (=*Spelobia tenebrarum*).

Banta (1907) published a classic account on the fauna of near Bloomington, in Monroe County. Essentially the same obligate subterranean species were found by Banta as Blatchley: isopod *Caecidotea stygia*, amphipod *Crangonyx gracilis* (=*C. packardi*), crayfish *Cambarus pellucidus testii* (=*Orconectes inermis testii*), millipede *Conotyla bollmani*, spider *Phanetta subterranea*, springtail *Sinella cavernarum*, cave beetle *Anophthalmus tenuis* (=*Pseudanophthalmus shilohensis mayfieldensis*), and fly *Limosina tenebrarum* (=*Spelobia tenebrarum*).

Barr (1960) published a monographic treatment of the cave beetles of the genus *Pseudanophthalmus* from the Mitchell Plain in southern Indiana. Included was the description of the new species *P. leonae*, known only from a small cave near Springville, in Lawrence County.

Christiansen (1960) presented a monograph of the collembolan genus *Sinella* and described the troglobite *Sinella alata* from in Monroe County.

In a monograph of cave crayfish of the genus *Orconectes*, Hobbs and Barr (1972) reported the cave crayfish *Orconectes inermis testii* from in Greene County. Fleming (1972) also reported the isopod *Caecidotea stygia* from

In his dissertation on ostracods commensal on crayfish, Hobbs (1973) visited numerous Indiana caves. In the vicinity of the project area, he reported the cave crayfish *Orconectes inermis testii* and the stygophile *Cambarus laevis* from in Monroe County. *Cambarus laevis* was also reported in in Greene County. From the commensal ostracods *Donnaldsoncythere donnaldsonensis*, *Sagittocythere barri*, *Uncinocythere xania* and *Dactylocythere susanae*. *Sagittocythere barri* was also found on crayfish in and *D. donnaldsonensis* in both in Greene County.

Lewis and Rafail (2003) conducted a survey of the life in caves and springs in the in Monroe County, a Bloomington city park a little over a mile west of SR 37 and adjacent to the present study area. This survey included a bioinventory of

and

Ten obligate subterranean species were

discovered in the nature park: northern cave isopod *Caecidotea stygia*, Barr's terrestrial isopod *Miktoniscus barri*, Packard's groundwater amphipod *Crangonyx packardi*, Bollman's cave millipede *Conotyla bollmani*, subterranean sheet-web spider *Phanetta subterranea*, cavernicolous sheet-web spider *Porrhoma cavernicola*, cave springtails *Sinella alata and Tomocerus celsus*, Mayfield cave beetle *Pseudanophthalmus shilohensis mayfieldensis*, and the cave dung beetle *Spelobia tenebrarum*.

In a monograph of the amphipod genus *Crangonyx* Zhang and Holsinger (2003) described the new species *Crangonyx indianensis* from in Greene County, as well as listing *C. packardi* from the same site.

Lewis et al. (2004) prepared a biological inventory of caves of the Hoosier National Forest. In Monroe County, within the Deam Wilderness, there is an isolated band of limestone that occurs just west of the Mt. Carmel Fault Zone. This limestone belt is approximately three miles in length and is not continuous with the other karst found to the west. Only a few caves were known in this area. However, in the seven caves sampled 12 obligate subterranean species were discovered, of which at least three were probably endemic to the area. These include an undescribed species of the cave ground beetle *Pseudanophthalmus*, cave ant beetle *Batriasymmodes*, and cave pseudoscorpion *Apochthonius*, all known only from

Also sampled by Lewis et al. (2004) was the of the Hoosier National Forest, located west of Bedford and appreciably south of the present study area. About 12 square miles of some of the most concentrated karst features in Indiana occur in this region, which lies just to the south of the East Fork of White River in Lawrence County. Many pits, including the deepest open-air free fall pit in the state, caves, springs and uncountable sinkholes exist in the area. Twenty-three species of obligate subterranean species were discovered in the area caves. Noteworthy was the presence of three species of troglobitic sheet-web spiders, including an undescribed species of *Oreonitides*. Most of the known localities of the rare pseudoscorpion *Apochthonius indianensis* are from as well as two of the three known populations of the troglobitic ant beetle *Batrisodes.* Other characteristic species found at that are endemic to the central part of Indiana's south-central karst are the millipede *Conotyla bollmani* and the ground beetle *Pseudanophthalmus stricticollis*.

Unpublished data was solicited from systematic zoologists. A search of the Grinnell College (Grinnell, Iowa) collembolan database by Dr. Kenneth Christiansen yielded a record of the troglobite *Sinella cavernarum* from in Greene County. Barr (personal communication 2006) reported the presence of an undescribed species of the cave beetle *Pseudanophthalmus* from and in Greene County.

3.0 Methods

The following methods of sampling were used during this project:

- Manual collections, which entailed examination of surfaces and turning stones, to find invertebrates that were then collected with a water color brush moistened in alcohol;
- Pitfall traps consisting of four-ounce glass specimen jars filled with 70% isopropyl alcohol as a preservative and baited with Limburger cheese. The jars were placed in mudbanks with the use of a trowel to excavate a small hole. At the time that the pitfall was removed the clay plug was placed back in the hole and the slope smoothed to return the mudbank to its original appearance;
- Berlese extraction, a method that consisted of placing a litter sample into a large funnel, with a light/heat source above that drove the invertebrates into an underlying vial of alcohol;
- Shrimp-baited jars in the springs or deep water habitats of caves, using a single uncooked marine shrimp placed in a jar with a perforated lid, and left typically overnight. Longer trap intervals cause the water in the jar to become anoxic with resulting loss of trap effectiveness;
- Gravel washings, consisting of extracting gravel into a pail, washing it with stream water, stirring the gravel and then quickly pouring the supernatant through a plankton net;
- Plankton tows, pulling a plankton net through a pool, returning the sample to the lab alive;
- Pool dipping/netting, consisting of dipping water from shallow drip pools fed by epikarstic waters, then straining the water through a plankton net for a live sample;
- Karaman-Chappuis extraction, in which a shallow hole is excavated next to a stream or spring, allowed to fill with water, and then water removed and strained through a plankton net to sample for interstitial aquatic fauna. A variation of this technique involves putting a 12-inch section of perforated PVC pipe into the shallow hole, back filling the hole, and putting a shrimp-baited jar in the pipe overnight.

Water sampled from the above aquatic sampling methods was put into jars, removed from the site, placed in a cooler and transported back to the laboratory. The samples were placed in Petri dishes and examined for living fauna under a dissecting microscope. Litter taken from the cave was placed in a Berlese funnel with overhead light/heat extracting the invertebrates into a vial of 40% isopropyl alcohol. Pitfall residues were screened, and then transferred into Petri dishes for sorting of the fauna under a dissecting microscope. Specimens of each taxon were placed in 3 or 4-dram vials of 40% isopropyl alcohol and labeled per cave of origin, state, county, distance to nearest town, date and collector.

Quantitative stream censusing was done using the methodology described in detail by Lewis (2000). In a Surber (square foot) Sampler was placed in the center of riffle areas and the fauna manually

dislodged by gently turning the gravel/stone substrate. Invertebrates taken in the sampler were then placed in a plastic bowl with an underlying millimeter grid for taking measurements. All animals were identified, measured and then released back to the stream alive. In
the shallow water depth was inadequate for using a Surber Sampler, so a standardized square foot quadrat was censused for comparative purposes. All animals were identified, sight estimation of length taken and then left undisturbed in the habitat.

Crayfish censusing was performed by visually locating the animals and removing them from the water by hand or with a net. The crayfish were identified to species, sexed by visual observation of the ventral genitalia, measured with a millimeter rule from the tip of the rostrum to the tip of the tail, and then released back to the stream. Any crayfish that could not be captured were identified and a sight estimate recorded of the length.

This study's sampling was directed at invertebrates; however, vertebrates are also listed in the report when identified from incidental observations. This work was completed under the authority of the appropriate scientific collectors permits (USFWS Endangered Species Permit TE023664-15)

Latitude/longitude locations in degrees/minutes/seconds were taken in with a hand held Garmin® (Olathe, Kansas) model GPSmap 76. Depending on the number of satellites being tapped at any given moment and the proximity to interference from forest canopy or cliffs, the accuracy of this instrument typically is within a diameter of 15-22 feet.

The usual practice of using the metric system for scientific measurements was adhered to in references to animals. Caves in the United States are mapped in feet and this system was maintained. Similarly, museum preparations of specimen labels for vials use the prevailing measurement system of the country in which the sampling was performed. Thus, distances were calculated in miles rather than kilometers.

4.0 Results

4.1 Faunal List Definitions –

In the following list each species is placed within a Linnaean hierarchical classification. For each species there is a scientific name, original author of the species, a descriptive common name and an ecological classification. The ecological classifications adhere to the following system:

Classification/Abbreviation and Definition

- Troglobite (TB) – terrestrial, morphologically adapted and restricted to caves, must feed and reproduce in the cave environment
- Troglophile (TP) – terrestrial, little if any morphological adaptations to caves, not restricted to caves, but can feed and reproduce in the cave environment
- Trogloxene (TX) – terrestrial, not usually morphologically adapted to caves, leaves the cave to either feed and/or reproduce
- Stygobite (SB) – aquatic, morphologically adapted and restricted to caves, must feed and reproduce in the cave environment

- Stygophile (SP) – aquatic, little if any morphological adaptation to caves, not restricted to caves, but can feed and reproduce in the cave environment
- Stygoxene (SX) – aquatic, not morphologically adapted to caves, usually leaves the cave to either feed or reproduce
- Accidental (AC) – fall or wash into caves with no demonstrable affiliation to the habitat
- Parasite/commensal (PS) – lives on or parasitizes a host animal
- Spring dweller (SPR) – spring inhabitant only, not groundwater related

Accompanying each taxon identified to the species level is a S-rank and G-rank, or State rank of rarity and Global rank of rarity, according to the following system:

Global Rank	*Sites*	*Description*
G1	1-5	critically imperiled
G2	6-20	imperiled
G3	21-100	vulnerable
G4	100+	apparently secure
G5		secure

State Rank	*Sites*	*Description*
S1	1-5	critically imperiled
S2	6-10	imperiled
S3	11-20	vulnerable
S4	21+	apparently secure
S5		secure
SE		exotic species

References in this report to listed species came from the Indiana Department of Natural Resources (IDNR), Division of Nature Preserves, Natural Heritage Program of endangered, threatened, rare and extirpated vertebrates and invertebrates of Indiana available at: http://www.in.gov/dnr /naturepr/pdf/vertinve.pdf.

The IDNR Division of Fish and Wildlife maintains a list of species of concern, threatened or endangered available at: http://www.in.gov/dnr/fishwild/endangered /rare.pdf. Vertebrates, mollusks and crustaceans that are listed as endangered in Indiana are protected from taking pursuant to the Nongame and Endangered Species Act of 1973 (IC 14-22-34) and Fish and Wildlife Administrative Rules (312 IAC). No cave invertebrates are presently listed. Species, status, and location are provided in Table 2.

4.2 Faunal List --

4.2.1 Phylum PLATYHELMINTHES –

Class TURBELLARIA –

Order TRICLADIDA –

Family KENKIIDAE –

Sphalloplana weingartneri (Kenk)
Weingartner's cave flatworm

- SB
- Monroe County:

- S4/G3; IDNR Watch List

This species is endemic to southern Indiana, where it has been reported from caves in Clark, Crawford, Harrison, Jefferson, Jennings, Lawrence, Martin, Orange, Ripley and Washington counties (Kenk 1970a; Lewis 1983, 1994, 1996, 1998; Lewis et al. 2004).

Family PLANARIIDAE –

Phagocata gracilis (Haldeman)
Slender spring flatworm

- SP/SX
- Greene County:

  Monroe County:
  Spring, Pic-A-
  ,
- S4/G4

This flatworm is ubiquitous in springs and caves of the eastern U.S. (Kenk 1972). It is also common in cave streams and in some populations the worms are depigmented and nearly white in color. Hyman (1937) described the unpigmented *Phagocata* in Lawrence County, as *Phagocata subterranea*, which Kenk (1970b) synonymized with *Phagocata gracilis*.

4.2.2 Phylum MOLLUSCA –

Class GASTROPODA –

Order BASOMMATOPHORA –

Family PHYSIDAE –

Physa sp.
Aquatic snail

- SPR
- Greene County:

These aquatic snails were found on the undersides of rocks around the outflow of the spring and are not subterranean in nature.

4.2.3 Phylum ARTHROPODA –

Class CRUSTACEA –

Order EUCOPEPODA –

Family CYCLOPIDAE –

Acanthocyclops einslei (Mirabdullayev and Defaye)
Einsle's copepod

- SPR
- Greene County:
- S4/G4

This species is one of the morphs in the *A. robustus-vernalis* group Mirabdullayev and Defaye (2004). Reid (email 2006) reported that *A. einslei* is common in small surface waterbodies.

Acanthocyclops sp.
Copepod

- SPR
- Monroe County:
- S4/G4

This copepod is one of the species of the robustus-vernalis group.

Eucyclops elegans (Herrick)
Elegant copepod

- SPR
- Greene County:
  Monroe County:
- S4/G4

This copepod was taken in shrimp-baited jars in the above localities. In it was taken from the back of the cave in near total darkness. This species is common in surface waters and has been found in much of the U.S. and Canada. Reid and Strayer (1994) pointed out that some species usually considered to be epigean maintain permanent populations in interstitial habitats. Lewis (1998) reported *E. elegans* from (Crawford County) and the at Orangeville (Orange County).

Eucyclops agilis (Koch)
Copepod

- SPR
- Greene County:
- S4/G4

This copepod was taken in a shrimp-baited jar in Lewis (1998) also reported it from the at Orangeville (Orange County).

Macrocyclops albidus (Jurine)
Copepod

- TX
- Greene County:
  Monroe County:
- S4/G4

This copepod was taken from the interstices of stream gravel. This species is not usually associated with groundwater, although Lewis (1998) found it in the at Orangeville (Orange County).

Macrocyclops fuscus (Jurine)
Copepod

- SPR
- Greene County:
- S4/G4

Lewis (1998) found this copepod in the dark zone of (Harrison County), where it was probably introduced with water from the adjacent Blue River.

Microcyclops varicans (G.O.Sars)
Copepod

- SPR
- Monroe County:
- S4/G4

Orthocyclops modestus (Herrick)
Copepod

- SPR
- Monroe County:
- S4/G4

Other groundwater habitats from which this copepod was taken in Indiana were a well in Crawford County and Harrison County (Lewis 1998).

Family CANTHOCAMPTIDAE –

Attheyella nordenskioldii (Lilljeborg)
Nordenskiold's copepod

- TX/SPR
- Monroe County:

- S4/G4

This species has been collected from caves and springs in Crawford, Harrison, Monroe, Orange and Washington counties (Lewis 1998; Lewis et al. 2003, 2004)

Order CLADOCERA –

Family MACROTHRICIDAE –

Ilyocryptus sordidus (Liéven)
Water flea

- Greene County:
- S4/G4

The cladocera of this genus are usually associated with littoral regions where they are found on or near the bottom (Pennak 1978). At it was taken with copepods in a shrimp-baited jar on the bottom of the spring.

Order OSTRACODA –

Family CANDONIDAE –

Candona acuta (Hoff)
Ostracod

- SPR
- Greene County:
- S4/G4

This is an epigean species that is abundant in streams and deltaic areas of lakes (DeLorme email 2006).

Cypria turneri (Hoff)
Ostracod

- SPR
- Greene County:
- S4/G4

This is an epigean species and is abundant in the same habitats as *Candona acuta*.

Pseudocandona jeanneli (Klie)
Jeannel's groundwater ostracod

- SB
- Monroe County:
- S1/G2; IDNR Endangered

This species was described from (Crawford County). Additional populations were found by Lewis (1998) in (Crawford County) and by Lewis et al. (2004) in the Hoosier National Forest at (Lawrence County), (Orange County) and (Monroe County). Formerly considered endemic to the south-central karst of Indiana, additional records were found in (Pulaski County, Kentucky) and (Overton County, Tennessee; Lewis and Lewis unpublished data). Evidence from the new collections suggests that this species is relatively widespread, but poorly known due to its cryptic nature.

Order ISOPODA –

Family ASELLIDAE –

Caecidotea stygia (Packard)
Northern cave isopod

- SB
- Greene County: Monroe County:
- S4/G5

This is one of the most wide ranging subterranean members of the genus, recorded from southwestern Ohio, most of Kentucky, southern Illinois and a small area of eastern Missouri (Lewis and Bowman 1981).

Lirceus fontinalis (Rafinesque)
Bluegrass spring isopod

- SX
- Greene County: Spring, Monroe County: Chic Spring Cave, Spring 179
- S4/G4

Hubricht and Mackin (1949) reported this species from about 45 localities in southern Indiana, Kentucky, southwestern Ohio and northern Tennessee. The isopod is a threshold trogloxene, primarily occurring in springs.

Family ARMADILLIDIDAE –

Cylisticus convexus (DeGeer)
Common convex pillbug

- TX
- Monroe County:
- SE/G5

This pillbug occurs occasionally in cave entrances.

Family LIGIIDAE –

Ligidium elrodi (Packard)
Elrod's terrestrial isopod

- TP/TX
- Greene County: Monroe County:
- S4/G4

These isopods were found on the moist mudbanks of and in the breakdown orifice of Described from (Orange County) by Packard (1873), this species was redescribed by Schultz (1970), who also reported it in caves in Tennessee, Georgia

and Virginia. In Indiana, it is common in caves, especially in or around moist detritus.

Family PORCELLIONIDAE –

Trachelipus rathkei (Brandt)
Rathke's terrestrial isopod

- TX
- Monroe County:
- SE/G5

This is an introduced European species. It is a common threshold trogloxene and was reported from caves in Clark, Crawford, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1995, 1996, 1998; Lewis and Rafail 2002; Lewis et al. 2004).

Order AMPHIPODA –

Family CRANGONYCTIDAE –

Crangonyx forbesi (Hubricht and Mackin)
Forbe's amphipod

- SP/SX
- Greene County:
  Monroe County:
- S4/G4

This amphipod occurs primarily in caves and springs, but has also been recorded from other streams and ponds. It is found from the Ozarks east to Pennsylvania (Zhang and Holsinger 2003).

Crangonyx indianensis (Zhang and Holsinger)
Indiana cave amphipod

- SB
- Greene County:
  Monroe County**:**
- S4/G3; IDNR Watch List

This species has been reported from caves and spring orifices in Clark, Crawford, Decatur, Dubois, Harrison, Jefferson, Lawrence, Martin, Monroe, Orange, Owen and Washington counties (Zhang and Holsinger 2003; Lewis et al. 2004).

Crangonyx packardi (Smith)
Packard's groundwater amphipod

- SB
- Monroe County:
  Monroe County:
- S3-4/G4; IDNR Watch List

This species, first described from a well in Orleans, Orange County, is now known to occur from Indiana west to Kansas (Zhang and Holsinger 2003). *Crangonyx packardi* occurs in drip pools, ephemeral as well as permanent cave streams. Lewis (1998) found it a meter deep in gravel interstices of the Blue River.

Family GAMMARIDAE –

Gammarus minus (Say)
Lesser spring amphipod

- SX/SP
- Greene County:
  Monroe County:
- S4/G5

This species is a common inhabitant of springs in Indiana. In several Indiana populations the amphipods are depigmented and have reduced eyes, similar to populations that occur in West Virginia. Elsewhere, it is known from similar habitats throughout the Appalachians, Interior Low Plateaus and Ozarks (Holsinger 1972).

Order DECAPODA –

Family CAMBARIDAE –

Cambarus laevis (Faxon)
Karst crayfish

- SP

- Greene County:
  Monroe County:

- S4/G4

Simon (2001; Simon and Thoma 2003; Simon et al. 2005) delineated several important morphological differences among the Indiana populations of *C. laevis* and *C. tenebrosus*. Simon et al. (2005) reported that *Cambarus laevis* was widespread in central and southern Indiana, where it was found in brooks, creeks and streams beneath large flat stones.

The cave crayfish *Orconectes inermis inermis* occurs from central Kentucky to Lawrence County, Indiana, where it is replaced by *Orconectes inermis testii* in Monroe and Owen counties. In vicinity of the project area, *Orconectes inermis inermis* was reported from (Lawrence County) and *O. inermis testii* from (Greene County; Hobbs et al. 1977). These reported localities essentially bracket in which *Orconectes inermis inermis* was not found. Closer examination of the record revealed that it is based on an unconfirmed sight record by a caver (Moore 1967). The presence of cave crayfish in Greene County remains a matter of speculation.

Class DIPLOPODA –

Order CHORDEUMATIDA –

Family CONOTYLIDAE –

Conotyla bollmani (McNeill)
Bollman's cave millipede

- TB/TP
- Greene County:
- S3-4/G3-4; IDNR Watch List

Described as *Trichopetalum bollmani* by McNeill (1887) from in Monroe County. Shear (1971), Hoffman and Lewis (1997) and Lewis (2003) summarized the range of this Indiana endemic, which occurs in caves in south-central Indiana in the East Fork of White River drainage (Orange, Lawrence, Monroe, Martin, and Owen counties).

Family TRICHOPETALIDAE –

Trichopetalum uncum (Cook and Collins)
Millipede

- TP
- Greene County:
- S1/G4

A single millipede was found deep in the cave on a bat guano pellet lying on a moist riparian mudbank. Described from an unspecified site in Bloomington, this species is unpigmented and has eyes that are either vestigial or absent. This species has been reported from Oklahoma to South Carolina, south to Georgia and Mississippi (Shear 1972; Shear email 2006)

Order POLYDESMIDA –

Family PARADOXOSOMATIDAE –

Oxidus gracilis (Koch)
Greenhouse millipede

- TX
- Monroe County:

- SE/G5

These millipedes were common on the walls of and were also present on the walls of the springhouse at This species probably originated in Japan, but has spread nearly worldwide in temperate counties and at higher elevations in the tropics. It is found across North America and is present in very high numbers in many parts of the eastern

U.S. (Hoffman 1999). It is frequently present in noxious numbers in caves.

Class ARACHNIDA –

Order ARANEAE –

Family AMAUROBIIDAE –

Coras sp.
Spider

- TX
- Monroe County:

The juvenile specimens collected in this cave are not identifiable to species, but are probably *Coras lamellosis*, a threshold trogloxene that has been taken from caves in Crawford, Martin and Orange counties (Lewis et al. 2004). It is common on bluffs and rock outcrops like the entrance to this cave.

Family DICTYNIDAE –

Cicurina sp.
Funnel-web spider

- TP
- Monroe County:

Juveniles collected in this cave are not identifiable to species, but are likely *Cicurina pallida* (Pallid funnel-web spider). This species has been reported from caves in Clark, Crawford, Harrison, Jennings, Monroe and Orange counties (Lewis 1995, 1996, 1998; Lewis et al. 2004). This species is found from Indiana east to the Atlantic states (Chamberlin and Ivie 1940).

Family LINYPHIIDAE –

Bathyphantes pallidus (Banks)
Pallid sheet-web spider

- TX
- Monroe County:
- S4/G5

This species occurs across the northern half of the United States into Canada. It usually occurs near water or under objects on damp ground, and is a common cave inhabitant (Ivie 1969).

Microneta viaria (Blackwell)
Sheet-web spider

- TX
- Greene County:
- S4/G5

This spider was taken in leaf litter in the entrance of the cave. It is holarctic in distribution and lives in a variety of habitats including forest litter, gardens and quarries.

Phanetta subterranea (Emerton)
Subterranean sheet-web spider

- TB
- Greene County:
  Monroe County:
- S4/G5

This tiny spider is ubiquitous in Indiana caves, where it has been found in essentially every county where there is karst (Lewis 1983, 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004). Originally described from Crawford County, the species was redescribed by Millidge (1984) and reported from a range between Alabama and Pennsylvania, west to Indiana. Peck and Lewis (1978) reported this species from Illinois and Missouri.

Porrhomma cavernicola (Keys)
Cavernicolous sheet-web spider

- TB
- Greene County:
- S2/G4

In this species was taken in the company of the more common *Phanetta*

subterranea. This spider is widespread, but very sporadic in its occurrence in the eastern U.S. In Indiana it was previously reported from caves in Jennings, Lawrence, Monroe and Orange counties (Lewis 1995, 1998; Lewis and Rafail 2002, 2003, Lewis et al. 2004).

Family TETRAGNATHIDAE –

Meta ovalis (Gertsch)
American cave orb weaver

- TP
- Greene County:
- S4/G5

This species is ubiquitous in caves of the eastern U.S. (Marusik and Koponen1992). It has been recorded from essentially every county in Indiana that has caves (Blatchley 1897; Banta 1907; Lewis 1983, 1994, 1995, 1996, 1998, 2001; Lewis and Rafail 2002, 2003; Lewis et al. 2004).

Class COLLEMBOLA –

Family ENTOMOBRYIDAE –

Pseudosinella collina (Wray)
Hilly springtail

- TP
- Monroe County:
- S2/G3-4; IDNR Rare

Reflecting a probable sampling trend where in some instances the cave fauna is better known than that of the surface, this springtail is known only from two surface collections in Indiana, but has been identified from caves in Martin, Monroe, Orange and Washington counties (Lewis 1998, Lewis et al. 2004). This springtail varies from white to blue in color with eyes on a single pair of eye patches. It is reported from Alabama, Tennessee, Illinois, Pennsylvania and Virginia, with numerous cave populations. Further analysis may reveal that this assemblage involves a complex of related species (Christiansen and Bellinger 1998c).

Pseudosinella fonsa (Christiansen)
Fountain cave springtail

- TB
- Greene County:
- S2/G2-3; IDNR threatened

This species is quite rare, usually known from single specimens taken at each locality. In a single specimen was taken from a mudbank along the cave stream, in the dark zone of the cave. Described from a cave in Clark County (Christiansen and Bellinger 1996), Lewis (1998; Lewis et al. 2004) subsequently recorded it from caves in Crawford, Harrison, Lawrence, Orange and Washington counties. It is also known from one cave in southwestern Ohio (Christiansen and Bellinger 1998c).

Sinella alata (Christiansen)
Indiana cave springtail

- TB
- Greene County:
- S4/G3-4; IDNR Watch List

In identifying these specimens Soto (email 2006) reported that the only consistent, unambiguous differences between the material and that from the type-locality in Monroe County was the number of macrochaeta on abdominal segments 2 and 3. There were differences in the shape of the antennal sensila and the setae of the male genital plate. These differences may reflect inaccuracies in the published drawings and the differences in the macrochaetae may also be mistakes by Christiansen and Bellinger (1998c). If on the other hand the Christiansen and Bellinger (1998c) is accurate, the material might be an undescribed

species closely related to *Sinella alata*. Until this can be resolved, this material is being considered as conspecific with that species.

This collembolan is one of the more abundant species in They were taken by Berlese extraction from leaf litter immediately inside the cave entrance and were common under stones in the entrance room. They were taken in small numbers in pitfall traps throughout the cave as well as easily found on riparian mudbanks and around pellets of bat guano. *Sinella alata* is endemic to Indiana, where it occurs in caves in Clark, Crawford, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1983, 1994, 1995, 1998, 2002; Lewis et al. 2004).

Family HYPOGASTRURIDAE –

Ceratophysella succinea (Gisin)
Springtail

- TX
- Greene County:
- S4/G5

The specimens from were intermediate between succinea and engadensis (Soto email 2006), and thus might be interpreted as an undescribed species. As currently understood, the 6 dental setae on the fucula place them in *C. succinea*. This species is a member of the *denticulata* species complex, an assemblage of species that remains taxonomically confused (Christiansen and Bellinger 1998a). As presently understood, this species occurs across the United States and Europe.

Family ISOTOMIDAE –

Desoria trispinata (MacGillivray)
Three-spined springtail

- TX
- Greene County:
  Monroe County:
- S4/G5

This springtail was taken from leaf litter in the entrance of and from pitfall traps in
This is a common nearctic species that is known from numerous collections from caves (Christiansen and Bellinger 1998b). Lewis (1998) reported it from caves in Harrison and Martin counties (Lewis 1998; Lewis et al. 2004).

Family NEELIDAE –

Megalothorax minimus (Willem)
Springtail

- AC
- Greene County
- S4/G5

One specimen of this springtail was taken in the entrance zone of the cave. It is common across North America, where it is occasionally found in caves (Christiansen and Bellinger 1998d).

Family SMINTHURIDAE –

Arrhopalites undescribed species
Ashcraft cave springtail

- TB
- Greene County:
- S1/G1; IDNR Endangered candidate

This is a species new to science known only from As presently known it is endemic to These animals were found on mudbanks where they were typically in the presence of *Sinella* around pellets of bat guano. Many troglobitic species are known in the genus *Arrhopalites*

(Christiansen and Bellinger 1998d), in Indiana including *A. lewisi, A. ater*, *A. carolynae*, and two undescribed species from Lawrence County (Lewis et al. 2004).

This species will be added to the IDNR natural heritage program list of endangered and threatened species after review of this document has been completed.

Family TOMOCERIDAE –

Tomocerus bidentatus (Folsom)
Two-toothed springtail

- TP
- Monroe County:
- S4/G4

This species was taken from pitfall traps in this cave. It is slightly troglomorphic and is known primarily from caves, although a few surface records exist (Christiansen and Bellinger 1998c). It has been reported in Indiana from caves in Crawford, Greene, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1995, 1998; Lewis and Rafail 2002, 2003; Lewis et al. 2004).

Tomocerus flavescens (Tullberg)
Golden springtail

- TP
- Greene County:
- S4/G5

Numerous specimens of this springtail were taken from leaf litter in a Berlese sample collected in the entrance zone of

This species has been recorded in caves in Clark, Crawford, Greene, Harrison, Jennings, Martin, Monroe, Orange and Washington counties, Indiana (Lewis, 1994; 1995; 1996; 1998, Lewis and Rafail 2002, 2003, Lewis et al. 2004). It occurs in caves through much of the U.S. and is known from many surface records (Christiansen and Bellinger 1998c).

Class INSECTA –

Order DIPLURA –

Family CAMPODEIDAE –

Tricampa rileyi (Silvestri)
Dipluran

- TP
- Greene County:
- S1/G4

This is a widespread species that had not been previously recorded from Indiana. The range otherwise runs from Ilinois south to Louisiana, and west to California into British Columbia. It has been found in enough caves to consider it a troglophile (Ferguson email 2006). Many of the non-troglobitic diplurans are edaphic and seldom encountered, leading to skewed perceptions as to their rarity.

Order ORTHOPTERA –

Family GRYLLACRIDIDAE –

Ceuthophilus brevipes (Scudder)
Cave cricket

- TX
- Greene County:
  Monroe County:
  Chic Spring Cave
- S4/G4

This species replaces *C. stygius* in the northern part of the Indiana karst and occurs sporadically in other Indiana caves. Hubbell (1936) reported it from seven localities in Indiana, including in Monroe County, as well as 20 states in the eastern U.S and Canada.

Order COLEOPTERA –

Family CARABIDAE –

Pseudanophthalmus undescribed species
Ray's cave beetle

- TB
- Greene County:
- S1/G1; IDNR Endangered

An undescribed species of the troglobite *Pseudanophthalmus* in the *tenuis* group occurs in and caves, Greene County (Barr email 2006). In it was found in small numbers (searching produced samples of 0-4 beetles per sampling trip) on mudbanks. Based on current knowledge, this species is endemic to a small area of Greene County. The full range of this species remains unknown.

To the south, *Pseudanopthalmus shilohensis shilohensis* occurs in Lawrence County caves, hybridizing with *P. s. mayfieldensis* in Monroe County (Barr 1960; Barr email 2006). *Pseudanophthalmus leonae* is known from a single specimen taken in near Springville in Lawrence County (Barr 1960).

Platynus tenuicollis (LeConte)
Slender ground beetle

- TP/TX
- Monroe County:
- S5/G5

This beetle is a common troglophile in the eastern U.S. (Barr, 1964).

Bembidion sp.
Ground beetle

- TX
- Monroe County:
- S4/G4

This is probably *Bembidion texanum*, a common cavernicole in eastern U.S. caves (Barr 1964).

Family LEIODIDAE –

Dissochaetus oblitus (LeConte)
Small carrion beetle

- TX/AC Monroe County:
- S4/G4

One specimen of this tiny beetle was taken from a pitfall trap. This species occurs across the eastern U.S.

Family STAPHYLINIDAE –

Subfamily ALEOCHARINAE –

Aleochara lucifuga (Casey)
Rove beetle

- TP
- Greene County:
  Monroe County:
- S4/G4

This species is known only from caves and animals burrows and has been reported from caves in the Appalachains and Interior Low Plateaus Klimaszewski and Peck (1986). In Indiana, it has been previously recorded from caves in Crawford, Dubois, Harrison, Lawrence, Monroe, Orange and Washington counties (Lewis 1998; Lewis and Rafail 2002, 2003; Lewis et al. 2004). The members of this group of rove beetles have larvae that are ectoparasitoids of the pupae of flies.

Atheta annexa (Casey)
Rove beetle

- TP
- Greene County:
  Monroe County:
- S4/G4

This species is known from Iowa, Illinois and Indiana south to Florida, but most of the records are from Kentucky, Tennessee and Alabama. This beetle is usually collected from organic debris, fungi, raccoon dung, and woodrat nests. It is on the edge of its range in Indiana, where Klimaszewski and Peck (1986) reported it from in Monroe County. Lewis et al. (2004) found it in caves in Dubois, Lawrence, Monroe and Orange counties.

Atheta troglophila (Klimaszewski and Peck)
Rove beetle

- TP
- Greene County:
- S4/G4

This species is known from Iowa to Pennsylvania, south to Florida, west to Arkansas. It is on the edge of its range in Indiana (Klimaszewski and Peck 1986).

Blepharrhymenus illectus (Casey)
Rove beetle

- TX
- Greene County:
- S1/G2-3

This species was previously known from caves in Alabama, Tennessee and Missouri and the type locality in Oregon. This distribution is odd and was speculated to be a collecting artifact (Klimaszewski and Peck 1986). Lewis et al. (2004) reported the first Indiana records from single caves in Lawrence and Orange counties.

Subfamily PSELAPHINAE –

Batrisodes krekeleri (Park)
Krekeler's cave ant beetle

- TB/TP
- Greene County:
- S1/G1; IDNR Endangered

A single female with slightly reduced eyes (Chandler email 2006) was taken under a stone in the entrance room of
This species is being tentatively identified as *B. krekeleri* pending comparison with type material. *Batrisodes krekeleri* was described from a single female specimen taken in in Clark County. Specimens resembling *B. krekeleri* have been collected from caves in Crawford and Lawrence counties (Lewis 1998, Lewis et al. 2004), but specific identification is problematic due to the incomplete nature of the original description.

Subfamily STAPHYLININAE –

Quedius erythrogaster (Mannerheim)
Rove beetle

- TX
- Greene County:
- S4/G5

One specimen of this beetle was taken from a pitfall trap in the entrance room of the cave, where it was associated with a raccoon latrine. This (and the following) species is commonly associated with raccoon dung communities in caves (Lewis 1998, Lewis et al. 2004).

Quedius spelaeus (Horn)
Spelean rove beetle

- TP
- Greene County:
- S4/G5

This species has been found only in subterranean habitats. The subspecies *Quedius spelaeus spelaeus* has been reported almost solely from caves from British Columbia to California, Idaho, Colorado, and in the east from Missouri to Nova Scotia. (Smetana 1971; Mosely et al. 2006). It is usually associated with mammal latrines. In it was found associated with raccoon latrines near the

entrance and came to cheese bait deeper in the cave.

Subfamily OMALIINAE –

Lesteva pallipes (LeConte)
Rove beetle

- TX
- Greene County:

- S4/G5

This beetle is common in cave stream habitats. Lewis (1998, Lewis et al. 2004) reported it from caves in Crawford, Harrison, Lawence, Monroe, Orange and Washington counties.

Order DIPTERA –

Family CHAOBORIDAE –

Undetermined species
Phantom midge

- SX
- Greene County:

This group of phantom midges has larvae that prey on micro-crustaceans (Pennak 1978). The specimens were taken in ceiling drip water collected and processed in a plankton net.

Family HELEOMYZIDAE –

Aecothea specus (Aldrich)
Heleomyzid fly

- TX
- Greene County:
  Monroe County:

- S4/G4

This species occurs on the walls and ceilings of caves. The ecology of heleomyzid flies in an Indiana cave was discussed in some detail by Busacca (1975).

Amoebaleria defessa (Osten Sacken)
Heleomyzid fly

- TX
- Greene County:
  Monroe County:
- S4/G4

This species occurs with *Aecothea specus* in the same wall and ceiling habitat.

Family PHORIDAE –

Megaselia cavernicola (Brues)
Cave hump-backed fly

- TP
- Greene County:
  Monroe County:

- S5/G5

This species is ubiquitous in caves of the eastern U.S. and has also been reported from surface collections (Borgmeier 1965). It probably occurs in nearly every cave in Indiana that is of any length (Lewis 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2003) and comes to baited pitfalls in abundance.

Family PSYCHODIDAE –

Threticus sp.
Moth fly

- TP/TX
- Monroe County:

Psychodid flies are common in caves where they usually occur around streams. The psychodid fauna of American caves is very poorly known and this identification is tentative. No obligate cavernicoles are known to occur in this group in the United States.

Family SCIARIDAE –

Sciara sp.
Dark-winged fungus gnat

- TP
- Greene County:
  Monroe County:

Similar to the situation with psychodids, sciarids are common in caves where they usually occur around streams, feeding on fungi and decaying organic material. They are frequently taken in pitfall traps in Indiana caves. The sciarid fauna of American caves is very poorly known and this identification is tentative. No obligate cavernicoles are known to occur in this group in the United States.

Family SPHAEROCERIDAE

Spelobia tenebrarum (Aldrich)
Cave dung fly

- TB
- Greene County:
  Monroe County:
- S5/G5

This fly is ubiquitous in Indiana caves and comes readily to pitfall traps (Blatchley 1897; Banta 1907; Lewis 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004). It is particularly common on raccoon dung and has been found in essentially every cave in Indiana where baited pitfalls have been placed. The species occurs in caves across the eastern U.S. and is a mildly troglomorphic troglobite (Marshall and Peck 1985).

Order SIPHONAPTERA –

Family LEPTOPSYLLIDAE –

Peromyscopsylla hesperomys (Baker)
Flea

- PS
- Greene County:
- S1/G2

This is a rarely collected ectocommensal on mice (Durden in literature), although it is difficult to know if the rarity is real or an artifact of collecting.

4.2.4 Phylum CHORDATA –

Class OSTEICHTHYES –

Order CYPRINIFORMES –

Family CYPRINIDAE –

Notropis sp.
Shiner

- SPR
- Monroe County:

These fish are common minnows - one was found swimming in the pooled stream in The cave owner reported that a Great blue heron frequents the area outside the cave entrance to feed on the minnows.

Order PERCIFORMES –

Family COTTIDAE –

Cottus carolinae (Gill)
Banded sculpin

- SP/SX
- Greene County:
- S4/G5

This species commonly occurs in caves. It is found from West Virginia south to Georgia, through southern Indiana west to Kansas (Clay 1975).

Class AMPHIBIA –

Order ANURA –

Family RANIDAE –

Rana clamitans (Latreille)
Green frog

- TX
- Greene County:
  Monroe County:
- S5/G5

This species is common throughout Indiana in a variety of habitats (Minton 2001).

Rana palustris (LeConte)
Pickerel frog

- TX
- Greene County:
  Spring
- S4/G5

Minton (2001) reported that in southern Indiana the Pickerel frog was nearly always found near spring streams, often in or near caves. Otherwise, this species occurs across much of the eastern U.S.

Order CAUDATA –

Family PLETHODONTIDAE –

Eurycea lucifuga (Rafinesque)
Cave salamander

- TP
- Greene County:
- S4/G5

Most of the records for the Cave salamander are from springs, spring-fed brooks or caves, but have also been found under stones on dry, open hillsides, under trash in an open field, and in suburban yards (Minton 2001). Compared to the Longtail salamander, the range of the Cave salamander is relatively restricted. In Indiana, it occurs only in the southern half of the state and a more compressed range essentially equal to the karst areas of the Appalachians, Interior Low Plateaus and Ozarks.

Eurycea longicauda (Green)
Longtail salamander

- TX/TP
- Greene County:
- S5/G5

This species is usually associated with rocky streams and is frequently associated with springs (Minton 2001). It was also noted by Minton that the Longtail salamander frequently occurred near the mouths of caves. Its overall range encompasses much of the eastern U.S.

Class MAMMALIA –

Order CHIROPTERA –

Family VESPERTILIONIDAE –

Myotis lucifugus (LeConte)
Little brown bat

- TX
- Greene County:
- S4/G5

The Little brown bat occurs almost exclusively in caves during hibernation, where they may occur singly, in small groups, or clustered in irregular rows. This species of bat does not form large, compact clusters during hibernation. Most Little brown bats seem to inhabit buildings during the summer, with bats found in caves during the summer being almost exclusively males (Mumford and Whitaker 1982).

Myotis sodalis (Miller and Allen)
Indiana bat

- TX
- Greene County:
- S1/G2; USFWS Endangered

This species hibernates in caves in the southern part of Indiana during the winter, and then occurs throughout the state during the summer when it lives in non-cavern habitats. Brack et al (2003, 2005) reported

on the status of the Indiana bat in Indiana, including its tenuous existence in

This species is declining throughout its range (Mumford and Whitaker 1982).

Perimyotis subflavus (Cuvier)
Eastern pipistrelle

- TX
- Greene County:
- S5/G5

The Eastern pipistrelle is a common, permanent inhabitant of southern Indiana. Mumford and Whitaker (1982) reported that almost every cave visited contained at least one bat of this species, although only three caves had 50 or more (one of these was

It was also noted that in small caves the pipistrelle was frequently the only bat species present. These bats always roost singly and usually occur on the walls or overhanging ledges rather than on the ceilings of caves. Pipistrelles occur in caves during all months of the year, although relatively few occur there during the summer months. This species was recently assigned to the genus *Perimyotis* from *Pipistrellus* by Hoofer et al. (2006).

Order RODENTIA –

Family CRICETIDAE –

Peromyscus leucopus (Rafinesque)
White-footed mouse

- TX
- Greene County:
- S5/G5

This species of mouse is one of the most common mammals in Indiana (Mumford and Whitaker 1982). It frequently enters caves and Banta (1907) recorded it at least 1500 feet from the entrance of

in Monroe County. The mice are seldom seen, but their droppings are commonly found in and around pitfall traps, as are the fleas that are their ectoparasites.

Family CASTORIDAE –

Castor canadensis (Kuhl)
Beaver

- TX
- Monroe County:
- S4/G5

In Indiana the beaver is believed to have become extinct by about 1840. The animal was reintroduced in 1935. The beaver has done well and is widely distributed in Indiana (Mumford and Whitaker 1982). Beavers have constructed a lodge in the upper side passage in and the rodents have gnawed numerous sticks scattered about the passage.

Order CARNIVORA –

Family PROCYONIDAE –

Procyon lotor (Linnaeus)
Raccoon

- TX
- Greene County:

  Monroe County:

- S5/G5

Evidence of raccoons in these caves consists of footprints, wall scratch marks and latrines. Raccoon dung is an important source of food and breeding habitat for the invertebrate community in caves (Mosely et al. 2006).

4.3 Sites Sampled --

4.3.1 –

4.3.1.1 Habitat –

The map of prepared in 1980 shows a length of 6074 feet.

is classified by USFWS as a Priority 3 Hibernaculum for *Myotis sodalis.* The Indiana Department of Natural Resources (IDNR) owns the cave entrance. The cave is entered via a hole in sandstone breakdown blocks located about 2/3 of the way up the hillside behind the spring resurgence of the cave stream. The passage enlarges to a walking height room immediately inside the entrance, with a sandstone roof and large blocks of sandstone breakdown on the floor. No aquatic habitat was present in the entrance area at the time of sampling for this project. Several raccoon latrines and a small amount of leaf litter coming in through the small entrance enriched dry terrestrial habitat. is a minor hibernaculum for Indiana bats and the entrance area exhibits significant temperature depression during the winter.

Descending through this entrance room leads to the main passage through which the cave is traversed. The first few hundred feet of passage appear to be a floodwater overflow route in which a small mud-bottomed stream, ponded in areas creating wider pools, creates aquatic habitat. Under base flow conditions the small stream is fed by ceiling drips that collect in small pools, and then enter the stream to flow away from the entrance toward the main stream passage. Under flood conditions, this flow presumably reverses allowing egress of the water from the cave.

The primary aquatic habitat in is the main stream, which is encountered about 400 feet from the entrance. The downstream section is primarily soft, mud-bottom substrate, probably resulting from ponding during flooding. The stream bifurcates at a side passage encountered about 500 feet from the entrance. The stream in the side passage is typically narrow and shallow, flowing over bedrock or through gravels. The stream in the main passage changes character upstream with the mud-bottomed pools becoming interspersed with gravel and breakdown riffle areas. The areas of gravel become more predominant the further upstream one travels.

Approximately 1000 feet from the entrance suds and foam were noted in the cave stream water. This is suggestive of contamination of the stream by a surface source.

The terrestrial habitat of the cave beyond the relatively dry entrance area consists of mudbanks lining the sides of the stream, merging above into the moist bedrock walls of the cave. Localized areas of breakdown occur throughout the cave.

4.3.1.2 Aquatic Community –

The subterranean amphipod *Crangonyx packardi* was common in drip pools near beginning of the stream passage. The troglophilic crayfish *Cambarus laevis* were present starting in residual flood pools where water is first encountered in the cave, and continuing in the main stream. In the main stream the isopod *Caecidotea stygia* was abundant under breakdown blocks in riffles.

Quantitative Surber samples were taken as noted in 3 riffle areas in the main stream passage. Each revealed a community dominated by the isopod *Caecidotea stygia*, with 4 to 5 isopods per sample. The third sample also contained 1 amphipod *Crangonyx forbesi*.

Stream gravel washings completed on 19 August 2006 at the same three sites where

Surber samples were taken revealed *Caecidotea stygia*, *Crangonyx packardi* and 1 cyclopoid copepod *Macrocyclops albidus*.

Three quantitative Surber samples were taken in on 19 August 2006. The first Surber sample was performed mid-stream at the first side passage on the right, about 800 feet from entrance. The habitat was riffle, with stream width 4 feet, sample depth 2 to 4 centimeters, substrate loose gravel on mud/sand. Fauna in this sample:

Caecidotea stygia (mm): 4, 4, 6, 5, and 3

Surber sample #2 was taken mid-stream at the first breakdown room, with habitat consisting of riffle, stream width 2.5 feet, sample depth 4 to 6 centimeters, with a single breakdown slab present, substrate otherwise with loose gravel on bedrock, with sand and mud, sampler placed 3 feet downstream from the upstream end of the riffle. Fauna in this sample:

Caecidotea stygia (mm): 5, 3, 4, and 9

Surber sample #3 was taken mid-stream at second breakdown room. The habitat was a riffle, stream width 7 feet, sample depth 3 to 10 centimeters, loose cobbles, gravel on mud and sand, sampler placed at downstream margin of riffle. Fauna in this sample:

Caecidotea stygia (mm): 8, 10, 9, and 7
Crangonyx forbesi (mm): 14

A bucket placed under a ceiling drip on 2 September 2006 had gathered about 2 liters of water by 4 September and was drained through a plankton net. Phantom midge larvae were present. A high intensity dive light was used to search for crayfish on 2 September 2006 and revealed only the stygophile *Cambarus laevis*.

The stream in the north side passage was investigated on 2 September 2006. The isopod *Caecidotea stygia* was common and the amphipod *Crangonyx indianensis* was found in the gravels. Crayfish were not found.

On 4 September 2006, a crayfish census was conducted from the beginning of the main stream to the passage stricture approximately 2000 feet from the entrance, a census area encompassing about 1600 linear feet. The stream was illuminated with a high intensity dive light. Visibility in the water was about 2 feet. This survey yielded the following fauna observed:

Cottus carolinae (mm): 40 and 75

Eight crayfish *Cambarus laevis* (mm): 82 (male), 75 (male), ca.60 (undetermined) 54 (female), 26 (female), 73 (female), 73 (male), 60 (male).

On 16 September 2006, the bucket that had been left under a drip in the lower level was found full of water and was then drained through a plankton net. No animals were found after examination under a dissecting microscope. It was left in the cave, and then resampled on 30 September 2006. The bucket was removed from the cave at that time. No fauna was appreciated in the sample.

4.3.1.3 Terrestrial Community –

The twilight zone of the cave is characterized by latrines of the raccoon *Procyon lotor*, inhabited by an invertebrate community dominated by the cave dung fly *Spelobia tenebrarum*. Also present was the

rove beetle *Quedius spelaeus*, hump-backed fly *Megaselia cavernicola*, springtail *Sinella alata* and sheet-web spider *Phanetta subterranea*. One ant beetle *Batrisodes* sp. was found under a rock. The cave orb weaver was present on webs suspended from the walls and ceiling. The heleomyzid fly *Aecothea specus* was present on the walls. The cave salamander *Eurycea lucifuga* occurred on walls and under stones in the entrance area.

Berlese extraction of leaf litter taken 19 August 2006 just inside the entrance produced the cave dung fly *Spelobia tenebrarum*, juveniles of the millipede *Conotyla bollmani*, sheet-web spider *Microneta viaria* and numerous collembolans: *Tomocerus flavescens*, *Sinella alata*, *Ceratophysella succinea*, *Desoria trispinata* and *Megalothorax minimus*.

Brack et al. (2003) documented small numbers of the endangered Indiana bat *Myotis sodalis* in 20 (1993), 28 (1995) and 3 (1999). Other bats present were the little brown bat *Myotis lucifugus* (190 in 1993, 170 in 1995, 29 in 1999), Eastern pipistrelles *Perimyotis subflavus* (6 in 1993 and 14 in 1995), and Big brown bats *Eptesicus fuscus* (4 in 1993). Brack et al. (2005) noted that the stream in during a 2005 visit left a watermark 2.3 meters above the base-flow level. This would have inundated most of the areas typically used by all of the hibernating bat species, resulting in their deaths. It was the belief of Brack et al. (2005) that declines in abundance were probably attributable to flooding of the cave.

In the dark zone of the cave the mud-banks were inhabited by springtails *Sinella* sp. and *Arrhopalites* undescribed species, the flies the cave dung fly *Spelobia tenebrarum*, spider *Phanetta subterranea*, and millipede *Conotyla bollmani*. The cave salamander *Eurycea lucifuga* and Longtail salamander *Eurycea longicauda* were present in small numbers of mud-banks. On 12 August 06 one little brown bat *Myotis lucifugus* and a few Eastern pipistrelles *Perimyotis subflavus* were noted. On 19 August 2006, 6 cave salamanders *Eurycea lucifuga* and 1 Longtail salamander *Eurycea longicauda* were noted in the part of the cave traversed along the main stream passage to point about 1500 feet from the entrance. One Eastern pipistrelle *Perimyotis subflavus* and one Indiana bat *Myotis sodalis* were noted. Eight *Myotis* sp. were noted in a breakdown dome about 800 feet from the entrance but dropped into flight before examination could be conducted.

On 19 August 2006, 12 pitfall traps (placed on 12 August in riparian mudbanks between the beginning of the lower level and the intersection of the main stream) were retrieved. Approximately 99% of the fauna present in the pitfalls were the flies *Spelobia tenebrarum*, *Megaselia cavernicola* and *Sciara* sp. A few of the heleomyzid fly *Aecothea specus*, rove beetles *Aleochara lucifuga and Atheta annexa*, millipede *Conotyla bollmani*, one larva of *Quedius spelaeus*, and one carabid beetle *Pseudanophthalmus* undescribed species were present.

On 2 September 2006 the cave was entered to retrieve the pitfall traps. The entrance room in the vicinity of the previous collection site of *Batrisodes* was searched without additional specimens being found. Of the 12 placed, all of them within approximately 4 vertical feet of base level

were destroyed by flooded. Five that had been placed higher remained intact. The pitfalls primarily contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola* and *Sciara* sp. Other species present were springtails *Arrhopalites* undescribed species and *Sinella* sp., cave cricket nymphs *Ceuthophilus brevipes*, a flea (probably from a mouse or raccoon feeding on the bait), heleomyzid fly *Aecothea specus*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, and millipede *Conotyla bollmani*, and *Quedius spelaeus*.

Observations of other fauna on 2 September 2006 included 1 Eastern pipistrelle *Perimyotis subflavus*, 9 Longtail salamanders *Eurycea longicauda,* and 5 Cave salamanders *Eurycea lucifuga*. Two cave beetles *Pseudanophthalmus* undescribed species were collected from riparian mudbanks. Twelve pitfall traps were placed in riparian mudbanks along the north side passage. A bucket was placed under a drip in the lower level to sample for the presence of epikarstic fauna.

On 4 September 2006, the millipede *Trichopetalum uncum* was found deep in the cave on a pellet of bat guano on a riparian mudbank. The collembolans *Sinella* sp. and *Arrhopalites* undescribed species were also regular on the guano pellets. Four of the Ray's cave beetle *Pseudanophthalmus* undescribed species were taken from riparian mudbanks. Several bats were noted flying about the cave, but none were seen other than in flight. Little water was present in the bucket, but it was poured through a plankton net and several phantom midges were found.

On 16 September 2006 the cave was entered and the entrance room again searched for *Batrisodes*. No pselaphids were noted, but the linyphiid spiders *Phanetta subterranea* and *Porrhomma cavernicola* were found under stones. Two Indiana bats *Myotis sodalis* were present and awake in the entrance room. Four pitfalls were placed in the entrance room.

The pitfalls placed in the north side passage were intact and pulled. The pitfalls primarily contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Sciara* sp. Other species present were springtails *Arrhopalites* undescribed species, *Sinella* sp., and two of the rove beetle *Aleochara lucifuga*.

On 30 September 2006 was sampled again. Approximately 400 stones were turned in the entrance room in search of *Batrisodes*, however none were found. The pitfalls were retrieved and contained numerous cave crickets *Ceuthophilus brevipes* and flies *Spelobia* tenebrarum, *Megaselia cavernicola*, *Sciara* sp., collembolans *Tomocerus flavescens*, *Sinella alata*, and 1 each of the staphylinid beetles *Aleochara lucifuga* and *Quedius erythrogaster*.

4.3.1.4 Species –

Obligate subterranean species: 12

Caecidotea stygia
Northern cave isopod

Crangonyx packardi
Packard's groundwater amphipod

Crangonyx indianensis
Indiana cave amphipod

Conotyla bollmani
Bollman's cave millipede

Phanetta subterranea
Subterranean sheet-web spider

Porrhomma cavernicola
Cavernicolous sheet-web spider

Arrhopalites undescribed species
Ashcraft cave springtail
Pseudosinella fonsa
Fountain cave springtail
Sinella alata
Indiana cave springtail
Pseudanopthalmus undescribed species
Ray's cave beetle
Spelobia tenebrarum
Cave dung fly
Batrisodes krekeleri
Krekeler's cave ant beetle

Species of concern: 8
Crangonyx packardi
Packard's groundwater amphipod
G4 IDNR Watch List
Crangonyx indianensis
Indiana cave amphipod
G4 IDNR Watch List
Conotyla bollmani
Bollman's cave millipede
G4 IDNR Watch List
Arrhopalites undescribed species
springtail
G1 IDNR Endangered candidate
Pseudosinella fonsa
Fountain cave springtail
G2-3 IDNR Threatened
Sinella alata Indiana cave springtail
G3-4 IDNR Watch List
Pseudanopthalmus undescribed species
Ray's cave beetle
G1 IDNR Endangered
Myotis sodalis Indiana bat
G2 USFWS Endangered

Vertebrates: 8
Eurycea lucifuga
Cave salamander
Eurycea longicauda
Longtail salamander
Eptesicus fuscus
Big brown bat
Myotis lucifugus
Little brown bat
Myotis sodalis
Indiana bat
Perimyotis subflavus
Eastern pipistrelle
Peromyscus leucopus
White-footed mouse
Procyon lotor
Raccoon

4.3.2 –

4.3.2.1 Habitat –

This is the exit for subterranean waters flowing from The water emerges from a series of unenterable holes among breakdown blocks below the entrance to the cave.

4.3.2.2 Aquatic Community –

The flatworm *Phagocata gracilis*, isopod *Lirceus fontinalis*, and amphipod *Gammarus minus* were present under stones and in aquatic mosses where the water emerges. A Pickerel frog was noted on 19 August 2006. On 30 September 2006 rocks in the emergence area of the spring were pried from the substrate and the cave isopod *Caecidotea stygia* was found.

4.3.2.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.2.4 Species –

Obligate subterranean species: 1
Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 1
Rana palustris Pickerel frog

4.3.3 –

4.3.3.1 Habitat –

This collapsed cave entrance was noticed blowing air while visiting ad had no previous name. It lies approximately 200 feet south and 50 feet west of the Ashcraft entrance. It appeared to be a lower alternate entrance to and was included in the survey. There was a definite drip line and the portion of this cave that could be surveyed is within the twilight zone. On 16 September 2006 a strong air current was blowing out of the cave. A dry streambed leads from the entrance, which is about 3 feet wide by 2 feet high. The cave is floored by breakdown and extends about 25 feet, although the narrow crawl continues to extend and might be enterable by a very small person. A passage in unstable breakdown near the entrance of leads toward the annex cave.

4.3.3.2 Aquatic Community –

This cave appears to be a wet-weather overflow from nearby but was completely dry when examined on 16 and 30 September 2006.

4.3.3.3 Terrestrial Community –

The spider *Phanetta subterranea* was found under a stone. The dung fly *Spelobia tenebrarum* was taken on raccoon dung. Two pitfalls were placed on 16 September 2006 in loose gravel at the limit of entry of the cave. The cave was re-visited on 30 September 2006. A Cave salamander *Eurycea lucifuga* was noted in the twilight zone. One of the pitfalls had been knocked over and emptied, possibly raccoon disturbance, and the other was removed intact. The surviving pitfall contained the cave cricket *Ceuthophilus brevipes*, flies *Megaselia cavernicola*, *Amoebaleria defessa*, and *Spelobia tenebrarum*, and the staphylinid beetle *Lesteva pallipes*.

Two additional pitfalls were placed on 30 September 2006 and retrieved on 8 October 2006. The pitfalls were intact and contained the cave cricket *Ceuthophilus brevipes*, flies *Megaselia cavernicola*, *Amoebaleria defessa*, and *Spelobia tenebrarum*, and the staphylinid beetle *Atheta annexa*. Two pitfalls were again put in the cave on 8 October 2006, which were retrieved on 14 October 2006. These pitfalls contained flies *Megaselia cavernicola*, *Spelobia tenebrarum*, and the staphylinid beetles *Atheta annexa* and *Lesteva pallipes*. The rocks removed from the cave to allow entry were replaced at the last visit to restore the entrance to its original dimensions.

4.3.3.4 Species –

Obligate subterranean species: 2

Phanetta subterranea
Subterranean sheet-web spider

Spelobia tenebrarum
Cave dung fly

Species of concern: 0

Vertebrates: 2

Eurycea lucifug
Cave salamander

Procyon lotor
Raccoon

4.3.4 –

4.3.4.1 Habitat –

The main flow of the spring appears to come from the deepest point in the basin, which is floored with slabs of stone. A concrete standpipe was in the spring to cover a water-inlet pipe used by the owner. The water is

dammed by an adjacent road and forms a wetland around the spring characterized by species such as Burreeds (*Sparganium*), Watercress (*Nasturtium officinale*), and Waterweed (*Elodea*).

4.3.4.2 Aquatic Community –

Hand collections made in the spring on 12 August 2006 produced the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*. A plankton tow produced the copepods *Acanthocyclops einslei* and *Eucyclops agilis*. A shrimp-baited jar was placed in the spring orifice area on 19 August and retrieved on 20 August 2006. It produced the flatworm *Phagocata gracilis*, isopod *Lirceus fontinalis*, ostracods *Candona acuta* and *Cypria turneri*, copepods *Acanthocyclops einslei*, *Eucyclops elegans*, and *Macrocyclops fuscus*, and cladoceran *Ilyocryptus sordidus*.

On 2 September 2006 the spring was visited. The water was murky with significantly reduced visibility. A shrimp-baited jar was placed in the spring. On 3 September 2006 the spring was re-visited and it was found that the line to the baited jar had been cut. Another shrimp-baited jar was placed on the morning 16 September 2006. Due to the previous vandalism of the sampling the jar was pulled that evening and contained the isopod *Lirceus fontinalis*.

The spring was visited on 8 October 2006. At that time the isopod *Lirceus fontinalis*, amphipod *Crangonyx forbesi* and snail *Physa* sp. were found on rocks and aquatic plants.

4.3.4.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.4.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1
Rana clamitans
Green frog

4.3.5 –

4.3.5.1 Habitat –

This spring emerges from the side of the hill and flows over a substrate of bedrock, broken rock and sand. The stream cascades to the nearby creek.

4.3.5.2 Aquatic Community –

The subterranean isopod *Caecidotea stygia*, spring isopod *Lirceus fontinalis*, and spring flatworm *Phagocata gracilis* were present in the area around the spring orifice. A shrimp-baited jar was buried in the substrate near where the water emerges on 19 August 2006, and then retrieved on 20 August 2006. Small numbers of spring isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*, were taken.

On 3 September 2006 the spring was visited and a shrimp-baited jar placed in the upstream orifice. The jar was removed on 4 September 2006 and contained the isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*.

4.3.5.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.5.4 Species –

Obligate subterranean species: 1

Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 0

4.3.6 –

4.3.6.1 Habitat –

The water emerges from breakdown at the base of an alcove with an overhanging shelter cave. The substrate is a mixture of bedrock, stones and sand.

4.3.6.2 Aquatic Community –

The isopod *Lirceus fontinalis* and spring flatworm *Phagocata gracilis* were present in the area around the spring orifice. A shrimp-baited jar was buried in the substrate near where the water emerges on 19 August 2006, and then retrieved on 20 August 2006. Large numbers of the spring flatworm *Phagocata gracilis* essentially covered the surface of the jar. A few of the spring isopod *Lirceus fontinalis* and amphipod *Gammarus minus* were also present. The terrestrial isopod *Ligidium elrodi* was noted in the breakdown orifice of the spring.

On 3 September 2006 the spring was visited and a shrimp-baited jar placed in the upstream orifice. The jar was removed on 4 September 2006 and contained the isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*.

4.3.6.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.6.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 0

4.3.7 –

4.3.7.1 Habitat –

A hole in the sandstone less than a foot in height (too small to enter by humans), had pronounced air blowing from it on 12 August 2006. The site was visited again on 19 August 2006 and was again blowing.

4.3.7.2 Aquatic Community –

No aquatic habitat exists at this site (
is below it).

4.3.7.3 Terrestrial Community –

A latrine of the raccoon *Procyon lotor* was present in the opening of the blowhole. The site was visited again on 19 August 2006 and a jar with Limburger bait was placed at arm's length into the hole. The jar was pulled on 20 August 2006 and no fauna appreciated. The jar was attached to a stout wire and pushed a total of perhaps 7 feet into the hole.

The site was visited on 3 September 2004 and the baited jar was removed. Several tiny braconid wasps were present – these wasps are parasitic on cave flies, laying their eggs on their larvae.

4.3.7.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1
Procyon lotor
Raccoon

4.3.8 –

4.3.8.1 Habitat –

At base-flow this cave has 1 to 3 feet of water from wall to wall with 1 to 2 feet of airspace. The substrate of the stream is primarily mud/silt, with a small area near the entrance floored with stones. A crawlway about 2 feet above the pool level is present and was mostly filled with beaver den debris. Adjacent to this is a water crawlway that can be entered for only a few feet before it becomes too small for egress. Limited areas of mudbanks are present along both walls. The cave ends in a sump, but examination below the water revealed continuation of the passage.

4.3.8.2 Aquatic Community –

One shiner *Notropis* sp. was noted by snorkeling the cave stream. A Green frog *Rana clamitans* was present on 13 and 19 August 2006. On 2 September 2006 the cave was visited and a shrimp-baited jar placed within a larger bait bucket in the upstream orifice. The jar and bucket were removed on 3 September 2006, the site was snorkeled and no crayfish were visualized in or near the bait. The stygobitic ostracod *Pseudocandona jeanneli* and copepod *Eucyclops elegans* were attracted to the shrimp bait. Inspection of rocks on the bottom of the stream near the cave entrance revealed the cave isopod *Caecidotea stygia*, spring isopod *Lirceus fontinalis*, spring amphipod *Gammarus minus*, and flatworm *Phagocata gracilis*.

A shrimp-baited jar was placed in the cave on 30 September 2006, and then removed on 1 October 2006. The jar contained the isopod *Lirceus fontinalis* and one cyclopoid copepod *Eucyclops elegans*.

4.3.8.3 Terrestrial Community –

Four pitfalls were placed on 13 August 2006 and retrieved on 20 August 2006. These traps were dominated by the hump-backed fly *Megaselia cavernicola*, with sparse cave dung flies *Spelobia tenebrarum*, Dark-winged fungus gnats *Sciara* sp., and heleomyzid flies *Aecothea specus*. The den of the beaver *Castor canadensis* appeared to be intact in the crawlway, but the owners reported that the animal had departed during the floods during the spring of 2006. It was not observed during the fieldwork.

Pitfall traps were pulled and replaced on 3 September 2006. The pitfalls contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Aecothea specus* and one cave cricket *Ceuthophilus brevipes*.

was again visited on 17 September 2006 and the pitfalls were pulled and replaced. The pitfalls contained a Cave salamander *Eurycea lucifuga*, flies *Spelobia tenebrarum* and *Megaselia cavernicola*, 3 cave crickets *Ceuthophilus brevipes*, and 1 ground beetle *Bembidion* sp.

The cave was revisited on 30 September 2006 and the pitfalls were removed. The pitfalls contained flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Sciara* sp., 2 ground beetles *Platynus tenuicollis* and 1 terrestrial isopod *Trachelipus rathkei*.

On 14 October 2006 a shrimp-baited jar was placed in which was retrieved on 15 October 2006. The bait attracted several cyclopoid copepods.

4.3.8.4 Species –

Obligate subterranean species: 3

Pseudocandona jeanneli

Jeannel's groundwater ostracod

Caecidotea stygia
Northern cave isopod
Spelobia tenebrarum
Cave dung fly

Species of concern: 1
Pseudocandona jeanneli
Jeannel's groundwater ostracod
G2 IDNR Endangered

Vertebrates: 3
Notropis sp.
Shiner
Rana clamitans
Green frog
Castor canadensis
Beaver

4.3.9 **–**

4.3.9.1 Habitat –

The entrance to this cave is 11 inches high and allows egress to 31 feet of passage that averages 2 feet wide by 2 feet high. A shallow stream flows the length of the cave. Upon entry, most of the wall area is bedrock, but the left wall has dry, desiccated clay on the wall ledge, the right wall has wet, oozy clay.

4.3.9.2 Aquatic Community –

Present in the stream are the subterranean isopod *Caecidotea stygia*, and amphipods *Crangonyx packardi* and *Gammarus minus* (census data below). A juvenile crayfish was presumptively *Cambarus laevis*.

stream census, 20 August 2006

Sample #1: 10 feet from entrance, habitat: stream width 4 to 7 inches, sample depth 0 to 2 centimeters, substrate mud; fauna:
Gammarus minus (mm): 14 and 6

Sample #2: 15 feet from entrance, habitat: stream width 19 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 4, 5, 4, 4, 3, 5, 6, 8, 3, 3, 7, 4, 7, 5, 5, 5, 3, 3, and 4
Gammarus minus (mm): 5, 3, and 2

Sample #3: 20 feet from entrance, habitat: stream width 19 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 4, 4, 6, 4, 4, and 4
Gammarus minus (mm): 5, 5, 5, and 5
Crangonyx spp. (*packardi*/*forbesi*) (mm): 2, 3, 3, and 3

Sample #4: 25 feet from entrance, habitat: stream width 21 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 6, 4, 4, 4, 2, 5, and 7
Gammarus minus (mm): 5, 4, 5, 5, 5, 4, 4, 4, and 4
Crangonyx spp. (*packardi*/*forbesi*; mm): 2, 2, and 3

On 17 September the cave was visited and in addition to the above species, one Weingartner's cave flatworm *Sphalloplana weingartneri* was found feeding on residual cheese bait on a pitfall jar that had been washed out and fallen into the stream during flooding.

4.3.9.3 Terrestrial Community –

Hand collections on 13 August 2006 included the spiders *Cicurina* sp. and *Coras*

sp. Four pitfalls were placed on 13 August 2006 and retrieved on 20 August 2006. These traps were dominated by the hump-backed fly *Megaselia cavernicola*, cave dung flies *Spelobia tenebrarum*, a few heleomyzid flies *Aecothea specus*. Also present were the rove beetles *Aleochara lucifuga* and *Blepharrhymenus illectus*, one small carrion beetle *Dissochaetus oblitus*, and one each of the spiders *Phanetta subterranea*, *Bathyphantes pallidus*, and *Cicurina* sp.

The cave was visited on 3 September 2006 to retrieve the pitfalls previously placed and another set of pitfalls was placed. The pitfalls contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola,* and *Aecothea specus*. Other species present were cave cricket nymphs *Ceuthophilus brevipes*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, millipede *Oxidus gracilis*, and the troglophilic ground beetle *Platynus tenuicollis*.

was again sampled on 17 September 2006. At that time when the entrance was approached it was noted that two of the pitfall trap lids were lying under the drip line. Upon entry, a third was sticking to the ceiling with other flood debris. All but one of the pitfalls were destroyed. One flooded pitfall contained the flies *Spelobia tenebrarum* and *Megaselia cavernicola*, rove beetle *Atheta annexa*, and 1 terrestrial isopod *Cylisticus convexus*. A new set of pitfalls were placed and baited. These were retrieved on 30 September 2006 and contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola, Threticus* sp., *Sciara* sp., and *Amoebaleria defessa*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, ground beetle *Platynus tenuicollis*

4.3.9.4 Species –

Obligate subterranean species: 4

Sphalloplana weingartneri
Weingartner's cave flatworm

Caecidotea stygia
Northern cave isopod

Phanetta subterranean
Subterranean sheet-web spider

Spelobia tenebrarum
Cave dung fly

Species of concern: 1

Sphalloplana weingartneri
Weingartner's cave flatworm G3
IDNR Watch List

Vertebrates: 0

4.3.10 –

4.3.10.1 Habitat –

This site is a wet weather seep near . No orifice is present. It was examined on 13 August 2006 and 20 August 2006 and damp leaves were present, but no water. On 3 September 2006 the area appeared moister but no water was present. On 17 September 2006 water was oozing from the ground in several spots and with a total flow of less than 1 gallon per minute. Subterranean fauna present in the intermittent stream below the seep is flushed from groundwater during periods of high flow. The site was visited again on 30 September 2006 and the seep was again oozing at about the same rate as the previous visit. On 8 October 2006 water was barely seeping out, and on 14 October flow had stopped and the stream had turned into a series of stagnating pools.

4.3.10.2 Aquatic Community –

On 17 September 2006 the isopods *Caecidotea stygia* and *Lirceus fontinalis*, and amphipod *Crangonyx indianensis* were found. The *Caecidotea* and *Crangonyx* were found by prying rocks out of the substrate and looking on the undersides. On 30 September 2006 the isopod *Caecidotea stygia* was again found in this manner. A plankton net was placed in the flow of the stream and the leaves and substrate were agitated. This sample yielded the isopod *Lirceus fontinalis* and the amphipod *Crangonyx forbesi*.

Another drift sample was taken on 8 October 2006. The seep was barely oozing water at that time. This sample contained *Lirceus fontinalis* and a harpacticoid copepod *Attheyella nordenskioldii*.

4.3.10.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.10.4 Species –

Obligate subterranean species: 2

Caecidotea stygia
Northern cave isopod

Crangonyx indianensis
Indiana cave amphipod

Species of concern: 1

Crangonyx indianensis
Indiana cave amphipod G4
IDNR Watch List

Vertebrates: 0

4.3.11 –

4.3.11.1 Habitat –

The main spring is covered by a block springhouse identified as measuring 7 feet 8 inches square and is 5 feet 8 inches high on the door side. The water emerges from holes near the base of the springhouse, ponds on the floor, and then discharges into a spring run.

The spring stream flows away from the springhouse following the edge of the hill from which it emerges. Perhaps 50 feet downstream is another small spring.
is about an equal distance upstream of the springhouse spring.

4.3.11.2 Aquatic Community –

Hand sampling on 13 August 2006 revealed the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*.

The spring was sampled on 17 September 2006 by placing a plankton net over the main spring orifice and left in place for approximately 8 hours. This sample contained the isopod *Caecidotea stygia* and copepods *Microcyclops varicans* and *Orthocyclops modestus*. Noted on the floor of the springhouse were the isopods *Caecidotea stygia* and *Lirceus fontinalis* and the amphipod *Crangonyx forbesi*.

On 30 September 2006 a Karaman-Chappuis sampling hole was excavated and a piece of perforated PVC pipe placed to retain the soil. A shrimp baited jar was placed in the hole and then retrieved on 1 October 2006. No fauna was found in this jar. A small shred of shrimp was returned to the jar and it was replaced in the hole. Stones in the orifice of the downstream spring were examined and found to contain the isopod *Lirceus fontinalis*, amphipod *Gammarus minus,* and flatworm *Phagocata gracilis*.

A second shrimp baited jar was placed 30 September 2006 in the pooled water in the springhouse immediately below the spring

orifice. This jar was also retrieved on 1 October 2006 and the contents removed. A plankton net was placed to receive the water flowing out of the spring orifice on 1 October 2006 for about an hour; no fauna was appreciated when the sample was examined in the lab.

The jar was returned to the springhouse basin on 1 October 2006 with a shred of shrimp for bait. The jar was drained through a plankton net on 8 October 2006 and contained juvenile cyclopoid copepods, probably *Acanthocyclops*. The jar and the remaining shrimp were returned to the springhouse basin. This was examined on 14 October 2006 for macrofauna and none was noted. A shrimp was placed in the jar and it was returned to the springhouse basin. The jar was removed on 15 October 2006 and contained 4 *Crangonyx forbesi*, 1 *Crangonyx indianensis*, and 2 cyclopoid copepods *Eucyclops elegans* and *Macrocyclops albidus*. A plankton net was hung on the spring orifice on 14 October and then retrieved on 15 October 2006. This sample contained 4 *Crangonyx forbesi*, 1 *Lirceus fontinalis*, cyclopoid *Acanthocyclops* sp., and harpacticoid *Attheyella nordenskioldii*.

The Karaman-Chappuis sampling hole was examined on 8 October 2006 and the jar had been removed and was lying nearby in the stream. It was refilled with water and returned to the sampling hole. On 14 October 2006 the site was re-visited. The PVC sampling well appeared to have been dislodged (as if someone had kicked it) and was leaning to one side in the hole, but the jar within was intact. It was examined and no macrofauna was seen. A shrimp was placed in the jar and it was returned to the sampling site. On 15 October 2006 the water from the jar was run through a plankton net and the sample returned to the lab. The PVC tube was removed and the hole filled with the soil that had been dug out initially. The sample contained 1 isopod *Lirceus fontinalis*, a cyclopoid copepod *Microcyclops varicans,* and was teeming with protozoans.

4.3.11.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.11.4 Species –

Obligate subterranean species: 1
Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 0

4.3.12 –

4.3.12.1 Habitat –

This spring occurs a short distance from emerging from the side of a hill. A small wetland characterized by the presence of bulrush (*Scirpus*) is present. The water from the spring flows toward the spring run from where it then becomes confluent. Water also emerges from the hillside about halfway between .

4.3.12.2 Aquatic Community –

Hand sampling on 13 August 2006 revealed the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*. A Green frog, *Rana clamitans,* was calling from the wetland area.

On 30 September 2006 a Karaman-Chappuis sampling hole was excavated and a piece of

perforated PVC pipe placed to retain the soil. A shrimp baited jar was placed in the hole and then retrieved on 1 October 2006. No fauna was found in this jar. A small shred of shrimp was returned to the jar and it was replaced in the hole. The site was visited on 8 October 2006 and the jar had been removed from the sampling hole and was lying nearby on the bank. It was refilled with water and returned to the sampling hole. Upon returning on 14 October 2006 the jar had again been removed and placed next to the stream. The jar was rebaited and placed back into the sampling well. It was removed intact on 15 October 2006 and contained 11 of the amphipod *Crangonyx forbesi*.

4.3.12.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.12.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1

Rana clamitans
Green frog

5.0 Discussion

Six sites (Figure 2, Table 1) were sampled for subterranean fauna based on identified hydrological connectivity to the Section 4 Corridor. Sites included:

1) including its resurgence and a crawlway that is probably a floodwater overflow route from (Greene County; sampled 12 August, 19 August, 2 September, 4 September, 16 September, 30 September, 8 October, and 14 October 2006).

2) and and a small associated blowing hole above (Greene County; sampled 12 August, 19 August, 20 August, 3 September, and 4 September 2006).

3) (Greene County; sampled 12 August, 19 August, 2 September, 3 September, 16 September, and 8 October 2006).

4) PicAChic Spring Cave and an associated wet weather seep, (Monroe County; sampled 13 August, 20 August, 3 September, 4 September, 17 September, 30 September, 8 October and 14 October 2006).

5) (Monroe County; sampled 13 August, 19 August, 3 September, 4 September, 17 September, 30 September, 1 October, 14 October, and 15 October 2006).

6) complex, including (Monroe County; sampled 13 August, 17 September, 30 September, 1 October, 8 October, 14 October, and 15 October 2006).

A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families and 67 genera (Table 2) were found in the survey of selected subterranean habitats in Section 4.

Of all species found, 14 were classified as obligate subterranean species:

1) *Sphalloplana weingartneri*
Weingartner's cave flatworm

2) *Pseudocandona jeanneli*
   Jeannel's groundwater ostracod
3) *Caecidotea stygia*
   Northern cave isopod
4) *Crangonyx indianensis*
   Indiana cave amphipod
5) *Crangonyx packardi*
   Packard's groundwater amphipod
6) *Conotyla bollmani*
   Bollman's cave millipede
7) *Phanetta subterranea*
   Subterranean sheet-web spider
8) *Porrhomma cavernicola*
   Cavernicolous sheet-web spider
9) *Pseudosinella fonsa*
   Fountain cave springtail
10) *Arrhopalites* undescribed species
   Ashcraft cave springtail
11) *Pseudanophthalmus* undescribed species
   Ray's cave beetle
12) *Batrisodes krekeleri*
   Krekeler's cave ant beetle
13) *Spelobia tenebrarum*
   Cave dung fly
14) *Sinella alata*
   Indiana cave springtail

Twelve species were classified as species of concern:

1) *Sphalloplana weingartneri*
   Weingartner's cave flatworm
   S3/G4 IDNR Watch List
2) *Pseudocandona jeanneli*
   Jeannel's groundwater ostracod
   S1/G2, IDNR Endangered
3) *Crangonyx indianensis*
   Indiana cave amphipod
   S4/G3, IDNR Watch List
4) *Crangonyx packardi*
   Packard's groundwater amphipod
   S3-4/G4, IDNR Watch List
5) *Conotyla bollmani*
   Bollman's cave millipede
   S3-4/G3-4, IDNR Watch List
6) *Pseudosinella collina*
   Hilly springtail
   S2/G3-4, IDNR Rare
7) *Pseudosinella fonsa*
   Fountain cave springtail
   S2/G2-3, IDNR threatened
8) *Sinella alata*
   Indiana cave springtail
   S4/G3-4, IDNR Watch List
9) *Arrhopalites* undescribed species
   Ashcraft cave springtail
   S1/G1, IDNR endangered candidate
10) *Pseudanophthalmus* undescribed species
   Ray's cave beetle S1/G1, IDNR
   Endangered
11) *Batrisodes krekeleri*
   Krekeler's cave ant beetle
   S1/G1, IDNR Endangered
12) *Myotis sodalis*
   Indiana bat
   S1/G2, USFWS Endangered

The *Arrhopalites* undescribed species is known only from The *Pseudanophthalmus* undescribed species has a slightly larger known range continuing northward to include two other caves within approximately 3 miles.

The following is a list of the top faunal caves in Indiana from cave bioinventories that surveyed over 500 caves (Lewis 1983, 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004, Lewis and Lewis 2006). The list is rank-ordered by the number of obligate subterranean species (troglobites and stygobites) identified from the cave. Placed within the context of this list, ranks within the fifth cohort of biologically significant caves:

Cave and obligate subterranean species

- (Harrison County): 19
- Wesley Chapel Gulf/ (Orange County): 18
- (Crawford County): 15
- (Harrison County): 12
- (Orange County): 12
- (Greene County): 11
- (Monroe County): 11
- (Monroe County): 11
- (Orange County): 11
- (Crawford County): 11
- (Harrison County): 11
- (Orange County): 11

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Appendix A
Figures

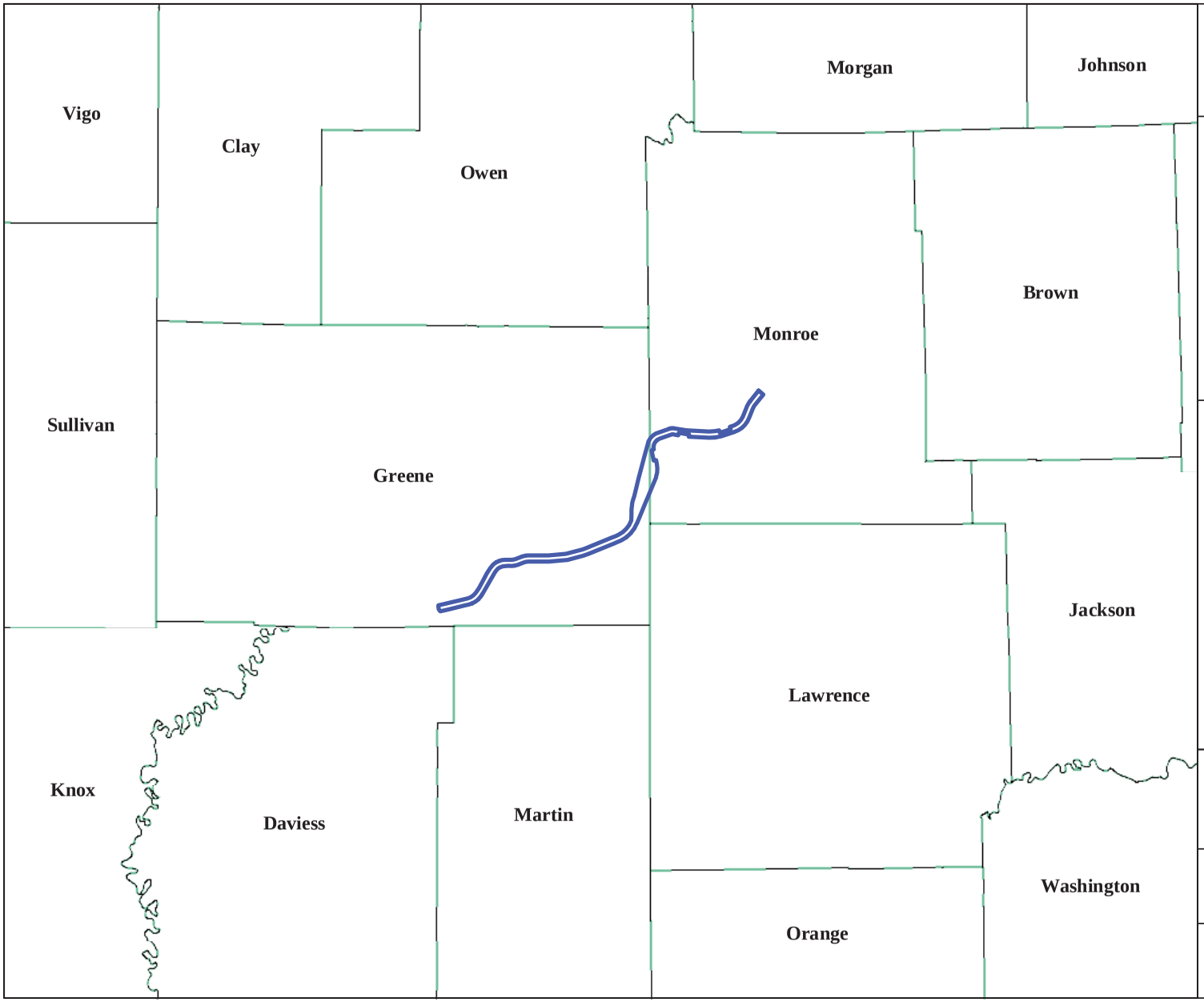
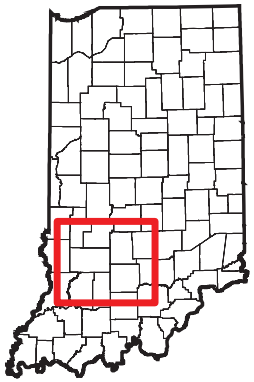


Figure 1. Location of Section 4 of the proposed I-69 corridor in Greene and Monroe counties, Indiana.

Section 4 Corridor

County boundary



N
W E
S

0 5 10 Miles

Base Map: ESRI Data, and I-69 GIS DAta

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Project No. 123.08

Figure 2 ("Cave fauna sampling sites on Section 4 of the proposed I-69 corridor in Greene and Monroe counties, Indiana") has been removed for confidentiality reasons related to caves.

Appendix B
Tables

Table 1 ("Locations of cave fauna sampling sites near the proposed I-69, autumn 2006") has been removed for confidentiality reasons related to caves.

Table 2. Cave fauna found during autumn 2006 sampling, including common name, site, ecological class, State/Global rank, and listing status (if any).

Taxon	Common Name	Site	Ecol. Class[1]	S/G Rank[2]	Listing Status (if any)
PHYLUM PLATYHELMINTHES					
CLASS TURBELLARIA					
ORDER TRICLADIDA					
FAMILY KENKIIDAE					
Sphalloplana weingartneri	Weingartner's cave flatworm		SB	S4/G3	IDNR Watch List
FAMILY PLANARIIDAE					
Phagocata gracilis	Slender spring flatworm		SP/SX	S4/G4	
PHYLUM MOLLUSCA					
CLASS GASTROPODA					
ORDER BASOMMATOPHORA					
FAMILY PHYSIDAE					
Physa sp.	Aquatic snail		SPR		
PHYLUM ARTHROPODA					
CLASS CRUSTACEA					
ORDER EUCOPEPODA					
FAMILY CYCLOPIDAE					
Acanthocyclops einslei	Einsle's copepod		SPR	S4/G4	
Acanthocyclops sp.	Copepod		SPR		
Eucyclops elegans	Elegant copepod		SPR	S4/G4	
Eucyclops agilis	Copepod		SPR	S4/G4	

Table 2 continued

Macrocyclops albidus	Copepod	TX	S4/G4	
Macrocyclops fuscus	Copepod	SPR	S4/G4	
Microcyclops varicans	Copepod	SPR	S4/G4	
Orthocyclops modestus	Copepod	SPR	S4/G4	
FAMILY CANTHOCAMPTIDAE				
Attheyella nordenskioldii	Nordenskioldi's copepod	TX/SPR	S4/G4	
ORDER CLADOCERA				
FAMILY MACROTHRICIDAE				
Ilocryptus sordidus	Water flea	SPR	S4/G4	
ORDER OSTRACODA				
FAMILY CANDONIDAE				
Candona acuta	Ostracod	SPR	S4/G4	
Cypria turneri	Ostracod	SPR	S4/G4	
Pseudocandona jeanneli	Jeannel's groundwater ostracod	SB	S1/S2	IDNR Endangered
ORDER ISOPODA				
FAMILY ASELLIDAE				
Caecidotea stygia	Northern cave isopod	SB	S4/G5	
Lirceus fontinalis	Bluegrass spring isopod	SX	S4/G4	

Table 2 continued

FAMILY ARMADILLIDIDAE				
Cylisticus convexus	Common convex pillbug	TX	SE/G5	
FAMILY LIGIIDAE				
Ligidium elrodi	Elrod's terrestrial isopod	TP/TX	S4/G4	
FAMILY PORCELLIONIDAE				
Trachelipus rathkei	Rathke's terrestrial isopod	TX	SE/G5	
ORDER AMPHIPODA				
FAMILY CRANGONYCTIDAE				
Crangonyx forbesi	Forbe's amphipod	SP/SX	S4/G4	
Crangonyx packardi	Packard's groundwater amphipod	SB	S3-4/G4	IDNR Watch List
Crangonyx indianensis	Indiana cave amphipod	SB	S4/G3	IDNR Watch List
FAMILY GAMMARIDAE				
Gammarus minus	Lesser spring amphipod	SX/SP	S4/G5	
ORDER DECAPODA				
FAMILY CAMBARIDAE				
Cambarus laevis	Crayfish	SP	S4/G4	
CLASS DIPLOPODA				
ORDER CHORDEUMATIDA				
FAMILY CONOTYLIDAE				
Conotyla bollmani	Bollman's cave millipede	TB/TP	S3-4/G3-4	IDNR Watch List
FAMILY TRICHOPETALIDAE				
Trichopetalum uncum	Cave millipede	TP/ED	S1/G4	

Table 2 continued

ORDER POLYDESMIDA				
FAMILY PARADOXOSOMATIDAE				
Oxidus gracilis	Greenhouse millipede	TX	SE	
CLASS ARACHNIDA				
ORDER ARANEAE				
FAMILY AMAUROBIIDAE				
Coras sp.	Spider	TX		
FAMILY DICTYNIDAE				
Cicurina sp.	Funnel-web spider	TP		
FAMILY LINYPHIIDAE				
Bathyphantes pallidus	Pallid sheet-web spider	TX	S4/G5	
Phanetta subterranea	Subterranean sheet-web spider	TB	S4/G5	
Porrhomma cavernicola	Cavernicolous sheet-web spider	TB	S2/G4	
Microneta viaria	Sheet-web spider	TX	S4/G5	
FAMILY TETRAGNATHIDAE				
Meta ovalis	American cave orb weaver	TP	S4/G5	
CLASS COLLEMBOLA				
FAMILY ENTOMOBRYIDAE				
Pseudosinella collina	Hilly springtail	TP		IDNR Rare
Pseudosinella fonsa	Fountain cave springtail	TB	S2/G2-3	IDNR Threatened
Sinella alata	Indiana cave springtail	TB	S4/G3-4	IDNR Watch List
FAMILY HYPOGASTRURIDAE				
Ceratophysella succinea	Springtail	TX	S4/G5	
FAMILY ISOTOMIDAE				
Desoria trispinata	Three-spined springtail	TX	S4/G5	
FAMILY NEELIDAE				
Megalothorax minimus	Springtail	TX/AC	S4/G5	
FAMILY SMINTHURIDAE				
Arrhopalites undescribed species	Ashcraft cave springtail	TB	S1/G1	IDNR Endangered Candidate
FAMILY TOMOCERIDAE				
Tomocerus bidentatus	Two-toothed springtail	TP	S4/G4	
Tomocerus flavescens	Golden springtail	TP	S4/G5	

Table 2 continued

CLASS INSECTA				
ORDER DIPLURA				
FAMILY CAMPODEIDAE				
Tricampa rileyi	Dipluran	TP	S1/G4	
ORDER ORTHOPTERA				
FAMILY GRYLLACRIDIDAE				
Ceuthophilus brevipes	Cave cricket	TX	S4/G4	
ORDER COLEOPTERA				
FAMILY CARABIDAE				
Bembidion sp.	Ground beetle	TX		
Platnus tenuicollis	Ground beetle	TP/TX	S4/G4	
Pseudanophthalmus undescribed species	Ray's cave beetle	TB	S1/G1	IDNR Endangered
FAMILY STAPHYLINIDAE				
Subfamily Aleocharinae				
Aleochara lucifuga	Rove beetle	TP	S4/G4	
Atheta troglophila	Rove beetle	TP	S4/G4	
Atheta annexa	Rove beetle	TP	S4/G4	
Blepharrhymenus illectus	Rove beetle	TX/TP	S1/G2-3	
Subfamily Pselaphinae				
Batrisodes krekeleri	Krekeler's cave ant beetle	TB	S1/G1	IDNR Endagnered
Subfamily Staphylininae				
Quedius erythrogaster	Rove beetle	TX	S4/G5	
Quedius spelaeus	Spelean rove beetle	TP	S4/G5	
Subfamily Omaliinae				
Lesteva pallipes	Rove beetle	TX	S4/G5	
ORDER DIPTERA				
FAMILY CHAOBORIDAE				
Unidentified species (larvae)	Phantom midge	SX		

Table 2 continued

FAMILY HELEOMYZIDAE			
Amoebaleria defessa	Heleomyzid fly	TX	S4/G4
Aecothea specus	Heleomyzid fly	TX	S4/G4
FAMILY PHORIDAE			
Megaselia cavernicola	Hump-backed fly	TP	S5/G5
FAMILY PSYCHODIDAE			
Threticus sp.	Moth fly	TP/TX	
FAMILY SCIARIDAE			
Sciara sp.	Dark-winged fungus gnat	TP/TX	
FAMILY SPHAEROCERIDAE			
Spelobia tenebrarum	Cave dung-fly	TB	S5/G5
ORDER SIPHONAPTERA			
FAMILY LEPTOPSYLLIDAE			
Peromyscopsylla hespermys	Mouse flea	PS	S1/G2
PHYLUM CHORDATA			
CLASS OSTEICHTHYES			
ORDER CYPRINIFORMES			
FAMILY CYPRINIDAE			
Notropis sp.	Shiner	TX/AC	
ORDER PERCIFORMES			
FAMILY COTTIDAE			
Cottus carolinae	Banded sculpin	SP/SX	S4/G5
CLASS AMPHIBIA			

Table 2 continued

ORDER ANURA					
FAMILY RANIDAE					
Rana clamitans	Green frog		TX	S4/G5	
Rana palustris	Pickerel frog	Spring	TX	S4/G5	
ORDER CAUDATA					
FAMILY PLETHODONTIDAE					
Eurycea lucifuga	Cave salamander		TP	S4/G5	
Eurycea longicauda longicauda	Longtail salamander		TX/TP	S5/G5	
CLASS MAMMALIA					
ORDER CHIROPTERA					
FAMILY VESPERTILIONIDAE					
Myotis lucifugus	Little brown bat		TX	S4/G5	
Myotis sodalis	Indiana bat		TX	S1/G2-3	USFWS Endangered
Perimyotis subflavus	Eastern pipistrelle		TX	S5/G5	
ORDER RODENTIA					
FAMILY CRICETIDAE					
Peromyscus leucopus	White-footed mouse		TX	S5/G5	
FAMILY CASTORIDAE					
Castor canadensis	Beaver		TX	S4/G5	
ORDER CARNIVORA					
FAMILY PROCYONIDAE					
Procyon lotor	Raccoon		TX	S5/G5	

1 Ecological Class = (TB) Troglobite, (TP) Troglophile, (TX) Trogloxene, (SB) Stygobite, (SP) Stygophile, (SX) Stygoxene, (AC) Accidental, (PS) Parasite/commensal, (SPR) Spring dweller

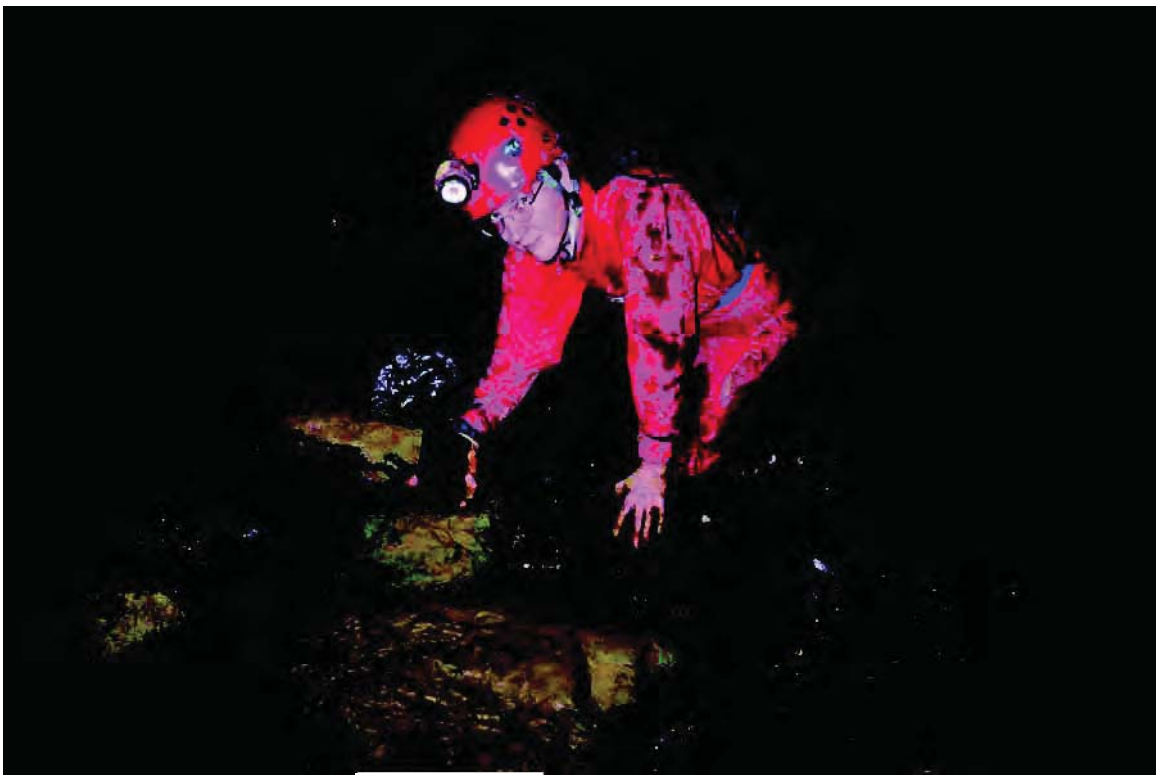
2 State/Global Rank = (S1/G1) critically imperiled, (S2/G2) imperiled, (S3/G3) vulnerable, (S4/G4) apparently secure, (S5/G5) secure, (SE) exotic species

Appendix C
Photographs

Entrance to (Greene County).

Placing a four-ounce pitfall trap jar in a typical mudbank habitat in (Greene County). This is typical habitat for the Ashcraft cave springtail (*Arrhopalites* undescribed species).

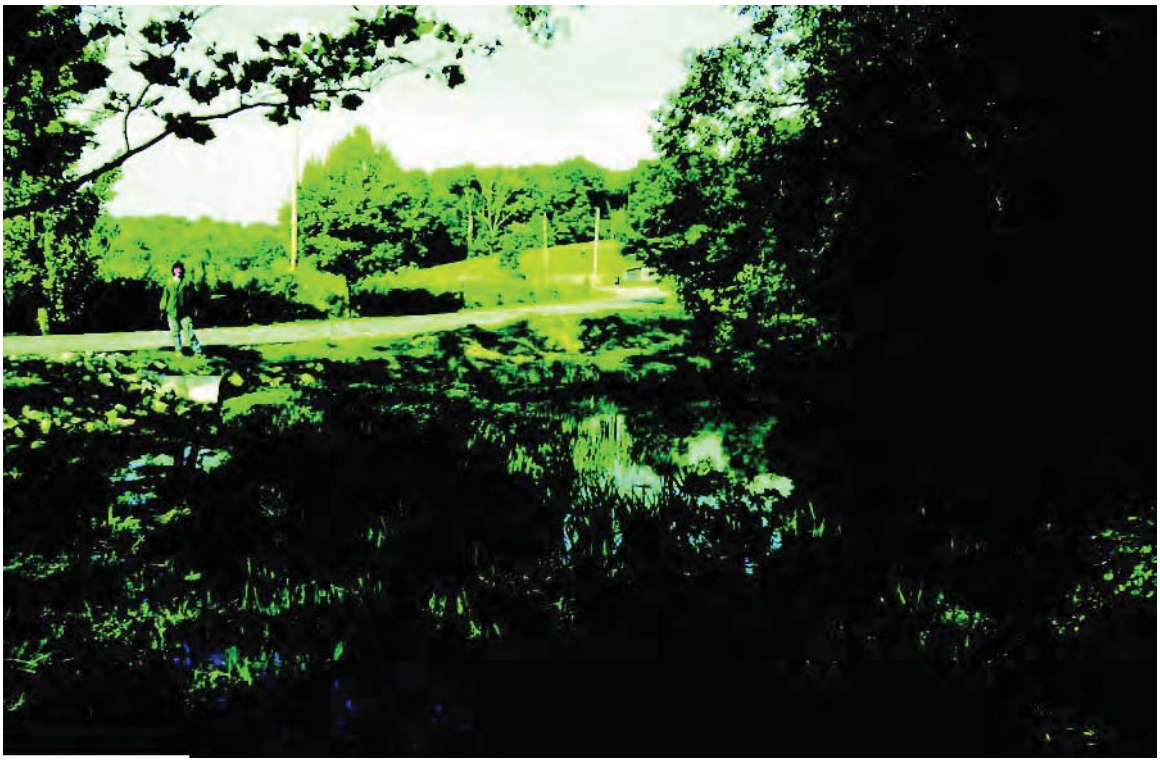
Deep mud floor in the downstream end of the stream passage in (Greene County). This is the habitat in which the Ray's cave beetle (*Pseudanophthalmus* undescribed species) was most frequently found.



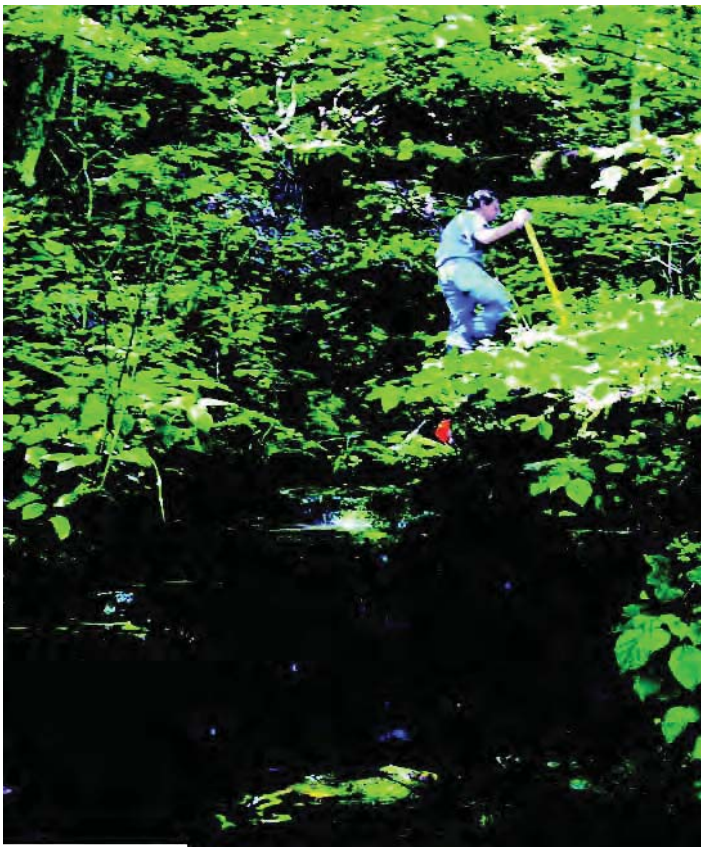
Breakdown riffle habitat in (Greene County).

Examining crayfish *Cambarus laevis* in stream passage of (Greene County).

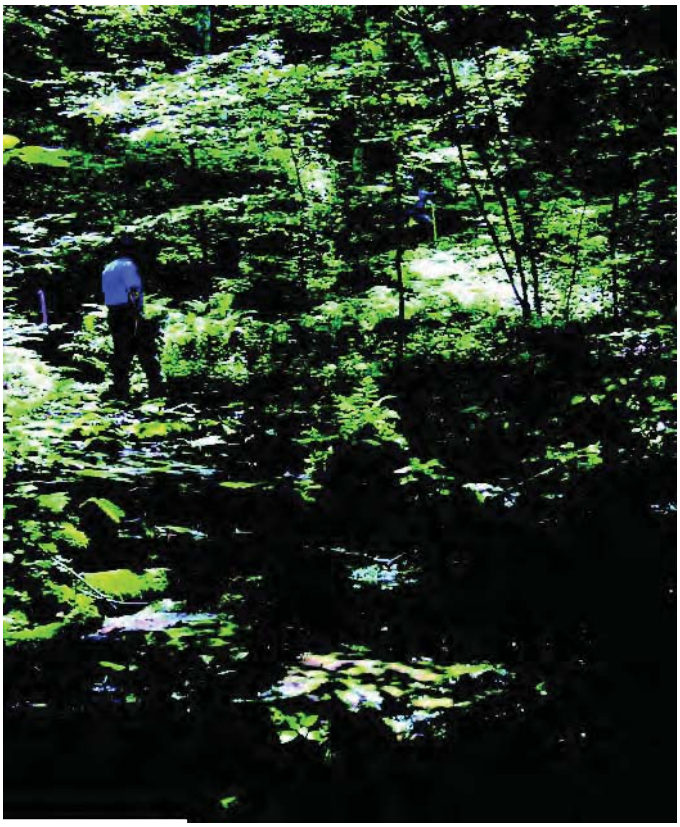
Entrance to (Greene County), a 20 foot long cave adjacent to



(Greene County) has been impounded by the adjacent county road.



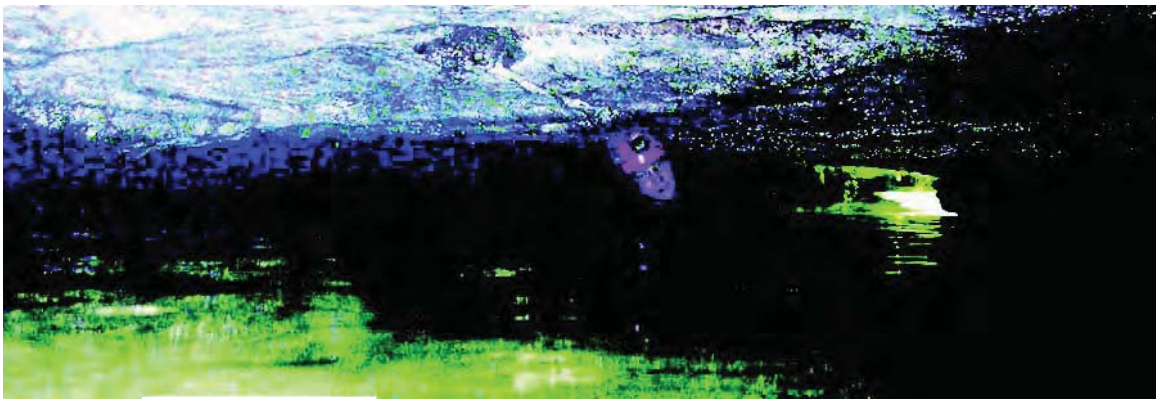
(Greene County).



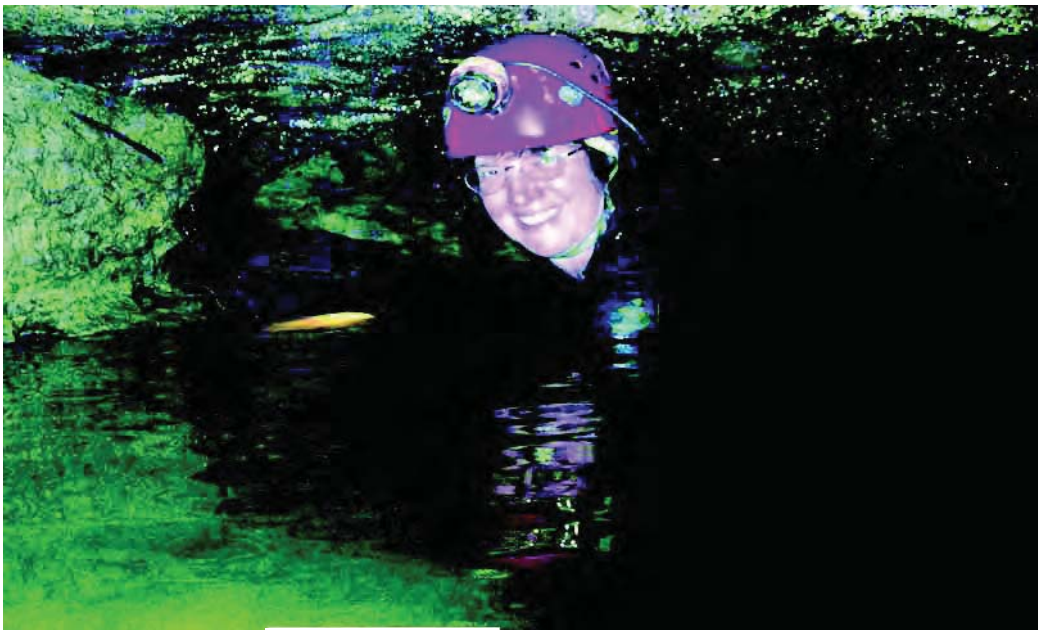
(Greene County).

Shrimp-baited jar taken from with numerous spring flatworms *Phagocata gracilis*.

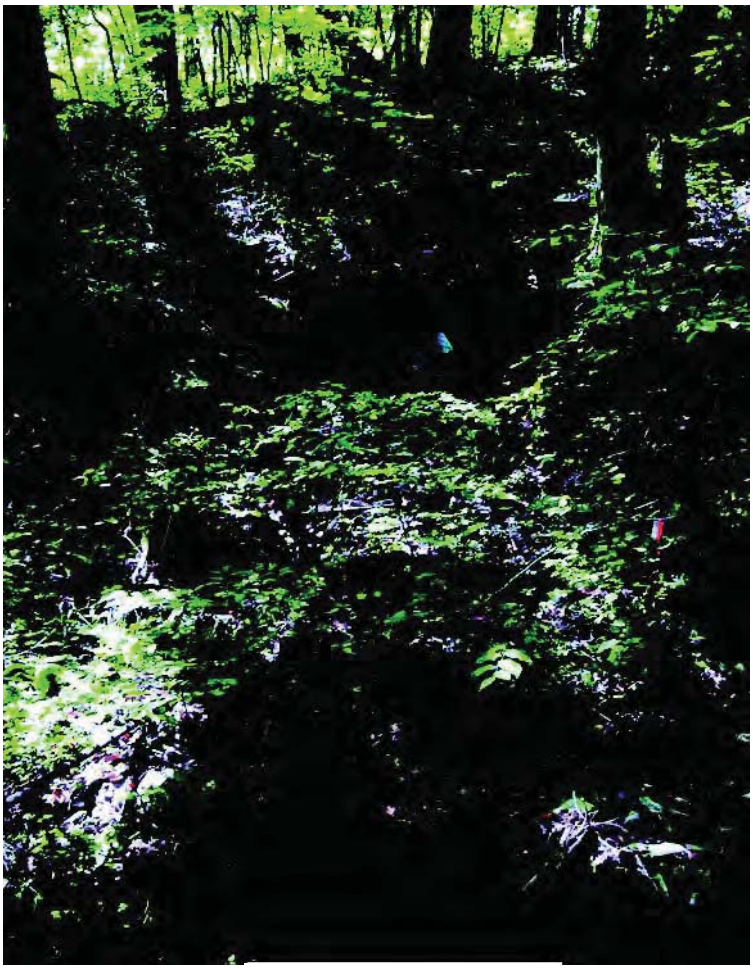
Entrance to (Monroe County) is under a rock outcrop. The cave is only enterable during base flow conditions.



Passage in looking toward entrance.

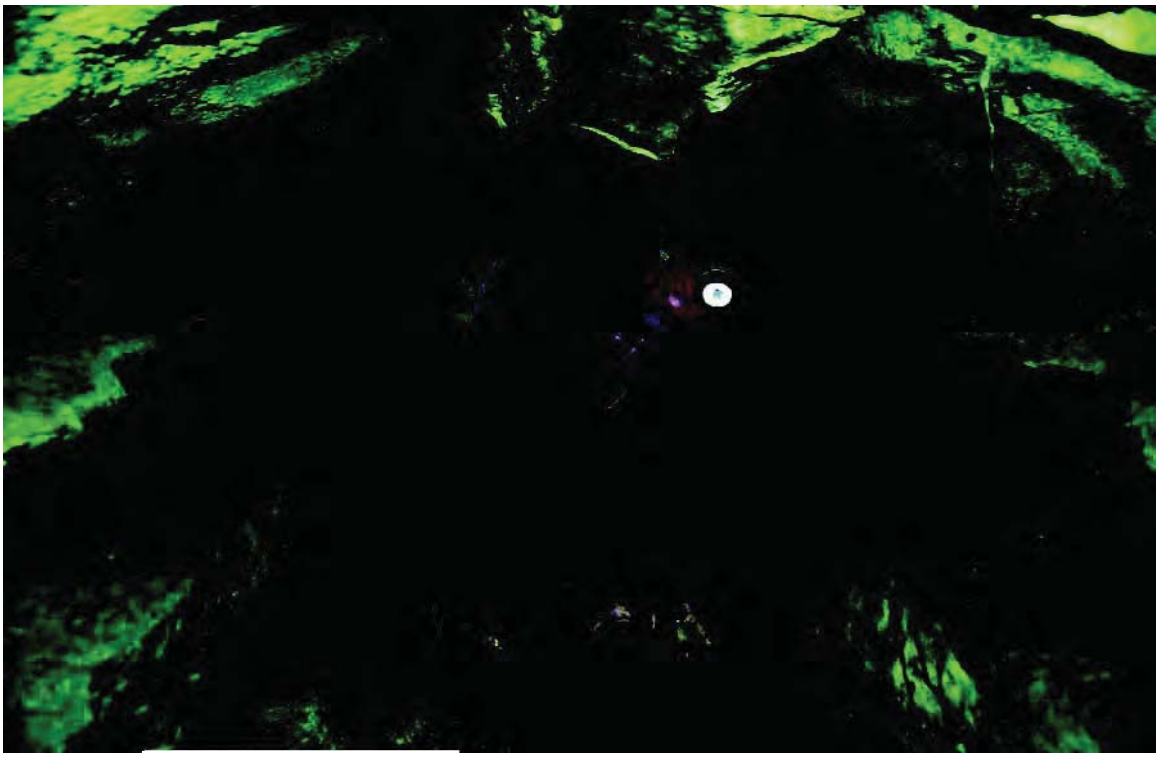


Mudbank at back of at point where the passage siphons.



Entrance alcove at (Monroe County).

The entrance to (Monroe County) is 11 inches high at the center.

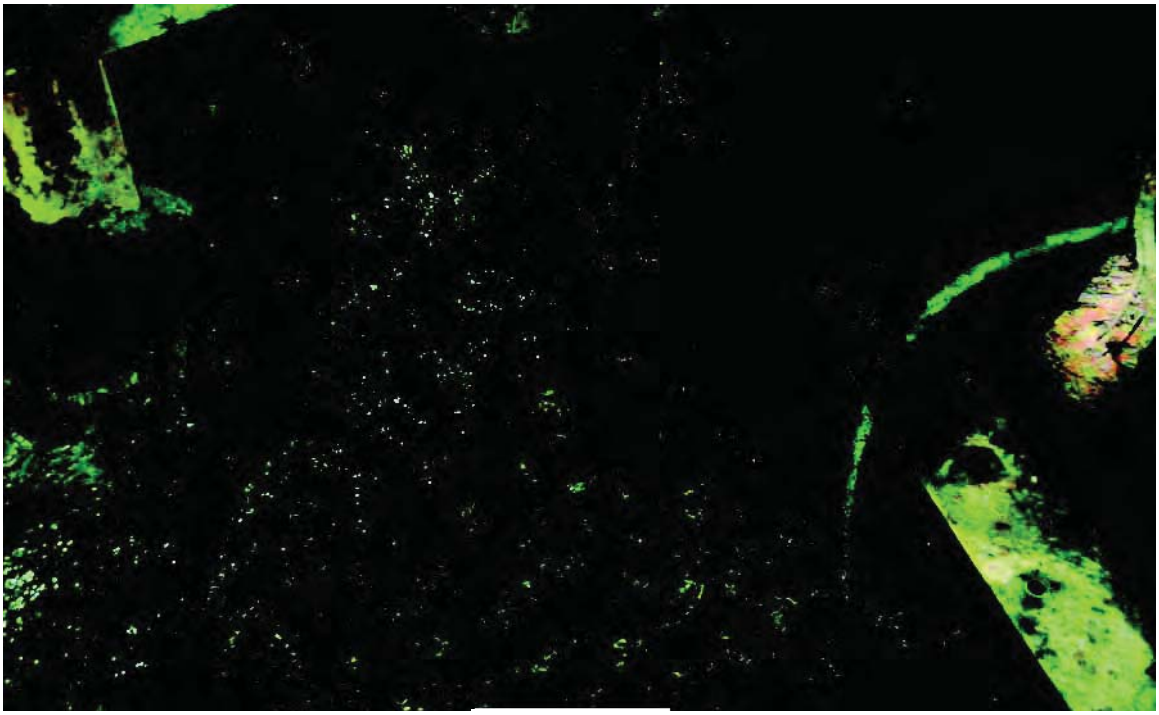


Passage in (Monroe County).

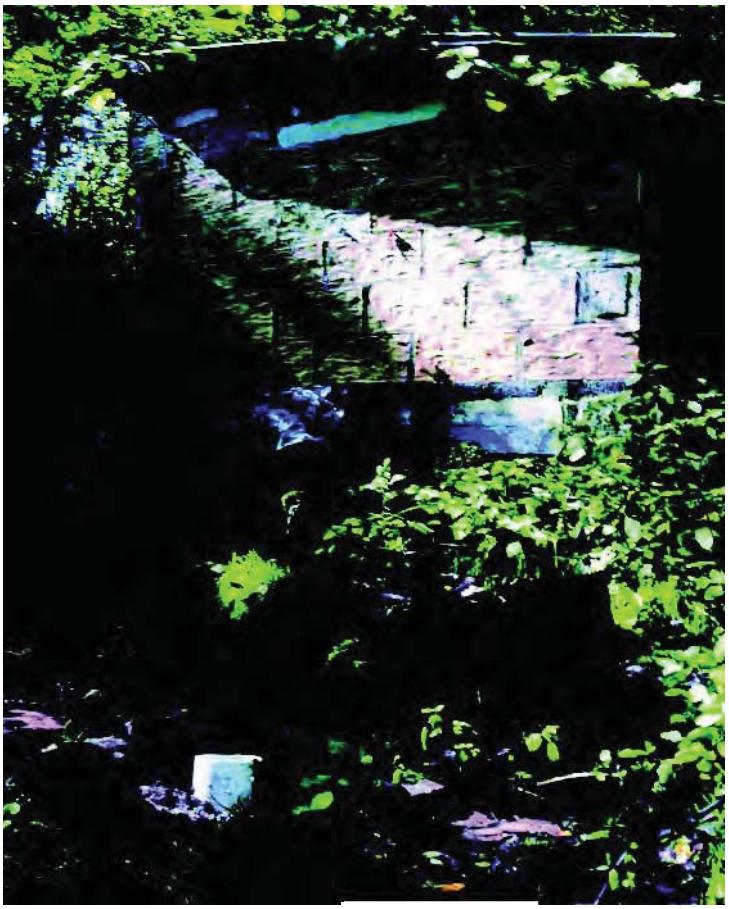
Seepage area at near (Monroe County).

near (Monroe County).

Spring house at (Monroe County).



Spring orifice inside springhouse at with shrimp-baited jar lying on floor of spring basin (obscured by ripples).



Exterior of springhouse at Water drains from the spring basin from the pipe at the base of the building, falls into a catchment basin, then flows into a spring run. White plastic pipe in the foreground is a Karaman-Chappuis shallow sampling well.

is part of a complex of springs emerging at Photo shows the use of a post-hole digger to excavate a shallow Karaman-Chappuis sampling well in the substrate adjacent to the spring run.

Appendix D
Cave Maps

Appendix D: (Cave Maps) has been removed for confidentiality reasons related to caves.

APPENDIX L – WATER WELL LOCATIONS IN THE SECTION 4 CORRIDOR

Figure L-1 has been removed for confidentiality reasons related to karst.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213513	ABOUT 2MI SW OF CLEAR CREEK IN, ON VICTOR RD. 2ND HOUSE ON L AFTER PASSING DILLMAN RD.	Jul 14, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM E. BORUFF	RR5, BLGTON IN	
Driller	FREDERICK SCOTT	RR4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 48.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	RED CLAY
4.0	29.0	STONE GRAY LS HARD
29.0	33.0	STONE BLUE LS HARD
33.0	42.0	STONE GRAY LS HARD
42.0	55.0	STONE WH LS SOFT
55.0	68.0	STONE GRAY LS SOFT
68.0	81.0	STONE GRAY LS HARD
81.0	93.0	STONE BLUE LS EX HARD
93.0	105.0	STONE GRAY SOAPSTONE SOFT

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213517		Mar 31, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLEO RADER	RR#5	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	75.0	WH LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213674	SOUTH EAST CORNER ROCKPORT RD & THAT ROAD. 2ND HOUSE SOUTH.	Sep 02, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY DAVIS	223 SO. MAPLE	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP & HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 71.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	26.5	DIRT
26.5	125.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213693	CORNER OF ROCKPORT ROAD & THAT ROAD ABOUT 3.5 SOUTH OF BLOOMINGTON	Jul 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIVER LINTHICOM	1416 WEST KIRKWOOD AVE.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	41.0	TOP SOIL & CLAY
41.0	120.0	MEDIUM WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213698	ON THAT ROAD ON NORTH SIDE 1 BLOCK EAST OF ROCKPORT RD.	Aug 12, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	29.0	TOP SOIL
2.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213719	CORNER OF THAT RD & ROCKPORT RD THEN SOUTH OF THAT RD 0.4 MILE	Jun 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEITH HILLENBURG		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	50.0	WHITE SOFT LIMESTONE
50.0	65.0	BLUE HARD LIMESTONE
65.0	85.0	BROWN MEDIUM HARD LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213744	CORNER OF THAT RD AND ROCKPORT RD SOUTH BLOOMINGTON, IN. THEN SOUTH OFF THAT RD 0.5 MILE	Jul 10, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	75.0	MEDIUM HARD WHITE LIMESTONE
75.0	85.0	HARD BLUE LIMESTONE
85.0	95.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
221993	W OF BLOOMINGTON 2 MI	May 13, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOGAN HOWARD	BLOOMINGTON, IN	
Driller	PAUL SHUTE	1420 W 14TH ST, BLOOMINGTON	
Operator	OREN LAKE	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 600.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W

Section: of Section 31 **Topo map:** BLOOMINGTON

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	14.0	RED CLAY
14.0	74.0	HARD BLUE STONE
74.0	99.0	MED LITE STONE
99.0	110.0	HARD STONE

Comments WELL 1 OF 2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
227746	GO E OF DOANS, IN ON HWY. 45/56E ABOUT 2.5MI TO GO RD 625E (NEXT TOKENTUCKEY RIDGE CHURCH) TURN N ON CR625E. GO 2.5MI CR MAKES 90*TURN, 2ND HOUSE ON L	Jan 28, 1993

Owner-Contractor	Name	Address	Telephone
Owner	ANDY STINSON	R.R. 3 BOX 466A BLOOMFIELD, IND	
Driller	MUMMA BROS. DRILLING INC.	R.R. 1 BOX 85 LYONS. IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 103.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 103.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 14 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	13.0	CLAY
13.0	23.0	SOFT SH
23.0	35.0	BREAK OF LIME DAR SH
35.0	40.0	LS & SH
40.0	66.0	YEL SANDROCK
66.0	68.0	CLAY SEAM
68.0	73.0	SAND ROCK
73.0	76.0	BR SANDY LIME
76.0	88.0	LS CRACK WATER, ODOR

88.0	91.0	CLAY
91.0	95.0	LS
95.0	100.0	BLUE SH RED ROCK
100.0	106.0	SANDY SH BLUE SH
106.0	110.0	REDROCK
110.0	130.0	SANDROCK , SANDY SH BREAKS
130.0	165.0	DARK SH
165.0	170.0	SANDROCK SANDY WH
170.0	176.0	LS
176.0	177.0	BROKEN CRACK WATER
177.0	185.0	LS CRACKS WATER

Comments 2GRS. HARDNESS /PH 8 IRON/NONE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231909	3140 W THAT RD	Jun 11, 1982

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FIDELLA SWANGO	4031 WOODLY N DR, BLOOMINGTON, IN	
Driller	FRED SMITH		
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	45.0	LS
45.0	105.0	LS & SH
105.0	170.0	LS

Comments ADD'L CONSTRUCTION INFO ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231943	SW. OF BLOOMINGTON,TAKE SR#375 TO ROCKPORT RD., TURN S.W ON ROCKPORT TO DUVALL RD. TURN GOTO GRAVE YARD 1ST. DRIVE PAST GRAVE YARD	May 29, 1991

Owner-Contractor	Name	Address	Telephone
Owner	BURLAN STONE	5156 W. DUVALL RD. BLOOMINGTON,IN.	(812) 344-8163
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:** Submersible
	Depth: 105.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 49.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 28.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	10.0	GRAY LS FINE
10.0	12.0	BLUE LS CRS
12.0	18.0	GRAY LS CRS
18.0	26.0	BUFF LS FINE
26.0	38.0	GRAY LS CRS
38.0	40.0	YEL SHALE

40.0	55.0	GRAY LS CRS
55.0	56.0	WHITE SHALE
56.0	59.0	GRAY LS CRS
59.0	61.0	BLUE SHALE
61.0	78.0	BLUE LS CRS
78.0	89.0	GRAY LS CRS
89.0	90.0	WHITE SHALE
90.0	98.0	BLUE LS CRS
98.0	105.0	GRAY LS FINE

Comments SEE MAP ;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231953	S. OF BLOOMINGTON,TAKE 37S TO THAT RD. , E. OF 3RD. DRIVEWAY TO N. , WELL OFF MAIN RD. , NEW BRICK HOUSE	Aug 16, 1990

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BARRY ELKINS	2010 W. THAT RD. BLGTON,IN.	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED & CURT SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 55.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PCX	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	9.0	YEL SHALE
9.0	14.0	GRAY LS MD CHIP
14.0	18.0	BLUE LS LARGE CHIP
18.0	22.0	GRAY LS MD CHIP
22.0	25.0	BLUE LS LARGE CHIP
25.0	38.0	GRAY LS FINE CHIP
38.0	55.0	BLUE LS FINE CHIP
55.0	63.0	BLUE SOAPSTONE LARGE CHIPS

63.0	77.0	BUFF LS FINE CHIPS
77.0	103.0	GRAY LS LARGE CHIPS
103.0	109.0	YEL LS MD CHIPS
109.0	128.0	GRAY LS MD CHIPS
128.0	138.0	LS LARGE CHIPS
138.0	145.0	GRAY LS LARGE CHIPS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231983	S.W. OF BLOOMINGTON, TAKE SR#37 TO ROCKPORT RD., R. STAY ON ROCKPORT RD,TIL LODGE RD.,L. GO NEXT TO LAST HOUSE ON R. # ON MAILBOX 7150	May 15, 1989

Owner-Contractor	Name	Address	Telephone
Owner	DAVID STULTZ	7150 S. LODGE RD. BLOOMINGTON,IN.	(812) 825-9100
Driller	FRED SCOTT'S WELL DRILLING	236 W. COWDEN RD. ELLETTSVILLE,IN.	(999) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 5.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR-PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	3.0	BR CLAY
3.0	4.0	YEL CLAY
4.0	20.0	GRAY LS HARD
20.0	26.0	BLUE LS HARD
26.0	31.0	GRAY LS HARD
31.0	35.0	BLUE LS HARD

35.0	48.0	GRAY LS HARD
48.0	60.0	BUFF LS HARD
60.0	75.0	GRAY LS HARD
75.0	82.0	BLUE LS HARD
82.0	118.0	GRAY LS HARD
118.0	125.0	BLUE LS HARD

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
257650	APPROX. 3.5 MI. N. OF JCT. #45 & #58 NEAR OWENSBURG,IN. TURN W. ON CR#300S. GO 1 MI. 1ST. DRIVE ON L.	Feb 28, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VAN ROBERSTON	R.R. #3 BOX 302 BLOOMFIELD,IN.	
Driller	MUMMA BROS. DRILLING,INC.	R.R.#1 BOX #85 LYONS,IN.	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 345.0	**Pump setting depth:** 320.0	**Water quality:**
Casing	**Length:** 166.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 18.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 200.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 130.0 to 163.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 9 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 28.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	21.0	LS
21.0	28.0	CLAY
28.0	38.0	SANDROCK,CLAY SEAMS
38.0	61.0	YEL SANDROCK
61.0	76.0	LS
76.0	84.0	BLUE SHALE
84.0	91.0	GREEN SANDROCK

91.0	100.0	GREENISH RED ROCK
100.0	144.0	SANDROCK
144.0	160.0	DARK SHALE
160.0	165.0	SANDY SHALE
165.0	235.0	SANDROCK
235.0	239.0	LS
239.0	243.0	GREEN SHALE
243.0	310.0	LS BROKEN
310.0	345.0	SANDY LS WATER

Comments PH7,HAR 20,IRON 1.0 PPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
274817	LEAVING SOLSBURG 1ST RD TO R OFF OF HWY 43, GO 1 MI OUT OF SOLSBERRY, TURN R ONTO WASHBOARD RD, STAY STRAIGHT FOR 3.5 MI HOUSE ON R WELL IN FRONT YARD	Aug 17, 1995

Owner-Contractor	Name	Address	Telephone
Owner	JEFF ADAMS	RR1 BOX 370A, SOLSBERRY, IN	(812) 825-9283
Driller	PHILLIP'S WELL DRILLING	RR12 BOX 624, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 220.0	**Pump setting depth:** 200.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 6.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOP SOIL
1.0	2.0	BLANK
2.0	17.0	CLAY
17.0	28.0	SS
28.0	56.0	LS
56.0	62.0	SHELL
62.0	220.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
278105	SW OF BLOOMINGTON TAKE SR 37 S TO ROCKPORT RD TURN SW GO TO DUALL RD TURN W GO 1.5 MI DRIVEWAY AT BOTTOM OF HILL HSE BACK OFF MAIN RD TOP OF HILL	Jul 22, 1994

Owner-Contractor	Name	Address	Telephone
Owner	STEVE CAIN	5950 W CUVALL RD, BLOOMINGTON, IN	(812) 334-4087
Driller	FRED SCOTTS WELL DRLG	6236 W COWDEN RD, ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 165.0	**Pump setting depth:** 150.0	**Water quality:** CLEAR
Casing	**Length:** 33.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 94.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 32.0 to 0.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	11.0	RED CLAY
11.0	35.0	GRAY LS CRS
35.0	39.0	BLUE LS CRS
39.0	60.0	GRAY LS FINE
60.0	62.0	BLUE SH
62.0	86.0	GRAY LS CRS

86.0	88.0	BLUE SH
88.0	92.0	BLUE LS FINE
92.0	96.0	GRAY LS FINE
96.0	124.0	BUFF LS EX FINE
124.0	143.0	GRAY LS CRS
143.0	146.0	BLUE SH
146.0	150.0	BLUE LS CRS
150.0	151.0	YEL SH
151.0	159.0	GRAY LS FINE
159.0	160.0	BLUE SH
160.0	165.0	GRAY LS FINE

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295360	FROM 37N TAKE ROCKPORT RD E GO APPROX 8 MI TO TRANWAY RD TURN LEFT GO 1.5 MI PLACE IS ON LF	May 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEVIN H. WRIGLEY	4198 W TRAMWAY RD., BLOOMINGTON, IN	
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 27.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 27.0
Installation Method: PUMP **Number of bags used:** 1.25

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	145.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295361	SR37 TO ROCKPORT RD GO 5 MI TO TRANWAY TURN L ONTO TRAMWAY GO .5 MI ON L	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.0 gpm for 60.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 37.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY
22.0	65.0	LS
65.0	73.0	SHELL
73.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295362	SR37 TO ROCKPORT RD GO 5 MI TO TRAMWAY TURN LEFT ON TO TRAMWAY GO .5 MI ON LEFT	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 2.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	24.0	CLAY
24.0	68.0	LS
68.0	75.0	SHELL
75.0	140.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295365	W OF STANFORD, ON HWY45 GO .25 MI DRIVEWAY ON N SD OF HWY	Apr 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ALOHA GINSENG FARM	9840 W ST HWY45, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 83.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	CLAY RED
15.0	22.0	SUB CLAY
22.0	25.0	SOFT SANDROCK
25.0	35.0	REDROCK
35.0	50.0	GREEN SANDY SHALE
50.0	53.0	SANDROCK
53.0	60.0	GREEN SHALE & BLUE SHALE

60.0	80.0	DK SHALE & LIME BKS
80.0	83.0	SANDY DK SHALE
83.0	90.0	DK SHALE
90.0	100.0	LS
100.0	103.0	BLUE SHALE
103.0	110.0	SANDROCK
110.0	123.0	DK SHALE & BLUE SHALE
123.0	132.0	LS
132.0	134.0	BLUE SAHLE
134.0	215.0	LS
215.0	240.0	LS CRACKS WATER

Comments SEE MAP; CHEM ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295367	FOLLOW BREEDEN RD S OF HWY45 2 MI TO PRIVATE DRIVE ON W SD OF RD	Jun 30, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP LONG	7625 S BREEDEN RD., BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 31.0 to 0.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	18.0	RED CLAY
18.0	68.0	LS
68.0	75.0	BLUE SHALE
75.0	100.0	LS
100.0	125.0	LS & CRACKS WATER

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309951	37/OLD 37 INTERSECTION GO ON OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 215.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 28.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
11.0	165.0	LIME STONE
166.0	175.0	LIME STONE
176.0	191.0	LIME STONE
192.0	215.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309952	37/OLD 37 INTERSECTION GO UP OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRARIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:**	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: YOM BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 28, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	75.0	LIME STONE
75.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309953	37/OLD 37 INTERSECTION - GO TO OLD 37 TO TOP OF HILL OR E	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ELEM BENT **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 25, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309959	OFF 37 TO OLD 37 INTERSECTION - TAKE OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 310.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
3.0	6.0	BUST LIMESTONE
7.0	29.0	HARD LIMESTONE
30.0	33.0	LIME STONE
34.0	82.0	HARD LIMESTONE
83.0	175.0	SOFT LIMESTONE
176.0	310.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
322971	8897 W THACKER RD, W 45 TO BREEDEN RD S ON BREEDEN TO THACKER .5 MI ON S	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CAMERON DECKARD	8897 W THACKER RD, BLOOMINGTON, IN	(812) 825-3530
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	
Company	CAMERON DECKARD		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 300.0	**Pump setting depth:** 280.0	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .025

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 32.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	22.0	RED CLAY
22.0	140.0	GRAY SH
140.0	221.0	LS
221.0	245.0	GRAY SH
245.0	300.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324080	45 R TO 580 - GO 5 MI	Oct 01, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE NEHRT	550 BRIDE DALYON RD BLOOMINGTON	
Driller	PHILLIPS WELL DRLG	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	JAY PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 80.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 9.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 80.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	CLAY
25.0	50.0	BLUE MUCK
75.0	100.0	SANDSTONE
100.0	125.0	LS
503.0	75.0	SHELLY SANDSTONE

Comments (? LOC)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324084	TAKE 45 TO BREEDEN RD GO 4 MI TO THOACKER RD GO 1.5 MI UNTIL YOU SEE A BIG RED BARN ON LT, THIS IS HIS HOME SITE	Jun 02, 1998

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY CLARK	3811 E ANDERSON RD., BLOOMINGTON, IN	(812) 331-8464
Driller	PHILLIPS WELL DRLNG	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 42.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 42.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	10.0	RED CLAY
10.0	24.0	BUSTED LS
24.0	27.0	RED CLAY
27.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
338841		Jul 23, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB BARTHOLOMEW	PO BOX 702 CLEAR CREEK IN	(812) 824-7841
Driller	PHILLIPS WELL DRLG & PUMP SVC	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	
Company	DISTRICTIVE HOMES		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 280.0	**Pump setting depth:** 260.0	**Water quality:** GOOD
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 2

Well Capacity Test

Type of test: Bailing **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL
7.0	40.0	SANDSTONE
40.0	66.0	LS
66.0	83.0	SANDSTONE
83.0	149.0	SHALE
149.0	280.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
339114	N SD OF STONE MILL & E OF RR VIADOCK	Nov 20, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL J. BUNCH	7665 S. VICTOR PIKE, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRLNG INC.	R1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.5 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 28.0 to 0.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	35.0	LS
35.0	36.0	SEAM WATER
36.0	50.0	LS
50.0	77.0	LS & SH BKS
77.0	105.0	GREY SANDROCK

Comments SEE MAP; PETROLIUM ODOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
349513	GO OFF SR54 AT THE HOBBIESVILLE TURNOFF GO DOWN RD TO "Y" HANG L GO ABOUT 1.5 MI UP GRAVEL RD YOU'LL SEE AN IRON GATE TURN L	Nov 10, 1999

Owner-Contractor	Name	Address	Telephone
Owner	BOB HILL	PO BXO 230, OOLITIC, IN	(000) 279-5904
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 320.0	**Pump setting depth:** 300.0	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 5.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 1 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	TOPSOIL
4.0	8.0	CLAY
8.0	16.0	SH LS
16.0	32.0	MUD SEAM
32.0	39.0	BUSTED LS
39.0	55.0	SH
55.0	60.0	SS

60.0	102.0	SH
102.0	244.0	SS
244.0	320.0	LS

Comments SEE MAP; HWY54 TO 1375E, R ON 1320E, APPROX .75 MI

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
349665	TAKE 54 W TO HOBBIESVILLE RD; TURN R; GO ABOUT 2.5 MI; ON L; 2ND HOUSE TO L PAST MYERS DRYWALL	Oct 18, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BRAD STURGEON	9960 W ROCKEAST RD BLOOMINGTON, IN	(812) 825-2034
Driller	PHILLIPS WELL DRILLING&PUMP	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Other
	Depth: 170.0	**Pump setting depth:**	**Water quality:** CLEAR/GOOD
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 3.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	11.0	CLAY
11.0	21.0	SS
21.0	27.0	BUSTED LS
27.0	58.0	SH
58.0	170.0	SOLID LS

Comments SEE MAP;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
352175	S OF KOLEEN, 1/2 TO COUNTY ROAD TO LT, GO .5 MILE	Apr 26, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID MONTGOMERY	PO BOX 50, KOLEEN, IN	
Driller	MUMMA BROS. DRLNG INC.	RR1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 53.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 140.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 53.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY & ROCKS
17.0	20.0	LS
20.0	30.0	SH
30.0	31.0	LS
31.0	44.0	SH & LIME BKS
44.0	48.0	SANDY SH
48.0	70.0	SANDROCK
70.0	83.0	BRN LS
83.0	100.0	GREY LS, HD
100.0	108.0	GREY SH & REDROCK

108.0	118.0	SANDROCK
118.0	130.0	DK SANDY SH
130.0	142.0	DK GREY SH
142.0	148.0	SANDROCK
148.0	179.0	REDROCK & DK SH
179.0	185.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
370693	W OF CAMP OLIVET FOUNDATION, ON W SD OF HWY54	May 16, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE BONNEY	OWENSBURG, IN	
Driller	MUMMA BROS. DRILLING INC.	RR1 BOX 84, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 370.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 150.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 220.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:** 220

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 174.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 150.0 to 0.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	18.0	YEL SANDROCK & CLAY SEAMS
18.0	28.0	BRN CLAY
28.0	35.0	SOFT SH
35.0	40.0	GREY SANDY SH
40.0	46.0	SANDROCK & LIME BKS
46.0	53.0	YELLOW SANDROCK
53.0	60.0	BROWN SANDROCK
60.0	80.0	BRKN SANDY SH
80.0	147.0	DK SH & LIME BKS

147.0	149.0	SANDY SH
149.0	160.0	LS
160.0	168.0	DK SH
168.0	173.0	BLUE SH SOFT
173.0	185.0	LS & SH BKS
185.0	240.0	LS
240.0	260.0	SANDY LS
260.0	275.0	LS CRACKS
275.0	295.0	LS
295.0	305.0	LS CRACKS
305.0	355.0	LS
355.0	370.0	BRKN LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383065	HWY 45 TO STANFORD, LEFT ON BREEDEN RD, 4 MI TO 1ST CROSS RD, GO RT, 2ND FARM ON LEFT;	Aug 10, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MICHAEL WAMPLER/CJ STURGEON	9501 ROCK EAST RD B'TON IN	(812) 825-5804
Driller	PHILLIPS WELL DRLG&PUMP SVC IN	RR 12 BOX 444 BEDFORD, INDIANA	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 56.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 4 IN

Well Capacity Test

Type of test: Air **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 27.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 50.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	RED CLAY
7.0	51.0	BUSTED ROCK
51.0	80.0	LIMESTONE

Comments SEE MAP;30-72W; PLAT 2;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
391301	ST RD 45 WEST TO COUNT ROAD BREADEN ROAD GO 5 MILE TO WEST CRAVES ROAD GO 1 MILE TO RIGHT BOX 8785	Nov 26, 2004

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF NEW	8785 WEST GRAVES ROAD	(812) 336-7537
Driller	J AND K WATER WELL SERVICE	1369 STATE ROAD 158 WILLIAMS IN	
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 112.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 5.0 gpm for 300.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 20.0 ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 5.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	SAND
5.0	10.0	SABD ABD PEA GRAVEL
10.0	15.0	SAND AND MUD
15.0	20.0	CLAY
20.0	25.0	LIMESTONE
25.0	30.0	LIMESTONE
30.0	35.0	BUSTED LIMESTONE
35.0	40.0	LIMESTONE
40.0	112.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
404946	SR54 - GO TO HOBBIEVILLE RD - GO THRU HOBBIEVILLE- CONTINUE ON - GO AROUND SHARP CURVE - PASS DECKARD HOME SALES - TO NEW CONSTRUCTION ON R! FENCED IN	Nov 19, 2005

Owner-Contractor	Name	Address	Telephone
Owner	JOE BYERS	RR1 SPRINGVILLE, IN	(812) 855-4307
Driller	PHILLIPS WELL DRILLING	RR3 BOX 55-A OWENSBURG, IN	(812) 863-4843
Operator	DEXTER SWARTZENTRUBER	License: 302	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth:	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 40.0	**Material:** STEEL	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 2

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	11.0	CLAY
11.0	14.0	BROKEN LIMESTONE
14.0	30.0	LIMESTONE
30.0	32.0	BROKEN LIMESTONE
32.0	85.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
407312	SOUTH WEST OF BLOOKINGTON ON 45 THRU STANFORD. LEFT OR SOUTH ON BREEDEN RD APP 1 MIL ACROSS CREEK (DRIVEWAY) ON RIGHT. REPLACES EXIST WELL AT OLD BARN	Apr 04, 2006

Owner-Contractor	Name	Address	Telephone
Owner	LISA SWOAPE	7625 S BREEDEN RD BLOOMINGTON, IN	
Driller	MADER WELL DRILLING	9262 OWEN PARK RD SPENCER, IN	(765) 795-3343
Operator	STEVE MADER	License: 541	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 95.0	**Pump setting depth:** 65.0	**Water quality:** CLEAR
Casing	**Length:** 41.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bail / Pump **Test rate:** 40.0 gpm for 0.5 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 15.0 ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: W-O-B **Depth:** from to
Installation Method: POUR **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 6.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	6.0	BROKEN LIMESTONE
6.0	15.0	LS
15.0	16.0	SOFTER
16.0	38.0	MD & SOFTER LS
38.0	75.0	HD GRAY LIMESTONE
75.0	85.0	GRAY LIMESTONE
85.0	88.0	HD DARKER GRAY LS
88.0	95.0	BROKEN LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40745		May 09, 1946

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	A PADGETT		
Driller	WAGGONER BROTHERS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 67.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 530.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	OVERBURDEN
15.0	31.0	SOFT RED SS
31.0	33.0	LS
33.0	43.0	BLUISH GRAY SANDY SHALE
43.0	45.0	HARD YELL SS, WATER
45.0	67.0	YELL SS, WATER

Comments WELL E-1, DATA FROM USGS BULL 11 AND WWRS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410928	37 - VICTOR PIKE - GO DOWN ABOUT 2.5 MILES TO 30 MILL ON R - WELL IS LOCATED BY BACK LOT	Jul 16, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3D STONE, INC/WHALEY INVESTMEN	4810 SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 55A OWENSBURG, IN	(812) 863-4843
Operator	TAMMY HOLLAND/REX MARTIN	License: null	

Construction Details

Well	**Use:** Industry	**Drilling method:**	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 24.0 ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 40.0 to 0.0
Installation Method: TREMMIE **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	135.0	LIMESTONE
135.0	136.0	SANDY SHALE
136.0	137.0	LIMESTONE
137.0	140.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410932	VICTOR PIKE - 3 D STONE INC. MILL ON VICTOR PIKE OFF OF HWY 37	Jul 10, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3 D STONE INC/WHALEY INVESTMEN	4810 WEST SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	HACKER PLUMBING & DRILLING	2687 S OLD DECKER RD VINCENNES, IN	(812) 882-8053
Operator	TIM HACKER	License: 152	
Company	PHILLIPS WELL DRILLING	R # 3 BOX 55A OWENSVILLE, IN	(812) 863-4844

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 340.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: BENTONITE **Depth:** from 0 to 340
Installation Method: TREMMIE **Number of bags used:** 10.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	110.0	LIMESTONE W/MUD SEAMS
110.0	170.0	LIMESTONE W/SANDY SHALE SHALE
170.0	340.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
52692	GO N OF JUNCTION HWY 45 & 48 GO N ON 45 .75 MI TO 1ST CROSS ROAD TURN W ENTERENCE AS STEEL GATES, PRIVATE DR .5 MI THRU CLASSIFIED FOREST	Oct 26, 1993

Owner-Contractor	Name	Address	Telephone
Owner	WENDELL LEEDY	R 3 BOX 29C OWENSBURG, IN	
Driller	MUMMA DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 365.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 100.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 280.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 100.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of Section 17 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	CLAY & SANDROCK
15.0	22.0	BREAK OF COAL & SH
22.0	34.0	SANDROCK & CLAY SEAMS
34.0	43.0	SOFT SH
43.0	55.0	SANDROCK (HARD)
55.0	61.0	BLUE SH
61.0	64.0	YEL SANDROCK

64.0	69.0	LS & SEAMS
69.0	95.0	DARK SH
95.0	134.0	SANDROCK
134.0	137.0	SH
137.0	155.0	LS
155.0	170.0	BLUE SH, REDROCK, GREEN SH
170.0	200.0	SANDY SH & SANDY LIME
200.0	212.0	DARK SH
212.0	225.0	SANDROCK & SANDY SH
225.0	245.0	DARK SH
245.0	255.0	SANDROCK & SHEAL BKS
255.0	260.0	SANDROCK
260.0	267.0	DARK SH
267.0	275.0	SANDROCK
275.0	298.0	LS
298.0	304.0	BLUE SH
304.0	365.0	LS CRACKS (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52702	GO S OF HWY 45 & 54 UCT ON 54S TO CR 1250E GO S TO CHURCH TURN R ON GRAV RD GO 200 YRDS TURN R GO TO TEE GO LEFT DEAD END	Aug 06, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM RICHARD	OWENSBURG, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 60.0 to 35.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	30.0	SANDROCK & SEAMS
30.0	55.0	SANDROCK
55.0	62.0	SANDY SH
62.0	78.0	DARK SH
78.0	85.0	YEL SANDROCK
85.0	95.0	DARK SH & SANDY SH
95.0	100.0	SANDROCK (WATER)
100.0	120.0	DARK SH
120.0	127.0	SANDROCK (WATER)
127.0	140.0	DARK SH & SANDROCK
140.0	145.0	LS

Comments 28 HARDNESS 7.0 PH28 HARDNESS 7.0 PH 3PPM IRON

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52704	GO 200 FT S OF HWY JCT 54 & 45 EXIT HWY 54 ONTO CR 50S (DEAD END) GO E .75 MI ONTO PRIVATE DR THRU WOODS	Jun 28, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOE JAMES	R 4 BOX 416 BLOOMFIELD, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2398
Operator	DAVID RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 285.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 82.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 200.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 80.0 to 20.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of Section 26 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	SANDROCK & SEAMS
15.0	20.0	SOFT SH
20.0	32.0	SANDY SH
32.0	68.0	DARK SH
68.0	69.0	LS
69.0	78.0	DARK SH

78.0	81.0	SANDROCK
81.0	100.0	DARK SH & SANDROCK BREAKS
100.0	102.0	GREEN SH
102.0	240.0	LS
240.0	273.0	LIMECRACKS
273.0	285.0	LIMECRACK (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213513	ABOUT 2MI SW OF CLEAR CREEK IN, ON VICTOR RD. 2ND HOUSE ON L AFTER PASSING DILLMAN RD.	Jul 14, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM E. BORUFF	RR5, BLGTON IN	
Driller	FREDERICK SCOTT	RR4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 48.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	RED CLAY
4.0	29.0	STONE GRAY LS HARD
29.0	33.0	STONE BLUE LS HARD
33.0	42.0	STONE GRAY LS HARD
42.0	55.0	STONE WH LS SOFT
55.0	68.0	STONE GRAY LS SOFT
68.0	81.0	STONE GRAY LS HARD
81.0	93.0	STONE BLUE LS EX HARD
93.0	105.0	STONE GRAY SOAPSTONE SOFT

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213517		Mar 31, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLEO RADER	RR#5	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	75.0	WH LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213674	SOUTH EAST CORNER ROCKPORT RD & THAT ROAD. 2ND HOUSE SOUTH.	Sep 02, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY DAVIS	223 SO. MAPLE	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP & HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 71.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	26.5	DIRT
26.5	125.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213693	CORNER OF ROCKPORT ROAD & THAT ROAD ABOUT 3.5 SOUTH OF BLOOMINGTON	Jul 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIVER LINTHICOM	1416 WEST KIRKWOOD AVE.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	41.0	TOP SOIL & CLAY
41.0	120.0	MEDIUM WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213698	ON THAT ROAD ON NORTH SIDE 1 BLOCK EAST OF ROCKPORT RD.	Aug 12, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	29.0	TOP SOIL
2.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213719	CORNER OF THAT RD & ROCKPORT RD THEN SOUTH OF THAT RD 0.4 MILE	Jun 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEITH HILLENBURG		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	50.0	WHITE SOFT LIMESTONE
50.0	65.0	BLUE HARD LIMESTONE
65.0	85.0	BROWN MEDIUM HARD LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213744	CORNER OF THAT RD AND ROCKPORT RD SOUTH BLOOMINGTON, IN. THEN SOUTH OFF THAT RD 0.5 MILE	Jul 10, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	75.0	MEDIUM HARD WHITE LIMESTONE
75.0	85.0	HARD BLUE LIMESTONE
85.0	95.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
221993	W OF BLOOMINGTON 2 MI	May 13, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOGAN HOWARD	BLOOMINGTON, IN	
Driller	PAUL SHUTE	1420 W 14TH ST, BLOOMINGTON	
Operator	OREN LAKE	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 600.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W

Section: of Section 31 **Topo map:** BLOOMINGTON

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	14.0	RED CLAY
14.0	74.0	HARD BLUE STONE
74.0	99.0	MED LITE STONE
99.0	110.0	HARD STONE

Comments WELL 1 OF 2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
227746	GO E OF DOANS, IN ON HWY. 45/56E ABOUT 2.5MI TO GO RD 625E (NEXT TOKENTUCKEY RIDGE CHURCH) TURN N ON CR625E. GO 2.5MI CR MAKES 90*TURN, 2ND HOUSE ON L	Jan 28, 1993

Owner-Contractor	Name	Address	Telephone
Owner	ANDY STINSON	R.R. 3 BOX 466A BLOOMFIELD, IND	
Driller	MUMMA BROS. DRILLING INC.	R.R. 1 BOX 85 LYONS. IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 103.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 103.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 14 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	13.0	CLAY
13.0	23.0	SOFT SH
23.0	35.0	BREAK OF LIME DAR SH
35.0	40.0	LS & SH
40.0	66.0	YEL SANDROCK
66.0	68.0	CLAY SEAM
68.0	73.0	SAND ROCK
73.0	76.0	BR SANDY LIME
76.0	88.0	LS CRACK WATER, ODOR

88.0	91.0	CLAY
91.0	95.0	LS
95.0	100.0	BLUE SH RED ROCK
100.0	106.0	SANDY SH BLUE SH
106.0	110.0	REDROCK
110.0	130.0	SANDROCK , SANDY SH BREAKS
130.0	165.0	DARK SH
165.0	170.0	SANDROCK SANDY WH
170.0	176.0	LS
176.0	177.0	BROKEN CRACK WATER
177.0	185.0	LS CRACKS WATER

Comments 2GRS. HARDNESS /PH 8 IRON/NONE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231909	3140 W THAT RD	Jun 11, 1982

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FIDELLA SWANGO	4031 WOODLY N DR, BLOOMINGTON, IN	
Driller	FRED SMITH		
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	45.0	LS
45.0	105.0	LS & SH
105.0	170.0	LS

Comments ADD'L CONSTRUCTION INFO ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231943	SW. OF BLOOMINGTON,TAKE SR#375 TO ROCKPORT RD., TURN S.W ON ROCKPORT TO DUVALL RD. TURN GOTO GRAVE YARD 1ST. DRIVE PAST GRAVE YARD	May 29, 1991

Owner-Contractor	Name	Address	Telephone
Owner	BURLAN STONE	5156 W. DUVALL RD. BLOOMINGTON,IN.	(812) 344-8163
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:** Submersible
	Depth: 105.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 49.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 28.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	10.0	GRAY LS FINE
10.0	12.0	BLUE LS CRS
12.0	18.0	GRAY LS CRS
18.0	26.0	BUFF LS FINE
26.0	38.0	GRAY LS CRS
38.0	40.0	YEL SHALE

40.0	55.0	GRAY LS CRS
55.0	56.0	WHITE SHALE
56.0	59.0	GRAY LS CRS
59.0	61.0	BLUE SHALE
61.0	78.0	BLUE LS CRS
78.0	89.0	GRAY LS CRS
89.0	90.0	WHITE SHALE
90.0	98.0	BLUE LS CRS
98.0	105.0	GRAY LS FINE

Comments SEE MAP ;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231953	S. OF BLOOMINGTON,TAKE 37S TO THAT RD. , E. OF 3RD. DRIVEWAY TO N. , WELL OFF MAIN RD. , NEW BRICK HOUSE	Aug 16, 1990

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BARRY ELKINS	2010 W. THAT RD. BLGTON,IN.	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED & CURT SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 55.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PCX	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	9.0	YEL SHALE
9.0	14.0	GRAY LS MD CHIP
14.0	18.0	BLUE LS LARGE CHIP
18.0	22.0	GRAY LS MD CHIP
22.0	25.0	BLUE LS LARGE CHIP
25.0	38.0	GRAY LS FINE CHIP
38.0	55.0	BLUE LS FINE CHIP
55.0	63.0	BLUE SOAPSTONE LARGE CHIPS

63.0	77.0	BUFF LS FINE CHIPS
77.0	103.0	GRAY LS LARGE CHIPS
103.0	109.0	YEL LS MD CHIPS
109.0	128.0	GRAY LS MD CHIPS
128.0	138.0	LS LARGE CHIPS
138.0	145.0	GRAY LS LARGE CHIPS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231983	S.W. OF BLOOMINGTON, TAKE SR#37 TO ROCKPORT RD., R. STAY ON ROCKPORT RD,TIL LODGE RD.,L. GO NEXT TO LAST HOUSE ON R. # ON MAILBOX 7150	May 15, 1989

Owner-Contractor	Name	Address	Telephone
Owner	DAVID STULTZ	7150 S. LODGE RD. BLOOMINGTON,IN.	(812) 825-9100
Driller	FRED SCOTT'S WELL DRILLING	236 W. COWDEN RD. ELLETTSVILLE,IN.	(999) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 5.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR-PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	3.0	BR CLAY
3.0	4.0	YEL CLAY
4.0	20.0	GRAY LS HARD
20.0	26.0	BLUE LS HARD
26.0	31.0	GRAY LS HARD
31.0	35.0	BLUE LS HARD

35.0	48.0	GRAY LS HARD
48.0	60.0	BUFF LS HARD
60.0	75.0	GRAY LS HARD
75.0	82.0	BLUE LS HARD
82.0	118.0	GRAY LS HARD
118.0	125.0	BLUE LS HARD

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
257650	APPROX. 3.5 MI. N. OF JCT. #45 & #58 NEAR OWENSBURG,IN. TURN W. ON CR#300S. GO 1 MI. 1ST. DRIVE ON L.	Feb 28, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VAN ROBERSTON	R.R. #3 BOX 302 BLOOMFIELD,IN.	
Driller	MUMMA BROS. DRILLING,INC.	R.R.#1 BOX #85 LYONS,IN.	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 345.0	**Pump setting depth:** 320.0	**Water quality:**
Casing	**Length:** 166.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 18.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 200.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 130.0 to 163.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 9 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 28.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	21.0	LS
21.0	28.0	CLAY
28.0	38.0	SANDROCK,CLAY SEAMS
38.0	61.0	YEL SANDROCK
61.0	76.0	LS
76.0	84.0	BLUE SHALE
84.0	91.0	GREEN SANDROCK

91.0	100.0	GREENISH RED ROCK
100.0	144.0	SANDROCK
144.0	160.0	DARK SHALE
160.0	165.0	SANDY SHALE
165.0	235.0	SANDROCK
235.0	239.0	LS
239.0	243.0	GREEN SHALE
243.0	310.0	LS BROKEN
310.0	345.0	SANDY LS WATER

Comments PH7,HAR 20,IRON 1.0 PPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
274817	LEAVING SOLSBURG 1ST RD TO R OFF OF HWY 43, GO 1 MI OUT OF SOLSBERRY, TURN R ONTO WASHBOARD RD, STAY STRAIGHT FOR 3.5 MI HOUSE ON R WELL IN FRONT YARD	Aug 17, 1995

Owner-Contractor	Name	Address	Telephone
Owner	JEFF ADAMS	RR1 BOX 370A, SOLSBERRY, IN	(812) 825-9283
Driller	PHILLIP'S WELL DRILLING	RR12 BOX 624, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 220.0	**Pump setting depth:** 200.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 6.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOP SOIL
1.0	2.0	BLANK
2.0	17.0	CLAY
17.0	28.0	SS
28.0	56.0	LS
56.0	62.0	SHELL
62.0	220.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
278105	SW OF BLOOMINGTON TAKE SR 37 S TO ROCKPORT RD TURN SW GO TO DUALL RD TURN W GO 1.5 MI DRIVEWAY AT BOTTOM OF HILL HSE BACK OFF MAIN RD TOP OF HILL	Jul 22, 1994

Owner-Contractor	Name	Address	Telephone
Owner	STEVE CAIN	5950 W CUVALL RD, BLOOMINGTON, IN	(812) 334-4087
Driller	FRED SCOTTS WELL DRLG	6236 W COWDEN RD, ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 165.0	**Pump setting depth:** 150.0	**Water quality:** CLEAR
Casing	**Length:** 33.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 94.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 32.0 to 0.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	11.0	RED CLAY
11.0	35.0	GRAY LS CRS
35.0	39.0	BLUE LS CRS
39.0	60.0	GRAY LS FINE
60.0	62.0	BLUE SH
62.0	86.0	GRAY LS CRS

86.0	88.0	BLUE SH
88.0	92.0	BLUE LS FINE
92.0	96.0	GRAY LS FINE
96.0	124.0	BUFF LS EX FINE
124.0	143.0	GRAY LS CRS
143.0	146.0	BLUE SH
146.0	150.0	BLUE LS CRS
150.0	151.0	YEL SH
151.0	159.0	GRAY LS FINE
159.0	160.0	BLUE SH
160.0	165.0	GRAY LS FINE

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295360	FROM 37N TAKE ROCKPORT RD E GO APPROX 8 MI TO TRANWAY RD TURN LEFT GO 1.5 MI PLACE IS ON LF	May 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEVIN H. WRIGLEY	4198 W TRAMWAY RD., BLOOMINGTON, IN	
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 27.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 27.0
Installation Method: PUMP **Number of bags used:** 1.25

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	145.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295361	SR37 TO ROCKPORT RD GO 5 MI TO TRANWAY TURN L ONTO TRAMWAY GO .5 MI ON L	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.0 gpm for 60.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 37.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY
22.0	65.0	LS
65.0	73.0	SHELL
73.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295362	SR37 TO ROCKPORT RD GO 5 MI TO TRAMWAY TURN LEFT ON TO TRAMWAY GO .5 MI ON LEFT	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 2.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	24.0	CLAY
24.0	68.0	LS
68.0	75.0	SHELL
75.0	140.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295365	W OF STANFORD, ON HWY45 GO .25 MI DRIVEWAY ON N SD OF HWY	Apr 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ALOHA GINSENG FARM	9840 W ST HWY45, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 83.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	CLAY RED
15.0	22.0	SUB CLAY
22.0	25.0	SOFT SANDROCK
25.0	35.0	REDROCK
35.0	50.0	GREEN SANDY SHALE
50.0	53.0	SANDROCK
53.0	60.0	GREEN SHALE & BLUE SHALE

60.0	80.0	DK SHALE & LIME BKS
80.0	83.0	SANDY DK SHALE
83.0	90.0	DK SHALE
90.0	100.0	LS
100.0	103.0	BLUE SHALE
103.0	110.0	SANDROCK
110.0	123.0	DK SHALE & BLUE SHALE
123.0	132.0	LS
132.0	134.0	BLUE SAHLE
134.0	215.0	LS
215.0	240.0	LS CRACKS WATER

Comments SEE MAP; CHEM ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295367	FOLLOW BREEDEN RD S OF HWY45 2 MI TO PRIVATE DRIVE ON W SD OF RD	Jun 30, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP LONG	7625 S BREEDEN RD., BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 31.0 to 0.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	18.0	RED CLAY
18.0	68.0	LS
68.0	75.0	BLUE SHALE
75.0	100.0	LS
100.0	125.0	LS & CRACKS WATER

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309951	37/OLD 37 INTERSECTION GO ON OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 215.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 28.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
11.0	165.0	LIME STONE
166.0	175.0	LIME STONE
176.0	191.0	LIME STONE
192.0	215.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309952	37/OLD 37 INTERSECTION GO UP OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRARIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:**	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: YOM BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 28, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	75.0	LIME STONE
75.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309953	37/OLD 37 INTERSECTION - GO TO OLD 37 TO TOP OF HILL OR E	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ELEM BENT **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 25, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309959	OFF 37 TO OLD 37 INTERSECTION - TAKE OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 310.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
3.0	6.0	BUST LIMESTONE
7.0	29.0	HARD LIMESTONE
30.0	33.0	LIME STONE
34.0	82.0	HARD LIMESTONE
83.0	175.0	SOFT LIMESTONE
176.0	310.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
322971	8897 W THACKER RD, W 45 TO BREEDEN RD S ON BREEDEN TO THACKER .5 MI ON S	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CAMERON DECKARD	8897 W THACKER RD, BLOOMINGTON, IN	(812) 825-3530
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	
Company	CAMERON DECKARD		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 300.0	**Pump setting depth:** 280.0	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .025

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 32.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	22.0	RED CLAY
22.0	140.0	GRAY SH
140.0	221.0	LS
221.0	245.0	GRAY SH
245.0	300.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324080	45 R TO 580 - GO 5 MI	Oct 01, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE NEHRT	550 BRIDE DALYON RD BLOOMINGTON	
Driller	PHILLIPS WELL DRLG	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	JAY PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 80.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 9.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 80.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	CLAY
25.0	50.0	BLUE MUCK
75.0	100.0	SANDSTONE
100.0	125.0	LS
503.0	75.0	SHELLY SANDSTONE

Comments (? LOC)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324084	TAKE 45 TO BREEDEN RD GO 4 MI TO THOACKER RD GO 1.5 MI UNTIL YOU SEE A BIG RED BARN ON LT, THIS IS HIS HOME SITE	Jun 02, 1998

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY CLARK	3811 E ANDERSON RD., BLOOMINGTON, IN	(812) 331-8464
Driller	PHILLIPS WELL DRLNG	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 42.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 42.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	10.0	RED CLAY
10.0	24.0	BUSTED LS
24.0	27.0	RED CLAY
27.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
338841		Jul 23, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB BARTHOLOMEW	PO BOX 702 CLEAR CREEK IN	(812) 824-7841
Driller	PHILLIPS WELL DRLG & PUMP SVC	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	
Company	DISTRICTIVE HOMES		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 280.0	**Pump setting depth:** 260.0	**Water quality:** GOOD
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 2

Well Capacity Test

Type of test: Bailing **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL
7.0	40.0	SANDSTONE
40.0	66.0	LS
66.0	83.0	SANDSTONE
83.0	149.0	SHALE
149.0	280.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
339114	N SD OF STONE MILL & E OF RR VIADOCK	Nov 20, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL J. BUNCH	7665 S. VICTOR PIKE, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRLNG INC.	R1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.5 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 28.0 to 0.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	35.0	LS
35.0	36.0	SEAM WATER
36.0	50.0	LS
50.0	77.0	LS & SH BKS
77.0	105.0	GREY SANDROCK

Comments SEE MAP; PETROLIUM ODOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
349513	GO OFF SR54 AT THE HOBBIESVILLE TURNOFF GO DOWN RD TO "Y" HANG L GO ABOUT 1.5 MI UP GRAVEL RD YOU'LL SEE AN IRON GATE TURN L	Nov 10, 1999

Owner-Contractor	Name	Address	Telephone
Owner	BOB HILL	PO BXO 230, OOLITIC, IN	(000) 279-5904
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 320.0	**Pump setting depth:** 300.0	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 5.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 1 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	TOPSOIL
4.0	8.0	CLAY
8.0	16.0	SH LS
16.0	32.0	MUD SEAM
32.0	39.0	BUSTED LS
39.0	55.0	SH
55.0	60.0	SS

60.0	102.0	SH
102.0	244.0	SS
244.0	320.0	LS

Comments SEE MAP; HWY54 TO 1375E, R ON 1320E, APPROX .75 MI

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
349665	TAKE 54 W TO HOBBIESVILLE RD; TURN R; GO ABOUT 2.5 MI; ON L; 2ND HOUSE TO L PAST MYERS DRYWALL	Oct 18, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BRAD STURGEON	9960 W ROCKEAST RD BLOOMINGTON, IN	(812) 825-2034
Driller	PHILLIPS WELL DRILLING&PUMP	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Other
	Depth: 170.0	**Pump setting depth:**	**Water quality:** CLEAR/GOOD
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 3.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	11.0	CLAY
11.0	21.0	SS
21.0	27.0	BUSTED LS
27.0	58.0	SH
58.0	170.0	SOLID LS

Comments SEE MAP;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
352175	S OF KOLEEN, 1/2 TO COUNTY ROAD TO LT, GO .5 MILE	Apr 26, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID MONTGOMERY	PO BOX 50, KOLEEN, IN	
Driller	MUMMA BROS. DRLNG INC.	RR1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 53.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 140.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 53.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY & ROCKS
17.0	20.0	LS
20.0	30.0	SH
30.0	31.0	LS
31.0	44.0	SH & LIME BKS
44.0	48.0	SANDY SH
48.0	70.0	SANDROCK
70.0	83.0	BRN LS
83.0	100.0	GREY LS, HD
100.0	108.0	GREY SH & REDROCK

108.0	118.0	SANDROCK
118.0	130.0	DK SANDY SH
130.0	142.0	DK GREY SH
142.0	148.0	SANDROCK
148.0	179.0	REDROCK & DK SH
179.0	185.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
370693	W OF CAMP OLIVET FOUNDATION, ON W SD OF HWY54	May 16, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE BONNEY	OWENSBURG, IN	
Driller	MUMMA BROS. DRILLING INC.	RR1 BOX 84, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 370.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 150.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 220.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:** 220

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 174.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 150.0 to 0.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	18.0	YEL SANDROCK & CLAY SEAMS
18.0	28.0	BRN CLAY
28.0	35.0	SOFT SH
35.0	40.0	GREY SANDY SH
40.0	46.0	SANDROCK & LIME BKS
46.0	53.0	YELLOW SANDROCK
53.0	60.0	BROWN SANDROCK
60.0	80.0	BRKN SANDY SH
80.0	147.0	DK SH & LIME BKS

147.0	149.0	SANDY SH
149.0	160.0	LS
160.0	168.0	DK SH
168.0	173.0	BLUE SH SOFT
173.0	185.0	LS & SH BKS
185.0	240.0	LS
240.0	260.0	SANDY LS
260.0	275.0	LS CRACKS
275.0	295.0	LS
295.0	305.0	LS CRACKS
305.0	355.0	LS
355.0	370.0	BRKN LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383065	HWY 45 TO STANFORD, LEFT ON BREEDEN RD, 4 MI TO 1ST CROSS RD, GO RT, 2ND FARM ON LEFT;	Aug 10, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MICHAEL WAMPLER/CJ STURGEON	9501 ROCK EAST RD B'TON IN	(812) 825-5804
Driller	PHILLIPS WELL DRLG&PUMP SVC IN	RR 12 BOX 444 BEDFORD, INDIANA	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 56.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 4 IN

Well Capacity Test

Type of test: Air **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 27.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 50.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	RED CLAY
7.0	51.0	BUSTED ROCK
51.0	80.0	LIMESTONE

Comments SEE MAP;30-72W; PLAT 2;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
391301	ST RD 45 WEST TO COUNT ROAD BREADEN ROAD GO 5 MILE TO WEST CRAVES ROAD GO 1 MILE TO RIGHT BOX 8785	Nov 26, 2004

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF NEW	8785 WEST GRAVES ROAD	(812) 336-7537
Driller	J AND K WATER WELL SERVICE	1369 STATE ROAD 158 WILLIAMS IN	
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 112.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 5.0 gpm for 300.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 20.0 ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 5.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	SAND
5.0	10.0	SABD ABD PEA GRAVEL
10.0	15.0	SAND AND MUD
15.0	20.0	CLAY
20.0	25.0	LIMESTONE
25.0	30.0	LIMESTONE
30.0	35.0	BUSTED LIMESTONE
35.0	40.0	LIMESTONE
40.0	112.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
404946	SR54 - GO TO HOBBIEVILLE RD - GO THRU HOBBIEVILLE- CONTINUE ON - GO AROUND SHARP CURVE - PASS DECKARD HOME SALES - TO NEW CONSTRUCTION ON R! FENCED IN	Nov 19, 2005

Owner-Contractor	Name	Address	Telephone
Owner	JOE BYERS	RR1 SPRINGVILLE, IN	(812) 855-4307
Driller	PHILLIPS WELL DRILLING	RR3 BOX 55-A OWENSBURG, IN	(812) 863-4843
Operator	DEXTER SWARTZENTRUBER	License: 302	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth:	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 40.0	**Material:** STEEL	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 2

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	11.0	CLAY
11.0	14.0	BROKEN LIMESTONE
14.0	30.0	LIMESTONE
30.0	32.0	BROKEN LIMESTONE
32.0	85.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
407312	SOUTH WEST OF BLOOKINGTON ON 45 THRU STANFORD. LEFT OR SOUTH ON BREEDEN RD APP 1 MIL ACROSS CREEK (DRIVEWAY) ON RIGHT. REPLACES EXIST WELL AT OLD BARN	Apr 04, 2006

Owner-Contractor	Name	Address	Telephone
Owner	LISA SWOAPE	7625 S BREEDEN RD BLOOMINGTON, IN	
Driller	MADER WELL DRILLING	9262 OWEN PARK RD SPENCER, IN	(765) 795-3343
Operator	STEVE MADER	License: 541	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 95.0	**Pump setting depth:** 65.0	**Water quality:** CLEAR
Casing	**Length:** 41.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bail / Pump **Test rate:** 40.0 gpm for 0.5 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 15.0 ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: W-O-B **Depth:** from to
Installation Method: POUR **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 6.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	6.0	BROKEN LIMESTONE
6.0	15.0	LS
15.0	16.0	SOFTER
16.0	38.0	MD & SOFTER LS
38.0	75.0	HD GRAY LIMESTONE
75.0	85.0	GRAY LIMESTONE
85.0	88.0	HD DARKER GRAY LS
88.0	95.0	BROKEN LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40745		May 09, 1946

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	A PADGETT		
Driller	WAGGONER BROTHERS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 67.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 530.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	OVERBURDEN
15.0	31.0	SOFT RED SS
31.0	33.0	LS
33.0	43.0	BLUISH GRAY SANDY SHALE
43.0	45.0	HARD YELL SS, WATER
45.0	67.0	YELL SS, WATER

Comments WELL E-1, DATA FROM USGS BULL 11 AND WWRS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410928	37 - VICTOR PIKE - GO DOWN ABOUT 2.5 MILES TO 30 MILL ON R - WELL IS LOCATED BY BACK LOT	Jul 16, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3D STONE, INC/WHALEY INVESTMEN	4810 SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 55A OWENSBURG, IN	(812) 863-4843
Operator	TAMMY HOLLAND/REX MARTIN	License: null	

Construction Details

Well	**Use:** Industry	**Drilling method:**	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 24.0 ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 40.0 to 0.0
Installation Method: TREMMIE **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	135.0	LIMESTONE
135.0	136.0	SANDY SHALE
136.0	137.0	LIMESTONE
137.0	140.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410932	VICTOR PIKE - 3 D STONE INC. MILL ON VICTOR PIKE OFF OF HWY 37	Jul 10, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3 D STONE INC/WHALEY INVESTMEN	4810 WEST SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	HACKER PLUMBING & DRILLING	2687 S OLD DECKER RD VINCENNES, IN	(812) 882-8053
Operator	TIM HACKER	License: 152	
Company	PHILLIPS WELL DRILLING	R # 3 BOX 55A OWENSVILLE, IN	(812) 863-4844

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 340.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: BENTONITE **Depth:** from 0 to 340
Installation Method: TREMMIE **Number of bags used:** 10.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	110.0	LIMESTONE W/MUD SEAMS
110.0	170.0	LIMESTONE W/SANDY SHALE SHALE
170.0	340.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
52692	GO N OF JUNCTION HWY 45 & 48 GO N ON 45 .75 MI TO 1ST CROSS ROAD TURN W ENTERENCE AS STEEL GATES, PRIVATE DR .5 MI THRU CLASSIFIED FOREST	Oct 26, 1993

Owner-Contractor	Name	Address	Telephone
Owner	WENDELL LEEDY	R 3 BOX 29C OWENSBURG, IN	
Driller	MUMMA DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 365.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 100.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 280.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 100.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of Section 17 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	CLAY & SANDROCK
15.0	22.0	BREAK OF COAL & SH
22.0	34.0	SANDROCK & CLAY SEAMS
34.0	43.0	SOFT SH
43.0	55.0	SANDROCK (HARD)
55.0	61.0	BLUE SH
61.0	64.0	YEL SANDROCK

64.0	69.0	LS & SEAMS
69.0	95.0	DARK SH
95.0	134.0	SANDROCK
134.0	137.0	SH
137.0	155.0	LS
155.0	170.0	BLUE SH, REDROCK, GREEN SH
170.0	200.0	SANDY SH & SANDY LIME
200.0	212.0	DARK SH
212.0	225.0	SANDROCK & SANDY SH
225.0	245.0	DARK SH
245.0	255.0	SANDROCK & SHEAL BKS
255.0	260.0	SANDROCK
260.0	267.0	DARK SH
267.0	275.0	SANDROCK
275.0	298.0	LS
298.0	304.0	BLUE SH
304.0	365.0	LS CRACKS (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52702	GO S OF HWY 45 & 54 UCT ON 54S TO CR 1250E GO S TO CHURCH TURN R ON GRAV RD GO 200 YRDS TURN R GO TO TEE GO LEFT DEAD END	Aug 06, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM RICHARD	OWENSBURG, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 60.0 to 35.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	30.0	SANDROCK & SEAMS
30.0	55.0	SANDROCK
55.0	62.0	SANDY SH
62.0	78.0	DARK SH
78.0	85.0	YEL SANDROCK
85.0	95.0	DARK SH & SANDY SH
95.0	100.0	SANDROCK (WATER)
100.0	120.0	DARK SH
120.0	127.0	SANDROCK (WATER)
127.0	140.0	DARK SH & SANDROCK
140.0	145.0	LS

Comments 28 HARDNESS 7.0 PH28 HARDNESS 7.0 PH 3PPM IRON

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52704	GO 200 FT S OF HWY JCT 54 & 45 EXIT HWY 54 ONTO CR 50S (DEAD END) GO E .75 MI ONTO PRIVATE DR THRU WOODS	Jun 28, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOE JAMES	R 4 BOX 416 BLOOMFIELD, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2398
Operator	DAVID RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 285.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 82.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 200.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 80.0 to 20.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of Section 26 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	SANDROCK & SEAMS
15.0	20.0	SOFT SH
20.0	32.0	SANDY SH
32.0	68.0	DARK SH
68.0	69.0	LS
69.0	78.0	DARK SH

78.0	81.0	SANDROCK
81.0	100.0	DARK SH & SANDROCK BREAKS
100.0	102.0	GREEN SH
102.0	240.0	LS
240.0	273.0	LIMECRACKS
273.0	285.0	LIMECRACK (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
20401	E OF HOBBIEVILLE, GO ABOUT 3.25MI, GO TO BOTTOM OF HILL AND STAY L TO ROCK E RD THEN ABOUT 1.25MI FROM BOTTOM OF HILL, LOT ON N SIDE OF RD	Oct 17, 1990

Owner-Contractor	Name	Address	Telephone
Owner	MIKE WAMPLER	10024 W ROCK EAST RD BLOOMINGTON IN	(812) 825-2076
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	CURT AND FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 38.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 5.0 to 30.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the SE of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 28, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1250.0 **Ft N of SL:** 500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**
UTM Easting: 527150.0 **UTM Northing:** 4317565.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELLOW CLAY
8.0	13.0	YELLOW SANDSTONE EX SOFT
13.0	20.0	YELLOW GUMMY SHALE
20.0	27.0	BLUE SHALE EX SOFT
27.0	39.0	GRAY LIMESTONE LARGE CHIPS
39.0	50.0	BLUE LIMESTONE MED CHIPS

50.0	76.0	GRAY LIMESTONE MED CHIPS
76.0	80.0	WHITE SHALE
80.0	95.0	BLUE LIMESTONE LARGE CHIPS
95.0	96.0	YELLOW SHALE
96.0	109.0	GRAY LIMESTONE FINE CHIPS
109.0	125.0	BLUE LIMESTONE FINE CHIPS

Comments LINER SET TO 100', WELL #1, SKETCH MAP, MC 632

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
20402	E OF HOBBIEVILLE GO E ABOUT 3.5MI, GO TO BOTTOM OF HILL AND STAY L, ROCK EAST RD ABOUT 1.5MI FROM BOTTOM OF HILL, HOUSE ON N SIDE OF RD	Oct 05, 1990

Owner-Contractor	Name	Address	Telephone
Owner	MIKE WAMPLER	10024 W ROCK EAST RD BLOOMINGTON IN	(812) 825-2076
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	CURT AND FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 31.5	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 42.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 6.0 to 31.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 28, 1992
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 527285.0 **UTM Northing:** 4317850.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLAY
5.0	21.0	BROWNISH RED SANDSTONE EX SOFT
21.0	26.0	YELLOW MUCKY SHALE
26.0	29.0	OPEN SEAM
29.0	39.0	GRAY LIMESTONE LARGE CHIP
39.0	46.0	BLUE LIMESTONE MED CHIPS

46.0	70.0	GRAY LIMESTONE MED CHIPS
70.0	80.0	BLUE LIMESTONE MED CHIPS
80.0	87.0	DEEP BLUE LIMESTONE LRG CHIPS
87.0	105.0	GRAY LIMESTONE LRG CHIPS

Comments VERIFIED BY OWNER, WELL #2, SKETCH MAP, MC 655

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
20404	S OF STANFORD, TAKE SR 45W TO BREEDEN RD TURN S PAST T. PHILLIPS RD, HOUSE ON R (W) SIDE OF RD	Jun 26, 1991

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RONALD PORTER	7211 S BREEDEN RD BLOOMINGTON IN	(812) 825-9307
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 26.0	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 60.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 5.25 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 26.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the NE of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 27, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2125.0 **Ft S of NL:** 2225.0
Ground elevation: 695.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 528115.0 **UTM Northing:** 4324760.0

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	YELLOW CLAY
7.0	52.0	GRAY LIMESTONE COARSE
52.0	57.0	BLUE LIMESTONE FINE
57.0	67.0	GRAY LIMESTONE FINE
67.0	85.0	YELLOWISH LIMESTONE FINE
85.0	105.0	GRAY LIMESTONE COARSE

Comments VERIFIED BY MAILBOX, SKETCH MAP, MC 688

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213403		

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUFUS FLEEMER		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 60.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 35.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1800.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 537946.0 **UTM Northing:** 4327746.0

Well Log

Top	Bottom	Formation
0.0	18.0	RED CLAY
18.0	60.0	WH LS

Comments RELATIVE VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213408	4 MI S BLOMINGTON ON SR37 TO DILLMAN RD&TURN R GOTO T RD&THIS PLACE IS ON NE SIDE OR 1ST HOUSE ON R AFTER YOU TURN R ON T RD.	May 12, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EARL KIRK		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 31.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SE of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 680.0 **Aquifer elevation:**
UTM Easting: 538163.0 **UTM Northing:** 4327099.0

Well Log

Top	Bottom	Formation
0.0	30.0	RED CLAY
30.0	110.0	WH LS

Comments MC 680;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213412	S BLOOMINGTON IN, ON SR37, 4 MI.	Aug 23, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARSHALL MAY	RR#4	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 75.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 10.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1600.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 614.0 **Aquifer elevation:**
UTM Easting: 539627.0 **UTM Northing:** 4327386.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	50.0	HARD LS
50.0	65.0	LAYERS LS & SHALE

Comments MC 614; OWNER & SIGN VERIFIED 60' W OF RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213413	NEAR CLEAR CREEK ABOUT 3MI SW ON BOWLIN RD.	Oct 16, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FLOYD MEADOWS	RR4	
Driller	PAUL SCOTT	SUGAR LANE 3615	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the SW of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1700.0 **Ft E of WL:** 2200.0 **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 666.0 **Aquifer elevation:**
UTM Easting: 537567.0 **UTM Northing:** 4327546.0

Well Log

Top	Bottom	Formation
1.0	14.0	CLAY
14.0	36.0	STONE BUFF LIME SOFT
36.0	45.0	STONE GRAY LIME HARD
45.0	52.0	STONE WH LIME HARD
52.0	78.0	STONE WH LIME SOFT
78.0	90.0	STONE BLUE LIME HARD
90.0	94.0	STONE GRAY LIME HARD
94.0	110.0	STONE BLUE SHALE SOFT
110.0	137.0	STONE GRAY LIME HARD
137.0	150.0	STONE BLUE SOAPSTONE SOFT

Comments MC 665; VERIFIED BY NEIGHBOR;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213417		May 08, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARSHALL MAY	RR#4, BLOOMINGTON	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 25, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 608.0 **Aquifer elevation:**
UTM Easting: 539590.0 **UTM Northing:** 4327343.0

Well Log

Top	Bottom	Formation
0.0	12.0	DIRT
12.0	30.0	BLUE HARD LS
30.0	75.0	BLUE SHALE

Comments MC 608; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213418	ON BOWLING LANE 1.05 MI SW, CLEAR CEEK IN.	May 11, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS. VEACH	RR#5, BLGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 37.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NE of the SW of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 700.0 **Aquifer elevation:**
UTM Easting: 537312.0 **UTM Northing:** 4327754.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	50.0	MD HARD GREY LS
50.0	106.0	WH MD HARD LS
106.0	125.0	VERH HARD WH LS

Comments DRY VERIFIED; MAILBOX LOCATION;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213422	NEAR OLD DILLMAN SCHOOL, N ABOUT 500' ON OLD SMITH FARM. L SIDE, 1ST HOUSE, N OF NEW RET.	Dec 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES SMITH	RR#4, BLOOMINGTON	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.13 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 645.0 **Aquifer elevation:**
UTM Easting: 539456.0 **UTM Northing:** 4327142.0

Well Log

Top	Bottom	Formation
0.0	24.5	RED CLAY
24.5	100.0	HARD WH LIME

Comments DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213492	S EDGE CLEAR CREEK IN.	Oct 17, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #4	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 42.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1500.0
Ground elevation: 660.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539490.0 **UTM Northing:** 4328099.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	100.0	HARD LS
100.0	125.0	BLUE SHALE

Comments MC 650; OWNER VERIFIED ABOUT 50 YDS NW OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213497	S EDGE CLEAR CREEK IN.	Sep 26, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #1	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1650.0
Ground elevation: 665.0 **Depth to bedrock:** 36.0 **Bedrock elevation:** 629.0 **Aquifer elevation:**
UTM Easting: 539514.0 **UTM Northing:** 4328057.0

Well Log

Top	Bottom	Formation
0.0	36.0	TOPSOIL & LAYERS LS
36.0	100.0	HARD LS
100.0	135.0	SHALE

Comments MC 629; OWNER VERIFIED 25' W OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213498	ON SIGO RD, WAS CALLED DILMAN RD.	Oct 25, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE LUCAS	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NE of the NE of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 25, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 680.0 **Depth to bedrock:** 49.0 **Bedrock elevation:** 631.0 **Aquifer elevation:**
UTM Easting: 539888.0 **UTM Northing:** 4326952.0

Well Log

Top	Bottom	Formation
0.0	49.0	BLANK
49.0	79.0	BLUE LS
79.0	115.0	BLUE SHALE

Comments MC; OWNER VERIFIED; DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213503	OLD PUBLIC SERVICE SUB STATION 4.5 MI S BLOOMINGTON IN, OFF SR37 ABOUT .125 MI.	Apr 06, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROY CRAIG	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 63.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 7.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 655.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 648.0 **Aquifer elevation:**
UTM Easting: 539404.0 **UTM Northing:** 4326466.0

Well Log

Top	Bottom	Formation
0.0	7.0	LS FILL
7.0	63.0	WH MD HARD LS

Comments MC 650; DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213507	S EDGE CLEAR CREEK IN.	Oct 08, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #3	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1850.0
Ground elevation: 675.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 667.0 **Aquifer elevation:**
UTM Easting: 539496.0 **UTM Northing:** 4327996.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOPSOIL
8.0	100.0	WH LS
100.0	145.0	BLUE SHALE

Comments MC 667; OWNER VERIFIED ABOUT 60 YDS SW OF HOUSE; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213508	1ST HOUSE INDIAN HILL STONE MILL ON VICTOR RD.	Feb 03, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	C.T. HAGERS	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 650.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 635.0 **Aquifer elevation:**
UTM Easting: 537322.0 **UTM Northing:** 4325621.0

Well Log

Top	Bottom	Formation
0.0	15.0	DIRT
15.0	50.0	HARD LS
50.0	100.0	BLUE SHALE

Comments MC 635; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213512	S EDGE CLEAR CREEK IN.	Oct 02, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #2	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 670.0 **Depth to bedrock:** 19.0 **Bedrock elevation:** 651.0 **Aquifer elevation:**
UTM Easting: 539514.0 **UTM Northing:** 4328032.0

Well Log

Top	Bottom	Formation
0.0	19.0	TOPSOIL & LAYERS LS
19.0	100.0	HARD DARK LS

Comments

MC 651; OWNER VERIFIED ON W SIDE OF FENCE LINE ABOUT 40 YDS. SW OF HOUSE; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213518	ON VICTOR PIKE 0.25 MILE S OF DILLMAN ROAD TEE.	Nov 28, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WILLIAM BOWFF	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 41.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 81.0 ft. **Bailer Drawdown** 29.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2600.0 **Ft S of NL:** 900.0
Ground elevation: 680.0 **Depth to bedrock:** 79.0 **Bedrock elevation:** 601.0 **Aquifer elevation:**
UTM Easting: 537674.0 **UTM Northing:** 4326725.0

Well Log

Top	Bottom	Formation
0.0	79.0	RED CLAY W/ LAYERS LIMESTONE
79.0	115.0	HARD WHITE LIMESTONE

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213644	ABOUT 2MI W CLEAR CREEK ON THAT RD JUST BACK OF POND OFF ROCKPORT RD. ABOUT 2MI W OF CLEAR CR ON THAT RD JUST BACK OF POND OFF ROCKPORT RD.	Apr 28, 1964

Owner-Contractor	Name	Address	Telephone
Owner	EUGENE STANFIERS #1	RR5, BLOOMINGTON	
Driller	PAUL SCOTT	3615 SUGAR ACRES, BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 28.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2200.0 **Ft E of WL:** 1300.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 766.0 **Aquifer elevation:**
UTM Easting: 537265.0 **UTM Northing:** 4329242.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	14.0	RED CLAY
14.0	16.0	GRAY LS SOFT
16.0	20.0	GRAY LS HARD
20.0	25.0	BLUE LS EX HARD
25.0	28.0	GRAY LS SOFTER
28.0	35.0	GRAY LS HARD

35.0	39.0	BUFF LS SOFT
39.0	46.0	GRAY LS HARD
46.0	50.0	GRAY LS SOFTER
50.0	60.0	GRAY LS EX HARD
60.0	65.0	LIGHT BLUE LS EX HARD
65.0	75.0	LIGHT GRAY LS HARD
75.0	84.0	WH LS SOFT
84.0	102.0	GRAY LS HARD
102.0	117.0	DARK GRAY LS SOFTER
117.0	125.0	WH LS SOFT
125.0	137.0	LIGHT GRAY LS HARD
137.0	146.0	LIGHT GRAY LS SOFTER
146.0	161.0	LIGHT GRAY LS HARD
161.0	165.0	LIGHT GRAY LS SOFTER

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213645	ON THAT ROAD WEST OF RODGERS ST. ABOUT 2 BLOCKS ON NORTH SIDE ROAD	Nov 25, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VIRGIL FENDER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 23.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0
Ground elevation: 680.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 675.0 **Aquifer elevation:**
UTM Easting: 539477.0 **UTM Northing:** 4329374.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL CLAY
5.0	80.0	VERY HARD LIMESTONE

Comments MC 675; OWNER VERIFIED; JUST NORTH OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213649	STONISFER LANE	May 15, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LAUGHLIN		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 85.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 687.0 **Aquifer elevation:**
UTM Easting: 536913.0 **UTM Northing:** 4328628.0

Well Log

Top	Bottom	Formation
0.0	13.0	TOP SOIL & LAYERS LIMESTONE
13.0	25.0	BROWN LIMESTONE (MED. HARD)
25.0	85.0	WHITE LIMESTONE (MED. HARD)

Comments NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213650	CLEAR CREEK	Oct 07, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JIM AKERS	CLEAR CREEK	
Driller	FRED SMITH	RR#1, HELTONVILLE IN	
Operator	FRED SMITH-TOM SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1400.0
Ground elevation: 660.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 539838.0 **UTM Northing:** 4329701.0

Well Log

Top	Bottom	Formation
0.0	5.0	SOIL
5.0	40.0	LS
40.0	100.0	BLUE SHALE

Comments MC 655; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213654	1ST DRIVE AST ROCKPORT ROAD ON SO. SIDE OF THAT ROAD THEN 0.25 MILE SOUTH.	May 17, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER #2	R5 BLOOMINGTON, IN.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 36.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 68.0 ft. **Bailer Drawdown** 47.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1500.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 34.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537294.0 **UTM Northing:** 4329047.0

Well Log

Top	Bottom	Formation
0.0	34.0	DIRT & LAYERS OF STONE
34.0	56.0	BROWN LIMESTONE (MED HARD)
56.0	105.0	WHITE LIMESTONE (MED HARD)
105.0	120.0	BLUE LIMESTONE (MED HARD)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213655	ON THAT ROAD 1 BNLOCK WEST RODGERS ST. ON SO. SIDE ROAD	Oct 23, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST KIEFFABER #1	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2050.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 665.0 **Aquifer elevation:**
UTM Easting: 539531.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL CLAY
5.0	70.0	LIMESTONE W/ LAYERS SHALE

Comments MC 665; OWNER VERIFIED; 10 FT EAST OF HOUSE THAT'S PAINTED GREEN.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213658	CORNER OF FULERTON PIKE & ROCKPORT ROAD ON EAST SIDE OF ROAD	Sep 18, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RODNEY VANPELT		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.5 gpm for hrs.
Drawdown: ft. **Static water level:** 51.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 250.0
Ground elevation: 770.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 537827.0 **UTM Northing:** 4330099.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	140.0	MEDIUM HARD WHITE LIMESTONE

Comments MC 760; NEIGHBOR VERIFIED; EAST OF HOUSE; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213659	NEAR CORNNER OF ROCKPORT ROAD AND THAT ROAD. IN STONSIFER ADDITION	Jul 16, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE RUSH	RR#5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 300.0 **Ft S of NL:**
Ground elevation: 720.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 711.0 **Aquifer elevation:**
UTM Easting: 536980.0 **UTM Northing:** 4328615.0

Well Log

Top	Bottom	Formation
0.0	9.0	TOP SOIL & LAYERS LIMESTONE
9.0	95.0	WHITE LIME MEDIUM HARD

Comments MC 711; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213660		Nov 05, 1980

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KIEFFABER	689 W. THAT	
Driller	GEORGE SNAPP	4625 S. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 665.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 539525.0 **UTM Northing:** 4329360.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL
5.0	65.0	BLUE LIMESTONE
65.0	75.0	BLUE SHALE

Comments VERIFIED BY OWNER WELL #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213663	ON ROCKPORT RD	Sep 30, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT VAUGHT	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 730.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 724.0 **Aquifer elevation:**
UTM Easting: 537986.0 **UTM Northing:** 4330160.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	80.0	BUFF LIMESTONE
80.0	110.0	BLUE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213664	NEAR CORNER OF ROCKPORT ROAD & THAT ROAD, IN STANSIFER ADDITION. WEST CLEAR CREEK, IN. 4 MILES SOUTH WEST OF BLOOMINGTON, IN	Jul 29, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PAUL PAGE	RR 5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.5	**Material:**	**Diameter:** 4.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1150.0 **Ft E of WL:** 350.0 **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 753.0 **Aquifer elevation:**
UTM Easting: 537024.0 **UTM Northing:** 4328914.0

Well Log

Top	Bottom	Formation
0.0	17.0	DIRT & LAYERS LIMESTONE
17.0	130.0	WHITE LIMESTONE

Comments MC 753; WELL DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213665	CLEAR CREEK, IN	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK JAMES	CLEAR CREEK	
Driller	GEORGE SNAPP	R5 BNOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 10.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 28, 1977
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 647.0 **Aquifer elevation:**
UTM Easting: 539684.0 **UTM Northing:** 4329330.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL
8.0	95.0	HARD BLUE LIMESTONE

Comments POST OFFICE VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213668	N THAT ROAD 2 MILES WEST OF CLEAR CREEK, IN. ON NORTH SIDE ROAD	Oct 09, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DEWEY WOODS	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 55.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2550.0
Ground elevation: 770.0 **Depth to bedrock:** 50.0 **Bedrock elevation:** 720.0 **Aquifer elevation:**
UTM Easting: 537904.0 **UTM Northing:** 4329392.0

Well Log

Top	Bottom	Formation
0.0	52.0	RED CLAY OPENINGS &LIMESTONE
50.0	100.0	SLIGHT BLUE LIMESTONE HARD
100.0	120.0	WHITE LIMESTONE

Comments MC 720; OWNER VERIFIED; 75 FT NORTH OF THAT RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213669	RIGHT OFF BY PASS #37 WEST BETWEEN THAT ROAD & VACTOR PIKE.	Jan 15, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE RICE	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 107.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SE of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 775.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 538382.0 **UTM Northing:** 4328598.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	20.0	LIMESTONE
20.0	23.0	CREVIS
23.0	107.0	MEDIUM HARD LIMESTONE WHITE

Comments MC 768; OWNER VERIFIED / 50 FT WEST OF HOUSE.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213670	GO S FROM BLOOMINGTON IN, ON RODGERS ST TO CLEAR CREEK IN, TURN W ON THAT RD. 6TH HOUSE ON S SIDE OF RD.	Nov 10, 1980

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST M. KIEFFSBER	689 W THAT RD	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 659.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539867.0 **UTM Northing:** 4329329.0

Well Log

Top	Bottom	Formation
0.0	9.0	RED CLAY
9.0	90.0	WH LS
90.0	125.0	BLUE SHALE

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213673	LOCATED 200' N OF INTERSECTION OF ROCKPORT RD & THAT RD.	Apr 06, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOUIS BAILEY		
Driller	ALBERT LENTZ	SMITHVILLE IN	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: US **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2800.0 **Ft E of WL:** 900.0 **Ft S of NL:**
Ground elevation: 783.0 **Depth to bedrock:** 39.0 **Bedrock elevation:** 744.0 **Aquifer elevation:**
UTM Easting: 537150.0 **UTM Northing:** 4329425.0

Well Log

Top	Bottom	Formation

Comments MC; WATER BEGIN COMING IN ABOUT 120' FILLED UP AROUND ABOUT 5 MPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213675	CLEAR CREEK, IN	Oct 01, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KIEFFABER	CLEAR CREEK, IN	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 35.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 15.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1850.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 648.0 **Aquifer elevation:**
UTM Easting: 539562.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	35.0	LIMESTONE

Comments MC 648; OWNER VERIFIED; 25 FT SE OF YELLOW HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213678	NE CORNER ROCKPORT RD & THAT RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RICHARD VANPELT		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	HASKLE GROGAN&JIM HAYES	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2750.0 **Ft E of WL:** 1150.0 **Ft S of NL:**
Ground elevation: 785.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 537650.0 **UTM Northing:** 4329435.0

Well Log

Top	Bottom	Formation
0.0	75.0	EXISTING WELL
75.0	130.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213679		Jun 18, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE SNAPP	4625 SO. STANISFER LANE BLOOMINGTON, IN	
Driller	GEORGE SNAPP	4625 SO. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 124.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 15.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 669.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 537365.0 **UTM Northing:** 4328920.0

Well Log

Top	Bottom	Formation
0.0	12.0	RED CLAY
12.0	75.0	BROWN LIMESTONE
75.0	120.0	WHITE LIMESTONE

Comments OWNER VERIFIED; WELL IS 10' WEST OF SW CORNER OF HOUSE (BURIED)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213680	GO WEST FROM CLEAR CREEK, IN. ON THAT ROAD TO 1ST ROAD TO LEFT THEN 3RD HOUSE ON LEFT.	Sep 11, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 40.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** 25.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3300.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 650.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 644.0 **Aquifer elevation:**
UTM Easting: 539139.0 **UTM Northing:** 4328845.0

Well Log

Top	Bottom	Formation
0.0	6.0	DIRT
6.0	40.0	WHITE LIMESTONE

Comments IN FLAT GROUND AT NE COR OF PROPERTY; #3

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213683	ON FULLERTON PIKE	Apr 21, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BUTCHER	R5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Jul 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2200.0 **Ft S of NL:** 100.0
Ground elevation: 775.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 537559.0 **UTM Northing:** 4330161.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	100.0	WHITE LIME
100.0	130.0	BLUE LIME

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213684	STANISFER LANE	Apr 13, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TERRY WHITE	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 350.0 **Ft E of WL:** 1350.0 **Ft S of NL:**
Ground elevation: 755.0 **Depth to bedrock:** 39.0 **Bedrock elevation:** 716.0 **Aquifer elevation:**
UTM Easting: 537291.0 **UTM Northing:** 4328669.0

Well Log

Top	Bottom	Formation
0.0	34.0	TOP SOIL W/ LAYERS LIMESTONE
34.0	115.0	WHITE MEDIUM HARD LIMESTONE

Comments MC 716; DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213685	FROM BLOOMINGTON SOUTH ROGERS STREET TOE THAT ROAD. 0.25 TO VICTOR PIKE ROAD. 1ST HOUSE ON LEFT	Oct 05, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD ROBERTSON		
Driller	FRED SMITH	8565 O. S. ROAD 37 SOUTH	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 25.0 ft. **Bailer Drawdown** 175.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1900.0 **Ft E of WL:** 2200.0 **Ft S of NL:**
Ground elevation: 679.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 673.0 **Aquifer elevation:**
UTM Easting: 539189.0 **UTM Northing:** 4329137.0

Well Log

Top	Bottom	Formation
0.0	6.0	SOIL
6.0	90.0	LIMESTONE
90.0	200.0	SHALE

Comments MC 673; NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213688	S. OF BLOOMINGTON TAKE 4LANE 37 S. TO ROCKPORT RD. GO LFT GO TO BOTTOM OF 1ST LITTLE HILL HOUSE ON LFT AT BOTTOM OF HILL	Oct 22, 1987

Owner-Contractor	Name	Address	Telephone
Owner	WILLIAM L WHEELER	4060 S. ROCKPORT RD., BLOOMINGTON, IN	
Driller	FRED SCOTTS DRILLING	6236 W COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 3.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 38.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JLL **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2550.0 **Ft S of NL:** 450.0
Ground elevation: 770.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 761.0 **Aquifer elevation:**
UTM Easting: 537650.0 **UTM Northing:** 4330050.0

Well Log

Top	Bottom	Formation
0.0	5.0	YEL CLAY
5.0	9.0	RED CLAY
9.0	13.0	GRAY LS HARD
13.0	15.0	YEL SH SOFT
15.0	30.0	GRAY LS H.
30.0	36.0	BLUE LS H.
36.0	52.0	GRAY LS H.
52.0	76.0	BUFF LS H.

76.0	84.0	BLUE LS H.
84.0	106.0	GRAY LS H.
106.0	120.0	WHITE LS H.
120.0	132.0	GRAY LS H.
132.0	145.0	DARK GRAY LS H.

Comments MAILBOX VERIFIED WELL OFF SW CORNER OF HOUSE VISABLE FROM RD., WELL 1550' NE OF HWY 37 ON N. SIDE ROCKPORT RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213689	CORNER OF THAT ROAD & ROCKPORT WEST CLEAR CREEK, IN. 2 MILES (NEST HOUSE WEST OF TRAILER.	Oct 11, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES WRIGHT	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 16.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1300.0 **Ft E of WL:** 400.0 **Ft S of NL:**
Ground elevation: 765.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 750.0 **Aquifer elevation:**
UTM Easting: 536994.0 **UTM Northing:** 4328975.0

Well Log

Top	Bottom	Formation
0.0	16.0	TOP SOIL & LAYERS LIMESTONE
16.0	50.0	BLUE HARD LIMESTONE
50.0	85.0	MEDIUM SOFT LIMESTONE WHITE
85.0	115.0	GREY MEDIUM WHITE LIMESTONE
115.0	125.0	BLUE LIMSTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213690	0.25 MILE SOUTH EAST OF CLEAR CREEK, IN. ON CHURCH LANE	Jun 07, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BILL STUCKEY	RR #5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 5.0 ft. **Bailer Drawdown** 31.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 450.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 684.0 **Aquifer elevation:**
UTM Easting: 539096.0 **UTM Northing:** 4328704.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	17.0	SOFT WHITE LIMESTONE
17.0	60.0	MEDIUM HARD WHITE LIMESTONE
60.0	70.0	SHALE BLUE
70.0	80.0	HARD WHITE LIMESTONE
80.0	90.0	HARD BLUE LIMESTONE

Comments MC 684; NEIGHBOR VARIFIED; SULFUR WATER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213694	SOUTH OF THAT ROAD	Sep 19, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ANCEL BLACK	RR#5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 55.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Feb 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 700.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 739.0 **Aquifer elevation:**
UTM Easting: 537292.0 **UTM Northing:** 4328797.0

Well Log

Top	Bottom	Formation
0.0	21.0	DIRT & LAYERS LIMESTONE
21.0	65.0	HARD BLUE LIMESTONE
65.0	70.0	MEDIUM WHITE LIMESTONE
70.0	95.0	MEDIUM BROWN LIMESTONE
95.0	105.0	MEDIUM WHITE LIMESTONE
105.0	115.0	HARD WHITE LIMESTONE
115.0	117.0	MEDIUM WHITE LIMESTONE
117.0	140.0	HARD WHITE LIMESTONE

Comments DRILLER VERIFIED; DRY HOLE; WATER AT 117

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213695	0.5 MI S/W CLEAR CREEK, IN. WELL 36' FROM S EAST CORNER OF OWNERS HOUSE.	Aug 25, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	W. M. ACUFF		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 6.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: NO **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 400.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 538992.0 **UTM Northing:** 4328687.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLLAY
17.0	70.0	LIMESTONE
70.0	80.0	SAND & GRAVEL

Comments MC 690;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213699	1ST DR E ROCKPORT RD ON S SIDE OF THAT RD THEN .5 MI S.	Jul 07, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE SNAPP	RR#5, BLOOMINGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 53.0 ft. **Bailer Drawdown** 56.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 1600.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537359.0 **UTM Northing:** 4328894.0

Well Log

Top	Bottom	Formation
0.0	24.0	DIRT & LAYERS LS
24.0	27.0	3' COAL
27.0	73.0	BR CLAY LS
73.0	95.0	WH LS
95.0	125.0	BLANK

Comments MC 735; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213700	GO WEST FROM CLEAR CREEK ON THAT ROAD TO 1ST ROAD TO THE LEFT; THE 3RD HOUSE ON LEFT.	Aug 25, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 690.0 **Aquifer elevation:**
UTM Easting: 539029.0 **UTM Northing:** 4328796.0

Well Log

Top	Bottom	Formation
0.0	5.0	DIRT
5.0	90.0	LIME BLUE CAST
90.0	140.0	BLUE SHALE

Comments DRY HOLE; IN BACK OF LITTLE BLOCK HOUSE.; #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213703	ON THAT RD, WEST OF CLEAR CREEK 0.25 MILE EAST OF ROCKPORT RD. ON NORTH SIDE OF THAT RD. (RT ON THAT RD, 1ST HOUSE ON LEFT.)	Jul 10, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOM LANGLEY		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 8.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 41.0 ft. **Bailer Drawdown** 48.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2500.0
Ground elevation: 760.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 753.0 **Aquifer elevation:**
UTM Easting: 537416.0 **UTM Northing:** 4329424.0

Well Log

Top	Bottom	Formation
0.0	7.0	RED CLAY
7.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213705	GO WEST FROM CLEAR CREEK, IN. ON THAT ROAD TO 1ST ROAD TO LEFT THEN THE 3RD HOUSE ON LEFT.	Sep 04, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 538987.0 **UTM Northing:** 4328802.0

Well Log

Top	Bottom	Formation
0.0	40.0	CREVI CE OF DIRT LIMESTONE
40.0	100.0	BLUE LIMESTONE

Comments DRY HOLE; #2IN FRONT OF NEW HOUSE, BETWEEN TWO TREES, AT ROAD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213708	SOUT OF SR45 ON ROGERS RD. TO ROCK PORT RD. & SOUTHWEST TO THAT RD. NORTH OF THAT RD APPROX 1000 FT. WEST SIDE OF RD.	Apr 21, 1965

Owner-Contractor	Name	Address	Telephone
Owner	PAUL COHOON	750 S, WALKER BLOOMINGTON	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	LEON ENGLISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 132.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 125.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1000.0 **Ft S of NL:** 2400.0
Ground elevation: 760.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 738.0 **Aquifer elevation:**
UTM Easting: 537209.0 **UTM Northing:** 4329462.0

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY YELLOW
22.0	132.0	LIMESTONE

Comments MC; MAILBOX VERIFIED; WELL IN FRONT OF HOUSE APPROX. 25 FT.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213709	STANSIFER ADDITION AT CORNER THAT ROAD & ROCKPORT ROAD SO. BLOOMINGTON, IN	Sep 19, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ARTHUR MELTON	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 5.5 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 738.0 **Aquifer elevation:**
UTM Easting: 536920.0 **UTM Northing:** 4328878.0

Well Log

Top	Bottom	Formation
0.0	22.0	RED CLAY W/ LAYERS LIMESTONE
22.0	120.0	LIMESTONE

Comments MC 738; WELL DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213710	.5 MI W CLEAR CREEK, 2ND ON THAT RD THEN 1ST RD TO L .5 MI, ON E SIDE RD.	Apr 25, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LESTER SEGO	RR#5	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.2 gpm for hrs.
Drawdown: ft. **Static water level:** 56.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 600.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 10.5 **Bedrock elevation:** 695.0 **Aquifer elevation:**
UTM Easting: 538986.0 **UTM Northing:** 4328735.0

Well Log

Top	Bottom	Formation
0.0	10.5	RED CLAY
10.5	105.0	WH LS
105.0	130.0	BLUE SHALE

Comments DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213713	3MI W OF CLEAR CREEK. 3RD HOUSE N OF THAT RD & ROCKPORT RD, ON L GOING N.	Aug 12, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CONNIE DAVIS	RR#4, BLOOMINGTON	
Driller	FREDERICK SCOTT	RR#4, BLOOMINGTON IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 20.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 5.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1200.0 **Ft S of NL:** 2250.0
Ground elevation: 785.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 769.0 **Aquifer elevation:**
UTM Easting: 537234.0 **UTM Northing:** 4329492.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	12.0	RED CLAY
12.0	16.0	YEL CLAY
16.0	26.0	STONE GRAY LS HARD
26.0	30.0	STONE LIGHT GRAY LS SOFTER
30.0	37.0	STONE LIGHT BLUE LS HARD
37.0	45.0	STONE DARK BLUE LS HARD
45.0	50.0	STONE LIGHT GRAY LS EX HARD
50.0	63.0	STONE LIGHT BR LS EX HARD
63.0	67.0	STONE GRAY LS HARD
67.0	71.0	STONE GRAY LS EX HARD

71.0	89.0	STONE BUFF LS SOFT
89.0	92.0	STONE BUFF LS HARD
92.0	104.0	STONE GRAY LS HARD
104.0	122.0	STONE GRAY LS EX HARD
122.0	140.0	STONE LIGHT GRAY LS HARD

Comments MC 769; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213714		May 23, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ARTHUR MELTON	RR5, BOX 21 I, BLOOMINGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 16.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 750.0 **Aquifer elevation:**
UTM Easting: 536920.0 **UTM Northing:** 4328878.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	67.0	MD HARD GREY LS
67.0	75.0	MD HARD BR LS
75.0	130.0	MD HARD WH LS

Comments FC #3 "OLD"; WATER AT 92' & 115' 130 GAL BASIN

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213718	3 MILES SOUTH BLOOMINGTON ON ROCKPORT ROAD	Apr 23, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH JOHNSON	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 77.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2450.0 **Ft S of NL:** 1000.0
Ground elevation: 800.0 **Depth to bedrock:** 76.0 **Bedrock elevation:** 724.0 **Aquifer elevation:**
UTM Easting: 537625.0 **UTM Northing:** 4329875.0

Well Log

Top	Bottom	Formation
0.0	60.0	LAYERS STONE & CLAY
60.0	76.0	CAVE OR OPENING
76.0	120.0	BROWN LIMESTONE

Comments MC 724; OWNER VERIFIED; JUST SOUTH OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213723	BLOOMINGTON 1 MILE SOUTH ON ROGERS RD. TO ROCKPORT RD. 3 MILE SOUTH ON ROCKPORT RD ON EAST SIDE OF RD 500 FT NORTH OF THAT RD.	Sep 08, 1964

Owner-Contractor	Name	Address	Telephone
Owner	STIGALL	R8 BOX 249 BLOOMINGTON	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	ED RYBAK JR	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 164.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2000.0
Ground elevation: 790.0 **Depth to bedrock:** 27.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 537399.0 **UTM Northing:** 4329577.0

Well Log

Top	Bottom	Formation
0.0	3.0	TOPSOIL
3.0	12.0	RED CLAY
12.0	27.0	CLAY W/ BROKEN LIME
27.0	170.0	LIMESTONE

Comments MC 763; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213724	CLEAR CREEK, IN. ON THAT ROAD. FARM ON RIGHT GOING WEST FROM CLEAR CREEK	Feb 24, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PAUL HAYES	CLEAR CREEK	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 4.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2400.0
Ground elevation: 665.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 658.0 **Aquifer elevation:**
UTM Easting: 539684.0 **UTM Northing:** 4329397.0

Well Log

Top	Bottom	Formation
0.0	7.0	DIRT & LAYERS LIMESTONE
7.0	58.0	HARD WHITE LIMESTONE
58.0	80.0	BLUE SHALE

Comments NEIGHBOR VERIFIED; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213728	2 MILES SO. BLOOMINGTON, IN. ON ROCKPORT RD TO FULLERTON PIKE THEN TURN WEST & 3RD HOUSE ON SO. SIDE RD	Nov 24, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GLEN LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CES **on:** Jul 01, 1966
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2600.0 **Ft S of NL:** 100.0
Ground elevation: 740.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 725.0 **Aquifer elevation:**
UTM Easting: 537694.0 **UTM Northing:** 4330161.0

Well Log

Top	Bottom	Formation
0.0	16.0	RED CLAY
16.0	30.0	WHITE SOFT LIMESTONE
30.0	95.0	WHITE MEDIUM HARD LIMESTONE
95.0	100.0	BLUE LIMESTONE HARD

Comments MC 725

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213729	ON THAT ROAD WEST OF ROGERS STREET AT CLEAR CREEK, IN. ABOUT 0.25 MILE WEST ON SO. SIDE OF ROAD	Jul 10, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST M, KIEFFABER	689 WEST THAT ROAD	
Driller	GEORGE SNAPP	4625 S. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 658.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539556.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL RED CLAY
8.0	80.0	HARD WHITE LIMESTONE

Comments VERIFIED BY MAILBOX

Record of Water Well

Indiana Department of Natural Resources

Reference Number
213733

Driving directions to well
ABOUT 2 ILES WEST CLEAR CREEK ON THAT ROAD. LAST HOUSE ON RIGHT BEFORE COMING TO ROCKPORT RD.

Date completed
Nov 05, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES GOAD	R5 BLOOMINGTON, IN	
Driller	FREDERICK SCOTT	R4 BLOOMINGTON, IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1300.0 **Ft S of NL:** 2500.0
Ground elevation: 780.0 **Depth to bedrock:** 23.0 **Bedrock elevation:** 757.0 **Aquifer elevation:**
UTM Easting: 537282.0 **UTM Northing:** 4329425.0

Well Log

Top	Bottom	Formation
0.0	12.0	YELLOW LCAY
12.0	23.0	RED CLAY
23.0	38.0	STONE GRAY LIMESTONE HARD
38.0	40.0	STONE BLUE SHALE SOFT
40.0	44.0	STONE DARK GRAY LS HARD
44.0	50.0	STONE GRAY LS HARD
50.0	71.0	STONE GRAY LS EXTRA HARD
71.0	98.0	STONE BUFF LS SOFT
98.0	117.0	STONE GRAY LS HARD
117.0	126.0	STONE WHITE OR GRAY LS HARD
126.0	150.0	STONE GRAY LS HARD

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213734	SOUTH OF TAHT ROAD WEST OF CLEAR CREEK, IN. ABOUT 2 MILES	Oct 07, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS DECKARD		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1200.0 **Ft E of WL:** 1300.0 **Ft S of NL:**
Ground elevation: 765.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 757.0 **Aquifer elevation:**
UTM Easting: 537275.0 **UTM Northing:** 4328960.0

Well Log

Top	Bottom	Formation
0.0	8.0	DIRT
8.0	45.0	MEDIUM HARD WHITE LIMESTONE
45.0	62.0	HARD BLUE LIMESTONE
62.0	85.0	MEDIUM WHITE LIMESTONE
85.0	99.0	MEDIUM HARD BROWN
99.0	117.0	MEDIUM BLUE LIMESTONE
117.0	125.0	HARD WHITE LIMESTONE

Comments DRILLER VERIFIED; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213738	SOUTH END OF STONSIFER LANE	May 07, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOHNSON	BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 41.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 400.0 **Ft S of NL:**
Ground elevation: 730.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 722.0 **Aquifer elevation:**
UTM Easting: 537005.0 **UTM Northing:** 4328627.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL & LAYERS LIMESTONE
8.0	45.0	BROWN LIMESTONE (MED HARD)
45.0	95.0	WHITE LIMESTONE (MED HARD)

Comments MC 722; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213739	GO S BLOOMINGTON ON RODGERS ST TO ROCKPORT RD THEN S ON ROCKPORT RD TO THAT RD TURN R 1 BLK TO SHARPCURVE.WELL IS ON L SIDE OF RD.	Aug 30, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GERALD FLYNN		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 34.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2100.0 **Ft E of WL:** 0.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 33.0 **Bedrock elevation:** 747.0 **Aquifer elevation:**
UTM Easting: 536891.0 **UTM Northing:** 4329201.0

Well Log

Top	Bottom	Formation
0.0	33.0	RED CLAY & LAYERS LS
33.0	90.0	WH MD HARD LS
90.0	120.0	BR MD HARD LS
120.0	165.0	WH LS

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213743	1ST DRIVE EAST OF ROCKPORT ROAD ON SOUT SIDE OF THAT ROAD THEN 2ND HOUSE ON EAST SIDE OF DRIVE	Aug 26, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT CRACROFT		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 61.0 ft. **Bailer Drawdown** 41.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1800.0 **Ft E of WL:** 1600.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537360.0 **UTM Northing:** 4329114.0

Well Log

Top	Bottom	Formation
0.0	24.0	TOP SOIL & LAYERS LIMESTONE
24.0	37.0	SOFT WHITE LIMESTONE
37.0	45.0	SOFT BROWN LIMESTONE
45.0	95.0	SOFT WHITE LIMESTONE
95.0	105.0	SOFT BROWN LIMESTONE
105.0	110.0	SOFT YELLOW LIMESTONE
110.0	120.0	HARD WHITE LIMESTONE

Comments MEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213748	SO OF THAT ROAD WEST OF CLEAR CREEK, IN. 2 MILES	May 03, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK SUMMERS		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1400.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 537427.0 **UTM Northing:** 4328991.0

Well Log

Top	Bottom	Formation
0.0	15.0	TOP SOIL
15.0	35.0	WHITE LIMESTONE MEDIUM
35.0	55.0	VERY HARD BLUE LIMESTONE
55.0	90.0	MEDIUM HARD WHITE LIMESTONE
90.0	95.0	MEDIUM BROWN LIMESTONE
95.0	120.0	MEDIUM BLUE LIMESTONE
120.0	130.0	MEDIUM WHITE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213749	ON SOUTH SIDE OF THAT ROAD 1.75 MILES WEST OF CLEAR CREEK, IN	Nov 10, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ENOS DYER		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 69.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2550.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 18.5 **Bedrock elevation:** 762.0 **Aquifer elevation:**
UTM Easting: 537233.0 **UTM Northing:** 4329352.0

Well Log

Top	Bottom	Formation
0.0	18.5	DIRT & RED CLAY
18.5	125.0	WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213753	WELL IS APPROXIMATELY 5 MILES SOUTHWEST OF BLOOMINGTON ON ROCKPORT RD. WELL IS ON WEST SIDE OF RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WOODROW HUESTON	R5 ROCKPORT RD BLOOMINGTON, IN	
Driller	ALBERT LENTZ		

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2400.0 **Ft E of WL:** 600.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 35.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 537062.0 **UTM Northing:** 4329298.0

Well Log

Top	Bottom	Formation
0.0	35.0	SOIL & UNCONSOLIDATED
35.0	150.0	LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213754	CORNER OF THAT ROAD & ROCKPORT RD. WEST CLEAR CREEK, IN. TRAILER WEST OF HOUSE	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES LANGLEY		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 24.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 800.0 **Ft S of NL:**
Ground elevation: 740.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 728.0 **Aquifer elevation:**
UTM Easting: 537122.0 **UTM Northing:** 4328913.0

Well Log

Top	Bottom	Formation
0.0	12.0	TOP SOIL
12.0	40.0	HARD WHITE LIMESTONE
40.0	70.0	MEDIUM HARD WHITE LIMESTONE
70.0	85.0	MEDIUM HARD BROWN LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213758	ABOUT 1.54 MILES WEST CLEAR CREEK, 1ST PIKE ROAD TO LEFT & 1ST HOUSE ON LEFT ON THE PIKE ROAD.	Oct 22, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	REX DECKARD	R5 BLOOMINGTON	
Driller	FREDERICK SCOTT	R4 BLOOMINGTON, IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 750.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 742.0 **Aquifer elevation:**
UTM Easting: 537586.0 **UTM Northing:** 4329259.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELLOW CLAY
8.0	12.0	STONE BLUE FLINT EXTRA HARD
12.0	18.0	STONE BUFF LS HARD
18.0	39.0	STONE GRAY LS SOFT
39.0	47.0	STONE BUFF LS HARD
47.0	61.0	STONE BROWNISH LS EXTRA HARD
61.0	65.0	STONE BROWNISH LS SOFTER
65.0	70.0	STONE GRAY LS HARD
70.0	76.0	STONE GRAY LS EXTRA HARD
76.0	82.0	STONE WHITE LS HARD
82.0	93.0	STONE WHITE LS SOFT
93.0	100.0	STONE WHITE LS HARD

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213759	S OF SR45 IN BLOOMINGTON ON ROGERS STREET TO ROCKPORT ROAD. SW ON ROCKPORT RD TO THAT ROAD. W ON THAT ROAD TO 1ST ROAD S. S ON EAST SIDE OF RD	Feb 19, 1966

Owner-Contractor	Name	Address	Telephone
Owner	JEWELL EVANS	1631 SOUTH OLIVER BLOOMINGTON, IN	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	LEON ENGLISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 180.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 170.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CAS **on:** Jul 01, 1966
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 4400.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 765.0 **Aquifer elevation:**
UTM Easting: 536904.0 **UTM Northing:** 4329341.0

Well Log

Top	Bottom	Formation
0.0	14.0	CLAY YELLOW
14.0	30.0	BROKEN LIMESTONE
30.0	180.0	LIME STONE

Comments MC 76?

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217441	3 MI NE OF HABBIEVILLE IN ON E BANK OF INDIAN CREEK	Sep 17, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFIELD IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 69.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 4.0 hrs.
Drawdown: ft. **Static water level:** 6.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NE of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: REB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1100.0
Ground elevation: 660.0 **Depth to bedrock:** 27.0 **Bedrock elevation:** 633.0 **Aquifer elevation:**
UTM Easting: 528309.0 **UTM Northing:** 4318731.0

Well Log

Top	Bottom	Formation
0.0	27.0	ORIGINAL WELL
27.0	67.0	GREY LS W/OCCSNL 1' LYERWHLS
67.0	69.0	SOFT SANDROCK MUD PELT H20

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217446	2 1/2 MI NE OF HOBBIEVILLE IN ON INDIAN CREEK RD	Jun 06, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFILED IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 35.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.7	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NE of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: PB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2450.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1400.0
Ground elevation: 650.0 **Depth to bedrock:** **Bedrock elevation:** 640.0 **Aquifer elevation:**
UTM Easting: 528169.0 **UTM Northing:** 4318633.0

Well Log

Top	Bottom	Formation
0.0	9.5	SOIL & SAND
9.5	10.5	FRACTURED LS
10.5	26.5	LS GREY & BLUE
26.5	27.0	SH GREY
27.0	32.0	GREY LS
32.0	35.0	CAVE OF FAULTE

Comments SLAUTING ROCK ON BOTTOM COULD NOT GO DEEPER:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217451	FROM BLGTN ON SR 45 S OF MONROE & GREEN COUNTY LINE TURN S GO 4 M TO ROCK E RD TURN R 3/4 OF W MI	Aug 28, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLIE STURGEN		
Driller	SMITH WELL DRILLING	8565 OLD ST RD 38 S	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the NW of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1650.0 **Ft S of NL:** 450.0
Ground elevation: 685.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 528048.0 **UTM Northing:** 4318970.0

Well Log

Top	Bottom	Formation
0.0	30.0	SOIL & BOLTERS
30.0	115.0	LS

Comments MC 655: OWNER VERIFIED 50' SW OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217506	S OF STANFORD GO TO BREEDEN RD TURN & GO TO ROCK EAST RD TURN RIGHT, THEN GO TO 1ST DRIVEWAY TURN GO TO TOP OF HILL	May 17, 1990

Owner-Contractor	Name	Address	Telephone
Owner	YEAGER	4154 DANIEL ST., BLGTON., IN	(812) 336-8240
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 225.0	**Pump setting depth:** 215.0	**Water quality:** CLEAR
Casing	**Length:** 73.5	**Material:** STEEL	**Diameter:** 6.625
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 225.0 ft. **Static water level:** 85.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 82.0 to 73.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JL **on:** Jul 28, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 450.0 **Ft S of NL:** 1850.0
Ground elevation: 790.0 **Depth to bedrock:** 3.0 **Bedrock elevation:** 787.0 **Aquifer elevation:**
UTM Easting: 529080.0 **UTM Northing:** 4320050.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	19.0	YEL SS
19.0	30.0	BLUE SHALE EX SOFT
30.0	56.0	BLUE SHALE SOLID
56.0	64.0	YEL SS HARD
64.0	66.0	GRAY LS HARD
66.0	70.0	OPEN HOLE

70.0	84.0	GRAY LS HARD
84.0	85.0	BLUE SHALE SOFTER
85.0	115.0	GRAY LS HARD
115.0	127.0	GREEN LS HARD
127.0	146.0	GRAY LS HARD
146.0	148.0	DARK GRAY LS
148.0	160.0	GRAY LS HARD
160.0	183.0	BUFF LS
183.0	185.0	BLUE SHALE SOFTER
185.0	205.0	CREAM LS SOFTER
205.0	215.0	GRAY LS HARD
215.0	225.0	LIGHT YEL LS

Comments MC787; VERIFIED BY NEIGHBOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217511	GO TO STANFORD .25 MI TURN L AND GO 4.5 MI TO CLYDE WEBSTER FARM; O NLEE PHILLIPS RD	Sep 15, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLYDE WEBSTER	R6,BLOOMINGTON, IN	
Driller	EADS & DECKARD	R9, BLOOMINGTON	
Operator	EADS & DECKARD	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the SW of the SE of Section 20 **Topo map:** STANFORD

Grant Number:

Field located by: JRP **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2000.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 825.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 787.0 **Aquifer elevation:**

UTM Easting: 529920.0 **UTM Northing:** 4319453.0

Well Log

Top	Bottom	Formation
0.0	38.0	CLAY & SH
38.0	152.0	LS

Comments MC 782; OWNER VER; 30' NE OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217516	UNION CHURCH NEAR STANFORD	Aug 08, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	UNION CHURCH	STANDORD	
Driller	FRED SMITH	HELTONVILLE IN RR #1	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 45.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2550.0 **Ft S of NL:** 1950.0
Ground elevation: 790.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 773.0 **Aquifer elevation:**
UTM Easting: 529725.0 **UTM Northing:** 4320078.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY
17.0	45.0	LS

Comments MC 773: NEIGHBOR & SIGN VARIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217521	ON THE ROCK EAST RD 2 MI SW KIRKSVILLE, IN	Jun 06, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH FILLDEN	RR9, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 23.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NE of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JRP **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 800.0
Ground elevation: 705.0 **Depth to bedrock:** 19.0 **Bedrock elevation:** 686.0 **Aquifer elevation:**
UTM Easting: 529938.0 **UTM Northing:** 4320430.0

Well Log

Top	Bottom	Formation
0.0	19.0	RED CLAY & LAYERS OF LS
19.0	80.0	WHITE VERY HARD LS

Comments MC 686; NEIGHBOR & MAILBOX VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217526	ABOUT 5 MI S OF STANFORD IN ON ROCK E RD	Dec 22, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLUADIE WEVER	R 9 BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR 4 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 16.0 ft. **Bailer Drawdown** 59.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NE of the NE of the SE of Section 19 **Topo map:** STANFORD

Grant Number:

Field located by: RC **on:** Jul 12, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 100.0 **Ft N of SL:** 2400.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 690.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 684.0 **Aquifer elevation:**

UTM Easting: 528868.0 **UTM Northing:** 4319813.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOP SOIL & YEL CLAY
6.0	24.0	STONE WH LS HARD
24.0	65.0	STONE WH LS EX HARD
65.0	75.0	STONE GRAY LS HARD

Comments MC 684: BY NEIGHBOR & MAILBOX:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217531	ABOUT 3 MI S OF STANSFORD ON BREEDEN RD BETWEEN CRUM RD & CARTER RD ON LEFT.	Aug 03, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GLEN CROHN	BREEDEN RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 84.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 10.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 164.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NE of Section 18 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2175.0
Ground elevation: 868.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 853.0 **Aquifer elevation:**
UTM Easting: 528906.0 **UTM Northing:** 4321625.0

Well Log

Top	Bottom	Formation
0.0	15.0	YEL CLAY
15.0	82.0	BLUE SH EX SOFT
82.0	105.0	STONE GRAY LS HARD
105.0	118.0	STONE BLUE LS EX HARD
118.0	130.0	STONE YELLOWISH LS HARD
130.0	162.0	STONE GRAY LS HARD
162.0	163.0	STONE BLUE SH SOFTER
163.0	189.0	STONE GRAY LS EX HARD
189.0	201.0	STONE DARK GRAY LS, HARD

201.0	202.0	STONE BLUE SH SOFTER
202.0	212.0	STONE GRAY LS EX HARD
212.0	213.0	STONE BLUE GREEN SH SOFTER
213.0	220.0	STONE DARK GRAY LS HARD
220.0	221.0	STONE GRAY SH SOFTER
221.0	237.0	STONE YELLOWISH LS HARD
237.0	251.0	STONE GRAY LS HARD
251.0	252.0	STONE WH SH SOFTER
252.0	265.0	STONE DARK GRAY LS HARD

Comments MC 853: VERIFIED BY OWNER - WELL BEHIND HOUSE 25':

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217536	ABOUT 3 1/2 MI S OF STANFORD TAKE ST 45 S TO BREEDEN RD TURN & GO TO CRUM RD TURN E GO TO 1ST HOUSE ON RIGHT.	May 11, 1983

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ED CROHN	S CRUM RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 25.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 189.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 300.0 **Ft S of NL:** 1500.0
Ground elevation: 860.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 845.0 **Aquifer elevation:**
UTM Easting: 529025.0 **UTM Northing:** 4321780.0

Well Log

Top	Bottom	Formation
0.0	15.0	YEL CLAY
15.0	17.0	YEL SS HARD
17.0	18.0	HOLE
18.0	19.0	YEL SS HARD
19.0	25.0	STONE BLUE LS HARD
25.0	27.0	BLUE SH SOFTER
27.0	38.0	BLUE SH HARD
38.0	44.0	RED SH HARD
44.0	101.0	BLUE SH HARD

101.0	117.0	STONE GRAY LS HARD
117.0	119.0	BLUE SH SOFT
119.0	127.0	STONE GRAY LS HARD
127.0	129.0	STONE WH SH SOFTER
129.0	136.0	STONE YEL LS HARD
136.0	137.0	BLUE SH HARD
137.0	141.0	STONE GRAY LS HARD
141.0	142.0	YEL SH SOFTER
142.0	154.0	STONEGRAY LS EX HARD
154.0	164.0	STOEN CREAM LS EX HARD
164.0	165.0	STONE WH SH SOFTER
165.0	178.0	STONE GRAY LS EX HARD
178.0	188.0	STONE DARK GRAY LS HARD
188.0	189.0	BLUE SH SOFTER
189.0	215.0	STONE GRAY LS HARD
215.0	216.0	STONE YEL SH SOFTER
216.0	236.0	STONE DARK GRAY LS HARD
236.0	238.0	STONE BLUE SHALE SOFTER
238.0	254.0	STONE GRAY LS HARD
254.0	255.0	STONE WH SH SOFTER
255.0	265.0	STONE DARK GRAY LS HARD

Comments MC 845: WELL LOCATED ON S SIDE OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217541	ABOUT 3 1/2 MI S OF STANFORD TAKE S HWY 45 TO BREEDEN RD GO TO CRUM RD TURN 1ST HOUSE ON LEFT APP 0.3 MI E OF BREEDEN RD ON N SIDE OF CRUM RD	Sep 10, 1980

Owner-Contractor	Name	Address	Telephone
Owner	DONALD CONDER	8888 W CRUM RD BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 166.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1100.0 **Ft S of NL:** 1250.0
Ground elevation: 870.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 858.0 **Aquifer elevation:**
UTM Easting: 529270.0 **UTM Northing:** 4321850.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	20.0	YEL SS HARD
20.0	27.0	RED CLAY
27.0	29.0	YELSH EX SOFT
29.0	56.0	BLUE SH EX SOFT
56.0	75.0	STONE GRAY SS HARD
75.0	80.0	STONE BLUE SOAPSTONE HARD
80.0	84.0	STONE GRAY SS HARD
84.0	102.0	STONE BLUE SH HARD

102.0	110.0	STONE GRAY LS HARD
110.0	125.0	STONE GRAY LS EX HARD
125.0	139.0	STONE YELLOWISH LS HARD
139.0	140.0	STONE WH SH SOFT
140.0	146.0	STONE LT BLUE LS EX HARD
146.0	172.0	STONE GRAY LS EX HARD
172.0	173.0	STONE BLUE SH SOFT
173.0	180.0	STONE GRAY LS EX HARD
180.0	203.0	STONE DARK GRAY LS HARD
203.0	204.0	STONE BLUE SH SOFT
204.0	212.0	STNE BROWNISH LS HARD
212.0	213.0	STONE BLUE SH SOFT
213.0	229.0	STONE GRAY LS HARD
229.0	230.0	STONE BLUE SH SOFT
230.0	245.0	STONE GRAY LS HARD

Comments MC 858: WELL IS BURIED LOCATED NE OF HOUSE BY OLD SHED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217546	ABOUT 5 MI S OF STANFORD LAKE BREEDEN RD TO CRUM RD TURN LEFT 1ST HOUSE ON RIGHT.	May 26, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LARRY CONDER	RR 9 BLOOMINGTON IN	
Driller	FRED SCOTT	RR 13 BOX 452 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 210.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 101.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 9.0 gpm for hrs.
Drawdown: ft. **Static water level:** 130.0 ft. **Bailer Drawdown** 200.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: FRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2500.0 **Ft S of NL:** 2400.0
Ground elevation: 840.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 832.0 **Aquifer elevation:**
UTM Easting: 529697.0 **UTM Northing:** 4321569.0

Well Log

Top	Bottom	Formation
0.0	8.0	YEL CLAY
8.0	25.0	STONE BR SS SOFT
25.0	60.0	STONE BLUE SH EX SOFT
60.0	70.0	STONE BR SS HARD
70.0	76.0	STONE GRAY SH EX SOFT
76.0	86.0	STONE WH SS EX HARD
86.0	88.0	MUE HOLE
88.0	92.0	STONE BR SS EX HARD
92.0	101.0	STONE GREY SH HARD
101.0	108.0	STONE GRAY LS EX HARD
108.0	126.0	STONE YELLOWISH LS EX HARD

126.0	132.0	STONE GRAY SL EX HARD
132.0	140.0	STONE BLUE LS EX HARD
140.0	170.0	STONE DARK YEL LS EX HARD
170.0	210.0	STONE YEL LS HARD

Comments MC 832: OWNER VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217551	1/2 MI SW OF STANFORD & 3 1/2 MI S ON BREEDEN RD 3/4 MI E ON CRUM RD.	Jul 24, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MR THOMAS R STONE	RR 9 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 146.0	**Material:**	**Diameter:** 6.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.5 hrs.

Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 230.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the NE of Section 17 **Topo map:** STANFORD

Grant Number:

Field located by: JRD **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 500.0

Ground elevation: 860.0 **Depth to bedrock:** 98.0 **Bedrock elevation:** 762.0 **Aquifer elevation:**

UTM Easting: 529875.0 **UTM Northing:** 4322114.0

Well Log

Top	Bottom	Formation
0.0	98.0	CLAY & SOFT SH & SANDROCK
98.0	140.0	LIME & CLAY SEAMS & MUD
140.0	215.0	LIME
215.0	245.0	LIME & BREAKS WATER

Comments MC 762: NEIGHBOR & MAILBOX VARIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number
217556

Driving directions to well
S OF STANDFORD LAKE BREEDEN RD OFF HWYT 45 JUST S OF STANDFORD GO TO CRUM RD TURN L 1ST NEW HOUSE ON RIGHT

Date completed
Apr 02, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TED JOHNSON	RR 9 BLOMINGTON IN	
Driller	FRED SCOTT	R1 ELLETTSVILLE IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 98.0	**Material:**	**Diameter:** 6.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 185.0 ft. **Bailer Drawdown** 215.0 ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NE of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 840.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 819.0 **Aquifer elevation:**
UTM Easting: 530086.0 **UTM Northing:** 4321746.0

Well Log

Top	Bottom	Formation
0.0	16.0	YEL CLAY
16.0	21.0	RED CLAY
21.0	33.0	STONE BR SS HARD
33.0	78.0	STONE BLUJE SH EX SOFT
78.0	84.0	STONE YEL SS HARD
84.0	95.0	STONE BLUE SH EX SOFT
95.0	117.0	STONE ST GREY LS EX HARD
117.0	145.0	STONE YELLOWISH LS HARD
145.0	168.0	STONE GRAY LS EX HARD
168.0	178.0	STONE CREAM LS HARD
178.0	203.0	STONE GRAY LS HARD
203.0	245.0	STONE YELLOWISH LS HARD

Comments
MC 819: OWNER VERIFIED 10' S OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217566	S OF STANFORD TURN OFF 45S AT BREEDEN RD GO TO YOU COME TO ROCK EAST RD, TURN LEFT GO TO 3RD DRIVEWAY ON LEFT, HAS A BOARD FENCE AROUND IT	Oct 09, 1989

Owner-Contractor	Name	Address	Telephone
Owner	ROBERT HARLOW	7898 ROCK EAST RD., BLOOMINGTON, IN	(812) 825-5834
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** STEEL	**Diameter:** 6.625
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 185.0 ft. **Static water level:** 78.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 31.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the SW of Section 16 **Topo map:** STANFORD
Grant Number:
Field located by: LW **on:** Jun 15, 1990
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 150.0 **Ft E of WL:** 150.0 **Ft S of NL:**
Ground elevation: 748.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 741.0 **Aquifer elevation:**
UTM Easting: 530595.0 **UTM Northing:** 4320660.0

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY HARDPAN
7.0	13.0	GRAY LS HARD
13.0	28.0	BLUE SHALE SOFT
28.0	42.0	GRAY LS HARD
42.0	45.0	BLUE SHALE SOFT
45.0	51.0	BLUE LS HARD
51.0	62.0	GRAY LS HARD

62.0	68.0	SMALL OPEN SEAM
68.0	89.0	GRAY LS HARD
89.0	91.0	BLUE SHALE SOFT
91.0	106.0	BLUE LS HARD
106.0	118.0	GRAY LS HARD
118.0	146.0	GRAY LS SEAMY
146.0	161.0	BLUE LS EX HARD
161.0	162.0	WHITE LS SOFT
162.0	185.0	GRAY LS HARD

Comments MC741; VERIFIED BY NEIGHBOR/FATHER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222643	ON ROCKPORT SOUTH BLOOMINGTON, IN ABOUT 5 MILES ON WEST SIDE ROAD	Jun 15, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOM LONGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	
Company	TOM LONGLEY	R5 BLOOMINGTON, IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 850.0 **Ft N of SL:** 300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 652.0 **Aquifer elevation:**
UTM Easting: 536632.0 **UTM Northing:** 4328683.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOP SOIL & LAYERS LIMESTONE
28.0	65.0	HARD LIMESTONE

Comments MC 652; OWNER VERIFIED; 15 FT EAST OF HOUSE; MC; SULPHUR WATER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222644	IN STANFORD, IN	Oct 14, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LLOYD HAWKINS	STANFORD, IN	
Driller	FRED SCOTT	R4 BLOOMINGTON, IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SW of the NW of Section 32 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 950.0 **Ft S of NL:** 1400.0
Ground elevation: 790.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 782.0 **Aquifer elevation:**
UTM Easting: 529149.0 **UTM Northing:** 4326617.0

Well Log

Top	Bottom	Formation
0.0	6.0	YELLOW CLAY
6.0	8.0	RED CLAY
8.0	20.0	STONE GREY LIMESTONE HARD
20.0	25.0	STONE GRAY SHALE SOFT
25.0	33.0	STONE GRAY LIMESTONE HARD
33.0	46.0	STONE WHITE LIMESTONE HARD
46.0	52.0	STONE BLUE LIMESTONE HARD
52.0	67.0	STONE GRAY LS EXTRA HARD
67.0	88.0	STONE BROWN LS EXTRA HARD
88.0	112.0	STONE GRAY LS EXTRA HARD
112.0	125.0	STONE WHITE LS EXTRA HARD
125.0	128.0	STONE GRAY LS EXTRA HARD
128.0	135.0	STONE GRAY LIMESTONE HARD

Comments MC 782; OWNER VERIFIED; 5 FT EAST OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222648	SO. OF BLOOMINGTON, IN ON ROCKPORT ROAD 4 MILES ON EAST SIDE OF ROAD	May 22, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLARENCE BRUMMETT	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 13.5 ft. **Bailer Drawdown** 67.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 450.0 **Ft N of SL:** 50.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 536747.0 **UTM Northing:** 4328621.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	HARD WHITE LIMESTONE

Comments MC 660; WELL DRILLER VERIFIED; 50 FT EAST OF RD; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222649	8 MILES SOUTH WEST OF BLOOMINGTON, IN. ON ROCKPORT ROAD TWO SOUTH UNION CHURCH WEST 1.75 MILES	Jan 04, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TODD	R9 BLOOMINGTON, IN	
Driller	PAUL SCOTT	R4 BLOOMINGTON, IN	
Operator	PAUL SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 114.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 76.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the NW of the NE of Section 34 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: MT **on:** Jul 13, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 900.0

Ground elevation: 840.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 828.0 **Aquifer elevation:**

UTM Easting: 533115.0 **UTM Northing:** 4326754.0

Well Log

Top	Bottom	Formation
0.0	12.0	DIRT
12.0	65.0	BUFF LIME HARD
65.0	80.0	YELLOW LIME XTRA HARD
80.0	114.0	BUFF LIME SOFT

Comments MC 825; HOLE AT 42 FT WITH MUD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222654	1MI W OF THE S UNION CHURCH ON DUNALL RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WINFRED SMITH	RR#5	
Driller	ALBERT LENTZ	BOX 83, SMITHVILLE IN	
Operator	BUYRIC ERA 22W	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 94.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:** Bailing	**Test rate:** gpm for hrs.	**BailTest rate:** 14.0 gpm for hrs.
	Drawdown: ft.	**Static water level:** 110.0 ft.	**Bailer Drawdown** 110.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: NE of the NE of the SE of Section 34 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 24, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 250.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 760.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: 533601.0 **UTM Northing:** 4326186.0

Well Log

Top	Bottom	Formation

Comments MC; OWNER VERIFIED W OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222659	KOONTZ RD	Jun 18, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JIM MARTIN	BLOOMINGTON RR5	
Driller	GEORGE SNAPP	RR5, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 300.0 **Ft N of SL:** 150.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 759.0 **Aquifer elevation:**
UTM Easting: 533587.0 **UTM Northing:** 4325454.0

Well Log

Top	Bottom	Formation
0.0	11.0	R CLAY & LAYERS LS
11.0	17.0	WH LS
71.0	75.0	LAYERS SHALE
75.0	90.0	WH LS

Comments MC 759; NEIGHBOR & MAILBOX VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222663	SOUTH UNION SCHOOL	Jun 06, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROGER MAY		

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SE of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 535262.0 **UTM Northing:** 4327248.0

Well Log

Top	Bottom	Formation

Comments MC 690; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222664	ABOUT 8MI S OF BLGTON,TAKE SR456 TO HARMONYRD,TURN L GOTO KOONTZRD, TURN L THEN TO DEVAUL RD,TURN L. 1ST HOUSE ON L.	Jun 28, 1974

Owner-Contractor	Name	Address	Telephone
Owner	BOYD JONES #1	RR#9, BLGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 252B, ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 195.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 195.0 ft. **Static water level:** 133.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3000.0 **Ft N of SL:** 400.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 840.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 835.0 **Aquifer elevation:**
UTM Easting: 532764.0 **UTM Northing:** 4325548.0

Well Log

Top	Bottom	Formation
0.0	5.0	RED CLAY
5.0	6.0	STONE BR SS HARD
6.0	11.0	YEL SHALE EX SOFT
11.0	30.0	STONE GRAY LS EX HARD
30.0	36.0	STONE WH LS EX HARD
36.0	52.0	STONE CREAM LS HARD
52.0	60.0	STONE WH LS EX HARD
60.0	63.0	STONE CREAM LS EX HARD
63.0	77.0	STONE WH LS EX HARD

77.0	82.0	STONE CREAM LS HARD
82.0	89.0	STONE GRAY LS HARD
89.0	91.0	STONE DARK GRAY LS HARD
91.0	95.0	STONE GRAY LS HARD
95.0	97.0	STONE DARK GRAY LS HARD
97.0	116.0	STONE GRAY LS HARD
116.0	118.0	STONE DARK GRAY LS HARD
118.0	158.0	STONE GRAY LS HARD
158.0	160.0	STONE YEL LS HARD
160.0	161.0	STONE WH SHALE SOFT
161.0	170.0	STONE GRAY LS HARD
170.0	195.0	STONE GRAY LS SOFT

Comments MC 835; OWNER VERIFIED 25' NE OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222668	ABOUT 6MI SW OF BLGTON ATINTSEC OF LEONARDSPRINGSRD&MAYRD. THE WELL IS ABOUT 145'N OF MAYRD&ABOUT 280'W OF LEONARDSPRINGS RD,NEXTDOOROLDSUNIONSCHOOL	Oct 21, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIE M. BOWFF	RR#9, BOX 343, BLOOMINGTON IN	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	ALBERT LENTZ	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 47.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 1.0 gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: 50.0 ft. **Static water level:** 50.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 200.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 47.0 **Bedrock elevation:** 613.0 **Aquifer elevation:**
UTM Easting: 535225.0 **UTM Northing:** 4327028.0

Well Log

Top	Bottom	Formation

Comments MC; NEIGHBOR DIRECTIONS ON WELL LOG & MAILBOX; CLAY 47' TO BOTTOM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222669	E OF STANFORD, TAKE KIRKVILLE RD TO HARMONY RD, TURN R GO KOONTZ RD TURN L GO DUVALL RD, TURN L, 1ST HOUSE ON L.	Nov 12, 1970

Owner-Contractor	Name	Address	Telephone
Owner	MARVIN SPARKS	RR9, BLOOMINGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 452, BLOOMINGTON IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 110.0 ft. **Bailer Drawdown** 150.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2900.0 **Ft N of SL:** 700.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 840.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 833.0 **Aquifer elevation:**
UTM Easting: 532813.0 **UTM Northing:** 4325658.0

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	7.0	RED CLAY
7.0	9.0	STONE GRAY LS HARD
9.0	16.0	STONE GRAY LS EX HARD
16.0	19.0	STONE LIGHT BLUE LS EX HARD
19.0	31.0	STONE GRAY LS HARD
31.0	56.0	STONE GRAY LS EX HARD
56.0	70.0	STONE BUFF LS EX HARD

70.0	98.0	STONE CREAM LS EX EX HARD
98.0	107.0	STONE GRAY LS EX EX HARD
107.0	139.0	STONE YEL LS EX EX HARD
139.0	144.0	STONE GRAY LS EX EX HARD
144.0	170.0	STONE LIGHT BR LS HARD

Comments MC 833; BROTHER VERIFIED 30' NW OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222678	ABOUT 10MI SW BLGTON ON MAY RD.	Oct 24, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WILLIAM KOONTZ	RR9, BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR4, BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 85.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the SW of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 950.0 **Ft S of NL:**
Ground elevation: 800.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 784.0 **Aquifer elevation:**
UTM Easting: 533982.0 **UTM Northing:** 4327062.0

Well Log

Top	Bottom	Formation
0.0	14.0	YEL CLAY
14.0	16.0	RED CLAY
16.0	23.0	STONE GRAY LS AHRD
23.0	24.0	YEL CLAY
24.0	29.0	STONE GRAY LS HARD
29.0	33.0	MUD
33.0	47.0	STONE GRAY LS HARD
47.0	48.0	STONE MUD
48.0	54.0	STONE BLUE LS HARD
54.0	63.0	STONE GRAY LS HARD
63.0	67.0	STONE BR LS HARD

67.0	70.0	STONE MUD
70.0	79.0	STONE GRAY LS HARD
79.0	81.0	MUD
81.0	99.0	STONE GRAY LS EX HARD
99.0	120.0	STONE GRAY LS HARD

Comments MC 784; OWNER VERIFIED 75' N OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222679	TAKE SR45 OUT OF BLGTON 5 MI TO HARMONY RD, TURN L ON HARMONY RD F GOTO KOONTZRD L ON 1ST RD. 3RD HOUSE ON L SIDE OF RD.	Mar 03, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOYD JANER #2		
Driller	FRED SMITH	R13, BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3700.0 **Ft N of SL:** 1050.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 795.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 774.0 **Aquifer elevation:**
UTM Easting: 532564.0 **UTM Northing:** 4325762.0

Well Log

Top	Bottom	Formation
0.0	21.0	SOIL
21.0	150.0	LS

Comments MC 774; OWNER VERIFIED 10' W OF FARMHOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222684	E OF STANFORD ABOUT 2.5 MILES, LAKE KIRKSVILLE RD TO HARMONY RD TURN R GO TO KOONTZ RD TURN & GO TO 2ND DRIVE ON L & TURN, HOUSE IS BACK OF MAIN ROAD	Oct 13, 1978

Owner-Contractor	Name	Address	Telephone
Owner	JAMES SHULTZ	R9 BLGTON, IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 161.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the SW of Section 34 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1020.0 **Ft E of WL:** 280.0 **Ft S of NL:**
Ground elevation: 880.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 875.0 **Aquifer elevation:**
UTM Easting: 532133.0 **UTM Northing:** 4325765.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLALY
5.0	8.0	YELLOW SHALE SOFT
8.0	10.0	STONE YEL SANDSTONE SOFT
10.0	15.0	STONE YEL SANDSTONE HARD
15.0	21.0	STONE BLUE SHALE
21.0	29.0	STONE YEL SANDSTONE HARD
29.0	87.0	STONE BLUE SOAPSTONE SOFTER
87.0	115.0	STONE GRAY LIMESTONE HARD
115.0	127.0	STONE DARK GRAY LS HARD

127.0	154.0	STONE GRAY LS EX. HARD
154.0	166.0	STONE GRAY LIMESTONE HARD
166.0	175.0	STONE GRAY LS EX. HARD
175.0	180.0	STONE DARK GRAY LS HARD
180.0	195.0	STONE GRAY LS EX. HARD
195.0	196.0	STONE BLUE GRN SHALE SOFTER
196.0	222.0	STONE GRAY LIMESTONE HARD
222.0	232.0	STONE DARK GRAY LS HARD
232.0	245.0	STONE GRAY LIMESTONE HARD

Comments MC 875; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number
222689

Driving directions to well
ABOUT 6MI S OF BLOOMINGTON, TAKE ROCKPORT RD TO TRAMWAY RD, PASS & IT 1ST HOUSE ON L.

Date completed
Jul 15, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	L.D. HONEYCUTT	RR5, BLOOMINGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 252B, ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 205.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: Air **Test rate:** gpm for 30.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 205.0 ft. **Static water level:** 25.0 ft. **Bailer Drawdown** ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SE of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 300.0 **Ft N of SL:** 950.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 675.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 535197.0 **UTM Northing:** 4325694.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	28.0	GRAY LS HARD
28.0	55.0	BUFF LS HARD
55.0	80.0	GRAY LS HARD
80.0	90.0	BLUE LS HARD
90.0	118.0	GRAY LS HARD
118.0	136.0	WH LS HARD
136.0	165.0	GRAY LS HARD
165.0	170.0	BLUE LS HARD
170.0	174.0	GRAY LS HARD
174.0	205.0	BLUE SOAPSTONE HARD

Comments MC 669; DIRECTIONS & MAILBOX VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222694	NE OF STANFORD IN, ON MAY RD, AROUND 4MI FROM STANDFORD.	Sep 15, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LUTHER HILLENBURG	R#9, BLGTON IN	
Driller	FRED SCOTT'S WELL DRLG	R#4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 67.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 55.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the NW of the NW of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 100.0
Ground elevation: 780.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 769.0 **Aquifer elevation:**
UTM Easting: 533792.0 **UTM Northing:** 4326972.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	11.0	RED CLAY
11.0	20.0	STONE GRAY LS HARD
20.0	49.0	STONE GRAY LS EX HARD
49.0	51.0	MUD HOLE
51.0	60.0	STONE BUFF LS HARD
60.0	64.0	MUD HOLE
64.0	75.0	STONE BUFF LS HARD
75.0	80.0	STONE LIGHT BLUE SHALE SOFT
80.0	100.0	STONE GRAY LS HARD
100.0	110.0	STONE GRAY LS EX HARD

Comments MC 770; VERIFIED BY NEIGHBOR;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222699		Oct 12, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS HARRIS ROBINSON		
Driller	GEORGE SNAPP	BLOOMINGTON, INDIANA, R#4	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 32.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the NW of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 2500.0
Ground elevation: 695.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 533955.0 **UTM Northing:** 4326252.0

Well Log

Top	Bottom	Formation
0.0	38.0	DIRT LAYER LS & DIRT
38.0	50.0	LS DARK
50.0	100.0	LS WHITE

Comments MC 657; NEIGHBORS (KIDS) VERIFIED; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222704	DRILLED ON TRANEWAY RD .5WAY BETWEEN ROCKPORT RD & VICTOR PK.	May 24, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LARRY BLACKERBY	101 S. CARRY PK	
Driller	GEORGE SNAPP	RR#5, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** 107.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the SE of the NE of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 950.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0
Ground elevation: 690.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 683.0 **Aquifer elevation:**
UTM Easting: 536613.0 **UTM Northing:** 4326238.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL & LAYERS OF LS
7.0	55.0	WH LS SOFT
55.0	65.0	BLUE LS SOFT
65.0	105.0	WH LS
105.0	140.0	BLUE LS HARD & ABRASIVE

Comments MC 683; OWNER VERIFIED JUST N OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222709	GO S FROM BLOOMINGTON ON IND #37 4 LANE TO VICTOR PIKE, TO TRAMWAY RD, GO W ON TRAMWAY ABOUT 1 MI. TRAILER ACROSS CREEK ON SIDE HILL	Jun 28, 1980

Owner-Contractor	Name	Address	Telephone
Owner	KENNY LONG	4371 W. TRAMWAY RD	(000) 824-8956
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.58 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 106.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the SE of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2450.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 662.0 **Aquifer elevation:**
UTM Easting: 536260.0 **UTM Northing:** 4325633.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL & LAYER LIMESTONE
8.0	0.45	WHITE LIMESTONE
45.0	95.0	GREY LIMESTONE
95.0	135.0	BLUE LIMESTONE

Comments

MC 662; LOCATION CORRECT - OWNER NOT HOME; WELL 30 FT SW OF SW CORNER OF TRAILER.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222714	ABOUT 8 MILES SOUTH BLOOMINGTON, ON ROCKPORT RD, BY SHAWNEE QUARRY	Jul 01, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	INDEPENDENT STONE CO.	SOUTH HWY 50 & 37 PO BOX 142 BEDFORD, IN	
Driller	FRED SCOTT	R13 BOX 452 BLOOMINGTON, IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 120.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the NW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 700.0 **Ft S of NL:** 2050.0
Ground elevation: 740.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 735.0 **Aquifer elevation:**
UTM Easting: 535516.0 **UTM Northing:** 4326369.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLAY
5.0	12.0	STONE GRAY LIMESTONE HARD
12.0	30.0	STONE DARK GRAY LS EX. HARD
30.0	45.0	STONE CREAM LIMESTONE HARD
45.0	88.0	STONE BUFF LIMESTONE BUFF
88.0	112.0	STONE GRAY LIMESTONE HARD
112.0	125.0	STONE WHITE LS EXTRA HARD

Comments MC 735; OWNER VERIFIED; ON TOP OF HILL ABOUT 200 FT EAST OF RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222719	5 MI. SOUTH BLOOMINGTON, IN ON ROCKPORT RD JUST AFTER GO BETWEEN TWO QUARRIES HOLES.	Sep 01, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH A. EADS		
Driller	GEORGE SNAPP	4625 SO STONSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 53.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the NW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 450.0 **Ft S of NL:** 1800.0
Ground elevation: 715.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 704.0 **Aquifer elevation:**
UTM Easting: 535437.0 **UTM Northing:** 4326455.0

Well Log

Top	Bottom	Formation
0.0	11.0	TOP SOIL & LAYERS STONE
11.0	135.0	WHITE LIME MEDIUM HARD

Comments MC 704; VERIFIED BY MAILBOX; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222724	GO SOUT ON SR37 TO ROCKPORT RD TURN ON ROCKPORT TO TRAMWAY RD THEN GO TO S CURVE ON TRAMWAY RD. WELL ON LEFT OF CURVE, ALONG DRIVE NEAR RD	Oct 27, 1981

Owner-Contractor	Name	Address	Telephone
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.11 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1575.0 **Ft E of WL:** 1625.0 **Ft S of NL:**
Ground elevation: 638.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 625.0 **Aquifer elevation:**
UTM Easting: 535790.0 **UTM Northing:** 4325860.0

Well Log

Top	Bottom	Formation
0.0	13.0	TOP SOIL
13.0	80.0	WHITE LIME
80.0	95.0	SHALE

Comments MC 625; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222727	W CLEAR CREEK ON CLEAR CREEK RD 2800' N OF SL 100' W OF EL	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEROY ROTHROCK		
Driller	SNAPPS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 0.5 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the NE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 536860.0 **UTM Northing:** 4329493.0

Well Log

Top	Bottom	Formation
0.0	8.0	SURFACE
8.0	130.0	LS

Comments

COLLECTED BY DGJ 6/20/57 USGS; OWNER NOT AT HOME MAY BE CORRECT LOCATION U-S 9/63

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222729	LAKE ROCKPORT RD OFF 4 LANE #37 SOUT TO TRAMWAY RD THEN GO TO S CURVE ON TRAMWAY RD. WELL ON LEFT SIDE OF CURVE.	Oct 23, 1981

Owner-Contractor	Name	Address	Telephone
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.083 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	75.0	WHITE LIMESTONE

Comments MC 630; VERIFIED BY OWNER; WELL IS 10' N OF N SIDE OF TRAILER UNDER SHED.; #3

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222732	7MI S OF BLGTON IN, ON ROCKPORT RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	E.L. WINTER	BLOOMINGTON RR#5	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	ALBERT LENTZ, BUYRIC ERIE M	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 160.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 45.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:** Pumping	**Test rate:** 36.0 gpm for 1.0 hrs.	**BailTest rate:** gpm for hrs.
	Drawdown: ft.	**Static water level:** ft.	**Bailer Drawdown** 100.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SW of the NW of the SE of Section 25 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: MT **on:** Jul 12, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2200.0 **Ft N of SL:** 1700.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 760.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: 536226.0 **UTM Northing:** 4327538.0

Well Log

Top	Bottom	Formation
0.0	160.0	BLANK

Comments MC; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222734	TAKE ROCKPORT RD OFF 4 LANE 37 SO TO TRAMWAY RD GO TO S CURVE. WELL ON LEFT OF CURVE.	Oct 19, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 11.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.46 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	WHITE LIMESTONE
80.0	90.0	BLUE LIMESTONE
90.0	130.0	BLUE SHALE

Comments MC 630; VERIFIED BY OWNER; WELL IS 15 FT NORTH OF NORTH SIDE OF TRAILER; #2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222737	THAT ROAD 2 MI. WEST OF CLEAR CREEK	Jul 15, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EDWARD L. CRUM	8 MI	
Driller	ALBERT LENTZ	SMITHVILLE, IN	
Operator	ALBERT LENTZ	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 1.5 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 80.0 ft. **Static water level:** 80.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the NE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 0.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 536877.0 **UTM Northing:** 4329340.0

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	140.0	LIMESTONE

Comments 22 ' CASING

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222739	TAKE ROCKPORT RD OFF 4 LANE 37 TO TRAMWAY RD THEN GO TO S CURVE. WELL ON NORTH SIDE OR LEFT SIDE OF RD.	Oct 15, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.16 gpm for hrs.
Drawdown: ft. **Static water level:** 14.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	WHITE LIMESTONE
80.0	90.0	BLUE LIMESTONE
90.0	145.0	BLUE SHALE

Comments MC 630; VERIFIED BY OWNER; WELL IS 5' NORTH OF NORTH SIDE OF TRAILER; #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222742		Mar 28, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ASSOCIATE BLDRS. C. ROTHROCK	ST. RD. 45 AT LEONARD SPR. RD	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 25.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the NE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1350.0
Ground elevation: 785.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 536848.0 **UTM Northing:** 4329779.0

Well Log

Top	Bottom	Formation
0.0	25.0	YELLOW DIRT
25.0	127.0	GREY LIMESTONE
127.0	132.0	BUFF COLOR LIMESTONE
132.0	140.0	GREY LIMESTONE

Comments

MC 60; OWNER VERIFIED / JUST WEST OF HOUSE; COULDN'T LOCATE, NEE SPECIFIC DISTANCE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222744	SW OF BLOOMINGTON ST. RD. 37 S. TO ROCKPORT RD. TURN RIGHT GO TO TRAMWAY RD. GO LEFT GO TO 2ND TRAILER ON LEFT	Sep 17, 1985

Owner-Contractor	Name	Address	Telephone
Owner	DON AXSOM	TRAMWAY RD., BLOOMINGTON, IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 164.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 55.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 11.6 ft. **Bailer Drawdown** 164.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: LH **on:** May 19, 1989

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** 1650.0 **Ft E of WL:** 2350.0 **Ft S of NL:**

Ground elevation: 634.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 620.0 **Aquifer elevation:**

UTM Easting: 536010.0 **UTM Northing:** 4325895.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	14.0	RED CLAY
14.0	17.0	YEL SH
17.0	23.0	GRAY LS
23.0	27.0	BLUE LS
27.0	40.0	GRAY LS
40.0	52.0	BLUE LS

52.0	62.0	BLUE LS
62.0	89.0	GRAY LS
89.0	100.0	DARK GRAY LS
100.0	121.0	GRAY LS
121.0	138.0	WHITE LS
138.0	154.0	GRAY LS
154.0	164.0	DARK GRAY LS

Comments MC 620: WELL 25' N. OF NW SIDE OF HOUSE: SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222747	ON WEST SIDE ROCKPORT ROAD JUST AFTER YOU PAS THAT ROAD SOUTH BLOOMINGTON, IN ABOUT 4 MILES	Dec 24, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 8.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:**	**Test rate:** gpm for hrs.	**BailTest rate:** 4.0 gpm for hrs.
	Drawdown: ft.	**Static water level:** 35.0 ft.	**Bailer Drawdown** 35.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 475.0 **Ft N of SL:** 500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 700.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 693.0 **Aquifer elevation:**

UTM Easting: 536742.0 **UTM Northing:** 4328755.0

Well Log

Top	Bottom	Formation
0.0	7.0	RED CLAY
7.0	40.0	WHITE MEDIUM HARD LIMESTONE
40.0	75.0	HARD WHITE LIMESTONE

Comments MC 693; OWNER VERIFED / 15 FT WEST OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222752	4 MILES SOUTH BLOOMINGTON, IN ON ROCKPORT RD 0.25 MILE SOUTH OF THAT ROAD ON WEST SIDE OF ROCKPORT ROAD.	Apr 22, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER #2	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.83 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** 400.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 4.0 **Bedrock elevation:** 696.0 **Aquifer elevation:**
UTM Easting: 536729.0 **UTM Northing:** 4328743.0

Well Log

Top	Bottom	Formation
0.0	4.0	TOP RED CLAY
4.0	115.0	HARD WHITE LIMESTONE
115.0	132.0	SOFT GREY LIMESTONE
132.0	140.0	HARD BLUE LIMESTONE

Comments MC 695; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222753	0.25 MILE SOUTH OF STANFORD; 1ST HOUSE N AFTER BRIDGE	Oct 08, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BYRON BOWMAN	R5 BLOOMINGTON	
Driller	EADS & DECKARD	R9 BLOOMINGTON	
Operator	EADS & DECKARD	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the SE of the NE of Section 31 **Topo map:** STANFORD

Grant Number:

Field located by: RC **on:** Jul 17, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0

Ground elevation: 722.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 710.0 **Aquifer elevation:**

UTM Easting: 528698.0 **UTM Northing:** 4326319.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	100.0	LIMESTONE

Comments MC 710; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222757	4 MILES SOUTH BLOOMINGTON, IN. ON ROCKPORT ROAD 0.25 MILE SOUTH OF THAT ROAD ON WEST SIDE OF ROCKPORT ROAD.	May 15, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER #1	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 3.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 26.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** 1100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 2.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 536602.0 **UTM Northing:** 4328945.0

Well Log

Top	Bottom	Formation
0.0	2.0	TOP SOIL
2.0	45.0	SOFT GREY LIMESTONE
45.0	70.0	HARD WHITE LIMESTONE

Comments MC 685; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222758	ON BURCH ROAD SO. OF STANFORD, IN.	Nov 16, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OTTIS HENDERSON	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 41.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 34.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** 200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 741.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 720.0 **Aquifer elevation:**
UTM Easting: 528793.0 **UTM Northing:** 4325550.0

Well Log

Top	Bottom	Formation
0.0	21.0	TOP SOIL
21.0	39.0	LAYERS OF RED CLAY & LS
39.0	75.0	HARD WHITE LIMESTONE

Comments MC 720; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223845	W OF BLOOMINGTON ON SR 45 TO STANFORD LEFT ON BURCH RD 3/4 MI TO EVANS RD 3/4 MI ON RIGHT 4TH HOUSE FROM CORNER.	Apr 30, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM CAMPBELL	R9 EVANS RD	
Driller	FRED SMITH	RR #13 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 186.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 105.0 ft. **Bailer Drawdown** 76.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2250.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 150.0
Ground elevation: 830.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 820.0 **Aquifer elevation:**
UTM Easting: 529778.0 **UTM Northing:** 4325385.0

Well Log

Top	Bottom	Formation
0.0	10.0	SOIL
10.0	30.0	LS WITH HOLES
30.0	186.0	LS

Comments MC 820: NEIGHBOR & MAILBOX VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223850	S OF STANFORD, TURN ON BURCH RD AT STANFORD, GO TO EVANS RD TURN LEFT THEN GO TO 2ND HOUSE ON RIGHT	Aug 22, 1988

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID SPEARS	8801 W. EVANS RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:**	**Diameter:** 6.625
Screen	**Length:** 160.0	**Material:**	**Diameter:** 4.0 **Slot size:** .32

Well Capacity Test

Type of test: Air / Pump **Test rate:** 20.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NE of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: LH **on:** May 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 50.0
Ground elevation: 755.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 529350.0 **UTM Northing:** 4325425.0

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	10.0	RED CLAY
10.0	40.0	GRAY LS HARD
40.0	44.0	BLUE LS HARD
44.0	83.0	GRAY LS HARD
83.0	87.0	LIGHT BLUE LS EX HARD
87.0	120.0	GRAY LS EX HARD
120.0	130.0	BLUE LS EX HARD

130.0	141.0	GRAY LS HARD
141.0	155.0	YEL LS HARD
155.0	158.0	BLUE SHALE SOFT
158.0	165.0	GRAY LS HARD

Comments MC745; VERIFIED BY OWNER; WELL IS 30' NE OF NE CORNER OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223855	S OF STANFORD, TURN ON BURCH RD AT STANFORD. GO TO EVANS RD TURN LEFT THEN GO TO 3RD HOUSE ON RIGHT	Aug 16, 1988

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RITA STULTZ	8701 W EVANS RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.625
Screen	**Length:** 175.0	**Material:**	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air / Pump **Test rate:** 8.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 185.0 ft. **Static water level:** 75.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: LH **on:** May 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2250.0 **Ft S of NL:** 50.0
Ground elevation: 794.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 788.0 **Aquifer elevation:**
UTM Easting: 529530.0 **UTM Northing:** 4325420.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	14.0	YEL SS SOFT
14.0	22.0	YEL SHALE EX SOFT
22.0	28.0	BLUE SHALE EX SOFT
28.0	74.0	GRAY LS HARD
74.0	76.0	BLUE SHALE
76.0	102.0	GRAY LS HARD
102.0	106.0	YEL LS SOFT

106.0	120.0	GRAY LS HARD
120.0	124.0	BROWN SS SOFT
124.0	137.0	LIGHT BLUE LS EX HARD
137.0	141.0	YEL LS HARD
141.0	164.0	GRAY LS HARD
164.0	167.0	BLUE SHALE SOFT
167.0	172.0	GRAY LS HARD
172.0	180.0	BLUE SHALE SOFT
180.0	185.0	BLUE LS HARD

Comments MC788; VERIFIED BY OWNER; WELL IS 20' NE OF NE CORNER OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223860	GO S OF STANFORD, IN ON CR, TO EVANS RD, TURN L GO 1.25 MI GO S .1 MI LOT TO R FROM CURVE EAST	Aug 13, 1987

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MIKE COMBS	STANFORD, IN	
Driller	MUMMA BROS DRILLING INC	RR1, BOX 85, LYONS, IN	
Operator	DAVID MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth:	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 100.0	**Material:**	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:**	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 30.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SE of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 250.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 883.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 868.0 **Aquifer elevation:**
UTM Easting: 530420.0 **UTM Northing:** 4324900.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	15.0	SANDROCK & CLAY SEAMS
15.0	19.0	SOFT SH
19.0	35.0	BR SANDROCK
35.0	36.0	CLAY SEAM
36.0	42.0	BR SANDROCK
42.0	45.0	MUD GRAY
50.0	55.0	CLAY & SOFT SH
55.0	57.0	YEL SANDROCK
57.0	67.0	LS BR
67.0	69.0	CLAY SEAM

69.0	72.0	SOFT GRAY SH
72.0	76.0	CLAY & MUD
76.0	88.0	SANDROCK BR
88.0	91.0	CLAY
91.0	155.0	LS WHITE
155.0	158.0	SEAM
158.0	161.0	LS
161.0	162.0	SEAM
162.0	180.0	LS BR SANDY
180.0	250.0	LS WATER AT 226

Comments MC 868; NO CONTACT MADE WELL LOCATED AT NW CORNER OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223865	SE OF STANFORD	Aug 30, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES EVANS	RR #9 BLOOMINGTON	
Driller	ALBERT MARTINDALE	RR #4 BLOOMFIELD IN	

Construction Details

Well	**Use:**	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 95.0	**Material:**	**Diameter:** 5.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for hrs.
Drawdown: ft. **Static water level:** 140.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: **on:** Apr 18, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 900.0
Ground elevation: 874.0 **Depth to bedrock:** 95.0 **Bedrock elevation:** 779.0 **Aquifer elevation:**
UTM Easting: 529890.0 **UTM Northing:** 4325183.0

Well Log

Top	Bottom	Formation
0.0	95.0	MUD
95.0	200.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223869	.5 MI S OF VICTOR STONE OOLITIC STONE CO	Sep 08, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOMAS DECKARD		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 182.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SW of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1300.0 **Ft E of WL:** 700.0 **Ft S of NL:**
Ground elevation: 805.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 535518.0 **UTM Northing:** 4322641.0

Well Log

Top	Bottom	Formation
0.0	215.0	ORIGINAL WELL
215.0	240.0	BROWNISH COLOR LS
240.0	250.0	BLUE LS

Comments MC; MAILBOX VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223870	ABOUT 7 MI SW OF BLOOMINGTON LAKE 45 HWY TO HARMONY RD TURN LEFT THEN GO EVANS RD TURN RIGHT 2ND HOUSE ON LEFT.	Jul 20, 1981

Owner-Contractor	Name	Address	Telephone
Owner	CHUCK MC QUARRY	EVANS RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.7	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 85.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NE of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1500.0
Ground elevation: 800.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 788.0 **Aquifer elevation:**
UTM Easting: 531590.0 **UTM Northing:** 4324955.0

Well Log

Top	Bottom	Formation
0.0	9.0	YEL CLAY
9.0	12.0	RED CLAY
12.0	18.0	STONE YEL SS HARD
18.0	29.0	RED CLAY
29.0	31.0	HOLE
31.0	42.0	STONE GRAY LS EX HARD
42.0	50.0	STONE DARK GRAY LS EX HARD
50.0	70.0	STONE GRAY LS EX HARD
70.0	98.0	STONE LT GREY LS EX HARD

98.0	101.0	STONE BLUE LS EX HARD
101.0	126.0	STONE GRAY LS HARD
126.0	134.0	STONE DARK GRAY LS HARD
134.0	145.0	STONE GRAY LS HARD

Comments MC 788: NOTE CONTACT MADE WITH OWNER WEL LOCATED N OF HOUSE WELL NO LONGER USED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223874	BLOOMINGTON IN ON VICTOR PIKE JUST N VICTOR QUARRY	Aug 21, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CECIL HENDRICKS	RR 5 BLOOMINGTON IN	
Driller	GEORGE H SNAPP	RR 5 BOX 86 BLOOMINGTON IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1650.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 50.0
Ground elevation: 600.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 594.0 **Aquifer elevation:**
UTM Easting: 536413.0 **UTM Northing:** 4323820.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOP SOIL
6.0	100.0	LS

Comments MC 594: NEIGHBOR VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223875	W ON BLOOMFIELD RD 7 MI TO HARMONY RD TO MT LION & TURN R ON MT QION RD 1/4 MI.	Oct 21, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES G GOBLE	R #5 BOX 374 A	
Driller	PAUL SHUTE	1420 W 14TH ST BLOOMINGTON IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 263.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 173.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SE of the SE of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 700.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 960.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 531900.0 **UTM Northing:** 4324105.0

Well Log

Top	Bottom	Formation

Comments NEIGHBOR & MAILBOX VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223879	65' 2ND RD AT DRIVE WAY ENTRANCE DUE W OFF OF VICTOR PIKE.	May 11, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP TEAGUE	7860 S VICTOR PIKE	
Driller	FRED L SMITH	S HWY 37 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 210.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 140.0 ft. **Bailer Drawdown** 140.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1950.0 **Ft N of SL:** 1275.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 815.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 797.0 **Aquifer elevation:**
UTM Easting: 534750.0 **UTM Northing:** 4322638.0

Well Log

Top	Bottom	Formation
0.0	18.0	SOIL
18.0	28.0	LS & HOLES
28.0	210.0	LS

Comments MC 797: VERIFIED BY NEIGHBOR: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223880	ABOUT 2 1/4 MI SE OF STANFORD THAKE BURCH RD TO EVANS RD TURN LEFT & GO TO 1ST HOUSE ON LEFT.	Oct 31, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE EAST	512 GRAHAM DR BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX 252B ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 142.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NW of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1150.0 **Ft S of NL:** 1250.0
Ground elevation: 895.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 871.0 **Aquifer elevation:**
UTM Easting: 530829.0 **UTM Northing:** 4325072.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	15.0	BLUE SH SOFT
15.0	18.0	YEL SH SOFT
18.0	24.0	BLUE SH SOFT
24.0	30.0	STONE BR SS HARD
30.0	39.0	BLUE SH SOFT
39.0	65.0	SOTNE BLUE SOAPSTONE HARD
65.0	68.0	STONE YEL SS HARD
68.0	140.0	STONE BLUE SOAPSTONE HARD

140.0	142.0	STONE GRAY LS HARD
142.0	168.0	STONE BLUE SOAPSTONE HARD
168.0	180.0	STONE GRAY LS HARD
180.0	197.0	STONE CREAM LS HARD
197.0	200.0	STONE BLUE SH SOFTER
200.0	218.0	STONE GRAY LS HARD
218.0	226.0	STONE BLUE LS EX HARD
226.0	240.0	STONE GRAY LS HARD
240.0	265.0	STONE YELLOWISH LS HARD

Comments MC 871: NEIGHBOR VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223884	ON VICTOR PIKE ABOUT 3 BLOCKS FROM ROCKPROT BELOW VICTOR OOLITIES STONE CO	May 01, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEPHEN LOCKWOOD	BLOOMINGTON IN RR5	
Driller	GEORGE SNAPP	BLOOMINGTON IN RR5	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 180.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 130.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 805.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 789.0 **Aquifer elevation:**
UTM Easting: 534811.0 **UTM Northing:** 4322620.0

Well Log

Top	Bottom	Formation
0.0	16.0	TOPSOIL
16.0	180.0	HARD LS

Comments MC 789: OWNER VARIFIED/ 10' E OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223885	S OF STANDFORD ABOUT 3 1/2 MI TAKE KIRKSVILLE RD TO HARMONY RD TURN R GO EVANS RD TURN R THEN 3RD HOUSE ON LEFT.	Nov 10, 1978

Owner-Contractor	Name	Address	Telephone
Owner	SARAH CABANAW	RR 9 BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6238 W COWDERN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 205.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 205.0 ft. **Static water level:** 97.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SE of the NW of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: RJS **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2500.0 **Ft S of NL:** 1400.0
Ground elevation: 835.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 828.0 **Aquifer elevation:**
UTM Easting: 531248.0 **UTM Northing:** 4325022.0

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	15.0	STONE YELLOWISH LS HARD
15.0	27.0	STONE YEL SS HARD
27.0	55.0	STONE BLUE SOAPSTONE SOFTER
55.0	64.0	STONE GRAY LS HARD
64.0	70.0	STONE BLUE LS HARD
70.0	105.0	STONE GRAY LS EX HARD
105.0	106.0	STONE BLUE SH SOFTER
106.0	112.0	STONE DARK GRAY LS EX HARD

112.0	135.0	STONE GRAY LS EX HARD
135.0	137.0	STONE BLUE SH SOFT
137.0	152.0	STONE CREAM LS HARD
157.0	162.0	STONE DARK GRAY LS EX HARD
162.0	165.0	STONE GRAY LS HARD
165.0	180.0	STONE GRAY LS EX HARD
180.0	187.0	STONE CREAM LS HARD
187.0	205.0	STONE YELLOWISH LS HARD

Comments MC 828: VERIFIED BY OWNER:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223889	BLGTN IN ON SR37, OLD #37 TURN S TO KETCHEM RD, R 1ST RD TO VICTOR PIKE, S TO RCKPRT RD 3 BLKS BACK ON VICTOR PIKE FROM ROCKPORT	Nov 12, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEWIS MAY SON	RR 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	RR 5 BOX 86 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 11.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 135.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2300.0 **Ft N of SL:** 1250.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 825.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 816.0 **Aquifer elevation:**
UTM Easting: 534616.0 **UTM Northing:** 4322620.0

Well Log

Top	Bottom	Formation
0.0	9.0	RED CLAY
9.0	100.0	WH LS
100.0	165.0	LAYERS LS & SOFT MATERIAL

Comments MC 816: OWNER VERIFIED / JUST W OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223894	SEE MAP	Apr 15, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MASTER BUILT HOMES		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	SNAPP & GROGAN	License: null	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SW of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: US **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 900.0 **Ft S of NL:**
Ground elevation: 860.0 **Depth to bedrock:** 12.5 **Bedrock elevation:** 847.5 **Aquifer elevation:**
UTM Easting: 534006.0 **UTM Northing:** 4322574.0

Well Log

Top	Bottom	Formation
0.0	12.5	DIRT YEL
12.5	200.0	LS GRAY HARD

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223895	E OF STANFORD, TAKE KIRKSVILLE RD TO KOONTZ RD TURN LEFT ABOUT 1.5 MI TRAILER ON RIGHT	May 08, 1985

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF SELF	6005 W. KOONTZ RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.25
Screen	**Length:** 110.0	**Material:**	**Diameter:** 4.0 **Slot size:** .40

Well Capacity Test

Type of test: **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 115.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NE of the NE of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JA **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 50.0
Ground elevation: 765.0 **Depth to bedrock:** 2.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 533350.0 **UTM Northing:** 4325375.0

Well Log

Top	Bottom	Formation
0.0	2.0	RED CLAY
2.0	7.0	GRAY LS H
6.0	10.0	BLUE SHALE S
10.0	26.0	GRAY LS H
26.0	30.0	BLUE SHALE S
30.0	38.0	GRAY LS H
38.0	40.0	BLUE SHALE S
40.0	62.0	GRAY LS EX. H
62.0	75.0	GRAY LS H

75.0	76.0	WHITE SHALE S
76.0	84.0	GRAY LS H
84.0	85.0	YEL SHALE S
85.0	105.0	WHITE LS H
105.0	115.0	GRAY LS H

Comments NEIGHBOR & MAILBOX VERIFIED; PITLESS ADAPTER VISIBLE W. SIDE OF TRAILER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223899	S ON ROCKPORT RD 8 MI FROM BLOOMINGTON, IN	Jul 20, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WESLEY BAXTER	RR13, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 45.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** 25.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NW of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1150.0 **Ft S of NL:** 1750.0
Ground elevation: 685.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 674.0 **Aquifer elevation:**
UTM Easting: 534088.0 **UTM Northing:** 4323299.0

Well Log

Top	Bottom	Formation
0.0	11.0	TOPSOIL & LAYERS LS
11.0	45.0	HARD LS

Comments MC 674; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223900	1/2 WAY DOWN KOONTZ RD BETWEEN HARMONY RD & ROCKPORT RD ON THE S SIDE OF THE RD LOCATED APROX 600' OFF THE RD COURSE RD AT BELOW ADDRESS	Aug 18, 1977

Owner-Contractor	Name	Address	Telephone
Owner	MICHAEL R MC KENNA	6123 W KOONTZ BLOOMINGTON IN	
Driller	FRED SMITH L WATER-WELL DRLG	RR 13 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 122.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NE of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 700.0
Ground elevation: 750.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 740.0 **Aquifer elevation:**
UTM Easting: 533260.0 **UTM Northing:** 4325204.0

Well Log

Top	Bottom	Formation
0.0	10.0	SOIL
10.0	90.0	LS
90.0	125.0	SH TO SOFT TO STAND UP

Comments MC 740: NEIGHBOR & MAILBOX VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223904	ABOUT 2 MI W OF KIRKSVILLE ON MT ZOIN RD	Dec 29, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MC CONNELL	RR 9 BLGTON IN	
Driller	FRED SCOTT	RR 4 BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 176.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** 200.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: SW of the SW of the NE of Section 9 **Topo map:** STANFORD

Grant Number:

Field located by: JRD **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2150.0

Ground elevation: 900.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 892.0 **Aquifer elevation:**

UTM Easting: 531383.0 **UTM Northing:** 4323214.0

Well Log

Top	Bottom	Formation
0.0	8.0	YEL CLAY
8.0	20.0	STONE BR SS SOFT
20.0	23.0	STONE BR SS EX HARD
23.0	35.0	STONE BR SS SOFT
35.0	38.0	STONE BLUE SH SOFT
38.0	40.0	STONE BR SS SOFT
40.0	42.0	STONE BR SS EX HARD
42.0	52.0	STONE BR SS HARD
52.0	60.0	STONE BR SS HARD
60.0	82.0	STONE BLUE SH SOFT

82.0	85.0	STONE BR SS HARD
85.0	109.0	STONE GRAY SH SOFT
109.0	115.0	STONE GRAY LS HARD
115.0	120.0	STONE GRAY LS EX HARD
120.0	132.0	STONE BR LS EX HARD
132.0	139.0	STONE BR LS EX HARD
139.0	165.0	STONE WH LS HARD
165.0	175.0	YEL MUD HOLE
175.0	210.0	STONE YELLOWISH BR LS EX HARD
210.0	236.0	STONE YEL LS HARD
236.0	250.0	STONE YEL LS EX HARD

Comments MC 892: OWNER VERIFIED ABOUT 50' E OF THE HOUSE THAT THEY RENT OUT ON MT ZION RD:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223905	S OF BLOOMINGTON ABOUT 8 M TAKE 45 W TO HARMONY RD TURN TO LEFT THEN TO KOONTZ RD TURN LEFT THEN TO DEVALL RD TURN R 1ST HOUSE TRAILER ON RIGHT	May 12, 1973

Owner-Contractor	Name	Address	Telephone
Owner	ROBERT KINDER	RR 9 BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX 252B ELLETSVILLIE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 45.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 135.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NE of the NW of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2800.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 700.0
Ground elevation: 755.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 735.0 **Aquifer elevation:**
UTM Easting: 532870.0 **UTM Northing:** 4325236.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	20.0	RED CLAY
20.0	32.0	STONE GRAY LS HARD
32.0	36.0	SEAM W/SOME HYEL CLAY
36.0	48.0	STONE GRAY LS HARD
48.0	57.0	STONE BLUE LS HARD
57.0	62.0	STONE YELLOWISH LS HARD
62.0	90.0	STONE GRAY LS HARD
90.0	112.0	STONE WH LS EX HARD
112.0	135.0	STONE DARK GRAY LS HARD

Comments MC 735: OWNER VERIFIED / 50' W OF RD: N OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223909	S W OF KIRKSVILLE IN	Jun 30, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLARENCE RATLIFF	RR #5	
Driller	GEORGE SNAPP	BLOOMINGTON IN RR #4	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.18 gpm for hrs.
Drawdown: ft. **Static water level:** 135.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 9 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2700.0 **Ft E of WL:** 2500.0 **Ft S of NL:**
Ground elevation: 900.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 860.0 **Aquifer elevation:**
UTM Easting: 531319.0 **UTM Northing:** 4323098.0

Well Log

Top	Bottom	Formation
0.0	20.0	BR DIRT
20.0	40.0	BLUE MUCK W/GRAV MIXED
40.0	42.0	HARD LS
42.0	80.0	BLUE MUCK W/GRAV MIXED
80.0	123.0	BR LS
123.0	126.0	BLUE MUCK W/GRAV MIXED
126.0	200.0	HARD WH LS

Comments MC 860: OWNER VERIFIED: DRY WELL:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223910	SEE MAP	Jul 22, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRANK PING	RR5	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 63.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.42 gpm for hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 700.0 **Ft S of NL:** 200.0
Ground elevation: 855.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 841.0 **Aquifer elevation:**
UTM Easting: 532334.0 **UTM Northing:** 4325394.0

Well Log

Top	Bottom	Formation
0.0	14.0	CLAY
14.0	65.0	LS & FULL CANES

Comments MC 841; SEE MAP; BUILDING VER; 15' S OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223914	S OF STANFORD, SR45 S TO BREEDEN RD TURN LEFT GO TO 2ND RD WHICH IS GRAVES RD, TURN LEFT. 3RD DRIVE ON LEFT. NEW HOUSE UP ON HILL	Oct 16, 1985

Owner-Contractor	Name	Address	Telephone
Owner	DONNA DWYER	8920 W GRAVES RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 175.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 84.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 175.0 ft. **Static water level:** 77.5 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 2100.0
Ground elevation: 770.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 765.0 **Aquifer elevation:**
UTM Easting: 529050.0 **UTM Northing:** 4323170.0

Well Log

Top	Bottom	Formation
0.0	5.0	YEL CLAY
5.0	6.0	YEL SHALE
6.0	16.0	YEL SS
16.0	17.0	BLUE SHALE
17.0	28.0	GRAY LS
28.0	32.0	BLUE LS
32.0	56.0	GRAY LS
56.0	65.0	DARK GRAY LS

65.0	71.0	GRAY LS
71.0	82.0	OPEN CAVE
82.0	105.0	GRAY LS
105.0	113.0	BROWNISH LS
113.0	130.0	GRAY LS
130.0	146.0	WHITE LS
146.0	162.0	GRAY LS
162.0	170.0	YELLOWISH LS
170.0	175.0	DARK BLUE LS

Comments MC765; WELL LOCATED ON N SIDE OF HOUSE; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223915	ON RD BETWEEN KIRKSVILLE & SR 45 1.5 MI FROM KIRKSVILLE	Aug 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SLOAN		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1975
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 200.0 **Ft S of NL:** 1450.0
Ground elevation: 920.0 **Depth to bedrock:** 26.0 **Bedrock elevation:** 894.0 **Aquifer elevation:**
UTM Easting: 532193.0 **UTM Northing:** 4325006.0

Well Log

Top	Bottom	Formation
0.0	26.0	CLAY RED
26.0	80.0	SH BLUE

Comments MC 894; WELL WAS DEEPENED 6 OVER 200' BY SNAPP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223919	FM SE OF BLOOMINGTON IN ON SR 45 OF 3 MI ON BREEDER RD	Sep 16, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WARD HARP	STANFORD IN	
Driller	PARRISH & SONS WELL DRILLING	RR #3 SPENCER IN	
Operator	ROBERT PARRISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 56.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 35.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SW of the NE of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2400.0
Ground elevation: 690.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 528373.0 **UTM Northing:** 4323166.0

Well Log

Top	Bottom	Formation
0.0	21.0	RED CLAY SOFT
21.0	55.0	LS HARD
55.0	56.0	BLUE SH HARD

Comments MC 669: OWNER VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223920	ON RD BETWEEN KIRKSVILLE & SR 45 1.5 MI FROM KIRKSVILLE; ORDERED BY ORGERS BUILDING SUPPLY	Nov 14, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SLOAN	RR9	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 175.0 ft. **Bailer Drawdown** 167.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 200.0 **Ft S of NL:** 1450.0
Ground elevation: 920.0 **Depth to bedrock:** 26.0 **Bedrock elevation:** 894.0 **Aquifer elevation:**
UTM Easting: 532164.0 **UTM Northing:** 4324995.0

Well Log

Top	Bottom	Formation
0.0	80.0	ORIGINAL WELL
80.0	105.0	SH & CREVIS
105.0	245.0	SLIGHTLY YEL LS

Comments MC 894; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223924	1/2 MI S STANFORD	May 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	T R STONE	STNAFORD	
Driller	ALBERT MARTINDALE	RR #4 BLOOMINGTON	
Operator	ALBERT MARTINDALE	License: null	

Construction Details

Well	**Use:**	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 68.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NE of the NE of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: PB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1050.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 850.0
Ground elevation: 725.0 **Depth to bedrock:** 68.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 528543.0 **UTM Northing:** 4325185.0

Well Log

Top	Bottom	Formation

Comments NEIGHBOR VERIFIED: 68' OF CASING REST LS:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223925	ABOUT 1 1/2 MI N O F KICKSVILLE ON ROCKPORT RD	Sep 09, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR #5 BEGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 57.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 645.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 615.0 **Aquifer elevation:**

UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	8.0	RED CLAY
8.0	30.0	RED CLAY & FLINTSTONE
30.0	31.0	STONE GRAY LS HARD
31.0	33.0	RED CLAY
33.0	34.0	STONE GRAY LS HARD
34.0	37.0	YEL SH EX SOFT
37.0	46.0	STONE GRAY LS HARD
46.0	48.0	STONE BLUE LS HARD
48.0	57.0	STONE GRAY LS HARD
57.0	77.0	STONE BUFF LS HARD

77.0	82.0	STONE DARK GRAY LS HARD
82.0	90.0	STONE WH GRAY LS HARD

Comments MC 615: OWNER VERIFIED/ 50' E OF RD: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223929	ABOUT 2 MI S STANFORD LAKE SR 45 TO BREEDEN RD AFTER ENTERING BREEDEN RD 2ND HOUSE ON R ON TOP OF A HILL IT HAT ABOUT 1/4 MI OF PRIVATE DRIVE.	May 07, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STARNES	R9 BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR 4 BLOOMINGTON IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 129.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NW of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 750.0 **Ft S of NL:** 550.0
Ground elevation: 810.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 804.0 **Aquifer elevation:**
UTM Easting: 527713.0 **UTM Northing:** 4325310.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	15.0	STONE BR SS SOFT
15.0	45.5	STONE GRAY SH SOFT
45.5	52.0	STONE BR SS HARD
52.0	75.0	STONE GRAY SH SOFT
75.0	92.0	STONE GRAY LS HARD
92.0	97.0	STONE GRAY LS SOFTER
97.0	121.0	STONE BUFF LS HARD
121.0	129.0	YEL CLAY WATER & GRAV
129.0	154.0	STONE BUFF LS HARD

154.0	163.0	STONE GRAY LS EX HARD
163.0	178.0	STONE WH LS HARD
178.0	185.0	STONE GRAY LS EX HARD

Comments MC 804: NEIFHBOR VARIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223930	6 MI S BLOOMINGTON ON ROCK PORT RD	Oct 22, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR5, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 88.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 7.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 645.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	38.0	ORIGINAL WELL
38.0	88.0	MED HARD WHITE LS

Comments OWNER VER; 50' E OF RD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223934	1 1/2 MI S OF STANFORD	May 24, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KARL ENGLISH	RR #9	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 220.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 102.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the SW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1750.0 **Ft E of WL:** 650.0 **Ft S of NL:**
Ground elevation: 845.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 825.0 **Aquifer elevation:**
UTM Easting: 529087.0 **UTM Northing:** 4324397.0

Well Log

Top	Bottom	Formation
0.0	20.0	SOIL
20.0	100.0	BLUE SH
100.0	220.0	LS HARD

Comments MC 825: OWNER VERIFIED / 50' W OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223935	ABOUT 1 1/2 MI N OF KICKSVILLE ON ROCKPORT RD	Sep 09, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR #5 BEGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX ELLETTSVILE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 57.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRH **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 645.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 615.0 **Aquifer elevation:**

UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	8.0	RED CLAY
8.0	30.0	RED CLAY & FLINTSTONE
30.0	31.0	STONE GRAY LS HARD
31.0	33.0	RED CLAY
33.0	34.0	STONE GRAY LS HARD
34.0	37.0	YEL SH EX SOFT
37.0	46.0	STONE GRAY LS HARD
46.0	48.0	STONE BLUE LS HARD
48.0	57.0	STONE GRAY LS HARD
57.0	77.0	STONE BUFF LS HARD

77.0	82.0	STONE DARK GRAY LS HARD
82.0	90.0	STONE WH LS HARD

Comments MC 615: OWNER VERIFIED / 50' E OF RD: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223939	2 MI E OF STANDFORD	Sep 30, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RALPH BRIDGES	6999 BURCH RD BLOOMINGTON IN	
Driller	MUMMA DRILLING IN	RR #2 BOX 131 SUNNYSIDE RD WASHINGTON IN	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 600.0 **Ft S of NL:** 1100.0
Ground elevation: 780.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 529018.0 **UTM Northing:** 4325140.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	75.0	LIME & MUD
75.0	85.0	LIME
85.0	90.0	SOFT SH
90.0	140.0	LIME
140.0	142.0	SH
142.0	190.0	LIME

Comments MC 768: OWNER VERIFIED / 15' S OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223940	8.5 MI S OF BLOOMINGTON, IN ON ROCKPORT RD	Jul 31, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	HAROLD SIMS	RR5, BLOOMINGTON, IN	
Driller	PARRISH WELL DRILLING	RR3, SPENCER, IN	
Operator	ROBERT PARRISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 109.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 14.0 ft. **Bailer Drawdown** 93.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** 2450.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 641.0 **Aquifer elevation:**
UTM Easting: 534550.0 **UTM Northing:** 4324602.0

Well Log

Top	Bottom	Formation
0.0	14.0	BR CLAY
14.0	48.0	BUFF LS
48.0	94.0	WHITE LS
94.0	104.0	GRAY STONE
104.0	109.0	WHITE LS

Comments MC 641; OWNER VER; 60' E OF RD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223944	ABOUT 2 MI SE OF STANDFORD ON EVANS RD	Apr 24, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DON LANE	RR 9 BLOOMINGTON IN	
Driller	FRED SCOTT	RR 13 BOX 452 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 160.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 85.0 ft. **Bailer Drawdown** 160.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 200.0
Ground elevation: 880.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 868.0 **Aquifer elevation:**
UTM Easting: 530047.0 **UTM Northing:** 4325406.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	25.0	STONE BR SS SOFT
25.0	38.0	STONE BLUE SH SOFT
38.0	52.0	STONE GRAY LS EX HARD
52.0	118.0	STONE CREAM LS EX HARD
118.0	124.0	STONE GRAY LS HARD
124.0	138.0	STONE GRAY LS EX HARD
138.0	148.0	STONE CREAM LS EX HARD
148.0	160.0	STONE YELLWISH LS EX HARD

Comments MC 868: OWNER VERIFIED / 5' S OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223945	ON KOONTZ RD ABOUT 1 BLOCK E OF ROCK PAST RD 7M S BLOOMINGTON IN	Jun 16, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARK A MAHRENHOLTZ	5221 W KOONTZ RD	
Driller	GEORGE SNAPP	4625 S STANSIFER LANE BLGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 36.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 50.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the NE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2375.0 **Ft S of NL:** 150.0
Ground elevation: 760.0 **Depth to bedrock:** 34.0 **Bedrock elevation:** 726.0 **Aquifer elevation:**
UTM Easting: 534590.0 **UTM Northing:** 4325376.0

Well Log

Top	Bottom	Formation
0.0	34.0	TOP SOIL
34.0	110.0	LS

Comments MC 726: VERIFIED BY NEIGHBOR & MAILBOX:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223950	TAKE ROCKPORT RD OFF HWY 378 GO TILL YOU PASS KOONTZ RD GO TO NUDEST CAMP AND THEN 1ST DRIVE ON RIGHT	Aug 25, 1987

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MATT JOHNSON	7330 ROCKPORT RD., BLOOMINGTON, IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 0.9 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 100.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NE of the SW of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JA **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1600.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**
UTM Easting: 534200.0 **UTM Northing:** 4324375.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	28.0	RED CLAY
28.0	29.0	SHALE YEL
29.0	32.0	GRAY LS
32.0	38.0	BLUE SHALE
38.0	48.0	BLUE LS
48.0	56.0	GRAY LS
56.0	58.0	BLUE SHALE
58.0	126.0	GRAY LS

126.0	155.0	BUFF LS
155.0	175.0	BLUE LS
175.0	195.0	GRAY LS
195.0	201.0	BLUE LS
201.0	226.0	GRAY LS
226.0	230.0	BLUE LS
230.0	239.0	GRAY LS
239.0	245.0	BLUE SOAPSTONE

Comments MC632; SEE MAP; VERIFIED BY MAILBOX

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223955	ON LODGE RD ABOUT .5 WAY BETWEEN ROCK PORT & VICTOR PIKE ON N SIDE ABOUT 5 MI SE BLOOMINGTON, IN	Aug 08, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CRANDELL	RR5, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 28.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 73.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SE of the NW of Section 1 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1550.0 **Ft S of NL:** 2200.0
Ground elevation: 710.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 682.0 **Aquifer elevation:**
UTM Easting: 535716.0 **UTM Northing:** 4324713.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOPSOIL & LAYERS LS
28.0	140.0	VARIOUS COLOR LS

Comments MC 682; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223960	VICTOR RD BLOOMINGTON IN NEAR QUARRY FOR DRINKING WATER SW OF BLOOMINGTON	Nov 30, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BLOOM LIME ST CO	BLOOMINGTON IN VICTOR RD	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	BUYRIC ERIE	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:**	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the SE of Section 1 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 400.0 **Ft N of SL:** 2200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 536800.0 **UTM Northing:** 4324520.0

Well Log

Top	Bottom	Formation
0.0	18.0	BLANK
18.0		LS

Comments EMPLOYEE VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223980	ON VICTOR PIKE S BLOOMINGTON IN LSAT HOUSE ON RIGHT	Nov 24, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT BAKER	RR 5 BLOOMINGTON IN	
Driller	GEORGE H SNAPP	BLOOMINGTON IN RR5 BOX 86	
Operator	GEORGE H SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** 160.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 1W
Section: NW of the NW of the NW of Section 6 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 0.0 **Ft S of NL:** 550.0
Ground elevation: 675.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 536930.0 **UTM Northing:** 4325159.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	130.0	HARD WH LS
130.0	200.0	MED HARD LS

Comments MC 669:WATER BETWEEN 50 - 55:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
30683	ABOUT .50 MI OF SR 45 ON SOLSBERRY RD ON RT SIDE	Sep 25, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GARY COVEY	R R 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	R R 5 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 50.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: NW of the SW of the NE of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 750.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 728.0 **Aquifer elevation:**
UTM Easting: 526798.0 **UTM Northing:** 4326558.0

Well Log

Top	Bottom	Formation
0.0	22.0	TOP SOIL & SHALE
22.0	32.0	SHALE
32.0	50.0	HARD WHITE LS

Comments NEIGHBOR VERIFIED, 20' N OF NW CORNER; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
30684	ABOUT .50 MI OFF SR 45 ON SOLSBERRY RD ON RT SIDE	Nov 14, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY FOWLER	R R 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	R R 5 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 63.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: NE of the SW of the NE of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1850.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1950.0
Ground elevation: 780.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 770.0 **Aquifer elevation:**
UTM Easting: 526881.0 **UTM Northing:** 4326476.0

Well Log

Top	Bottom	Formation
0.0	10.0	YELL SANDY SOIL
10.0	45.0	SS
45.0	75.0	HARD GRAY LS
75.0	100.0	SS

Comments OWNER VERIFIED, 25' N OF NW CORNER; MV

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34733	NE CORNER OF SW .25 OF SW .25 OF SEC 1, RUNNING S, 78 RD NW 47 RODS TO BLOOMINGTON & BLOOMFIELD RD 45, 10.2 MI SW HWY 45 OF BLOOMINGTON IN DR-WAY	Apr 18, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL WAYNE WORKMAN	R 1 SOLSBERRY IN	
Driller	HAROLD JACKSON		
Operator	HAROLD JACKSON	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: 40.0 ft. **Static water level:** ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NE of the SW of the SW of Section 1 **Topo map:** STANFORD
Grant Number:
Field located by: RJS **on:** Jan 28, 1964
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 885.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 878.0 **Aquifer elevation:**
UTM Easting: 526250.0 **UTM Northing:** 4324125.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	100.0	BRN SS
100.0	125.0	RED SHALE
125.0	140.0	SANDY LIME YELL

Comments MC 885

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34738	AOBUT 5 MI S OF STANFORD, TAKE BREEDEN RD OFF HWY 45 TO CARTER RD, TURN GO ABOUT 1.5 MI, A LOG HOUSE ON LF	Apr 19, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JADE BUTCHER	8119 W RATLIFF RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 305.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.6	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 7.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 305.0 ft. **Static water level:** 112.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NW of the SE of the SE of Section 13 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 700.0 **Ft N of SL:** 1250.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 772.0 **Aquifer elevation:**
UTM Easting: 527289.0 **UTM Northing:** 4321068.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELL CLAY
8.0	45.0	S YELL SS HARD
45.0	52.0	S BLUE SOAPSTONE HARD
52.0	65.0	S YELL SS HARD
65.0	70.0	S BLUE SPST HARD
70.0	75.0	S GRAY SS HARD
75.0	77.0	S BLUE SHALE SOFTER
77.0	85.0	S YELL SS HARD

85.0	145.0	S BLUE SPST HARD
145.0	147.0	S GRAY LS HARD
147.0	148.0	S BLUE SHALE SOFTER
148.0	165.0	S GRAY LS HARD
165.0	166.0	S BLUE SHALE SOFTER
166.0	175.0	S GRAY LS HARD
175.0	195.0	S GRAY LS EX HARD
195.0	196.0	S BLUE GREEN SHALE SOFTER
196.0	209.5	S GRAY LS EX HARD
209.5	210.0	S BLUE SHALE SOFTER
210.0	218.0	S DK GRAY LS HARD
218.0	219.0	S BLUE SHALE SOFTER
219.0	235.0	S GRAY LS HARD
235.0	249.0	S DK GRAY LS HARD
249.0	250.0	S BLUE SHALE SOFTER
250.0	272.0	S GRAY LS EX HARD
272.0	285.0	S BLUE LS HARD
285.0	305.0	S GRAY LS EX HARD

Comments VERIFIED BY OWNER, WELL WAS WITCHED; FC-MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34754	NE OF LITTLE CINCINNATI ABOUT 3 MI, TAKE HWY 45 TO 1ST RD TO LF, TURN GO 1.5 MI, NEW HOUSE ON LF	Oct 11, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GARRY HESHELMAN		
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 51.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 170.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NW of the SW of Section 24 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1650.0 **Ft E of WL:** 250.0 **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 689.0 **Aquifer elevation:**
UTM Easting: 526010.0 **UTM Northing:** 4319561.0

Well Log

Top	Bottom	Formation
0.0	6.0	YELL CLAY
6.0	8.0	STONE YELL SS HARD
8.0	29.0	S YELL SHALE EX SOFT
29.0	47.0	S BLUE SHALE EX SOFT
47.0	55.0	S YELL SS HARD
55.0	78.0	S GRAY LS HARD
78.0	88.0	S BLUE LS HARD
88.0	105.0	S GRAY LS HARD
105.0	132.0	S WHITE LS HARD
132.0	150.0	S GRAY LS HARD
150.0	170.0	S YELL LS HARD

Comments OWNER VERIFIED, 40' NE OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34755	2 MI NE OF HOBBIEVILLE IN, ON INDIAN CREEK RD	Jun 02, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFIELD IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 64.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 33.6	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W

Section: SE of the NE of the SE of Section 25 **Topo map:** STANFORD

Grant Number:

Field located by: RLB **on:** Aug 08, 1962

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 300.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 630.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 624.0 **Aquifer elevation:**

UTM Easting: 527425.0 **UTM Northing:** 4317875.0

Well Log

Top	Bottom	Formation
0.0	6.0	SAND
6.0	33.0	FRACTURED LS & SS
33.0	35.0	LS & GRAY, BLUE
35.0	37.0	LIME SHALE
37.0	64.0	GRAY LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34756	ABOUT 2 MI E & N OF HOBBYVILLE, 1 MI N OF 190S ON E SIDE OF 1375E	Jan 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY SIRUCEK	R R 5 BOX 342 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SW of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1350.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 635.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 625.0 **Aquifer elevation:**
UTM Easting: 527107.0 **UTM Northing:** 4317495.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	30.0	LIME
30.0	38.0	LIME & MUDDY SAND
38.0	60.0	LIME
60.0	61.0	DK GRAY SHALE
61.0	72.0	LIME
72.0	100.0	LIME & DOMITE
100.0	130.0	LIME & DIRTY SEAMS

Comments OWNER VERIFIED, 25' N OF HOUSE; PH 8, IRON .1, HARDNESS 10 GRAINS; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34768	HOBBYVILLE IN, E .25 MI	Jun 11, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GENE NORRIS	R R 1 SPRINGVILLE IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 261.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 245.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the NW of the SE of Section 35 **Topo map:** OWENSBURG
Grant Number:
Field located by: PW **on:** Aug 19, 1971
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 525335.0 **UTM Northing:** 4316325.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY
17.0	26.0	LIME
26.0	57.0	GREEN SHALE & RED ROCK
57.0	67.0	SANDROCK
67.0	90.0	GREEN, GRAY SHALE & BRK OF LIM
90.0	137.0	DK GRAY SHALE & BRK OF LIME
137.0	150.0	SANDROCK
150.0	160.0	BRK OF LIME & SOFT SHALE
160.0	261.0	LIME, WATER

Comments VERIFIED BY NEIGHBOR; PH 7.7, IRON .2, HARDNESS 11 GRAINS; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34769	NEAR BLK TOP RD, E OF HOBBIESVILLE	Nov 04, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CARL L & MAYME B MITCHELL	R R 1 SPRINGVILLE IN	
Driller	FRED SMITH	R R 1 HELTONVILLE IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 51.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 52.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SW of the SW of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: PW **on:** Aug 19, 1971
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 500.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 642.0 **Aquifer elevation:**
UTM Easting: 526250.0 **UTM Northing:** 4315930.0

Well Log

Top	Bottom	Formation
0.0	18.0	SOIL
18.0	49.0	BLK SHALE
49.0	130.0	LS HARD, WATER

Comments VERIFIED BY OWNER; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34770	ROCKPORT RD TO KIRKSVILLE THEN 1ST RD W OF KIRKSVILLE AND GO WITHIN 1 MI OF SR 54	Oct 08, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RICHARD DECKARD	R R 1 SPRINGVILLE IN	
Driller	GEORGE SNAPP	R R 5 BOX 86 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 29.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NE of the SW of the SW of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1100.0 **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 652.0 **Aquifer elevation:**
UTM Easting: 526232.0 **UTM Northing:** 4316081.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOP SOIL
28.0	40.0	SHALE
40.0	150.0	LS

Comments OWNER VERIFIED, 25' W OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383062		May 15, 2003

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB STURGIS	BLOOMINGTON, IN	
Driller	MUMMA BROS	RR1 BOX 85 LYONS, IN	(812) 659-2280
Operator	DAVE MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 155.0	**Pump setting depth:** 0.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 120.0	**Material:** PVC LINER	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 10.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 155.0 ft. **Static water level:** 41.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 0.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from 0 to 0
Installation Method: **Number of bags used:** 0.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: DRILLER **on:** Oct 29, 2004
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1750.0 **Ft S of NL:** 2075.0
Ground elevation: 670.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 664.0 **Aquifer elevation:**
UTM Easting: 537451.0 **UTM Northing:** 4326349.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	58.0	LIMESTONE
58.0	63.0	DARK SHALE
63.0	80.0	LIMESTONE
80.0	88.0	SANDY SHALE AND QURTZ
88.0	117.0	GREY LIMESTONE
117.0	120.0	DARK SHALE
120.0	155.0	GREY SANDY SHALE

Comments MC 664; SEE MAP; DATUM NAD27, SOURCE GPS;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40740	.50 MI W OF KOLEEN AND 4 MI E OF MINERAL ON THE MINERAL & KOLEEN RD	Aug 05, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT SLADCIK	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the SW of the NE of Section 10 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1900.0
Ground elevation: 535.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 497.0 **Aquifer elevation:**
UTM Easting: 514078.0 **UTM Northing:** 4313409.0

Well Log

Top	Bottom	Formation
0.0	38.0	MUD
38.0	70.0	SANDROCK

Comments MC; OWNER VERIFIED, 20' S OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40741	1 MI W OF KOLEEN	Aug 13, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WINFRED BAKER	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 100.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 75.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NE of the NW of Section 10 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2450.0 **Ft S of NL:** 550.0
Ground elevation: 525.0 **Depth to bedrock:** 65.0 **Bedrock elevation:** 460.0 **Aquifer elevation:**
UTM Easting: 513783.0 **UTM Northing:** 4313840.0

Well Log

Top	Bottom	Formation
0.0	65.0	CLAY & MUD
65.0	98.0	SOFT & GREEN SHALE, REDROCK
98.0	104.0	LIME
104.0	106.0	GREEN SHALE
106.0	110.0	LIME, WATER

Comments MC, NEIGHBOR VERIFIED, PH 8.5, IRON .5, HARDNESS 2 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40742	IN COLEEN IN	Oct 09, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOMMY PITCHER	COLEEN IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 70.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 850.0 **Ft S of NL:** 1600.0
Ground elevation: 565.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 553.0 **Aquifer elevation:**
UTM Easting: 514894.0 **UTM Northing:** 4313516.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	12.0	SANDROCK & SEAMS
12.0	39.0	SANDROCK
39.0	43.0	BRK LIME LOOSE
43.0	63.0	LIME
63.0	88.0	RED ROCK, GREEN & GRAY SHALE
88.0	115.0	SANDROCK, WATER

Comments MC; OWNER VERIFIED, 15' NE OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40743		Apr 21, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LESTER FLYNN	KOLEEN IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 55.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 33.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:**	**Test rate:** gpm for hrs.	**BailTest rate:** 45.0 gpm for 0.5 hrs.
	Drawdown: ft.	**Static water level:** ft.	**Bailer Drawdown** ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN

Grant Number:

Field located by: JRD **on:** Jul 18, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** 100.0 **Ft S of NL:** 1800.0

Ground elevation: 525.0 **Depth to bedrock:** 32.0 **Bedrock elevation:** 493.0 **Aquifer elevation:**

UTM Easting: 514659.0 **UTM Northing:** 4313467.0

Well Log

Top	Bottom	Formation
0.0	32.0	CLAY & MUD
32.0	55.0	SANDROCK, WATER

Comments OWNER VERIFIED, NE OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40744	ABOUT 1.5 MI S OF KOLEEN, 1ST DR ON LF AFTER CROSSING BRIDGE	Jul 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DON COMBS	217 CARLISLE TERR MANHATTAN KS	
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 148.5	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 30.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** 145.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: SW of the NE of the SW of Section 11 **Topo map:** KOLEEN

Grant Number:

Field located by: JRD **on:** Jul 18, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** 1400.0 **Ft E of WL:** 1800.0 **Ft S of NL:**

Ground elevation: 650.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**

UTM Easting: 515207.0 **UTM Northing:** 4312812.0

Well Log

Top	Bottom	Formation
0.0	14.0	YELL CLAY
14.0	18.0	RED CLAY
18.0	27.0	STONE YELL SS SOFT
27.0	36.0	S BRN SS SOFT
36.0	62.0	S YELL SS SOFT
62.0	69.0	S REDDISH SS SOFT
69.0	75.0	S BRN SS SOFT

75.0	132.0	S YELL SS SOFT
132.0	144.0	S YELL SEAM WITH MUD
144.0	170.0	S YELL SS SOFT

Comments MC, NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40746	3 MI E OF KOLEEN	Nov 08, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WALTER SMITH	R R 3 BLOOMFIELD IN 47424	
Driller	MUMMA DRILLING INC	R R 2 BOX 131 SUNNYSIDE RD WASHINGTON IN 47501	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 85.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 70.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 30.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SE of the SW of the NE of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: PES **on:** Jul 31, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1350.0 **Ft N of SL:** 3200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 550.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 525.0 **Aquifer elevation:**
UTM Easting: 517400.0 **UTM Northing:** 4313350.0

Well Log

Top	Bottom	Formation
0.0	25.0	CLAY
25.0	55.0	SANDROCK
55.0	56.0	BRK SANDROCK, WATER BAD, IRON
56.0	66.0	SANDROCK
66.0	67.0	SANDROCK, WATER BAD, IRON
67.0	72.0	SANDY SHALE
72.0	85.0	WATER

Comments MC 525, VERIFIED BY NEIGHBOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40747	1 MI E OF KOLEEN IN	Apr 26, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS. CHAS CUMMINGS	KOLEEN IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	DEAN & NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 71.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test **Type of test:** **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information **Material:** **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment **Sealing material:** **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SW of the SE of the NW of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: U **on:** Mar 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2300.0
Ground elevation: 540.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 502.0 **Aquifer elevation:**
UTM Easting: 516525.0 **UTM Northing:** 4313250.0

Well Log

Top	Bottom	Formation
0.0	38.0	CLAY MUD
38.0	42.0	SANDROCK, WATER
42.0	50.0	GREEN SHALE
50.0	52.0	SANDROCK
52.0	68.0	SANDY SHALE, BRK SANDROCK
68.0	71.0	BRN LIME

Comments PH 7.5 NON ACID SIDE, IRON LESS THAN .5 PPM, HARDNESS 7 GRAINS; MC 502

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40749	E OF KOLEEN ABOUT 3 MI	Apr 23, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAYMOND BAKER	KOLEEN IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	NORMAN & DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 94.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SE of the NE of the NE of Section 13 **Topo map:** KOLEEN
Grant Number:
Field located by: U **on:** Mar 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1000.0
Ground elevation: 560.0 **Depth to bedrock:** 42.0 **Bedrock elevation:** 518.0 **Aquifer elevation:**
UTM Easting: 517650.0 **UTM Northing:** 4312075.0

Well Log

Top	Bottom	Formation
0.0	42.0	CLAY MUD
42.0	45.0	SANDROCK
45.0	67.0	GREEN SHALE, BRK SANDROCK SOFT
67.0	94.0	SANDROCK, WATER

Comments PH 7.5 NON ACID, IRON LESS THAN .5 PPM, HARDNESS 7 GRAINS; MC 548

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40750	2.5 MI S OF KOLEEN	Apr 19, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BURTON H CALKINS	3742 W MONTROSE AVE CHICAGO IL	
Driller	MUMMA BROS DRILLING CO	LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 47.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 25.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: NE of the SE of the SE of Section 15 **Topo map:** KOLEEN

Grant Number:

Field located by: MT **on:** Jul 06, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 400.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 565.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 555.0 **Aquifer elevation:**

UTM Easting: 514495.0 **UTM Northing:** 4311163.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	47.0	SANDROCK, MUD SEAMS, SOFT SHAL
47.0	70.0	YELL SANDROCK, WATER

Comments OWNER VERIFIED, PH 7.7, IRON .2 PPM, HARDNESS 9 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40751	2.25 MI N OF DOANS	Jul 16, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHEMMA WERNER	R R 3 BOX 220 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 104.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the NE of the SE of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 720.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 708.0 **Aquifer elevation:**
UTM Easting: 512745.0 **UTM Northing:** 4311564.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	25.0	SANDROCK
25.0	35.0	COAL & FIRECLAY
35.0	100.0	BLUE SHALE & SANDROCK
100.0	101.0	LIME
101.0	102.0	GREEN SHALE
102.0	106.0	SANDROCK
106.0	107.0	GREEN SHALE
107.0	123.0	LIME

123.0	140.0	RED ROCK
140.0	175.0	DK GRAY SHALE
175.0	180.0	LIME
180.0	182.0	DK GRAY SHALE
182.0	215.0	SANDROCK
215.0	240.0	SHALE

Comments MC, NEIGHBOR & MAILBOX VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40752	W OF OWENSBURG, ON TAYLOR RIDGE RD, THERE IS NO RD MARKING FOR THE RD, 475E ?	May 24, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM CUTSHALL	5527 BROADWAY INDPLS IN	
Driller	FRED SCOTT	R 1 ELLETTSVILLE IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 220.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.5	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 220.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NW of the NE of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 250.0
Ground elevation: 695.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 683.0 **Aquifer elevation:**
UTM Easting: 512599.0 **UTM Northing:** 4312330.0

Well Log

Top	Bottom	Formation
0.0	12.0	YELL CLAY
12.0	19.0	STONE YELL SS HARD
19.0	27.0	S BRN SS HARD, COAL
27.0	30.0	S YELL SS HARD
30.0	155.0	S BLUE SHALE HARD
155.0	170.0	S GRAY LS HARD
170.0	177.0	S BLUE SHALE HARD
177.0	207.0	S GRAY LS HARD
207.0	209.0	S BLUE SHALE HARD
209.0	220.0	S GRAY LS HARD

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40758	E OF HOBBYVILLE 2 MI ON SR 54	Jul 17, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVE ROLLINS	400 PERRACE DR #19 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the SE of Section 2 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1150.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 604.0 **Aquifer elevation:**
UTM Easting: 525525.0 **UTM Northing:** 4314379.0

Well Log

Top	Bottom	Formation
0.0	16.0	CLAY
16.0	22.0	LIME & SOFT SHALE
22.0	70.0	LIME
70.0	90.0	BRK IN LIME, WATER

Comments MC; OWNER VERIFIED, 25' N OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40759	ABOUT 1.5 MI E OF JCT 54 & 45	Oct 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES ROY BOX	R R 1 SPRINGVILLE IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 126.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 55.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W

Section: NE of the SE of the SE of Section 2 **Topo map:** OWENSBURG

Grant Number:

Field located by: JRD **on:** Aug 01, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 300.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 635.0 **Depth to bedrock:** 36.0 **Bedrock elevation:** 599.0 **Aquifer elevation:**

UTM Easting: 525782.0 **UTM Northing:** 4314340.0

Well Log

Top	Bottom	Formation
0.0	36.0	CLAY
36.0	85.0	LIME
85.0	95.0	LIME, BRKS, WATER
95.0	115.0	LIME, BRKS, WATER
115.0	126.0	LIME

Comments OWNER VERIFIED, 25' W OF HOUSE; MC; PH 7.8, IRON .5, HARDNESS 22 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40760	APPROX 3.5 MI N OF JCT 45 & 58 ON SR 45 NEAR OWENSBURG IN., .50 MI W ON CR, SPRINGHILL FARMS	Nov 22, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK TAYLOR		
Driller	S & M DRILLING INC	R R 1 MONTGOMERY & BOX 67 LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 325.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 96.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the SE of the SW of Section 4 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2650.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 735.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 726.0 **Aquifer elevation:**
UTM Easting: 521869.0 **UTM Northing:** 4314098.0

Well Log

Top	Bottom	Formation
0.0	9.0	CLAY
9.0	35.0	SANDROCK, BRN
35.0	55.0	LS, ULTRA HARD
55.0	59.0	SOFT SHALE & MUD SEAM, GRAY
59.0	75.0	GREEN SHALE & REDROCK
75.0	84.0	BRN SANDROCK
84.0	94.0	GRAY SHALE & SANDY SHALE
94.0	124.0	SANDROCK, WATER
124.0	145.0	DK SHALE

145.0	187.0	SANDROCK
187.0	197.0	LS
197.0	204.0	SANDROCK & SANDY SHALE
204.0	212.0	LIME & GREEN SHALE, LITE
212.0	299.0	LS
299.0	325.0	LS & CRACK, WATER

Comments MC, NEIGHBOR & SIGN VERIFIED, PH 8.0, HARDNESS 11, IRON LOW

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40761	3 MI E OF KOLEEN	Nov 09, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RONNIE CRAIG	R R 3 BLOOMFIELD IN 47424	
Driller	MUMMA DRILLING INC	R R 2 BOX 131 SUNNYSIDE RD WASHINGTON IN 47501	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SW of the SW of the NW of Section 7 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 250.0 **Ft S of NL:** 2500.0
Ground elevation: 565.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 525.0 **Aquifer elevation:**
UTM Easting: 517913.0 **UTM Northing:** 4313237.0

Well Log

Top	Bottom	Formation
0.0	25.0	CLAY
25.0	40.0	MUD SEAMS
40.0	50.0	SANDROCK
50.0	80.0	SHALE
80.0	98.0	SANDY SHALE
98.0	130.0	LIME
130.0	132.0	SHALE
132.0	165.0	LIME
165.0	166.0	SHALE
166.0	190.0	LIME

Comments MC, NEIGHBOR & MAILBOX VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40762	2.5 MI S OF JCT 45 & 54, ABOUT 1.5 MI W, CLIFTY MEMORIAL ASSOC., AT EDGE OF WOODS 100' W OF CK, HOUSE JUST E OF CREEK, HILL BEHIND CHURCH	Aug 06, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLIFTY MEMORIAL ASSOCATION		
Driller	MUMMA BROS DRILLING CO	LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** 138.0 ft. **Bailer Drawdown** 190.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the NE of the NE of Section 8 **Topo map:** KOLEEN
Grant Number:
Field located by: MT **on:** Jul 06, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 635.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 620.0 **Aquifer elevation:**
UTM Easting: 520684.0 **UTM Northing:** 4313993.0

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	15.0	MUD
15.0	35.0	SANDROCK, BAD WATER
35.0	58.0	BLUE SHALE
58.0	90.0	GRAY SANDROCK
90.0	140.0	LIME, BRK, WATER
140.0	200.0	LIME, WATER

Comments VERIFIED BY NEIGHBOR, PH 7.8, IRON .1, HARDNESS 13 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40763	FROM BLOOMINGTON COME W OUT ON 54 TO 45 PAST FIRE TOWER TO 3RD STONE RD, WRIGHT RD, TURN LF 6TH HOUSE ON LF	Mar 01, 1977

Owner-Contractor	Name	Address	Telephone
Owner	AUDREY BENNETT	R R 1 SPRINGVILLE IN	
Driller	PHILLIPS WELL DRILLING	R 1 BOX 305 SPRINGVILLE IN	
Operator	JUNIOR PHILLIPS	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 157.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 107.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the SE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 1000.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 524025.0 **UTM Northing:** 4312780.0

Well Log

Top	Bottom	Formation

Comments FATHER VERIFIED, 25' N OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40764	5 MI N OF OWENSBURG, 3 MI W OF BETHEL CHRISTIAN CHURCH, WRIGHT RD	May 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VINCE JACKSON	SPRINGVILLE IN	
Driller	LOUIE O SMITH	R 1 BEDFORD IN	
Operator	LOUIE O SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 115.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SW of the SE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2050.0 **Ft N of SL:** 700.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 670.0 **Aquifer elevation:**
UTM Easting: 523650.0 **UTM Northing:** 4312709.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	68.0	SS
68.0	75.0	BLUE SS
75.0	125.0	HARD SS

Comments MC; OWNER VERIFIED, 15' W OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40765	1.25 MI S OF VILLAGE HOBBIEVILLE IN	Apr 10, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SAMUEL F LYNN	R R 1 SPRINGVILLE IN	
Driller	HAROLD JACKSON		
Operator	HAROLD JACKSON	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 162.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 110.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NW of the NW of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: RJS **on:** Jan 29, 1964
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 4100.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 825.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 820.0 **Aquifer elevation:**
UTM Easting: 524635.0 **UTM Northing:** 4313725.0

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	110.0	BRN SS
110.0	135.0	RED SHALE
135.0	162.0	BLUE LS

Comments MC 820

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40766	1.5 MI S OF HOBBYVILLE BY THE BETHEL CHRISTAIN CHURCH	Sep 30, 1964

Owner-Contractor	Name	Address	Telephone
Owner	GUY KEISTER	PLAINFIELD IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	DEAN & NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 260.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 79.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** 195.0 ft. **Bailer Drawdown** 260.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SW of the NW of the SE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: MT **on:** Jul 06, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2300.0 **Ft N of SL:** 1900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 764.0 **Aquifer elevation:**
UTM Easting: 525158.0 **UTM Northing:** 4313120.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	39.0	SANDROCK & MUD SEAMS
39.0	52.0	LIME
52.0	57.0	MUD SEAMS
57.0	79.0	SOFT SHALE
79.0	90.0	SANDROCK, SANDY SHALE
90.0	100.0	GREEN SHALE
100.0	106.0	RED ROCK
106.0	130.0	SANDROCK, SANDY SHALE
130.0	190.0	BLUE SHALE

190.0	215.0	LIME
215.0	220.0	LIME & SHALE, WATER
220.0	260.0	LIME

Comments OWNER VERIFIED, PH 7.8, IRON .1 PPM, HARDNESS 6 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40772	3 MI N OF BLOOMINGTON & CRANE GATE ON HWY 45 & .25 MI W, APPROX .4 MI W OF SR 45 ON S SIDE OF 425 S, WRIGHT RD, BACK A LANE	Feb 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOSEPH JACOB	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 455.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 71.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of the NW of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: BER **on:** Feb 16, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1300.0 **Ft S of NL:** 1600.0
Ground elevation: 850.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 838.0 **Aquifer elevation:**
UTM Easting: 521432.0 **UTM Northing:** 4311963.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	20.0	SANDROCK & CLAY SEAMS
20.0	46.0	SOFT SHALE
46.0	53.0	LIME
53.0	62.0	SOFT SHALE
62.0	67.0	COAL & FIRECLAY
67.0	73.0	SANDY SHALE
73.0	80.0	SOFT SHALE & SANDROCK
80.0	85.0	YELL SANDROCK
85.0	95.0	BRN LIME & BRN SANDROCK

95.0	98.0	GRAY LIME
98.0	113.0	SOFT GRAY SHALE
113.0	120.0	GRAY LIME
120.0	125.0	SANDY SHALE
125.0	132.0	LIME & SHALE
132.0	165.0	YELL SANDROCK
165.0	183.0	LIME
183.0	186.0	GREEN SHALE
186.0	195.0	SANDROCK
195.0	197.0	GREEN SHALE
197.0	218.0	SANDROCK, DEAD OIL
218.0	223.0	LIME
223.0	228.0	GRAY SHALE
228.0	235.0	SANDY SHALE
235.0	260.0	SANDROCK & SANDY LIME, DEADOIL
260.0	275.0	SANDY SHALE
275.0	318.0	SANDROCK
318.0	331.0	LIME
331.0	335.0	GREEN SHALE
335.0	425.0	LIME
425.0	431.0	GRAY SHALE LT
431.0	455.0	LIME

Comments MC838, OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40773	4 MI E OF COLLEEN	Feb 23, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H ADRIAN REHNER	OWENSBURG IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 20.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SW of the NE of Section 18 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 635.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 617.0 **Aquifer elevation:**
UTM Easting: 518793.0 **UTM Northing:** 4311883.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	18.0	CLAY & SANDROCK
18.0	38.0	SANDROCK
38.0	61.0	LS
61.0	80.0	RED ROCK & GREEN SHALE
80.0	95.0	GRAY & YELL SANDROCK
95.0	150.0	GRAY SANDROCK & SHALE
150.0	195.0	SANDROCK, WATER
195.0	200.0	LIME

Comments MC; OWNER VERIFIED, 20' SE OF GARAGE-BARN

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40921	45 W TO STANFORD TURN LF ON BREEDEN RD GO 4 MI TO ROCK EAST RD TURN RT GO 1.5 MI ON RT, AT CO LINE JUST W OF HEBRON CH	May 11, 1984

Owner-Contractor	Name	Address	Telephone
Owner	DAN STURGEON	R R 1 SPRINGVILLE IN	
Driller	FRED SMITH	8565 S OLD SR 37 BLOOMINGTON IN	
Company	WILLIAM WAMPLER	S KETCHAM RD	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 73.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 1.0 gpm for 12.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 64.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SE of the NE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2350.0
Ground elevation: 680.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 527492.0 **UTM Northing:** 4318350.0

Well Log

Top	Bottom	Formation
0.0	20.0	SOIL
20.0	34.0	LS, WITH HOLES
34.0	77.0	LS

Comments MC 660; WELL SE OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40944	4.3 MI S OF 54 ON 45, TURN W ON 425S WRIGHT RD, THEN .4 MI ON LF	Jun 17, 1986

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD L HENSLEY	RR3 BOX 316C BLOOMFIELD IN 47424	
Driller	FRED SMITH WELL DRILLING	8565 S SR 37 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 477.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 40.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 60

Well Capacity Test

Type of test: **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 360.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the NW of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: BEB **on:** Feb 16, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1600.0 **Ft S of NL:** 1550.0
Ground elevation: 862.0 **Depth to bedrock:** 32.0 **Bedrock elevation:** 830.0 **Aquifer elevation:**
UTM Easting: 521541.0 **UTM Northing:** 4311975.0

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	51.0	SS
51.0	75.0	SHALE
75.0	140.0	SS
140.0	175.0	SHALE
175.0	190.0	LS
190.0	331.0	SHALE
331.0	345.0	LS
345.0	477.0	LS

Comments OWNER VERIFIED; MC 830; WELL HAS LINER WITH SHALE TRAP 80' FROM BOTTOM

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40945	N AT KENTUCKY RIDGE BAPTIST CHURCH ALONG HWY 45, GO 2.75 MI N ON CR 875, HOME ON HILLSIDE ON E SIDE OF RD	May 20, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BERT CALKINS	RR 3 BOX 448 BLOOMFIELD IN	
Driller	MUMMA BROS DRILLING INC	RR1 BOX 85 LYONS IN	
Operator	DAVE MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIRO **Depth:** from 60.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NE of the NW of Section 23 **Topo map:** KOLEEN
Grant Number:
Field located by: JP **on:** May 23, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2400.0 **Ft S of NL:** 600.0
Ground elevation: 575.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 555.0 **Aquifer elevation:**
UTM Easting: 515340.0 **UTM Northing:** 4310585.0

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY & ROCKS
20.0	30.0	SOFT SHALE & LIME BKS
30.0	42.0	SOFT SHALE
42.0	46.0	REDROCK & GREEN SHALE
46.0	50.0	SANDROCK & SHALE
50.0	80.0	BRN SANDROCK
80.0	102.0	LS
102.0	115.0	GREEN SHALE & REDROCK

115.0	120.0	SANDROCK
120.0	123.0	SHALE
123.0	128.0	GREEN SANDROCK
128.0	165.0	GRAY SHALE & DARK SHALE
165.0	180.0	SANDROCK, WATER
180.0	182.0	SHALE
182.0	185.0	LS

Comments MC 555

APPENDIX M – INDIANA BAT WINTER HIBERNACULA SURVEY

Reconnaissance of Caves in West-Central Indiana, As Part of Tier-2 Environmental Impact Investigations Of Winter Hibernacula of the Indiana Bat (*Myotis sodalis*) For the Proposed Interstate-69 Transportation Corridor

Final Report
To Bernardin, Lochmueller and Associates, Inc.
August 22, 2005

From the
Indiana Geological Survey
Bloomington, Indiana

Principal Investigators:
Samuel Frushour and Denver Harper

Reconnaissance of Caves in West-Central Indiana, as Part of Tier-2 Environmental Impact Investigations of Winter Hibernacula of the Indiana Bat (*Myotis sodalis*) for the Proposed Interstate-69 Transportation Corridor

By **Denver Harper and Samuel Frushour, Indiana Geological Survey**

Introduction

The Indiana bat (*Myotis sodalis*) is an endangered species. As part of Tier-2 environmental impact investigations being conducted in association with the proposed Interstate-69 transportation corridor through southwestern Indiana, it was necessary to determine if any caves within 5 miles of the proposed corridor (including parts of Monroe, Greene, and Lawrence Counties) are winter hibernacula for this species. Thorough biological assessments were needed to avoid or mitigate any negative impacts of the proposed highway on the endangered species.

In summer 2004, the Indiana Geological Survey (IGS) was contracted by Bernardin, Lochmueller and Associates, Inc. (BLA) and the Indiana Department of Transportation (INDOT) to perform a reconnaissance of all known caves within the study area. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat and make recommendations regarding independent, more detailed investigations that were to be conducted later by teams of biologists.

Method

The reconnaissance began with the compilation of a database of known cave locations by Samuel Frushour (IGS). The locations were derived from various publications and from oral and unpublished reports and maps made by cave explorers over a period of decades. While a few of the locations had been derived from global positioning system (GPS) surveys, most were obtained from points plotted on 1:24,000-scale topographic quadrangle maps of the United States Geological Survey and were in the Public Land Survey System (Township, Range, and Section). The accuracy of such locations varied widely; in some cases, footage information was available, but where footage information was not available, the point was located to the center of the smallest quarter-section given.

The location information was converted from the Public Land Survey System into Universal Transverse Mercator (UTM) coordinates. Geographic information system (GIS) software was then used to convert the database into ESRI ArcGIS shapefile format and to eliminate those caves that were more than 5 miles from either side of the proposed transportation corridor. The resulting shapefile, which includes 330 points, is named "CAVES_I69_IGS" (Table 1 and Figure 1) and accompanies this report on CD-ROM. A Microsoft Excel spreadsheet derived from the shapefile's database is included in Appendix 1, and metadata for the shapefile are included in Appendix 2.

Based on knowledge of Frushour and other cave explorers with considerable Indiana experience, 96 of the caves were eliminated from consideration as winter hibernacula for the Indiana bat because they were too small, too warm in winter, too wet, or subject to flooding. Eight other records from the original database were eliminated because they were recognized as duplicate entries appearing under different cave names. Five caves could not be visited because access to the property was not granted by landowners.

Table 1. Summary of CAVES_I69_IGS Original database that was used to guide the search		
Total number of records	330	
Duplicate records	8	
Caves deemed "not worth visiting"	96	Indicated by a value of "NV" ("not visited") in the field named "Visited" and a value of "1" ("not a habitat") in the field named "Bat_Potent."
Access to property denied	5	Indicated by a value of "NV" ("not visited") in the field named "Visited" and a value of "0" (status unknown) in the field named "Bat_Potent."
Caves searched for, but not found	14	Indicated by a value of "NF" ("not found") in the field named "Visited."
Caves that were visited	207	Indicated by a value of "Y" ("yes") in the field named "Visited."

Figure 1 has been removed for confidentiality reasons related to caves.

Figure 1. Map showing final status of the search for caves in the original database (CAVES_I69_IGS). Some caves were not visited because they were known to be unsuitable as winter hibernacula, access to the property was denied, or searches were unsuccessful because of poor location data.

Beginning on July 20, 2004, field investigations were undertaken to visit each of the caves. The investigators used the locations contained in CAVES_I69_IGS to guide their search, as waypoints in GPS instruments. Fourteen of the caves were never found in the field. In most cases, failure to locate those caves can be attributed to bad location data. In addition to 207 caves from the original database, 41 caves were visited that were not part of the original database; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Also, two abandoned railroad tunnels were visited and evaluated as possible winter hibernacula.

When each cave was visited in the field, investigators determined accurate locations by using Garmin 76CS GPS instruments, photographed the caves, and made notes regarding the potential suitability of the cave as a winter hibernaculum for the Indiana bat. The evaluations for suitability as hibernacula were subjective and based upon observations by Samuel Frushour and Drew Packman (IGS) of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors. Such factors are discussed in detail in Kurta and Kennedy (2002). Five values

of potential suitability as winter hibernacula appear in the field named "Bat_Potent" in CAVES_I69_IGS: (1) "Status unknown," (2) "Not a habitat," (3) "Possible but unlikely," (4) "Possible," and (5) "Definitely a habitat."

During each visit to a cave, field investigators recorded measurements and observations on paper records referred to as "Cave and Karst Feature Reports." Selected data for visited caves were later compiled in a Microsoft Excel spreadsheet, which was subsequently converted into shapefile format. The shapefile, which is named "CAVES_I69_GPS_IGS," accompanies this report (Table 2 and Figure 2). A Microsoft Excel spreadsheet derived from the shapefile's database is included in Appendix 1, and metadata for the shapefile are included in Appendix 2. At the suggestion of personnel of the U.S. Fish and Wildlife Service, the subjective categorization of caves as potential winter hibernacula was increased from five to six values: (1) "Not a habitat," (2) "Unlikely," (3) "Weak Possible," (4) "Medium Possible," (5) "Strong Possible," and (6) "Definitely a habitat."

Table 2. Summary of CAVES_I69_GPS_IGS
Database of caves that were visited

Total number of caves that were visited		250		
New caves (not included in CAVES_I69_IGS)		41		
Railroad tunnels (not included in CAVES_I69_IGS)		2		
Evaluation of caves as potential habitat			Netted 2004	Recommended for netting 2005
	Not habitat	113	0	0
	Unlikely	61	14	3
	Weak possible	25	16	6
	Medium possible	29	21	8
	Strong possible	11	8	3
	Definite habitat	11	0	0

Figure 2 has been removed for confidentiality reasons related to caves.

Figure 2. Map showing evaluation of visited caves (CAVES_I69_GPS_IGS) as possible winter hibernacula.

During field visits, investigators also took photographs of cave openings. Selected images are included on the CD-ROM that accompanies this report.

Results

In August 2004, personnel of the IGS, in consultation with personnel of BLA and the U.S. Fish and Wildlife Service, used the evaluations contained in CAVES_I69_GPS_IGS to recommend 59 caves for intensive investigations as winter hibernacula. In CAVES_I69_GPS_IGS, these caves are indicated by a value of "Y" ("yes") in the field named "Net." Biological teams subsequently conducted mist-netting at the entrances to the recommended caves in autumn 2004 and entered and explored selected caves in winter 2004-2005. (Note that an additional cave—Cave—was also netted, but it was later determined that the cave is outside the 5-mile buffer, and so it does not appear in the database.)

In August 2005, an additional 20 caves were recommended for investigations in autumn and winter 2005. In CAVES_I69_GPS_IGS, these caves are indicated by a value of "R" ("recommended") in the field named "Net."

The results of the biological investigations will be reported separately by the responsible agencies.

Reference

Allen Kurta and Jim Kennedy (eds.), 2002, The Indiana Bat—Biology and Management of an Endangered Species: Bat Conservation International, Austin, Texas, 253 p.

Appendix 1

Spreadsheets Extracted from Shapefiles

This spreadsheet has been removed for confidentiality reasons related to caves

CAVES_I69_IGS

Explanation of fields and coded values:

UTMX83 and UTMY83: Location according to the original database. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

NOTES2004: Explanation of why a cave was not found or not visited, or identification of a cave that was re-named or identified as a duplicate of another record.

VISITED:

NF = Not found, even though an attempt was made to find the cave.

NV = Not visited, either because access to the property was denied (Bat_Potent = 0) or because the cave was deemed not worthy of visiting (Bat_Potent = 1).

Y = Yes, the cave was visited by field investigators of IGS.

BAT_POTENT:

0 = Status unknown.
1 = Not a habitat.
2 = Unlikely habitat.
3 = Possible habitat.
4 = Definitely a habitat.

CAVES_I69_GPS_IGS

Explanation of fields and coded values:

CAVE_NAME: Name of the cave. The designation of "New Cave" indicates that the cave was not included in the original database.

DATE_VISIT: The date on which the cave was visited by field investigators of IGS.

FLAG_ID: The unique identification number assigned to the cave by IGS field investigators. The alphanumeric identification consists of the date visited (MM/DD/YYYY), followed by the initials of the individual who completed the "Cave and Karst Feature Report" (SF, Samuel Frushour; DP, Drew Packman; DH, Denver Harper), followed by a number indicating the sequence in which the cave was visited on that day.

UTMX83 and UTMY83: Location obtained in the field by field investigators of IGS using GPS instruments. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

PARK_X and PARK_Y: Location of parking area that was used by IGS field investigators. These locations may not necessarily provide the best access to the cave. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

ENT_SIZE_F: Entrance dimensions of the cave (in feet).

AIRFLOW: Qualitative estimate of airflow

IND_BAT_HAB: Subjective evaluation by Samuel Frushour or Drew Packman of the likelihood that the cave serves as a winter hibernaculum for *Myotis sodalis*. Values include: "No," "Unlikely," "Weak Possible," "Medium Possible," "Strong Possible," and "Definite."

NET: A value of "Y" indicates that the cave was investigated by biological teams (mist netting and possibly cave exploration) in autumn and winter, 2004-2005). A value of "R" indicates that the cave was recommended for intensive biological investigation in autumn and winter, 2005-2006.

HAB_NOTE: Notes regarding suitability of the cave as a winter hibernaculum.

Appendix 2

Metadata for Shapefiles

Metadata for CAVES_I69_IGS

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Indiana Geological Survey (IGS)
      Originator: Samuel Frushour (Data collection)
      Originator: Denver Harper (Data collection and GIS compiler)
      Originator: Drew Packman (Data collection)
      Originator: Chris Dintaman (Data collection and GIS compiler)
      Originator: Chris Walls (Data collection)
      Originator: Chris Parks (Data collection)
      Publication_Date: 20050804
      Title:
        CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Environmental Impact Investigation for a Proposed
        Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile)
      Geospatial_Data_Presentation_Form: Vector digital data
      Publication_Information:
        Publication_Place: Bloomington, Indiana
        Publisher: Indiana Geological Survey
      Other_Citation_Details:
        The Microsoft Excel database from which this shapefile was derived was compiled by Samuel Frushour of the Indiana Geological Survey. This shapefile was produced in association with another shapefile named "CAVES_I69_GPS_IGS."
  Description:
    Abstract:

        CAVES_I69_IGS is a point shapefile that shows the distribution of caves in southwestern Indiana that are located within 5 miles of a transportation corridor associated with a proposed extension of Interstate 69 from Indianapolis to Evansville, Indiana. The locations of the caves are derived from a database that was compiled by Samuel Frushour (Indiana Geological Survey). The accuracy of these locations varies greatly because the data were collected over a period of decades from various sources, including oral and unpublished written reports, as well as published material.

        As part of the Tier-2 environmental impact investigation of the proposed corridor, as many of the caves as possible were visited by personnel of the Indiana Geological Survey. The investigators used the locations contained in this shapefile to guide their search, as waypoints in GPS instruments. When the investigators found a cave, they collected more accurate locational data by using the GPS instruments. Those more accurate coordinates were used to create an associated shapefile named "CAVES_I69_GPS_IGS."

    Purpose:
        The purpose of this shapefile was to assist researchers in locating caves within a 5-mile buffer around a proposed extension of Interstate 69 through southwestern Indiana as part of a Tier-2 environmental impact investigation.
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 1959
        Ending_Date: 20050804
    Currentness_Reference: Publication date
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: None planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -86.8621

East_Bounding_Coordinate: -86.5000
North_Bounding_Coordinate: 39.2617
South_Bounding_Coordinate: 38.9058
Keywords:
Theme:
Theme_Keyword_Thesaurus: Metadata Service Keyword Thesaurus
Theme_Keyword: geoscientificInformation
Theme:
Theme_Keyword_Thesaurus: IGS Metadata Keyword Thesaurus
Theme_Keyword: Indiana Geological Survey (IGS)
Theme_Keyword: cave
Theme_Keyword: caves
Theme_Keyword: karst
Theme_Keyword: Interstate 69 (I69)
Theme_Keyword: Indiana bat
Theme_Keyword: Myotis sodalis
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Indiana
Place_Keyword: Greene County
Place_Keyword: Lawrence County
Place_Keyword: Monroe County
Access_Constraints:
This file is available to anyone, but access may be contingent on written request, specific terms relevant to the agency or person making the request, and (or) current freedom of information statutes in the state of Indiana.
Use_Constraints:
INDIANA GEOLOGICAL SURVEY DATA DISCLAIMER
This data set is provided by Indiana University, Indiana Geological Survey, and contains data believed to be accurate; however, a degree of error is inherent in all data. This product is distributed "AS-IS" without warranties of any kind, either expressed or implied, including but not limited to warranties of suitability of a particular purpose or use. No attempt has been made in either the designed format or production of these data to define the limits or jurisdiction of any federal, state, or local government.

These data are intended for use only at the published scale or smaller and are for reference purposes only. They are not to be construed as a legal document or survey instrument. A detailed on-the-ground survey and historical analysis of a single site may differ from these data.

CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:

Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Native_Data_Set_Environment: ESRI ArcGIS version 9.1 shapefile format, approximately 65 Kb

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The locations of the caves are derived from a database that was compiled by Samuel Frushour (Indiana Geological Survey) from various publications and from oral and unpublished reports and maps by various cave explorers over a period of decades. While a few of the locations were derived from GPS surveys, most were obtained from points plotted on 1:24,000-scale USGS topographic quadrangle maps. The coordinates estimated from those points were compiled into a database and converted from the Public Land Survey System into UTM coordinates using Geographix software.

Evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) are highly subjective and based upon observations by Samuel Frushour and Drew Packman of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors.
Logical_Consistency_Report:
Subjective evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) were made by either of two different field investigators (Samuel Frushour and Drew Packman).
Completeness_Report:
This shapefile includes all cave locations contained in the database provided by Samuel Frushour that are situated within 5 miles of the transportation corridor for the proposed extension of Interstate 69.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Most of the locations were obtained from hand-plotted points on 1:24,000-scale USGS topographic quadrangle maps. Geographix software was then used to convert the locational data from the Public Land Survey System to UTM coordinates. In some cases footage information was available, and this was used in the conversion. Where footage information was not available, the point was located to the center of the smallest quarter-section given. A few of the locations were derived from GPS surveys.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: Not a factor in the production of this shapefile.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Indiana Geological Survey
Publication_Date: Unpublished material
Title: None
Geospatial_Data_Presentation_Form: Tabular digital data
Publication_Information:
Publication_Place: Bloomington, Indiana
Publisher: Indiana Geological Survey
Type_of_Source_Media: Tabular digital data

Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1959
Ending_Date: 20040611
Source_Currentness_Reference: 20040611
Source_Citation_Abbreviation: DRAFTI69CavesJuneil2004.xls
Source_Contribution: Cave locations
Process_Step:
Process_Description:
A Microsoft Excel spreadsheet named "DRAFTI69CavesJuneil2004.xls" was obtained from Samuel Frushour, Indiana Geological Survey. This spreadsheet contained records for 378 caves. Although the spreadsheet contained locational information in the Public Land Survey System (Township, Range, and Section), the coordinate information had previously been processed using Geographix software, so that the spreadsheet also contained coordinate information in Universal Transverse Mercator (UTM) Zone 16, NAD27.

The spreadsheet was opened and saved as a TXT file, which was then added to an ESRI ArcView project. The "Add Event Theme" and "Convert to Shapefile" functions were then used to create a shapefile. ESRI ArcToolbox was then used to convert the shapefile from NAD27 to NAD83.

Except for the field giving the names of the caves, all the fields in the shapefile were deleted, new fields were added, and the shapefile was saved as "Caves_I69_IGS."
Source_Used_Citation_Abbreviation: PDRAFTI69CavesJuneil2004.xls
Process_Date: 20040701
Source_Produced_Citation_Abbreviation: CAVES_I69_IGS.SHP
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Process_Step:
Process_Description:
This metadata file was pre-parsed and parsed using CNS (Chew and Spit, v. 2.6.1) and MP (Metadata Parser, v. 2.7.1) software written by Peter N. Schweitzer (U.S. Geological Survey). The errors generated by MP were all addressed and corrected, except that no values were assigned to "Abscissa_Resolution" and "Ordinate_Resolution."
Process_Date: 20050805
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper

Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Point
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
Point_and_Vector_Object_Count: 330

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 16
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -87.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: Row and column
Coordinate_Representation:
Abscissa_Resolution:
Ordinate_Resolution:
Planar_Distance_Units: Meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: GRS 80
Semi-major_Axis: 6378137.0000000
Denominator_of_Flattening_Ratio: 298.26

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: CAVES_I69_IGS.DBF
Entity_Type_Definition: Shapefile Attribute Table
Entity_Type_Definition_Source: None
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry
Attribute_Definition_Source: ESRI software generated

Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features
Attribute:
Attribute_Label: Cave_name
Attribute_Definition: Name of the cave
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Utmx83
Attribute_Definition: X-coordinate (UTM Zone 16, NAD83) of the feature, as derived from a database compiled by Samuel Frushour of the Indiana Geological Survey
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 514179.64
Range_Domain_Maximum: 543138.89
Attribute:
Attribute_Label: Utmy83
Attribute_Definition: Y-coordinate (UTM Zone 16, NAD83) of the feature, as derived from a database compiled by Samuel Frushour of the Indiana Geological Survey
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 4306437.76
Range_Domain_Maximum: 4345823.52
Attribute:
Attribute_Label: Notes2004
Attribute_Definition:
Miscellaneous notes regarding reasons why a cave was not visited or not found.
Also, notes regarding caves that were renamed or had multiple names.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Visited
Attribute_Definition: Has the cave been visited by field researchers?
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: NF
Enumerated_Domain_Value_Definition: Not found. At attempt was made to find the cave in the field, but the attempt was unsuccessful.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: NV
Enumerated_Domain_Value_Definition:
Not visited. There are two possible reasons why a cave was not visited --

1. The cave might not have been visited because access to the property was denied by the landowner (this is indicated by a value of "0" in the field named "Bat_Potent").

2. The cave was not considered to be worth visiting for evaluation as a potential bat hibernaculum, as determined by Samuel Frushour, based upon his knowledge of the feature (this is indicated by a value of "1" in the field named "Bat_Potent").
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey

Enumerated_Domain:
Enumerated_Domain_Value: Y
Enumerated_Domain_Value_Definition:
Yes. The cave has been visited by field investigators of the Indiana Geological Survey. More detailed information that was recorded during the visit can be obtained from the shapefile named "CAVES_I69_GPS_IGS.SHP."
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Attribute:
Attribute_Label: Bat_potent
Attribute_Definition:
Subjective evaluation of field investigators regarding the suitability of the cave as possible winter hibernaculum for the Indiana bat (Myotis sodalis).
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 0
Enumerated_Domain_Value_Definition:
Unknown status. The cave has not been visited by field researchers of the Indiana Geological Survey, and there is no preexisting information that disqualifies the feature as a possible winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition:
No. The cave is definitely not suitable as a winter hibernaculum for the Indiana bat (Myotis sodalis). This evaluation may be based on either (1) field observations by researchers of the Indiana Geological Survey, or (2) prior knowledge by Samuel Frushour of the Indiana Geological Survey.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 2
Enumerated_Domain_Value_Definition:
Possible but unlikely. Based on field observations by researchers of the Indiana Geological Survey, it is unlikely that the cave serves as a winter hibernaculum for the Indiana bat (Myotis sodalis), but the possibly cannot be entirely ruled out.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 3
Enumerated_Domain_Value_Definition:
Possible. Based on field observations by researchers of the Indiana Geological Survey, the cave may serve as a winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 4
Enumerated_Domain_Value_Definition:
Definite. The cave is known to serve as a winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Publication Sales

Contact_Position: Publication Sales Coordinator
Contact_Address:
Address_Type: Mailing and physical address
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City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Resource_Description: Downloadable data

Distribution_Liability:
CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

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Metadata_Date: 20050804
Metadata_Review_Date: 20050805
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address

Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Metadata_Standard_Name: FGDC CSDGM
Metadata_Standard_Version: FGDC-STD-001-1998

Metadata for CAVES_I69_GPS_IGS

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Indiana Geological Survey (IGS)
      Originator: Samuel Frushour (Data collection)
      Originator: Denver Harper (Data collection and GIS compiler)
      Originator: Drew Packman (Data collection)
      Originator: Chris Dintaman (Data collection and GIS compiler)
      Originator: Chris Walls (Data collection)
      Originator: Chris Parks (Data collection)
      Publication_Date: 20050804
      Title:
        CAVES_I69_GPS_IGS: Caves in Southwestern Indiana that Were Visited by Field Researchers as part of a Tier-2 Environmental Impact Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile)
      Geospatial_Data_Presentation_Form: Vector digital data
      Publication_Information:
        Publication_Place: Bloomington, Indiana
        Publisher: Indiana Geological Survey
      Other_Citation_Details: This shapefile was produced in association with another shapefile named "CAVES_I69_IGS."
  Description:
    Abstract:
      CAVES_I69_GPS_IGS is a point shapefile that shows the distribution of caves in southwestern Indiana that are located within 5 miles of a transportation corridor associated with a proposed extension of Interstate 69 from Indianapolis to Evansville, Indiana, and that have been visited by field researchers. The locations of the caves are derived from GPS measurements made by the researchers during their visits.

      Also, the investigators made notes and subjectively evaluated the suitability of each feature as a possible winter hibernaculum for the Indiana bat (Myotis sodalis). Their evaluations were subsequently used to identify and prioritize caves for later biological investigations.
    Purpose:
      The purpose of this shapefile was to assist researchers in prioritizing subsequent biological investigations of caves as winter hibernacula within a 5-mile buffer around a proposed extension of Interstate 69 through southwestern Indiana.
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 20040720
        Ending_Date: 20050804
    Currentness_Reference: Publication date
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: None planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -86.8621
      East_Bounding_Coordinate: -86.5000
      North_Bounding_Coordinate: 39.2617
      South_Bounding_Coordinate: 38.9058
  Keywords:
    Theme:

Theme_Keyword_Thesaurus: Metadata Service Keyword Thesaurus
Theme_Keyword: geoscientificInformation
Theme:
Theme_Keyword_Thesaurus: IGS Metadata Keyword Thesaurus
Theme_Keyword: Indiana Geological Survey (IGS)
Theme_Keyword: cave
Theme_Keyword: caves
Theme_Keyword: karst
Theme_Keyword: Interstate 69 (I69)
Theme_Keyword: global positioning system (GPS)
Theme_Keyword: tools and techniques
Theme_Keyword: Indiana bat
Theme_Keyword: Myotis sodalis
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Indiana
Place_Keyword: Greene County
Place_Keyword: Lawrence County
Place_Keyword: Monroe County
Access_Constraints:
This file is available to anyone, but access may be contingent on written request, specific terms relevant to the agency or person making the request, and (or) current freedom of information statutes in the state of Indiana.
Use_Constraints:
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CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_GPS_IGS: Caves in Southwestern Indiana that Were Visited by Field Researchers as part of a Tier-2 Environmental Impact Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
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City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208

Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Native_Data_Set_Environment: ESRI ArcGIS version 9.1 shapefile format, approximately 65 Kb

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The locations of the caves were obtained from field-averaged measurements that were made using hand-held Garmin 76CS GPS units.

Evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) are highly subjective and based upon observations by Samuel Frushour and Drew Packman of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors.
Logical_Consistency_Report:
Subjective evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalist) were made by either of two field investigators (Samuel Frushour and Drew Packman).
Completeness_Report:
This shapefile includes locations for 269 cave openings that were visited by field researchers. These caves are all situated within 5 miles of the transportation corridor for the proposed extension of Interstate 69.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: Plus or minus 10 meters.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: Not a factor in the production of this shapefile.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Indiana Geological Survey
Publication_Date: Unpublished material
Title: Cave and Karst Feature Report
Geospatial_Data_Presentation_Form: Paper field notes
Publication_Information:
Publication_Place: Bloomington, Indiana
Publisher: Indiana Geological Survey
Type_of_Source_Media: Paper
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20040720
Ending_Date: 20050804
Source_Currentness_Reference: 20050804
Source_Citation_Abbreviation: Cave and Karst Feature Reports
Source_Contribution:
Cave locations and observations by Sam Frushour and Drew Packman
regarding suitability of caves as winter hibernacula for the Indiana bat (Myotis sodalis).
Process_Step:
Process_Description:
A Microsoft Excel spreadsheet named "Caves_I69_GPS_IGS.xls" was compiled from field notes by Samuel Frushour and Drew Packman (IGS). These field notes contained measurements of cave locations and the locations where the researchers parked their vehicles before visiting the caves

(derived from hand-held Garmin 76CS GPS units), as well as a unique identification number for each cave. The field notes also contain observations regarding the dimensions of the cave, air flow directions and outside temperatures, moisture conditions, susceptibilities to flooding, and miscellaneous other notes. In most cases, the caves were not entered by the field researchers; when caves were entered, notes were taken regarding the presence of bats and other conditions.

Source_Used_Citation_Abbreviation: Cave and Karst Feature Reports
Process_Date: 20050804
Source_Produced_Citation_Abbreviation: Caves_I69_GPS_IGS.xls
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays

Process_Step:
Process_Description:
Caves_I69_GPS_IGS.xls was opened and saved as a tab-delimited TXT file, which was then added to an ESRI ArcView 3.3 project. The "Add Event Theme" and "Convert to Shapefile" functions were then used to create a shapefile named "CAVES_I69_GPS_IGS."

Source_Used_Citation_Abbreviation: CAVES_I69_GPS_IGS.xls
Process_Date: 20050630
Source_Produced_Citation_Abbreviation: CAVES_I69_GPS_IGS.SHP
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Process_Step:
Process_Description:

This metadata file was pre-parsed and parsed using CNS (Chew and Spit, v. 2.6.1) and MP (Metadata Parser, v. 2.7.1) software written by Peter N. Schweitzer (U.S. Geological Survey). The errors generated by MP were all addressed and corrected, except that no values were assigned to "Abscissa_Resolution" and "Ordinate_Resolution."
    Process_Date: 20050805
    Process_Contact:
      Contact_Information:
        Contact_Person_Primary:
          Contact_Organization: Indiana Geological Survey
          Contact_Person: Denver Harper
        Contact_Position: Geologist
        Contact_Address:
          Address_Type: Mailing and physical address
          Address: 611 North Walnut Grove
          City: Bloomington
          State_or_Province: Indiana
          Postal_Code: 47405-2208
          Country: USA
        Contact_Voice_Telephone: 812-855-1369
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        Contact_Electronic_Mail_Address: dharper@indiana.edu
        Hours_of_Service: 0800 to 1700 Eastern Standard Time
        Contact_Instructions: Monday through Friday, except holidays

Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Point
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Point
      Point_and_Vector_Object_Count: 250

Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Planar:
      Grid_Coordinate_System:
        Grid_Coordinate_System_Name: Universal Transverse Mercator
        Universal_Transverse_Mercator:
          UTM_Zone_Number: 16
          Transverse_Mercator:
            Scale_Factor_at_Central_Meridian: 0.999600
            Longitude_of_Central_Meridian: -87.000000
            Latitude_of_Projection_Origin: 0.000000
            False_Easting: 500000.000000
            False_Northing: 0.000000
      Planar_Coordinate_Information:
        Planar_Coordinate_Encoding_Method: Row and column
        Coordinate_Representation:
          Abscissa_Resolution:
          Ordinate_Resolution:
        Planar_Distance_Units: Meters
    Geodetic_Model:
      Horizontal_Datum_Name: North American Datum of 1983
      Ellipsoid_Name: GRS 80
      Semi-major_Axis: 6378137.0000000
      Denominator_of_Flattening_Ratio: 298.26

Entity_and_Attribute_Information:
  Detailed_Description:
    Entity_Type:
      Entity_Type_Label: CAVES_I69_GPS_IGS.DBF
      Entity_Type_Definition: Shapefile Attribute Table
      Entity_Type_Definition_Source: None
    Attribute:
      Attribute_Label: Shape
      Attribute_Definition: Feature geometry
      Attribute_Definition_Source: ESRI software generated
      Attribute_Domain_Values:
        Unrepresentable_Domain: Coordinates defining the features
    Attribute:
      Attribute_Label: Cave_name
      Attribute_Definition: Name of the cave
      Attribute_Definition_Source: Indiana Geological Survey
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field
    Attribute:
      Attribute_Label: Date_Visit
      Attribute_Definition:
        The date (MM/DD/YYYY) on which the cave was visited by field researchers of
        the Indiana Geological Survey.
      Attribute_Definition_Source: Indiana Geological Survey
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field
    Attribute:
      Attribute_Label: Flag_ID
      Attribute_Definition:
          The identification number of flagging that was placed near the cave opening by
          field researchers of the Indiana Geological Survey. The number consists of the date (MMDDYY),
          followed by the initials of a member of the visiting research team. The initials are as follows: SF,
          Sam Frushour; DP, Drew Packman; DH, Denver Harper. The number that appears after the initials
          indicates the sequence in which the cave was visited on that day.
      Attribute_Definition_Source: Indiana Geological Survey
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field
    Attribute:
      Attribute_Label: Utmx83
      Attribute_Definition:
        X-coordinate (UTM Zone 16, NAD83), as determined using a hand-held Garmin 76CS
        GPS unit.
      Attribute_Definition_Source: Indiana Geological Survey
      Attribute_Domain_Values:
        Range_Domain:
          Range_Domain_Minimum: 514171
          Range_Domain_Maximum: 541494
    Attribute:
      Attribute_Label: Utmy83
      Attribute_Definition:
        Y-coordinate (UTM Zone 16, NAD83), as determined using a hand-held Garmin 76CS
        GPS unit.
      Attribute_Definition_Source: Indiana Geological Survey
      Attribute_Domain_Values:
        Range_Domain:
          Range_Domain_Minimum: 4305977

Range_Domain_Maximum: 4345819
Attribute:
Attribute_Label: Park_X
Attribute_Definition:
X-coordinate (UTM Zone 16, NAD83) of the location where the field researchers parked their vehicle, as determined using a hand-held Garmin 76CS GPS unit.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 514209
Range_Domain_Maximum: 541285
Attribute:
Attribute_Label: Park_Y
Attribute_Definition:
Y-coordinate (UTM Zone 16, NAD83) of the location where the field researchers parked their vehicle, as determined using a hand-held Garmin 76CS GPS unit.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 4306078
Range_Domain_Maximum: 4345697
Attribute:
Attribute_Label: Ent_Size_F
Attribute_Definition: Estimated dimensions (in feet) of the cave opening.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Airflow
Attribute_Definition:
Subjective evaluation of air flow through the cave opening at the time the cave was visited.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Ind_Bat_Ha
Attribute_Definition:
Subjective evaluation by Samuel Frushour or Drew Packman (IGS) regarding the possible suitability of the cave as a winter hibernaculum for the Indiana bat (Myotis sodalis). Values in increasing likelihood of suitability are as follows -- "No," "Unlikely," "Weak Possible," "Medium Possible," "Strong Possible," "Definite."
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Net
Attribute_Definition: Has the cave been netted by field biology teams?
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: blank
Enumerated_Domain_Value_Definition: No, the cave has not been netted by field biology teams.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: Y

Enumerated_Domain_Value_Definition: Yes, the cave was netted by field biology teams in 2004.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: R
Enumerated_Domain_Value_Definition: The cave was recommended for netting in 2005.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Attribute:
Attribute_Label: Hab_Notes
Attribute_Definition:
Notes by Samuel Frushour or Drew Packman (IGS) regarding the possible suitability of the cave as a winter hibernaculum for the Indiana bat (Myotis sodalis).
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Publication Sales
Contact_Position: Publication Sales Coordinator
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-7636
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Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Resource_Description: Downloadable data

Distribution_Liability:
CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_GPS_IGS: Caves in Southwestern Indiana that Were Visited by Field Researchers as part of a Tier-2 Environmental Impact Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).
WARRANTY
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Metadata_Reference_Information:
  Metadata_Date: 20050804
  Metadata_Review_Date: 20050805
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Indiana Geological Survey
        Contact_Person: Denver Harper
      Contact_Position: Geologist
      Contact_Address:
        Address_Type: Mailing and physical address
        Address: 611 North Walnut Grove
        City: Bloomington
        State_or_Province: Indiana
        Postal_Code: 47405-2208
        Country: USA
      Contact_Voice_Telephone: 812-855-1369
      Contact_Facsimile_Telephone: 812-855-2862
      Contact_Electronic_Mail_Address: dharper@indiana.edu
      Hours_of_Service: 0800 to 1700 Eastern Standard Time
      Contact_Instructions: Monday through Friday, except holidays
  Metadata_Standard_Name: FGDC CSDGM
  Metadata_Standard_Version: FGDC-STD-001-1998

APPENDIX N – POLLUTANT LOADING ESTIMATE TABLES AND FHWA METHODOLOGY

Exhibit 1 has been removed for confidentiality reasons related to karst.

Exhibit 2 has been removed for confidentiality reasons related to karst.

Exhibit 3 has been removed for confidentiality reasons related to karst.

Exhibit 4 has been removed for confidentiality reasons related to karst.

Exhibit 5 has been removed for confidentiality reasons related to karst.

Exhibit 6 has been removed for confidentiality reasons related to karst.

FHWA HIGHWAY RUNOFF WATER QUALITY TRAINING COURSE

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

Estimated Time for Section:

The CONTENT of this Section

This section introduces impact prediction techniques developed by FHWA and others to assess highway runoff water quality impacts. Several specific procedures will be introduced either by lecture or by case study problems. Specific methods include estimating the highway runoff impact, maintenance practice impacts, groundwater impacts, and aquatic system impacts. Also, a brief overview of water quality models which have been developed to assess the impact of nonpoint pollution on watersheds relative to highway runoff will be provided.

The GOAL of this Section

Participants will become familiar with predicting quality changes in water quality parameters associated with highway runoff water quality.

The PURPOSE of this Section

To introduce participants to different qualitative and quantita- tive techniques for predicting highway runoff water quality impacts.

Listing of Sessions — Time

Session 8.1	Impact Procedures and Data Requirements
Session 8.2	Introduction to Highway Runoff Pollutant Characteristics Predictive Procedures
Session 8.3	Prediction of Pollutant Loadings and Runoff Concentrations on Highway Surfaces - Case Study
Session 8.4	Prediction of Loading Impacts of Highway Runoff - Case Study
Session 8.5	Prediction of Maintenance Impacts
Session 8.6	Prediction of Groundwater Impacts
Session 8.7	Aquatic System Impacts
Session 8.8	Introduction to Water Quality Models for Predicting Water Quality Impacts

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.1: IMPACT PROCEDURES AND DATA REQUIREMENTS

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be introduced to a procedure for the assessment of effects of stormwater runoff from operating highways on receiving waters.
- Be introduced to a general procedure for evaluating potential impacts of highway maintenance practices on water quality.
- Know what data may be required to assess impacts of highway stormwater runoff on quality.

SESSION OVERVIEW:

This session introduces general procedures for assessing potential water quality impacts of highway stormwater runoff and maintenance practices. The specific methods will be introduced in later sessions. An overview of data required to assess water quality impacts of highway stormwater runoff is also presented.

I. INTRODUCTION

Data requirements to assess the need to conduct impact analysis or the potential effects of highway operations on surface water quality are identified in Table 8.1.1. This check list may be supplemented by site-specific data requirements.

II. ASSESSMENT OF HIGHWAY STORMWATER RUNOFF IMPACTS

Determining the need to assess the impact of highway stormwater runoff and the level of analysis depends on a number of factors. Selected factors include:

- The amount of traffic anticipated or currently traveling on the highway.
- The proximity of the highway site to receiving waters and their designated uses (e.g., drinking water, recreation, etc).
- Local and state requirements for control of nonpoint and stormwater point sources.
- Climatic factors, such as frequency and intensity of rainfall.
- The ratio of impervious surface to total watershed area upstream of project site.
- Local controversy.

Figure 8.1.1, illustrates a procedure for assessment of effects of stormwater runoff from operating highways on receiving waters. The first step in the procedure involves determining the anticipated impacts and/or the degree of controversy involved. Possible criteria useful in making the determination are:

- Traffic volumes in excess of 30,000 ADT.
- The highway site located near receiving stream where low dilutive capacities exist.
- Direct discharge of highway runoff to poorly flushed areas of lakes, wetlands, or coastal embayments.

If the decision is made to conduct an analysis, then either a seasonal/annual pollutant loading analysis or an event analysis should be made.

Table 8.1.1. Data for assessing water quality impacts of highway stormwater runoff.

Highway Design Features
- Length
- Number of lanes and lane widths
- Type of access
- Access ramps or intersecting roads
- Paving material
- Type of section(s) involved (at grade, cut, fill)
- Slopes (longitudinal and side)
- Median characteristics (width, paving, barrier type)
- Shoulder characteristics (width, paving, barrier type)
- Characteristics of area outside the shoulders but within the right-of-way (dimensions, topography, vegetation)
- Total impervious surface area

Operating Conditions
- Design average daily traffic (ADT)
- Projected vehicle composition
- Expected daily, weekly and seasonal traffic patterns
- Anticipated average speeds and braking characteristics
- Summary of applicable accident and spill data (from records on similar highways

Drainage System Characteristics (to the extent available during environmental assessment)
- Channel types (closed conduit, paved open channel, bare open channel, vegetated open channel, unchanneled overland flow, etc.)
- Channel dimensions and slopes
- Soils and vegetation characteristics in flow path
- Discharge points
- Collection systems (type, dimensions and spacings of drop boxes, etc.)
- Design flow rates

Hydrologic Characteristics
- Average annual precipitation (rain and snow) and monthly distribution of precipitation
- Receiving water and ground water data --
  - Streams (base flow, annual average flow, peak flow, flood plain maps)
  - Lakes and reservoirs (surface area, mean depth, water residence time)
  - Wetlands (surface area)
  - Groundwater (locations of aquifers, recharge characteristics)
- Summary of available data on point and nonpoint source flows in the watershed

Water Quality and Aquatic Biological Data

- Summary of available receiving water and groundwater monitoring data (water quality; microflora; microfauna, aquatic plants, benthic macroinvertebrates; fish populations, migrations and spawning areas)
- Sensitive or unique habitats
- Threatened and endangered species
- Summary of available data on effluent quality of sources in the watershed
- Beneficial use classification
- Established water quality criteria

Surrounding Land Use Characteristics
- Total watershed area
- Percentage of total area in each land use category (organized as in Tables 3 and 4)

Projected Highway Maintenance Characteristics
- Sanding application (quantity, frequency, particle size description)
- Deicing agent application (type, quantity, frequency, additives used)
- Pesticide application (type, quantity, frequency, toxicity)
- Roadway maintenance (sweeping, washing)
- Right-of-way maintenance (mowing, ditch cleaning, fertilizing, irrigation)

Description of Special Features
- Construction on woodwaste fill
- Detention basins
- Oil and grease traps
- Other mitigative features

Source: Horner et al., 1982

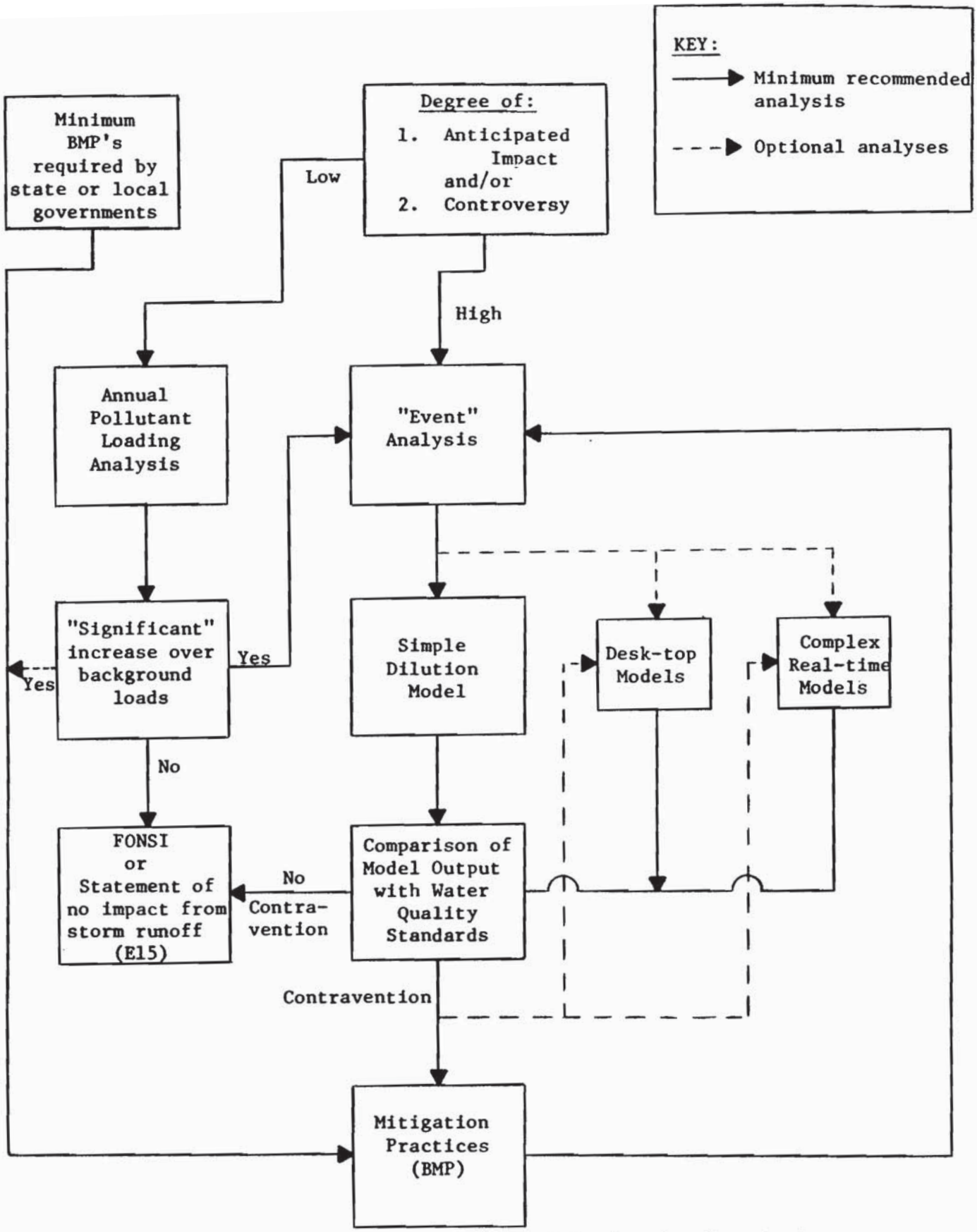


Figure 8.1.1. Simplified procedure for determining levels of analysis required to assess affects of stormwater runoff from operating highways on receiving streams.

Source: Dupuis and Kobriger, 1985.

A. SEASONAL/ANNUAL ANALYSIS

The seasonal/annual analysis determines the highway pollutant loadings relative to other loadings in the watershed. This seasonal/annual pollutant loading analysis may include either a simple determination of loadings (in pounds/yr), or the increase in stream pollutant concentration, using seasonal/annual highway pollutant input and mean flow conditions as a first cut on whether potential water quality problems may occur.

B. EVENT ANALYSIS

If the seasonal/annual analysis indicates the potential for more elaborate analysis, an event analysis may require using predictive model procedures or a simple dilution procedure. The assumption implied in dilution models are conservative, and if they show a standards exceedance, violations are not likely to appear under more exacting conditions.

If a more complex modeling effort is required, several models have been developed that provide the necessary level of analysis. In the majority of cases, these complex, real-time dynamic models would not need to be used.

Which ever approach is used, the results are compared with state water quality standards or, if standards have not been established, then the results may be compared with water quality criteria, to determine if mitigation is required.

Because of the variety of pollutants in highway stormwater runoff and the limited knowledge of the chemical, biological and physical impacts, any results may be subject to a considerable amount of uncertainty. The approaches presented in this section of the training course are intended to provide reasonable estimates of impacts based on the available information to date, and to provide highway agencies with the qualitative and quantitative procedures to make prudent planning decisions regarding highway stormwater runoff and water quality.

III. ASSESSMENT OF MAINTENANCE IMPACTS

Assessment of highway maintenance practice impacts is generally dependent on the extent and magnitude of the activity and its proximity to receiving waters. Session 2.1 provided an overview of when maintenance activity impacts should be assessed. Maintenance activities with potential impacts on water quality that need to be addressed are identified in Figure 8.1.2 with a general impact assessment method or procedure. This method is based on methods which are described in

Sessions 8.5 and 8.7. As with many procedures, it contains some subjective aspects relative to determining potentially significant impacts. It is intended to quantify, to the extent possible, selected maintenance impacts relative to the resource value of the stream, and to evaluate when mitigation measures are warranted. Specific aspects of this general method will be described in later sessions.

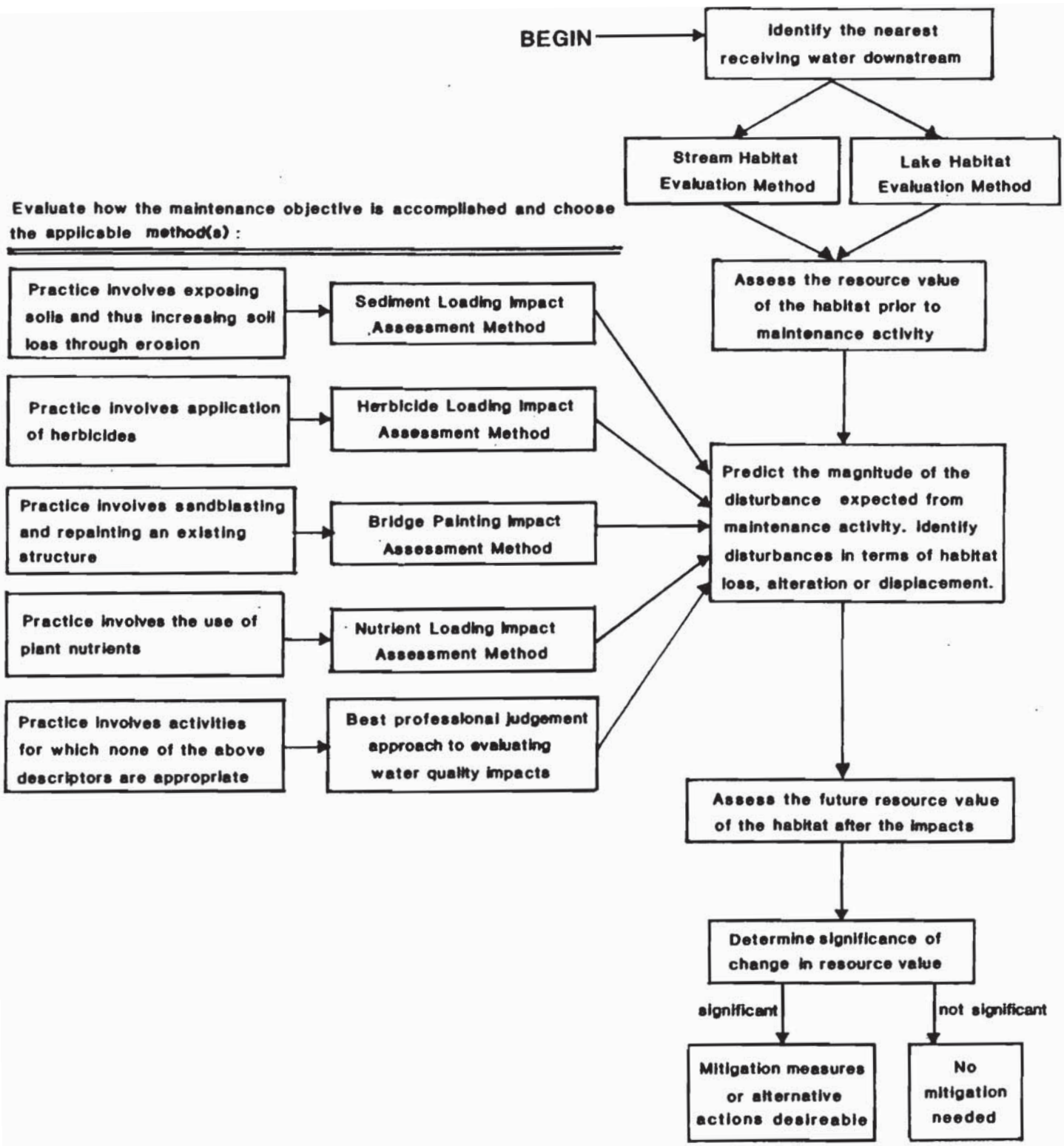


Figure 8.1.2. General impact assessment method for evaluating potential impacts to water quality from highway maintenance practices.

Source: Kramme et al., 1985

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.2: INTRODUCTION TO HIGHWAY RUNOFF POLLUTANT CHARACTERISTICS PREDICTIVE PROCEDURES

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be familiar with the sections of FHWA's Predictive Procedure for Determining Pollutant Characteristics in Highway Runoff.
- Be familiar with other prediction methods developed to estimate highway runoff pollutant characteristics.
- Be knowledgeable about the limitations of the methods presented.

SESSION OVERVIEW:

A lecture will introduce the components of FHWA's Predictive Procedure not previously presented. Also, a brief overview of alternative methods will be examined to determine how they differ from FHWA's Procedure. The limitation of each method will also be discussed.

I. FHWA PREDICTIVE PROCEDURE

A. INTRODUCTION

Previous sessions presented selected components of FHWA's procedure on rainfall evaluation and highway runoff evaluation. An overview of the entire manual procedure and a detailed description of the procedure's remaining component follows. The model procedure is computerized both for mainframe and for personal computer.

The development of the procedure is based upon the monitoring program conducted in 1976 and 1977 at sites in Milwaukee, Wisconsin; Harrisburg, Pennsylvania; Nashville, Tennessee; and Denver, Colorado. Complete details of the monitoring programs can be found in Kobriger et al. (1981c).

B. PURPOSE

The predictive procedure offers highway designers and other interested parties a simplified tool to estimate the quantity and quality of storm generated highway runoff. It consists of a series of equations which can be solved manually or by computer. The procedure is composed of four components corresponding to the following functions:

- Rainfall runoff
- Pollutant build-up
- Pollutant wash-off
- Constituent loadings

The predictive procedure can be used for Environmental Impact Statements (EIS) or to determine the loadings for pollutant discharge effects of various design storms at a particular site. The predictive procedure is not meant to be an all-inclusive model which predicts hydrographs and concentrations versus time, but rather an easy-to-use method of determining the total volume of runoff and total pounds of a pollutant discharged from a highway area. The highway area under consideration is defined as the paved roadway and total nonpaved area which contribute to a particular discharge point.

In addition to EIS applications, the procedure evaluates existing highway systems. Thus, the effects of increased traffic, changes in the curb or barrier configuration, or modifications to the nonpaved area can be determined as they relate to the total pollutant loading. Design storm analyses can be conducted on an existing highway drainage area using the predictive procedure. The pollutant loadings, as predicted for these storms, can then be used to evaluate different water quality impacts through mass balance or modeling analyses. In this manner, the pounds of a pollutant discharged from a highway drainage area can be compared to other pollutant sources within the watershed.

C. GENERAL OVERVIEW

In order to use this method, the following information is required:

- Rain event data including date, total rainfall, estimated rainfall duration, and number of dry days between rainfall events
- Average Daily Traffic (ADT)
- Length of highway expressed as miles
- Drainage area above the point of discharge expressed as acres
- Estimated initial pollution levels expressed as pounds
- Total solids accumulation rate (optional, since the rate may be estimated based on ADT)

All of the above information is readily available to the highway engineer and water quality scientist.

Figure 8.2.1 provides an overview of the FHWA procedure.

1. Pollutant Accumulation Equation

The pollutant accumulation equation of the predictive model is as follows:

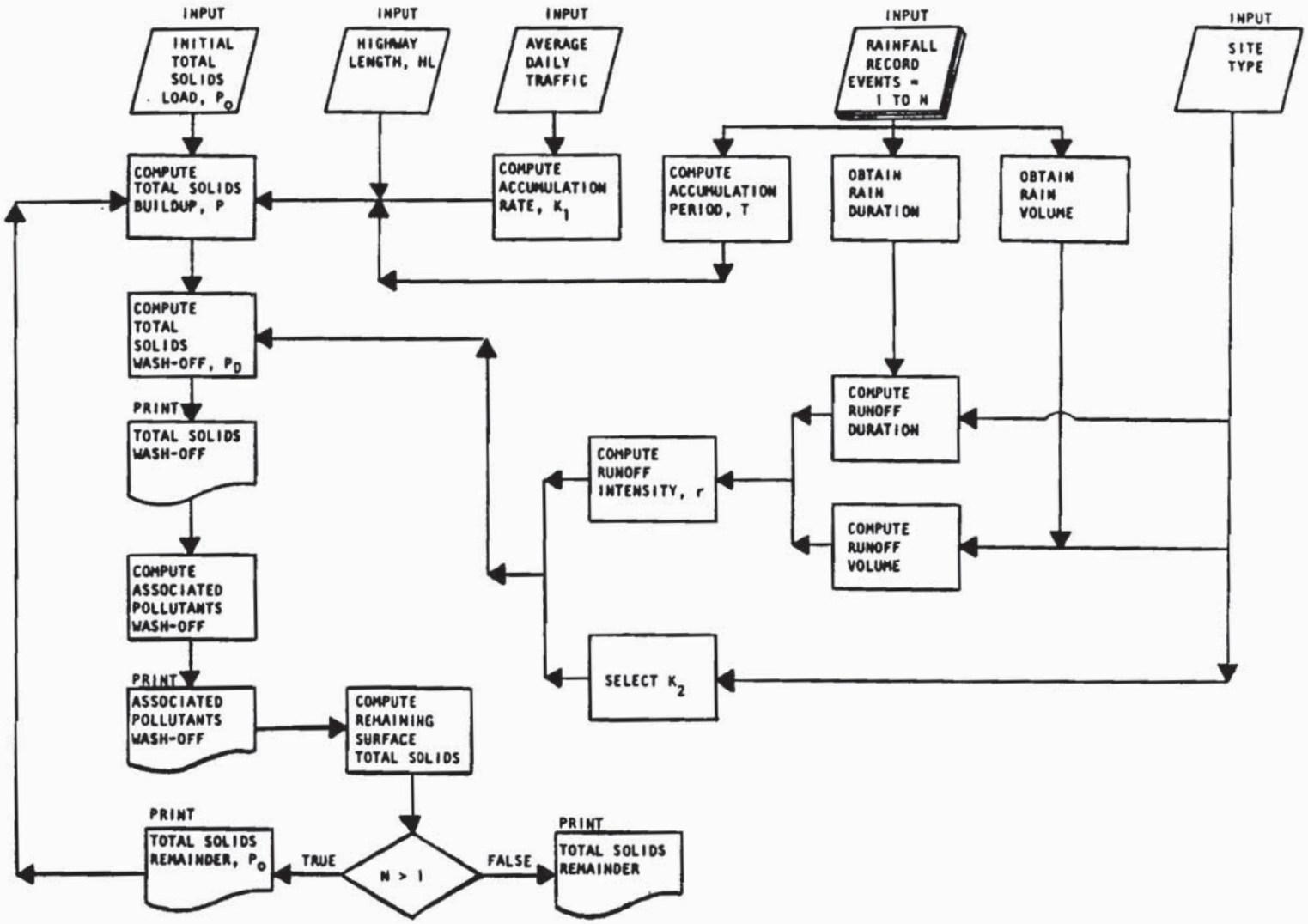
$$P = P_o + (K_1 * HL * T) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:
P = pollutant level after build-up, lb (kg)
P_o = initial surface pollutant load, lb (kg)
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
T = time of accumulation, days (20 day maximum)
HL = highway length, mi (km)

This model predicts the highway surface pollutant load (P) which accumulates during a selected time period (T) at a specified rate (K_1). Surface pollutants accumulate on the surface of all-paved sites (e.g., elevated bridge sections) and on the paved and unpaved surfaces of highway sections which have right-of-way areas (e.g. gravel shoulders, grassy areas, etc.). For purposes of the predictive model, pollutant load refers to that fraction of the total highway load available for wash-off.

The monitoring data from this study were "end-of-the-pipe" wash-off data, which are not a direct measure of pollutant build-up. Therefore, monitoring data could not be used to establish whether pollutant build-up

Figure 8.2.1 Predictive flow diagram



Source: Gupta, M.K. et al., 1981c

on highways is linear, exponential, or another mathematical function. The pollutant accumulation equation assumes that pollutants build up linearly during the accumulation period. This equation is similar to that used in Storage, Treatment, Overflow, Runoff Model (STORM) from Abbott (1976), which is based on a linear pollutant build-up relationship developed from a study on urban runoff in Chicago.

The surface pollutant accumulation variable K_1 is the rate at which the carrier pollutant, total solids, accumulates in pounds per mile per day (kg/km/day). A carrier pollutant exhibits the highest degree of association with all other pollutants being considered. In many mathematical models, the predicted quantity of carrier pollutant is used to estimate the quantity of all other pollutants being modeled. This method eliminates the need for each pollutant to be predicted separately by the model, greatly reducing the number of calculations required. Total solids were chosen as the carrier pollutant for the predictive model developed in this study, because they showed the highest correlation with the other monitored quality parameters when regression analyses were performed. The term total solids (TS) refers to total suspended solids (TSS) plus total dissolved solids (TDS). Under the new nomenclature of Standard Methods, total solids as used in this study, are defined as total residue.

K_1 was developed from monitored data, and is expressed as pounds per mile - day (kg/km-day). The unit miles refers to the actual length of highway section in the contributing drainage area. This is in contrast to curb mile or lane mile, which is a multiple of the highway length. K_1 is site specific, and its value may be based upon actual monitoring data, if it exists, or estimated from average daily traffic. K_1 estimation based on average daily traffic is discussed at the end of this section.

The initial surface pollutant load (P_o) is the pounds of pollutants on the surface at the beginning of the accumulation period. The accumulation period can be intervals within an actual rainfall record, intervals within a series of design storms, or the period prior to a single design storm event.

If an accumulation period follows a large storm event, the initial surface pollutant load will be considered zero (P_o=0). The definition of a large storm is based upon that used in the Stormwater Management Model (SWMM) for the rate of pollutant removal during a storm event. For purposes of the predictive procedure, a large storm event is defined as one with greater than one inch (2.54 cm) of total rainfall, and having at least one hour in which the average intensity is 0.5 inches per hour (1.27 cm/hr). For such a storm, SWMM estimates that approximately 90 percent of the surface pollutants available for wash-off have been removed.

For succeeding rainfall events in a continuous rainfall record, P_o is the surface pollutant load remaining after wash-off from the previous rainfall event. For rainfall records which do not follow a large storm event or for design storms, the initial surface pollutant load must be estimated using a site specific K_1 value, site length, and a specified period of build-up or estimate. An analysis of monitored wash-off data and rainfall records during the subject study suggests that dry periods greater than 20 days over-estimate the surface load; therefore, any dry periods exceeding 20 days are assumed to equal 20. The initial surface pollutant load for a site with a K_1 of 80, and a site length of 5 miles would be:

$$80 \frac{\text{lbs}}{\text{mi-day}} * 5 \text{ mi.} * 20 \text{ days} = 8{,}000 \text{ lbs } (3{,}629 \text{ kg})$$

Any rainfall less than 0.05 inches (0.13 cm) is considered a trace of rain not producing runoff of sufficient volume and rate to effect pollutant wash-off. Figure 8.2.2. indicates the relationship between pollutant build-up and rainfall intensity and volume.

The minimum runoff duration that can be used in calculating average runoff intensity is 0.5 hours. Short duration flows, less than 0.5 hours, are often the result of small storms producing less than 0.1 inches (.25 cm) of flow. Using the high average runoff rates calculated from such storms gives more weight to the pollutant wash-off ability of a small storm that occurs. For this reason, all storms used in the predictive procedure were considered to have a duration of at least 0.5 hours, eliminating overestimates of total solids wash-off for short duration storms. For example, a storm producing 0.05 inches (.12 cm) of runoff in 0.17 hours (10 minutes) would have an average runoff rate calculated using an adjusted runoff duration of 0.5 inch/hr as follows:

$$\begin{aligned} \text{Average runoff rate} &= 0.05 \text{ inch of flow} \div 0.5 \text{ hours} \\ &= 0.10 \text{ inch/hr } (0.25 \text{ cm/hr}) \end{aligned}$$

Otherwise, the average rate calculated from the actual runoff duration (0.17 hr) would be 0.29 inch/hr (0.73 cm/hr) and would cause a large overprediction of pollutant wash-off.

2. K_1 Variable

The total solids accumulation rate (K_1) varies from location to location. Selected K_1 previously reported in the literature are indicated in Table 8.2.1.

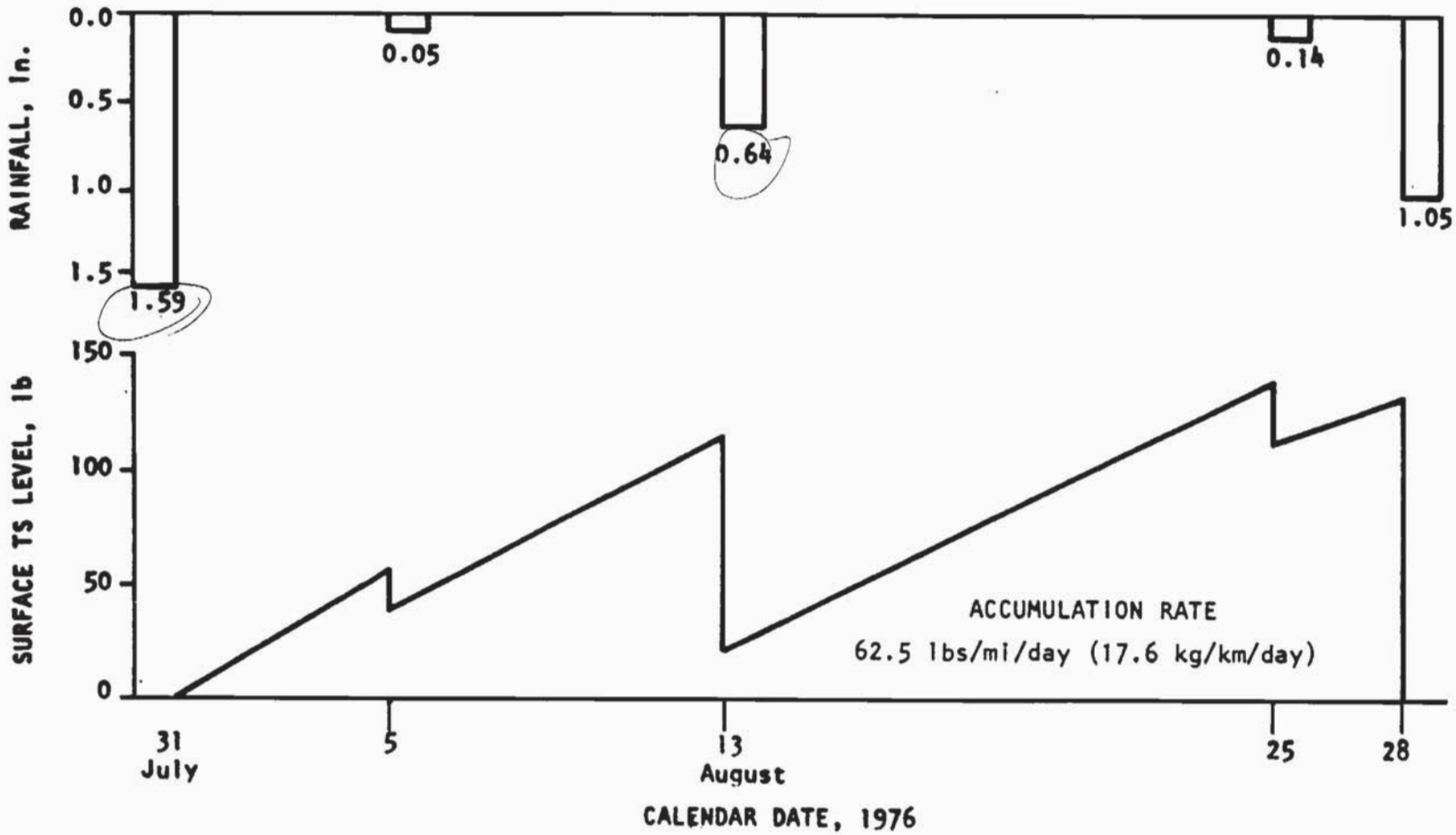


Figure 8.2.2. **Surface total solids level, Milwaukee - Hwy I-794.**

Table 8.2.1. Published K_1 values

Total solids accumulation rate, lb/mi-day	Location	Solids collection Techniques	Reference
1,580	Chicago City Sts.	Sweeping	American Public Works Association, 1969
1,180	11 U.S. City Sts.	Combined sweeping and flushing	Sartor, J.D. and G.B. Boyd, 1972
10.4	Seattle Highway	Runoff analysis	Sylvester, R.O. and F.B. DeWalle, 1972
382	Washington, D.C.	Vacuuming and	Shaheen, D.G., 1975
69.4	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973
26.6	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973a
236.9	Milwaukee (non-winter)	Mass balance for TS 250	Kobriger, N.P., 1984

metric units: lb x 0.454 = kg
mi x 1.609 = km

The total solids accumulation rate was correlated with ADT for the sites included in the monitoring study (Figure 8.2.3). As a result, it is possible to calculate the appropriate solids build-up rate using the following equation, when site specific rates are not available:

$$K_1 = (ADT^{0.89})\ 0.007$$

3. Wash-Off Coefficient (K_2)

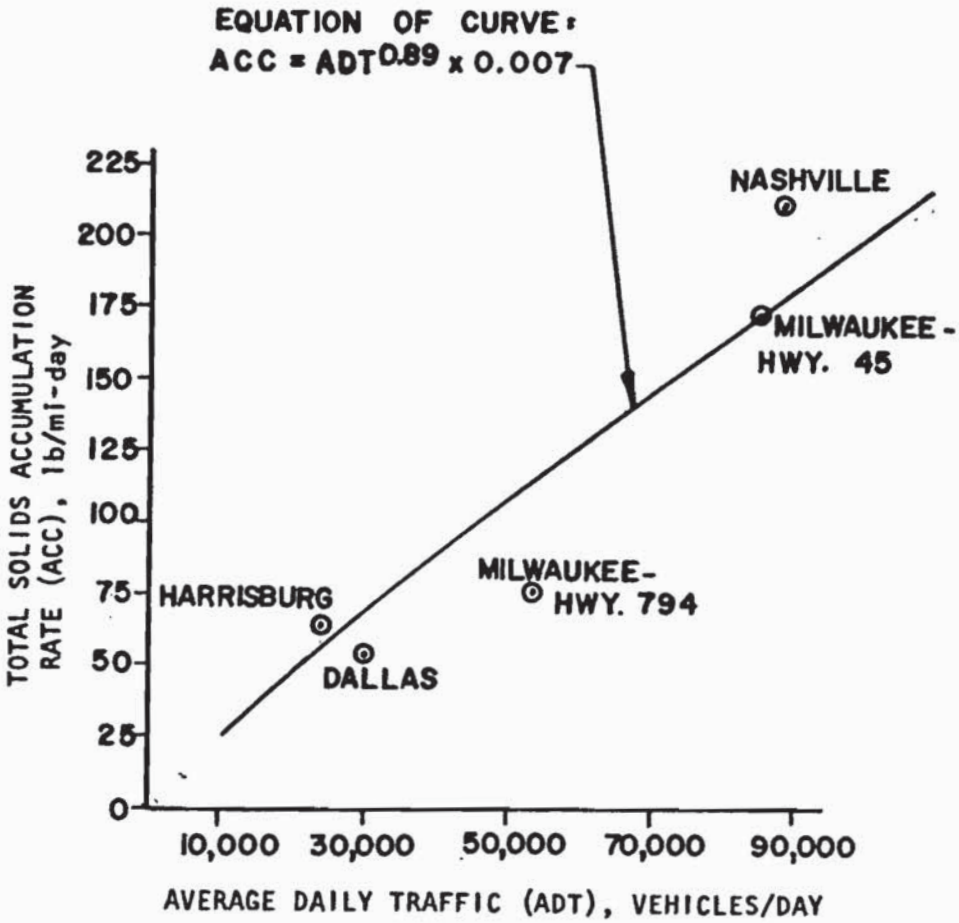
The coefficient K_2 is used in the predictive procedure to remove a portion of the carrier pollutant from the surface of the drainage area. The general wash-off equation in the Corps of Engineer STORM model and U.S. EPA Stormwater Management Model (Huber, 1975) is used as part of this procedure.

$$P_D = P\ (1-e^{-K_2 r})$$

Where: P_D = pounds (kilograms) of pollutant discharged
P = surface load at start of the runoff event.
K_2 = wash-off coefficient
r = average runoff rate, in./hr. (cm/hr)

For purposes of the predictive procedure, a single K_2 value is required for each of the three site categories. Based upon the comparison of individual K_2 values with actual monitoring data, a K_2 value of 6.5 represents sites which contain some curb or barrier, structured drainage, and grassy right-of-way (Type II). A value of 12 represents a rural, flush shouldered site (Type III) which uses grassy

Figure 8.2.3. Selected total solids accumulation rates versus average daily traffic



Source: Kobriger, N.P. et al., 1981

ditch conveyance for the surface runoff. A K_2 value of 5.0, selected for the Type I site, will be used for elevated bridge decks which are completely paved.

The Type III site requires the highest K_2 value in order to wash-off larger amounts of the pollutant load per runoff volume than other sites. This site type's flush shoulder and the nonpaved drainage conditions probably account for the high, since the grassy areas adjacent to the roadway require more pollutant wash-off per event to remove the pollutant load. The Type I site has the lowest K_2 value, indicating that pollutant wash-off is easier from a site that is all paved than a site with both paved and unpaved areas (Type II and III).

4. Constituent Loadings

The final component of the predictive procedure transforms the pounds of total solids washed off into pounds of lead, COD, suspended solids, or any other of the 16 quality constituents available in the model. The prediction of heavy metals, nutrients, solids and other parameters for individual storm events rely upon linear regression equations for predicting each parameter as a function of the total solids load for each site (Tables 8.2.2 and 8.2.3).

For example, the determination of the COD load for the Milwaukee I-794 site is as follows:

$$COD\ (lb) = 0.202\ TS + 5.47$$

where: TS = total solids in pounds

The asterisk in Tables 8.2.2 and 8.2.3 next to equations indicates significance at the 95 percent confidence limits (1). This indicates that one can be 95 percent confident that the sample was not selected from a population for which no correlation exists (i.e., that the correlation coefficient R is equal to zero). An equation may still provide good estimates even if the variables in that equation do not show a significant correlation at the 95 percent confidence level (Gupta et al., 1981c). An equation developed using regression techniques is the best fit of the data being analyzed.

The predictive procedure uses a separate constituent equation for each general site type. Individual equations account for differences between site drainage and solids retention characteristics.

D. PREDICTIVE PROCEDURE RESULTS

Table 8.2.4. summarizes the application results of the procedure to the five monitoring sites, plus a sixth site not included in the development of the procedure.

Table 8.2.2 Constituent equations developed for Type I and Type III sites.

Parameter		Type I Milwaukee I-794	Type III Harrisburg I-40
SS	=	0.53TS - 3.2*	0.32TS - 36.8*
VSS	=	0.191TS + 0.2*	0.061TS-3.3*
TVS	=	0.221TS + 13.3	0.32TS - 32.3*
TKN	=	3.3×10^{-3} TS + 0.16	3.1×10^{-3}TS+ 0.55*
BOD	=	0.023TS + 1.5*	N/A
TOC	=	0.057TS + 0.80*	0.068TS - 5.85*
COD	=	0.202TS + 5.47*	0.087TS + 0.65*
TN	=	1.37×10^{-3} TS + 0.12	1.83×10^{-3} TS+0.054*
TPO_4	=	1.0×10^{-3} TS + 3.0×10^{-4}	2.15×10^{-3}TS - 0.245
Cl^-	=	0.034TS + 2.59	0.135TS + 2.6*
Pb	=	5.6×10^{-3}TS - 0.024	4.1×10^{-4}TS - 0.029*
Zn	=	8.4×10^{-4}TS + 0.014	2.67×10^{-4}TS-0.011*
Fe	=	0.015TS + 0.59	0.014TS - 1.61*
Cu	=	2.9×10^{-4}TS+7.3×10^{-4}	7.4×10^{-5}TS+8.78×10^{-3}*
Cd	=	1.4×10^{-4}TS-1.4×10^{-3}	4.0×10^{-5}TS+0.007
Cr	=	1.6×10^{-4}TS+1.2×10^{-3}	2.3×10^{-4}TS-0.028
Hg	=	-7.6×10^{-7}TS+8.8×10^{-4}	-5.8×10^{-6}TS+0.015*

Note: TS = total solids (lb)
* - Variables correlate at the 95 percent confidence level.
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.3 **Constituent equations developed for Type II sites.**

Parameter	Equation
SS	$0.63TS - 188$
VSS	$0.152TS + 13.5$
TVS	$0.263TS + 243$
TKN	$5.46 \times 10^{-3}TS + 1.28$
BOD	$3.0 \times 10^{-2}TS + 28.3$
TOC	$5.6 \times 10^{-2}TS + 25.2$
COD	$0.193TS + 275.3$
TN	$1.3 \times 10^{-3}TS + 0.713$
TPO_4	$2.25 \times 10^{-3}TS - 0.32$
Cl	$0.042TS + 87$
Pb	$1.02 \times 10^{-3}TS + 0.04$
Zn	$5.84 \times 10^{-4}TS + 0.103$
Fe	$1.96 \times 10^{-2}TS - 5.0$
Ni	N/A
Cu	$3.16 \times 10^{-4}TS + 0.064$
Cd	$4.16 \times 10^{-5}TS + 0.021$
Cr	$4.3 \times 10^{-5}TS + 0.036$
Hg	$2.44 \times 10^{-6}TS + 1.006 \times 10^{-6}$

Note: TS = total solids (lb)
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.4. Summary of Model Versus Actual Monitored Non-Winter Total Pollutant Loads Used to Develop the Predictive Procedures (except the Dallas Site)

Site Location	Total Solids, lb	Suspended Solids, lb	TPO_4, lb	COD, lb	Lead, lb[1]	Iron, lb
Milwaukee I-794						
Actual	1,862	570	1.03	271	5.17	22.94
Predicted	1,640	658	0.86	245	4.55	20.66
Predicted vs. Actual %	-11.9	+15.4	-16.5	-9.6	-12.0	-10.0
Milwaukee Hwy 45						
Actual	55,024	29,123	34.76	6,863	53.6	929.75
Predicted	63,478	36,665	137.11	17,205	65.47	1,115.14
Predicted vs. Actual %	+15.4	+25.9	+294.4	+150.7	+22.2	+24.2
Nashville I-40						
Actual	20,273	10,692	65.81	3,909	24.76	268.06
Predicted	23,325	11,369	30.62	6,294	24.53	367.97
Predicted vs. Actual %	+15.1	+6.3	-53.5	+61.0	-1.0	+37.3
Harrisburg I-81						
Actual	3,655	767	6.43	212	1.40	31.97
Predicted	3,689	835	5.64	170	1.22	36.59
Predicted vs. Actual %	+1.0	+8.9	-12.3	-19.8	-12.9	+14.5
Denver I-25						
Actual	11,016	7,263	13.66	4,338	11.99	252.43
Predicted	15,118	7,189	27.67	7,029	16.04	231.97
Predicted vs. Actual %	+37.2	-1.0	+117.2	+62.0	+33.8	-8.1
Dallas I-45						
Actual	468	204	NA	345	1.18	5.60
Predicted	626	307	NA	169	3.32	14.10
Predicted vs. Actual %	+33.8	+50.5	-	-51.0	+181.4	+151.8

[1]Caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive procedure equation was developed.

As can be seen, the predicted versus the actual monitored data are within one order of magnitude for all values. Total solids and suspended solids in particular, are fairly close, although greater variation exists for other constituents. When predicted versus actual loadings on an event basis are compared, greater variation exists. Thus, the model is best suited for monthly or non-winter period evaluations.

The model is undergoing further evaluation and validation by FHWA in a study initiated in September, 1984, titled Design Procedures to Estimate Pollutant Loadings from Higher Stormwater Runoff. The study is to be completed in FY 1986.

E. MODEL LIMITATIONS

The predictive procedure is a tool for evaluating the effects of increased traffic, changes in the highway configuration, or other design aspects, on the loading of solids or other constituents to the receiving water.

Because of the complex interaction of rainfall, runoff and traffic on a highway, the prediction model has certain limitations. Users of the procedure are encouraged to further study the Predictive Procedures to ensure a full understanding of the components of the model and aid in the interpretation of the results (Kobriger, 1981c).

Specific limitations of the procedure are as follows:

- Geographic locations with low intensity, frequent rainfalls, e.g., Washington state, should not use this procedure. Research (Horner et al., 1982) demonstrates situations where ADT is not a valid variable to estimate pollutant accumulation on the roadway surface. This method will not be acceptable for use in California and states with similar climatic conditions.

- The procedure should be limited to non-winter periods. As such, the results will reflect only a portion of the total loadings that can be expected from a roadway. As shown in a more recent study (Kobriger, 1984), winter pollutant accumulation can be significant, although the dispersion is more complex and highly variable.

- The predictive procedure is better suited to continuous simulation using daily rainfall records covering periods of at least one month, since it is unable to predict surface loads prior to individual events.

- The model assumes the highway area to be uniformly characterized by the three site types that are listed. Significant variations in a site may have widely varying results.

- The predicted pounds of total solids washed off during a rainfall event are dependent upon the model prediction of the surface load at the start of the storm. If the surface load is underestimated, the pounds discharged will be low.

- The use of average runoff rate to remove surface pollutants is the quickest and easiest method. Peak runoff intensities during the runoff hydrograph may be more accurate, but are too complex for this procedure.

- Long dry periods and overlapping storms present predictive problems in determining the pre-storm surface load.

- Construction activities are difficult to simulate unless monitoring data is available to determine K_1 values.

II. FHWA PROCEDURE FOE ESTIMATING POLLUTANT LOADS

1. Determine the pollutant accumulation rate for the project site being evaluated if site specific or other accumulation values are being used:

$$K_1 = (ADT^{0.89}) * 0.007$$

where: K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
ADT = average daily traffic, vehicles/day

Example: If the site has an ADT of 30,000 vehicles per day, the K_1 value that results would be:

$$K_1 = (30{,}000^{0.89}) * 0.007$$
$$= 67.6 \text{ lb/mi-day } (19.1 \text{ kg/km-day})$$

2. a. Using K_1, determine the pounds of total solids on the surface of the project site at the start of the storm event:

$$P = P_o + (K_1 * HL * T)$$

where: P_o = initial surface pollutant load, lb
P = pollutant level after build-up, lb
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
HL = highway length, mi(km)
T = time of accumulation, days (20 days maximum)

The variable P_o is a function of the amount (load) of pollutants estimated to be left on the surface after the last rainfall event. If more than one event is being evaluated, e.g., monthly or seasonal loadings are being determined, the results of P_o are carried through the calculations on an iterative basis by subtracting the pounds washed off from the previous pollutant load. The build-up rate, K_1, is then used for each dry day to add to P_o until the pollutant load at the start of the next event is determined.

The initial estimation of a P_o is made easier if the first storm to be evaluated follows a storm of average rainfall intensity greater than 0.5 inches (1.27 cm) per hour. This large storm is assumed to wash-off essentially all of the available total solids load on the surface. The succeeding dry days are then used to build up the available surface load to the start of storm conditions. Further descriptions of P_o and K_1 are included in the components description of this report.

Example: If the accumulation period is six days, the highway length is 6.5 miles, K_1 is 67.6 16/mi-day (19.1 kg/km-day) (predicted from the ADT of 30,000 vehicles/day) and P_o is zero (assume accumulation period started with a large storm). The pollutant level after build-up (P) would be:

$$
\begin{aligned}
P &= P_o + (K_1 * HL * T) \\
&= 0.0 + (67.6 \text{ lb/mi-day} * 6.5 \text{ miles} * 6 \text{ days}) \\
&= 0.0 + (2{,}636.4 \text{ lbs}) \\
&= 2{,}636.4 \text{ lbs } (1{,}196 \text{ kg}) \text{ of total solids available at the start of event number one.}
\end{aligned}
$$

b. If a large rainfall event does not occur at the beginning of the initial accumulation period of the month or period being evaluated, P_o must be estimated. One method is to evaluate local climatic data to determine the average number of dry days between rainfall events. P_o can then be estimated using the average number of dry days, K_1 and highway length.

Another approach would be to estimate the pollutant load for the first event in the period, and determine the number of dry days since the last rain event prior to the start of the event period actually being evaluated. Note: The event used to establish the accumulation period for the first event in the period or month of concern must be rainfall, not snowfall, otherwise use the first approach. Assume that $P_o = 0$. Then count the number of dry days to determine the load available for the first event for the period. This will slightly underestimate the pollutant load on the highway's surface if this previous event was less than 0.5 in./hr., since it will not account for the load left on the surface. This applies to the first approach as well.

Example (1st approach): If a large storm did not precede the initial accumulation period, and if the average number of dry days between storms was determined to be four, the estimate of P_o would be calculated as follows:

$$P_o = K_1 * HL * T$$
$$= 67.6 * 6.5 * 4$$
$$= 1{,}758 \text{ lb } (797 \text{ kg})$$

3. Calculate load wash-off using the average runoff rate (r) using the following formula:

$$P_D = P(1-e^{-K_2 r})$$

where: P_D = pollutant load discharged (total solids), lb (kg)
P = pollutant load at the storm start, lb (kg)
K_2 = wash-off coefficient r = average runoff rate - inch/hr (cm/hr)

K_2 is selected based upon site characteristics as follows:

K_2 =	Type 1	Type 2	Type 3
	5.0	6.5	12.0

Example: Assuming the site is Type II, the pounds of total solids removed would be determined as follows (P = 2,636 lbs; r = .019 in./hr, assumed here; K_2 = 6.5)

$$P_D = P(1-e^{-K_2 r})$$
$$= 2{,}636\ (1-e^{-(6.5)(0.019)})$$
$$= 306 \text{ lb of total solids discharged } (139 \text{ kg})$$

4. Calculate the surface load remaining after the storm from the above example.

$$P_o = P - P_D$$
$$= 2{,}636 \text{ lb} - 306 \text{ lbs}$$
$$= 2{,}330 \text{ lb of total solids remaining } (1{,}057 \text{ kg})$$

Thus, P_o for the next event is 2,330 lb (1,057 kg). This amount is then added to P (pollutant load after build-up that is available for washoff by next rainfall event.)

5. To calculate loadings, use the equations in Tables 8.2.2 and 8.2.3 for each pollutant of interest for each site type. The results will be expressed as pounds of pollutants discharged at the highway site for each event.

Example: From the previous example, it was determined that 306 lbs of total solids were washed off from the site. To calculate the amount of the pounds Zn washed off:

$$Zn = 5.84 * 10^{-4}TS + 0.103$$
$$= 5.84 * 10^{-4}(306) + 0.103$$
$$= .28 \text{ lbs of Zn}$$

6. Determine the average concentration of Zn in the highway runoff using the following formula (7.48 is a conversion factor to convert volume to gallons):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

Example: From the previous step, the loading of Zn was determined to be .28 lbs. Thus, the average concentration in the runoff would be (Assume Q_{cf} = 7,000):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

$$= \frac{.28 \text{ lbs} * 454{,}000 \text{ mg/lbs}}{7{,}000 \text{ cf} * 7.48 * 3.785 \text{ liters/gallon}}$$

$$= \frac{127{,}120 \text{ mg}}{198{,}182 \text{ liters}}$$

$$= .641 \text{ mg/liter of Zn in highway runoff.}$$

7. Repeat the above calculations to obtain the total solids wash-off for each event and pollutants.

III. CALIFORNIA METHOD FOR ESTIMATING

A. INTRODUCTION

Caltrans has developed a different procedure for estimating highway runoff quality (Howell et al., 1982; Kerri et al., 1985). Its method reflects the findings of studies for sites located in California:

- The number of dry days between storm events and the corresponding cumulative traffic volume before the storm were found to be not statistically significant for estimating constituent loads.

- Equations used to estimate the cumulative loads of the following pollutants were found to be statistically significant at the .05 level, on a storm event basis when:

- Correlated with vehicles during the storm: COD, Filterable Residue (Dissolved Solids), Lead (T), TKN, ZN(T).

- Correlated with total residue: COD, Nonfilterable Residue (Suspended Solids), ZN(T).

- No statistically significant correlations at the .05 level of significance were found with any of the independent variables examined: boron, cadmium, nitrate nitrogen, ammonia nitrogen, total phosphorus, dissolved orthophosphate, oil and grease. Thus, these pollutants cannot be estimated using the Caltrans procedure.

- The method is considered suitable on an event basis.

- The regression equations developed in this research can be used for calculating constituent loads from the paved travelled way and shoulder area. In order to assess the effects of the constituent load on nearby receiving waters - the load must be routed through the drainage system and ultimately to the receiving water - runoff from other sources may be encountered and must be included - highway runoff dilution factors in terms of the receiving water source must be accounted for.

B. PROCEDURE FOR USING THE REGRESSION EQUATIONS

In using the Caltran procedure the following assumptions are made:

- The vehicle fleet and fuels used are relatively the same as the years of actual data collection (1979 through 1981) to build the regression equations.

- The highway is in an urban setting.

- The drainage area of the roadway surface is between 2.00 and 3.00 acres, as this was the smallest area from which data were collected to build the equations. (HL * HW of pavement = 72<3 acres).

- The median, traveled lanes, and shoulders are 100 percent paved.

- The procedure should be used with highways having ADT exceeding 30,000 vehicles, and only when a sensitive receptor, e.g. stream, lake etc., is located adjacent to the facility.

- Runoff from the assumed drainage area is conveyed via open channels to a single point of discharge. (Runoff quantity and quality from the unpaved area adjacent to the paved area was excluded from the research.)

- The storm chosen is an annual one-day rainfall event (two-year return interval) versus actual continuous events evaluation required by FHWA procedure.

- A 24-hour storm is chosen as the storm duration, since a storm lasting 24 hours will be sufficient to wash-off the gutter load and will allow both the AM and PM peak traffic to travel through the site and contribute to the runoff load. A 24-hour storm is used because the future traffic prediction is a 24-hour value.

- A runoff coefficient of 0.90 is used to compute the cumulative runoff volume because the drainage area is completely paved.

1. Using the projected average daily traffic (ADT), compute constituent loads using the linear regression equations below which were evaluated and found to be acceptable.

Eq.1	Pb	= 14.3 + 0.00189 (ADT)
Eq.2	Zn	= 14.3 + 0.00060 (ADT)
Eq.3	FR	= 5360 + 0.140 (ADT)
Eq.4	COD	= 3590 + 0.221 (ADT)
Eq.5	TKN	= 150 + 0.00342 (ADT)

Where: Pb, Zn, FR, COD, and TKN are the cumulative loads in grams for lead, zinc, filterable residue, chemical oxygen demand, and total Kjeldahl nitrogen, respectively, the intercepts represent initial dry loads in grams, while the slopes represent the washoff of a constituent in grams per ADT during storm.

2. To forecast an annual load, divide the depth (amount) of the total annual rainfall (2-year return interval, 365-day value) for the station by the 1-day depth. The result is the theoretical number of 1-day events per year. Multiply each of the daily loads by the number of 1-day events to arrive at an annual load.

3. The flow weighted concentration is computed by dividing the daily event load determined in Step 1 (above) by the 1-day cumulative runoff volume.

4. The following linear regression equations are used to calculate nonfilterable residue loads:

Eq.6	Zn	= 11.5 + 0.00064 (TR)
Eq.7	COD	= 3600 + 0.214 (TR)
Eq.8	NR	= -760 + 0.65 (TR)

Where: TR is total residue in grams, Zn, COD, and NR are the cumulative loads in grams for zinc, chemical oxygen demand, and nonfilterable residue, respectively. The intercepts represent the initial dry loads in grams, while the slopes represent the fraction of constituent found in the total residue load washed from the pavement during the storm. Because total residue is an independent variable for which no easy future value can be obtained, the following procedure should be executed. Substitute values of the total zinc load computed from Equation 2 and the chemical oxygen demand load computed from Equation 4 in Equations 6 and 7 and compute two values of total residue. Then use the average value of total residue to compute the nonfilterable residue load using Equation 8. Compute the flow-weighted concentration as in Step 3 (above).

5. The final step is to check the computed loads and flow-weighted concentrations to make sure that the computed values are bound by the field observations. Table 8.2.5. shows the limits of the observed concentrations and loads.

Table 8.2.5. Limits of observed concentrations and loads of single events from monitored events in California.

Constituent	Concentration (mg/l)		Load (grams)	
	Low	High	Low	High
Total lead	0.17	4.10	4.0	304
Total zinc	0.10	1.80	2.0	84
Filterable residue	16	461	428	50,167
Chemical oxygen demand	23	724	382	26,344
Total kjeldahl nitrogen	0.1	14.0	34	1,070
Nonfilterable residue	18	2,660	143	55,259

Source: Howard et al., 1982

6. Final water quality assessment must be made using the values of loads and concentrations in a receiving water analysis.

C. EXAMPLE PROBLEM USING CALTRAN PROCEDURE

The following example problem is taken directly from Howell (1982) and is reproduced here to demonstrate the use of the Caltran model.

Problem: An urban freeway has been proposed for year 2005 and will have the following dimensions:

46 feet of paved median	=	46 ft
Two 10-foot wide shoulders	=	20 ft
Four 12-foot wide lanes	=	48 ft
		114 ft width

The ADT for year 2005 is 56,800 vehicles. The project will cross a river used for recreation and fishing. Trout (Salmo gairdneri) inhabit the river. Average annual rainfall for the site is 22 inches.

Make the following assumptions:

- The paved width of 114 ft and each 750 ft of freeway length will be drained to a single discharge point.
- Runoff coefficient is 0.90; thus, .90 * rainfall volume = runoff volume.
- A 24-hour storm delivers 2.06 inches of continuous rainfall.
- The vehicle fleet (and fuel used) will be the same in 2005 as it was in 1980. The vehicles are operating normally, i.e., at speeds of 55 miles per hour with no accidents or spills.

Given the above data and assumptions compute:

- The area of the assumed catchment.
- The cumulative volume of runoff (in liters).
- The loads and flow-weighted concentrations of the constituents: lead (Pb), Zinc (Zn), filterable residue (FR), chemical oxygen demand (COD), and total Kjeldahl nitrogen (TKN), and nonfilterable residue, using equations 1 through 5.

1. Area = length (ft) * width (ft) $\left(\frac{1 \text{ acre}}{43{,}560 \text{ ft}^2}\right)$ = acres

$$= 750 * 114 * \frac{1}{43{,}560} = 1.96 \text{ acres}$$

(1.96 acres approaches the lower limit of 2.0 acres, the smallest area from which data were collected to build the equations).

2. Cumulative Runoff Volume = runoff coefficient * rainfall volume

   = [0.90] * [2.06 in] * [1.96 ac] * [3630 ft^3/ac-in] [28.32 l/ft^3]

   = 373,564 call 373,500 liters

3. First, compute the load in grams using the appropriate regression equation, then compute the flow-weighted concentration (conc.) in milligrams per liter:

$$\text{conc.(mg/l)} = \frac{\text{Load (grams)}}{\text{cumulative runoff volume (liters)}} * \frac{\text{1000 milligrams}}{\text{1 gram}}$$

Eq.1	Pb	=	14.3 + 0.00189 (56,800)	
		=	121.65	122 grams
	$\overline{\text{conc.}}$	=	121.65/373,500 * 1,000	
		=	0.326	0.33 mg/l
Eq.2	Zn	=	14.3 + 0.00060 (56,800)	
		=	48.38	48 grams
	$\overline{\text{conc.}}$	=	48.38/373,500 * 1,000	
		=	0.129	0.13 mg/l
Eq.3	FR	=	5,360 + 0.140 (56,800)	
		=	13,312	13,300 grams
	$\overline{\text{conc.}}$	=	13,312/373,500 * 1,000	
		=	35.64	35.6 mg/l
Eq.4	COD	=	3,590 + 0.221 (56,800)	
		=	16,142	16,150 grams
	$\overline{\text{conc.}}$	=	16,142/373,500 * 1,000	
		=	43.22	43.2 mg/l
Eq.5	TKN	=	150 + 0.00342 (56,800)	
		=	344.26	344 grams
	$\overline{\text{conc.}}$	=	344.26/373,500 * 1,000	
		=	0.922	0.92 mg/l

Using the forecasted values of zinc (48 grams) and chemical oxygen demand (16,150 grams), an average value of total residue (TR) can be calculated using equations 6 and 7.

Eq.6 Zn = 11.5 + 0.000640 (TR)

Eq.7 COD = 3600 + 0.214 (TR)

Solve for total residue (TR):
Using (6) TR = 57,031 grams
Using (7) TR = 58,645 grams
Sum = 115,676 grams
Avg = 57,838 57,840 grams

Using Equation 8 and the average value of 57,840 grams for total residue (TR), solve for nonfilterable residue (NR):

Eq.8 NR = -760 + 0.65 (57,840)
= 36,836 grams 36,840 grams
conc. = 36,836/373,500 * 1000
= 98.62 98.6 mg/l

4. Check

The computed values within Table 8.2.5 to see if they are within the limits of the values recorded.

The results must be compared to established water quality criteria, and if any excessive values are found, mitigating measures (or transportation alternatives) may be needed.

IV. WASHINGTON STATE DEPARTMENT OF TRANSPORTATION PROCEDURE FOR WATER QUALITY IMPACTS

A. INTRODUCTION

The State of Washington has developed a procedure (Horner and March, 1982) to assess highway stormwater water quality, in-stream water quality and aquatic ecological impacts of operation highways. The procedure is based on a model (Chui et al., 1982) developed as part of an ongoing multi-year study, sponsored by the Washington Department of Transportation (WSDOT) and conducted by the Department of Civil Engineering of the University of Washington.

This model to estimate cumulative pollutant loadings is applicable when soils, climate, and land use are similar to those at the monitored highway sites used to develop the model. Thus, Oregon, Northern California, and Southern Idaho as well as Washington State, may find the model suitable for assessing the impact of highway stormwater runoff. The impact assessment component of the WSDOT procedure has been incorporated into the FHWA procedure (Session 8.4).

The model for estimating loadings differs in that it relies on vehicles during the storm (VDS) as the primarily independent variable to

estimate pollutant loads. Washington State experiences low intensity, long duration rainfall events unique to this portion of the country. This contrasts with other locations in the country where relatively intense but brief precipitation events occur. As has been shown in the State of Washington, the migration and transport of highway pollutants are more of a function of the kinetic energy provided by moving vehicles than by rainfall (Chui et al., 1982).

The model expresses cumulative runoff pollutant loadings as functions of highway geometry, drainage configuration, and, vehicles during the storm expressed as follows:

Eq.1 $TSS = (K)\ (VDS)\ (C)$

Eq.2 Pollutant loading i = (Kp_i) (TSS Loading)

where:
- TSS = loading of total suspended solids from runoff (lb/highway-mi)
- K = loading constant (lb/1000 VDS/highway-mi)
- VDS = vehicles during the storm (in thousands)
- C = runoff coefficient (ratio of runoff volume to precipitation volume)
- Kp_i = ratio of pollutant i to TSS

The model, in addition to its geographic considerations, is limited in suitability for long-term (monthly or annually) versus individual event projections. This is similar to FHWA's Predictive Procedure (Kobriger, 1981). Loadings in a given locale are highly variable on an event basis, but more constant in a longer time frame when normalized for traffic and using a runoff coefficient.

B. WSDOT ANNUAL POLLUTANT LOADING ASSESSMENT PROCEDURE

The following procedure is taken directly from Horner and Mar (1982) and represents only one portion of the procedure. If based on the initial annual analysis described in the procedure, a monthly evaluation is required and presented here as an example of another possible approach, given the restrictions previously described. It also illustrates the variations between highway sites.

1. Estimate the hr/yr during which the roadway is expected to be wet as equal to the hr/yr of recorded precipitation. The reported hr/yr of recorded precipitation ($\leq$0.01 inch) represents the mean of a number of years of data (1948-1964). Trace quantities are eliminated from consideration, since they generally do not produce runoff. The tabulated data are recommended as an estimate of the hr/yr of wet roadway, recognizing that two counteracting factors are operating: (1) the highway remains wet for some time after precipitation stops; however (2) precipitation does not necessary fall throughout a recorded hour.

2. Estimate the total annual vehicles passing during storms (VDS/yr) as follows:

$$\text{VDS/yr} = \text{ADT} \quad \frac{\text{wet hr/yr}}{\text{24 hr/day}}$$

where: ADT = projected average daily traffic on highway lanes draining to receiving water.

3. Estimate annual highway runoff TSS loading according to:

$$\text{TSS (lb/highway - mi/yr)} = (K) \quad \frac{\text{VDS/yr}}{1000} \; (C)$$

where: K = 6.4 lb TSS/highway-mi/1000 VDS for western Washington
K = 26 lb TSS/highway-mi/1000 VDS for eastern Washington
C = runoff coefficient for the site

The loading constants given apply to new highways and existing highways where traffic increase is anticipated. On existing highways the constants apply whether or not additional lanes are constructed, up to a maximum of four lanes in a single direction, representing the cases contributing to the data base (Little, 1982). With greater widths, pollutants deposited on innermost lanes may be transported less effectively into shoulder drainage, such that K would tend to decrease; however, there was no sampling to test this hypothesis.

Note: If the lanes in one direction only drain to the receiving water, adjust ADT accordingly.

4. Express total annual highway loading (L_H) by multiplying by number of highway-mi.

5. If a mitigation device such as a detention basin is provided, reduce the TSS loading according to the solids removal capability of the device. If highway runoff is discharged to receiving water via a vegetated drainage course, multiply the estimated TSS loading by the appropriate fraction as follows in Table 8.2.6 (after Wang, 1981). Interpolate as necessary.

6. Estimate annual highway loadings of other pollutants from:

$$\text{Loading (lb/yr)} = (K_p) \text{ (TSS Loading)}$$

where: K_p = ratio of pollutant P to TSS (Table 8.2.7.)
TSS Loading previously estimated

Table 8.2.6. Solids removal ability of vegetated drainage course.

Length of Vegetated Drainage Course (ft)	Fraction of Pollutant Remaining
≤30	1
31- 60	0.50
61- 90	0.40
91-120	0.30
121-150	0.26
151-180	0.23
≥180	0.20

Use the modified TSS loading in further calculations.

Source: Wang, 1981

Table 8.2.7 K_p (Pollutant:TSS Ratios) for Various Contaminants in Highway Runoff.

Pollutant	Abbreviation	K_p
Chemical Oxygen Demand	COD	$K_{COD} = 0.4$
Lead (Western Washington)	Pb	$K_{Pb} = 1.5 \times 10^{-4} + (8.7 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Pb} = 5.3 \times 10^{-4} + (2.8 \times 10^{-9})(ADT)$ (Note 1)
Zinc (Western Washington)	Zn	$K_{Zn} = 1.4 \times 10^{-4} + (3.0 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Zn} = 2.0 \times 10^{-4} + (3.2 \times 10^{-7})(ADT)$
Copper	Cu	$K_{Cu} = 7.9 \times 10^{-5} + (2.7 \times 10^{-9})(ADT)$
Nitrate + Nitrite-Nitrogen	NO_3+NO_2-N	$K_N = 2.0 \times 10^{-3}$
Total Kjeldahl Nitrogen (Western Washington)	TKN	$K_{TKN} = 2.7 \times 10^{-3}$
(Eastern Washington)		$K_{TKN} = 1.2 \times 10^{-3}$
Total Phosphorus	TP	$K_{TP} = 2.1 \times 10^{-3}$

Note: (1) Base predicted lead loading on the lead concentration in gasoline at the time in proportion to that during the years of research. During those years, the concentration was 0.13 grams/liter. That concentration is scheduled to be reduced under U.S. Environmental Protection Agency regulations, and that agency can provide information on adherence to the schedule. For estimation purposes, it should be assumed that the proportion of vehicles using leaded gasoline remains constant.

SESSION QUESTIONS:

1. Based on the different procedures, what are the major differences bewteen the predictive procedures presented?

2. What limitations restrict the use of the procedures presented?

3. In what ways may the most applicable procedure presented here be adopted to use in a particular state?

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will be able to:

- Calculate pollutant loadings from other land uses within a watershed, using the simplified method presented.
- Assess the loading impacts from the highway, relative to loadings from other land uses within the watershed.
- Recognize the problems of the method presented, and be introduced to other approaches that might be used when more sensitive analysis is required.

SESSION OVERVIEW:

One approach to assess the potential impacts of pollutant loadings from highways surfaces compares the area loadings from other land uses within the watershed to those loadings estimated from the highway right-of-way.

This session introduces a simplified procedure for conducting an impact analysis. Case Study 8.4 will be distributed and participants will complete the required analysis.

Participants will review questions at the end of the session and discuss the findings and other approaches used when more sensitive analysis is required.

8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

I. DETERMINATION OF BACKGROUND LOADINGS FOR THE DRAINAGE AREA

The following procedure is adapted from Horner and Mar (1982). This simplified procedure may be used for non-winter periods to determine background loadings for a watershed area, based on typical area pollutant loadings and typical runoff concentrations data for selected land uses reported in the literature. The actual loadings and runoff concentrations vary for each location, based on site characteristics (e.g., rural or urban), soil types, and other factors, and the results should be interpreted with caution. The procedure provides a relative indication of highway loads to background loadings, and may determine whether a more detailed evaluation using more complicated procedures is required. The steps of the procedure are:

1. If the receiving water is a stream and if a comprehensive water quality record exists for the stream, proceed to Step 2. Otherwise, go to Step 3.

2. Estimate the mean monthly loading of each pollutant transported by the stream, prior to the presence of the highway (L_s, lb/mo) according to:

$$L_s = 1{,}965\ Q_s C_s$$

where: Q_s and C_s are average quantities for the month in question.

where: Q_s = average stream discharge (cfs)
C_s = average pollutant concentration (mg/l)

The loadings for each month should be aggregated for the period, if the measured flow data are available.

Q_s may be the discharge rate determined for a specific drainage area; however, then C_s must be a flow weighted average for the same flow rate.

If the stream is gaged, obtain Q_s in the U.S. Geological Survey Water Resources Data provided for the most recent water year. If the stream is not gaged, estimate Q_s from the record of a nearby stream with similar watershed characteristics, as follows:

$$Q_s = Q_s^{\ 1} \frac{A_w}{A_w^{\ 1}}$$

where: Q_s = average discharge in runoff receiving stream (cfs)

$Q_s^{\ 1}$ = average discharge in stream of record (cfs)

A_w = runoff receiving stream watershed area (any area units)

$A_w^{\ 1}$ = stream of record watershed area (any area units)

3. Determine the areas (in acres) in Central Business District, Other Commercial, Industrial, Single-Family Residential, Multiple-Family Residential, Cropland, Pasture, and Forested and Open Land used in the watershed draining to the highway runoff discharge point located farthest downstream. If it is projected by the planning agency for the location that development will modify land uses substantially in coming years, conduct the analysis for both present and ultimate land uses.

4. Determine annual area loading (lb/acre/yr) of each contaminant for each land use in the receiving water basin from local data, if they exist, or Table 8.4.1. (Note storm runoff pollutant loadings for specific land use categories.) Where a range is given, use the lower value if a conservative estimate of highway contribution to total loading is desired; otherwise, use the midpoint of the range. If pollutant loading rates are not available for a specific pollutant, then go to Step 7.

5. Approximate the proportion of each annual area loading delivered during the month or period in question according to:

   lb/acre/mo (period)=[(hr ppt during month (period)/annual hr ppt) (lb/acre/yr)] or lb/acre/mo = []

6. Multiply loadings in lb/acre/mo by the respective acres to obtain loadings for the month (period) in question for each land use (L_{Li}). Then sum over all land uses for each pollutant (summation L_{Li}). Record results on Worksheet 8.4.a.

7. From Table 8.4.1a, determine the runoff coefficient for each land use in the watershed, above the discharge point for the project.

8. Multiply the runoff coefficient for each land use by the total seasonal rainfall for the site to obtain the runoff in inches.

9. Convert the runoff in inches to runoff volume by the following equation:

$$Q_{cf} = \frac{R \quad * \quad acres}{12 \quad * \quad 43{,}560}$$

R = runoff in inches
Q_{cf} = runoff in cubic feet

10. Convert Q_{cf} to liters by multiplying by 28.31625.

$R_L = Q_{cf} * 28.31625$

R_L = Runoff in liters

11. Determine total lbs. of pollutant by using the following equation and Table 8.4.2. Record results on Worksheet 8.4.b:

$P_{pD} = R_L * P_{conc} * 2.2046 * 10^{-6}$

where: P_{pD} = total pollutant loading
R_L = runoff volume expressed as liters
P_{conc} = pollutant concentration

12. If the receiving water is a stream, proceed to Step 13. If the receiving water is a lake or wetland, go to Step 15.

13. Estimate point source loadings (L_p) of each pollutant as follows:

L_p (lb/mo) = 1,965 Q_pC_p

where: Q_p and C_p are monthly quantities for the month in question

Q_p = point source effluent flow rate (cfs) (average over year if not continuous). Obtain flow from discharge monitoring report as required by NPDES permit or develop industry typical flow.

C_p = average point source effluent pollutant concentration (mg/l). Obtain from monitoring records or from industry typical discharge concentrations available from U.S. EPA Development Document Series for the specific point source category.

14. Estimate total stream loadings prior to highway presence as:

L_s = summation $L_{Li} + L_p$

Table 8.4.1. Storm runoff pollutant loadings for specific land use categories.

Land	Loading (lb/acre/yr)							
	TSS	COD	Pb	ZN	Cu	$+NO_3$ $_2$	TKN	TP
Central Business District	964	955	6.3	2.7	1.9	4.0	13	2.5
Other Commercial	750	906	2.7	2.9	N/A	0.6	13	2.4
Industrial	50	56	1.8-6.3	3.1-11	0.3-1.0	0.4	2-13	0.8-3.6
Single-Family Residential	15	25	0.1	0.2	0.03	0.3	1-5	0.2-1.3
Multiple-Family Residential	390	297	0.6	0.3	0.3	3.4	3-4	1.2-1.4
Cropland	402	N/A	0.004-0.005	0.03-0.07	0.01-0.05	7.0	1.5	0.3
Pasture	306	N/A	0.003-0.013	0.02-0.15	0.02-0.04	0.3	0.6	0.06
Forested	76	N/A	0.01-0.03	0.01-0.03	0.02-0.03	0.5	2.6	0.08
Open	6	1.8	N/A	N/A	N/A	0.3	1.5	0.06

NOTES:

1. Means given where available; otherwise ranges are reported.

2. N/A -- Not available. (If specific pollutant loadings are not indicated here, then, determine loadings based on mean concentration values.

SOURCE: Horner, R.R. et al., 1982.

Table 8.4.1a Values of runoff coefficients (C) for use in the runoff volume estimation.

Type of surface	Runoff coefficient (C)[a]
Rural Areas	
Concrete or sheet asphalt pavement	0.8-0.9
Asphalt macadam pavement	0.6-0.8
Gravel roadways or shoulders	0.4-0.6
Bare earth	0.2-0.9
Steep grassed areas (2:1)	0.5-0.7
Turf meadows	0.1-0.4
Forested areas	0.1-0.3
Cultivated fields	0.2-0.4
Urban Areas	
Flat residential, with about 30 percent of area impervious	0.40
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep built up area, with about 70 percent of area impervious	0.80
Flat commercial, with about 90 percent of area impervious	0.80

Source: Searcy, 1973.

[a] For flat slopes or permeable soil, use the lower values. For steep slopes or impermeable soil, use the higher values.

Table 8.4.2. Mean urban runoff concentrations by land use (NURP) (U.S. EPA, 1983)

Pollutant	Units	Residential	Commercial	Industrial	Mixed	Open
TSS	mg/l	206.0	160.0	143.0	297.0	218.0
BOD	mg/l	12.0	12.4	9.5	12.4	2.0
TN	mg/l	3.64	2.45	2.32	2.51	1.85
TP	mg/l	0.465	0.493	0.539	0.489	0.188
FCB (winter only)	cells/100 ml	7,099.0	7,099.0	7,099.0	7,099.0	7,099.0
S/S/F	cells/ 100 ml	31,995.0	31,995.0	31,995.0	31,995.0	31,995.0
O&G[a]	mg/l	3.89	13.13	7.1	6.23	.0
Fe	mg/l	2.73	2.73	2.73	2.73	2.73
As	ug/l	4.25	4.25	4.25	4.25	4.25
Cd	ug/l	1.58	1.58	1.58	1.58	1.58
Cr	ug/l	8.51	8.51	8.51	8.51	8.51
Cu	ug/l	19.7	19.7	19.7	19.7	19.7
Pb	ug/l	72.8	72.8	72.8	72.8	72.8
Hg	ug/l	0.5	0.5	0.5	0.5	0.5
Zn	ug/l	103.7	103.7	103.7	103.7	103.7
PCBs	ug/l	2.96	2.96	2.96	2.96	2.96
CHPs	ug/l	9.07	9.07	9.07	9.07	9.07

[a]Data taken from Stenstrom et al., 1984.

15. Express the impact on stream pollutant loadings in terms of the estimated increase due to P_d highway runoff as a percentage of the original stream loadings (L_s). If the estimated increase exceeds 10 percent for any pollutant, then mitigation may be required. If the stream eventually discharges to a lake or wetland, also evaluate the impact on the body of water according to the next Steps 16 and 17.

16. If the immediate or eventual receiving water is a lake or wetland, estimate total loadings for the month in question prior to the highway presence (L_{La}) as equal to summation L_{Li} plus any point source loading (1,965 Q_pC_p).

17. If the immediate or eventual receiving water is a lake, conduct a special analysis to assess the potential impact of phosphorus loading on trophic state as follows:

    a. Convert P_d and L_{La} to kg/mo by dividing by 2.2 lb/kg.

    b. Estimate annual loadings from the monthly or seasonal loadings found previously by proportion (for both P_d and summation L_{Li} + L_B):

$$\text{kg/yr} = \frac{\text{annual hr precipitation}}{\text{hr precipitation during the month}} \text{ (kg/mo)}$$

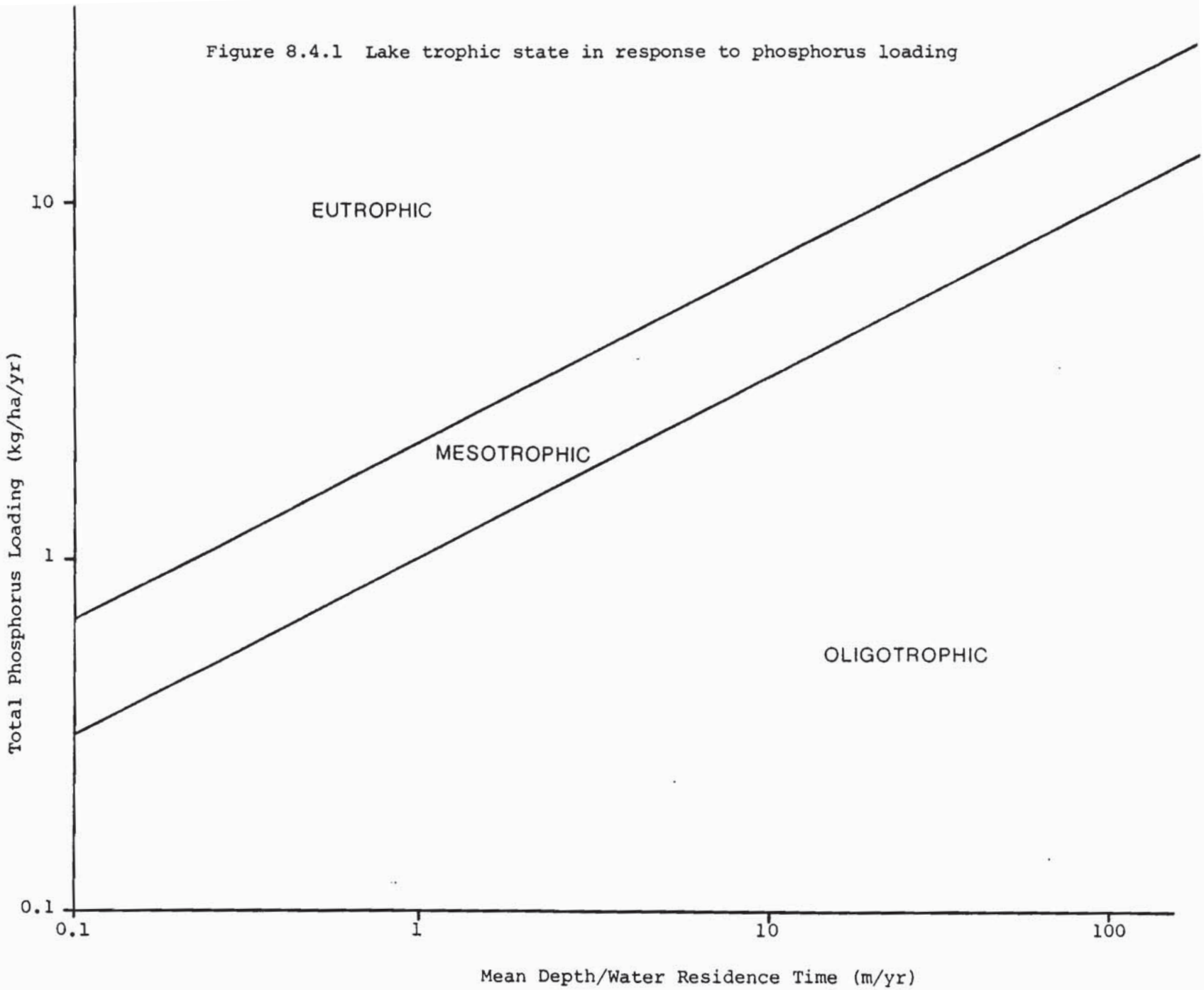
    c. Find the contributions of the highway and all other sources to the lake area total phosphorus (TP) loading (kg/ha/yr) by dividing L_H and L_{La}, respectively, by the lake surface area (A_{La}, ha). [Note: 1 hectare (ha) = 2.47 acres.]

    d. Divide lake mean depth (m) by water residence time (yr), where water residence time = lake volume (any volume units)/outflow rate (any consistent volume/yr units).

    e. Locate the lake on Figure 8.4.1, the trophic state graph (Vollenweider and Dillon, 1974), by using L_{La}/A_{La} as ordinate and the result of the previous step as abscissa.

18. If the highway loading addition does not move the status point near or into a higher trophic category, declare minimal impact on lake eutrophication and analyze impacts associated with maintenance or special problem areas. If a substantial impact on trophic state appears likely, mitigation should be further considered.

Figure 8.4.1 Lake trophic state in response to phosphorus loading



Source: Vollenweider and Dillon, 1974

I-69 EVANSVILLE TO INDIANAPOLIS

Tier 2 Studies

Survey of Karst Features Report

Section 4, US 231 to SR 37

Contains Confidential Information

June, 2010

Prepared for

Federal Highway Administration and
Indiana Department of Transportation

Executive Summary

This study was conducted to support the I-69 Tier 2, Section 4 Environmental Impact Statement (EIS) and to address items 1 through 4 of the 1993 Memorandum of Understanding (MOU). The Indiana Department of Transportation (INDOT), the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and U.S. Fish and Wildlife Service (USFWS) entered into the MOU to define guidelines for the development of transportation projects in karst areas and minimize the impact of construction projects in these areas. This study was prepared by Hydrogeology Incorporated of Bloomington, Indiana.

The scope of this study included identification and mapping of visible karst features within the I-69 Section 4 corridor, including field verification of previously reported or mapped karst features. In addition, groundwater flowpaths for karst features have been identified for evaluation of potential highway impacts and avoidance/minimization considerations.

Section 4 Karst Setting

The Section 4 Survey of Karst Features covers the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. This section of I-69 extends from near the intersection of US 231 and State Road 45/58 near Scotland, IN to State Road 37 (SR 37) near its intersection with Victor Pike southwest of Bloomington, IN.

Karst Areas

Three distinct areas of karst geology were identified within the study area. These areas are described below.

Taylor Ridge to SR 54

Taylor Ridge to SR 54 Karst extends from Taylor Ridge southwest of Koleen to SR 54. The ridges in this area are mostly sandstone and the valleys are limestone. The sandstone cap rock limits sinkhole development on the ridges. Some recharge occurs along fractures in the sandstone ridges but most of the recharge occurs in swallets and joints in the dry run valleys where limestone units outcrop. In most of this area the Big Clifty sandstone is found on the ridges and springs are developed in the underlying Beech Creek limestone. This area is typical of the Crawford Upland Physiographic Region.

SR 54 to Harmony Road

SR 54 to Harmony Road Karst extends from SR 54 to Harmony Road south of Stanford, Indiana. Sinkhole development occurs on the ridges, primarily in the eastern portion. Sinkhole development is limited to the eastern portion because karst-developing limestone beds dip to the southwest which decreases the surface expression of karst features. Karst features develop in limestones of the Blue River and Sanders Group. Swallets and sinking streams provide the majority of recharge to springs. This area is part of the Crawford Upland Physiographic Region.

Harmony Road to SR 37

Harmony Road to SR 37 Karst extends from Harmony Road to SR 37 intersection southwest of Bloomington. The karst in this area is exemplified by ridges and valleys that are comprised of limestones of the Blue River and Sanders Group. Sinkhole and swallet development occurs in the cap rock on the ridges and in drainages. The features act as recharge areas during rain events. This recharge provides the water for the springs located in the valleys. This area is typical of the Mitchell Plain physiography.

Non-Karst Areas

The non-karst portion of the Section 4 corridor extends from US-231 to the Taylor Ridge area. Historical data and field checks for karst features were conducted in this area with the identification of no karst features.

Physiography

Section 4 is divided into the Mitchell Plain and Crawford Upland Physiographic Regions. The mutual boundary of the Crawford Upland and Mitchell Plain is irregular, following the rugged escarpment of clastic beds overlying the limestones.

The Crawford Upland portion of Section 4 extends from US 231 to Harmony Road. The Crawford Upland is underlain by the upper Mississippian West Baden and Stephensport Groups. These two groups are composed of beds of shale, sandstones and limestone. The presence of these more silici-clastic rocks makes the Crawford Upland more resistant to dissolution. The silici-clastic rocks line the ridges forming a rugged topography with considerable relief (320 ft from SR 45/58 to between the ridges and the valleys. The valleys are generally formed in the Beech Creek Limestone, which is the major hydrogeologic unit in the area.

The Mitchell Plain portion of Section 4 extends from Harmony Road to SR 37. The Mitchell Plain contains most of the karst features in Indiana and in the Section 4 corridor. The carbonate bedrock units of the Blue River Group, consisting of the St. Louis and Ste. Genevieve

Limestones are the primary karst forming geologic units. The thinly bedded, highly jointed, nature of the St. Louis, Ste. Genevieve and Paoli Limestones makes them more prone to karst development. The Harrodsburg and Salem limestone of the Sanders Group and the Paoli limestone of the Blue River Group also develop karst features in the Mitchell Plain.

Bedrock Characteristics

Depth to bedrock is shallow (0-12 ft) on the ridges and deeper in the valleys (8-15 ft). Water infiltrates into the limestone bedrock along bedding planes, fractures and joints; dissolving and widening those areas which results in an irregular bedrock surface which is referred to as epikarst.

Soil Characteristics

Soil section on the ridges is as follows:
Organic Soil (0-1 ft)
Mineral Soil (1-12 ft)
Soil section in valleys is as follows:
Organic Soil (0-1 ft)
Mineral Soil (1-15 ft)

Organic soils may be thicker in areas of alluvial sedimentation. Additionally, soil thickness estimates are general values for the area and not based on specific soil sampling.

Land Use

Land use in Section 4 consists primarily of forested and agricultural land, with limited residential and commercially developed areas. Within the Section 4 corridor there are 4,803 acres of upland habitat, which amount to 64% of the corridor area. There are 2,164 acres under agricultural uses, which amount to 29% of the corridor area. Wetland acres (42) and open water acres (94) amount to about one percent of Section 4 corridor. Residential, commercial and other developed land uses occupy the remaining 6% of the corridor area.

Mining

Mining operations in the Section 4 Study area include limestone quarrying for both dimension and aggregate stone. The active limestone quarries present in the vicinity of the study area include Victor Oolitic and Independent Limestone. Several small abandoned quarries are located in the vicinity of Tramway Road and Victor Pike. According to the Indiana Geological Survey (IGS) abandoned coal mining operations are reported for the Koleen area, which have been identified as very old, small, and abandoned shallow surface and slope excavations. None of

these operations' remnants were identified in the field by the Project Team. The Project Team in consultation with IDNR Division of Reclamation has determined that these were small volume, short lived mines used mainly for consumption by the landowners. Some location data available from IGS and IDNR has not been field verified by these Agencies. Based on the results of field reconnaissance, and coordination with IDNR and IGS, these excavations have, apparently become overgrown and non-discernable due to their shallow nature.

Water Supply

Groundwater and surface water are both used as potable water sources in the Section 4 study area. Groundwater wells are used abundantly throughout Section 4 and springs are also used as a potable water supply for individual landowners. Public water supplies in the study area include:

- City of Bloomington Utilities (Bloomington)
- Van Buren Water (Southwester Monroe County)
- Eastern Heights Water (Greene County)
- Eastern Water (Greene County)
- Ellis Water (Greene County).

Hydrogeologic Units

US 231 to Taylor Ridge

The springs in this area discharge from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

Taylor Ridge to SR 54

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the West Baden, and Stephensport Groups. The Beech Creek Limestone is the major hydrogeologic unit with the Haney and Beaver Bend Limestones serving as minor hydrogeologic units.

SR 54 to Harmony Road

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones. The Indian Creek Beds serve as an impermeable unit and is important in directing groundwater flow. Water moving vertically from permeable units (Paoli Limestone) encounters the impermeable unit (Indian Creek Beds) and will then flow horizontally along hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of discharge features.

Harmony Road to SR 37

Recharge to springs generally comes from sinkholes located at the tops and flanks of the ridges. The major hydrogeologic units are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, and Ste. Genevieve Limestones. The Indian Creek Beds and Lost River Chert Bed both serve as impermeable units and are important in directing groundwater flow. Water moving vertically from permeable units encounters the impermeable units and will then flow horizontally along hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of discharge features.

Methodology

The study methodology was developed, and the study was conducted to ensure the project's adherence to the objectives of the 1993 Karst MOU (in italics below) in the following manner:

Research available public and private sources for information relative to karst features:

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey (IGS), Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. In addition, the information included in the 1994 Karst Features in the Bloomington to Evansville Highway Report and associated data was reviewed. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

During the study, coordination was maintained among the Project Team to review and exchange new information discovered by other project related studies. These included ongoing studies

regarding caves as potential Indiana bat habitat, as well as karst studies and other field evaluations being conducted for the I-69 corridor within adjacent sections and within Section 4. This included cross referencing all previous mapping collected with the field investigations and the IGS cave entrance surveys conducted in support of the Project Team's Section 7 Consultation with USFWS for this project.

Field check karst and cave features that appear from the first task and identify any additional karst features:

Field checks were conducted to verify and map previously recorded karst features along the length of the Section 4 corridor. In addition, a field reconnaissance was conducted to determine the presence of, and map previously unrecorded visible karst features within the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area and surface water drainage patterns of the area:

Drainage areas, drainage patterns, and land use specifically related to the karst features were determined and mapped. Additionally, dye tracing tests were conducted on karst features within the karst study area in order to determine and map the subsurface flow from recharge features (caves, sinkholes, swallets, and sinking/losing streams) to discharge features (springs and gaining streams) and establish groundwater flow patterns within the study area.

Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be requested to review and comment on the findings at the early coordination phase of project development:

The project team has conducted ongoing coordination with the agencies signatory to the Karst MOU (signatory agencies), including a karst study progress update meeting for the agencies during the development of this report. This meeting and other coordination has addressed comments and questions raised by INDR, IDEM, and USFWS as well as other review agencies to date.

Indiana Department of Transportation, using the input from Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will begin to formulate appropriate measures to offset unavoidable impacts to the karst features:

The project team will determine the appropriate measures to offset unavoidable impacts to karst features through coordination with the signatory agencies and any other appropriate review agencies. Any future agency concerns or questions relating to the findings or recommendations presented in this report, or any other karst related issues will be addressed by the project team through ongoing coordination relative to addressing the Karst MOU.

Results

The Section 4 Karst study produced the following results:

Karst Mapping

- Three distinct areas of karst were investigated over the 27-mile length of the Section 4 corridor
- Mapped karst features relevant to the corridor:
  - 63 caves, 14 within the corridor
  - 993 sinkholes, 305 within the corridor
  - 62 swallets, 19 within the corridor
  - 15 sinking streams, 6 within the corridor
  - 331 springs, 103 within the corridor
- Land use and drainage areas for karst features were determined
- Sixty-three (63) caves were identified. The scope of this project required only surface description of caves, not detailed surveying and exploration. Features were described as caves if it appeared to the field surveyor that the feature was large enough to enter and explore. It is possible that some of these features have a very limited extent of passage (conduit) large enough for human exploration.
- Ten areas of importance were identified (Cave, Cave, Cave, Cave, Cave, Spring, Cave, Cave, the SR 37 Interchange and Tramway Road Karst Area) based on hydrogeologic, geologic, engineering, and cultural reasons

- Water chemistry differences were observed between springs designated karst and non-karst

- Pollutant load estimates for pre and post construction

- Potential measures to offset impacts to karst include alternative drainage, mitigation/treatment, and operations and maintenance measures.

Dye Tracing

- A total of 39 dye tracing tests were conducted. The results of these tests show 47 groundwater flowpaths

- 9 groundwater flowpaths were shown to cross the Section 4 corridor

- The length of groundwater flowpaths varies greatly within Section 4 (340 ft to 21,774 ft). The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway. The average length was just over one mile

- Over 250 dye tracing sampling locations were established, and over 7,000 samples were analyzed

- Groundwater flow was characterized based on the dye tracing tests. The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point

- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point

- Cave, Cave, Cave, Cave, Cave, and Cave have all been hydrogeologically linked to the Section 4 corridor

- When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points.

Surveys of Section 4 Caves

Six sites were sampled to determine the presence of cave invertebrates. Sampling was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling.

A reconnaissance was conducted of all known caves within five miles of the Section 4 corridor. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat (*Myotis sodalis*) and make recommendations regarding further, more detailed investigations for bats that were to be conducted later by teams of biologists. There are 315 known caves located within five miles of the Section 4 corridor. Of these caves, 226 were judged by cave investigators to be potential Indiana bat hibernacula. Two-hundred and seven (207) of these caves were inspected to determine whether they are potential hibernacula. In addition, 41 caves were visited that were not part of the originally identified caves; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Access was denied to five sites, and 14 caves could not be located. As a result, 59 caves were recommended for intensive investigations as Indiana bat winter hibernacula.

Summary and Conclusions

Karst resources in the Section 4 study area have been impacted to a limited extent during historical and recent development within Monroe and Greene Counties. Due to the relatively undisturbed nature of Section 4 karst resources, appropriate areas outside of the Section 4 corridor were determined to be necessary to catalogue all relevant karst features. The project consisted of karst feature mapping and characterization, groundwater tracing of relevant karst features, and to determine the hydrogeology characteristics of the Section 4 corridor.

All karst features, and karst geology in general cannot be avoided within the Section 4 corridor; however, individual karst features can be avoided. Therefore, the focus of the alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features, alternative drainage, mitigation/treatment, and operation and maintenance measures.

The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point. Four dye traces demonstrated flowpaths to multiple discharge points from a single injection point. Eight groundwater flowpaths were shown to cross the Section 4 alignment. The length of groundwater flowpaths varies greatly (340 ft to over 20,000 ft) in length. The longer

flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway.

Cave, Cave, Cave, Cave, Cave, and Cave have been hydrogeologically linked to the Section 4 corridor.

Spring discharge within the study area varies greatly, due to the hydrogeologic nature of the spring and flow conditions (i.e. high or low flow). The spring discharges range from less than 0.1 gpm to 1,000 gpm. Spring discharges were estimated by field hydrogeologist and were not gauged. Water chemistry for karst and non-karst springs was analyzed and compared. The karst springs had lower pH, higher conductivity and higher calcium concentration than the non-karst springs.

Hydrogeologic characterization by area is as follows:

- Taylor Ridge to SR 54: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances are long (up to 4 miles), and subsequently had long travel times (1-3 weeks). Groundwater generally flowed west/southwest (along dip) and/or southeast/northwest (along strike)

- SR 54 to Harmony Road: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances were long (up to 3 miles), and subsequently had longer travel times (1-6 weeks). Groundwater generally flowed west/southwest (along dip) and/or southeast/northwest (along strike)

- Harmony Road to SR 37: Recharge to springs generally enters the karst system through sinkholes located at the tops and flanks of the ridges. Groundwater travel distance in this area were shorter (up to 3,000 ft), and subsequently had relatively short travel times, generally under three days.

Areas of Importance

Cave

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 4-1434, 4-1525, and 4-1524), four of which receive direct run-off from the Section 4 corridor. The drainage area associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) crosses into the Section 4 corridor. It should be noted that the affected drainage areas are linked

to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

The entrance to Cave is located approximately miles north of the corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. The drainage area associated with 4-0037 crosses into the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with swallet 4-0037. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made such that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is not located within the Section 4 corridor. This cave will not be directly impacted by highway construction. The Section 4 Alternatives are located approximately miles from the cave. However, dye tracing tests revealed that recharge to Cave is derived in part from four swallets (4-0166, 4-0173, 4-0175, and 4-1504) which receive run-off from the Section 4 corridor. Three other recharge features (4-0174, 4-0203, and 4-0204), which were not dye traced, are potentially hydrogeologically linked to Cave. The drainage area associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) crosses into the Section 4 corridor. The Section 4 Alternatives are on a common alignment in the vicinity of the above-noted features, and all Alternatives will impact the features and associated drainage areas in the same manner. Construction in this area could impact the recharge to Cave. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special

consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is located approximately south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to a spring, which is presumably connected to Cave based on best available data, is derived in part from a sinking stream (4-0661) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave and the associated spring. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with sinking stream 4-0661. Due to the relationship between the proposed road and existing topography, it is not anticipated that highway derived runoff would be directed toward sinking stream 4-0661. Special planning should be conducted, where appropriate and practicable, to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

Cave

Cave is located approximately south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from a swallet (4-1035) which does receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment, predominately down-gradient of swallet 4-1035 in this area. The Alternatives will impact the drainage area of swallet 4-1035 in a similar manner and therefore have the same potential to affect the cave spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Spring

Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. The spring will not be directly impacted by highway construction. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-1228) in a drainage east of

Spring within the Section 4 corridor. It is likely that the area downstream of sinking stream 4-1228 acts as a sinking stream during high flow periods and also provides recharge to Spring. Sinking stream 4-1228 and the potential losing stream reach down gradient from it would receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Spring. The Section 4 Alternatives area on a common alignment in this area and will unavoidably cross sinking stream 4-1228. They will not encroach upon the drainage area of sinking stream 4-1228. The Alternatives will cross sinking stream 4-1228 in a similar manner and therefore have the same potential to affect the spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

Cave

Cave is not located within the Section 4 corridor. The cave will not be directly impacted by highway construction. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. Cave is located southeast of Cave and lies between it and the input features for the dye traces. The Section 4 Alternatives are about a half-mile south of the cave location and share a common alignment in this area. All Alternatives would result in the same impact upon the drainage areas of potential Cave recharge features located within the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicates probability that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario the water could pass out of and back into the limestone one or more times. The majority of the recharge to the cave is derived from more proximal features. Therefore, it is not anticipated that the project will cause a material degradation of the cave spring's water quality or quantity.

Cave

Cave is located approximately south of the Section 4 corridor. Cave has been mapped and the cave passage trends toward the Section 4 corridor. The mapped extent of this cave terminates outside the Section 4 corridor, over 1,000 feet south of the Section 4 Alternatives. Dye tracing tests revealed that recharge to Cave is derived in part from a sinking stream (4-1271) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same impacts along the northern edge of the drainage area of sinking stream 4-1271. Where appropriate and practicable,

special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special consideration should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

SR 37 Interchange

Dye tracing tests reveal the northeastern side of SR 37 near its intersection with Victor Pike to be part of the recharge area for one significant spring (4-1501). The southwestern side of SR 37 near its intersection with Victor Pike is a concern from an engineering standpoint due to the high density of karst features. The bedrock is likely highly fractured and could pose unique design and construction issues. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. Additionally, the construction of SR 37 and surrounding development has already altered the land surface and drainage patterns. Sinkholes have been filled and altered which could be problematic during construction. Drainages and conduits have also been altered which present problems in studying the hydrogeology. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same encroachment within the recharge area along the northeastern side of SR 37 near Victor Pike. Special planning, where appropriate and practicable, should be conducted to insure that highway derived runoff within the drainage area of sinkhole 4-1496 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special planning should be conducted so that construction does not sever this recharge feature by sedimentation or impervious cover.

Tramway Road Karst Area

This area is located within the corridor, north of Tramway Road and west of Victor Pike. Dye tracing tests reveal short isolated groundwater systems and the karst features do not provide recharge to any significant springs. This area will need additional engineering measures to account for the high density of karst features and the highly fractured bedrock. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. The instability of the bedrock was highlighted by a sinkhole collapse documented by the project team. This collapsed occurred on the edge of a sinkhole (4-0133) identified during field mapping. The review did not identify that an alternative outside the corridor would provide substantial karst impact and/or roadway stability benefits compared to alternatives within the corridor. The Section 4 Alternatives utilize three alignments in this area and would affect a similar overall number of features. The Preferred Alternative (Alternative 2) as well as Alternatives 3 and 4 minimize impacts to higher infiltration features and minimize anticipated stability concerns in the area by cresting the hill north of Tramway Road on its east side, approximately 30 feet lower in elevation in comparison to Alternative 1.

General Environmental Concerns

- Karst groundwater systems can transport sediment and contaminants virtually unimpeded into cave and spring systems. Dye tracing studies of the groundwater systems within the Section 4 corridor identify the potential for highway related contamination in locations removed from the source. The average distance between dye injection and detection was just over one mile

- Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides is common. If contaminants enter the karst system the location for establishing a response could be difficult to predict.

General Engineering Concerns

- Collapse of filled (naturally and otherwise) sinkholes and cave passages can compromise adjacent and overlying structures. These failures can occur without surface expression prior to collapse. There are sinkholes within the Section 4 corridor that have been filled by natural and man-made processes

- Impervious surfaces, such as roads, alter the natural patterns of run-off and infiltration. Concentrated and redirected runoff into open sinkholes or over sinkholes without surface expression can result in sinkhole collapse. Unlined retention or detention structures can increase the localized hydraulic head, which could result in collapse of adjacent sinkholes. Alteration of surface run-off can also increase erosion which can effectively sever recharge features by sedimentation

- Impervious surfaces, such as roads, can sever recharge features. This can result in decrease spring discharges and alteration of habitat for any biological communities within the karst system

- The karst landscape is an ever evolving landscape. Karst features can change rapidly with subsequent opening and infilling of sinkholes, caves and swallets as well as increase and decrease in spring discharges

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted low-salt/no spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

- The drainage design for I-69 should provide for proper energy dissipation devices at the culvert and storm sewer system outlet locations to prevent erosion to existing channels. Energy dissipater devices include such items as scour holes, riprap linings and stilling basins. Design of energy dissipater devices and ditch linings should be based on INDOT's Drainage Design Manual

- Run-off from the roadway should have as much natural treatment as is possible. It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching potential karst recharge features

- The roadway construction, when possible, should be planned to maintain the drainage to karst recharge features

- Utilization of lined ditches to the outfall discharge points are recommended within the karst areas designed to prevent erosion. Water flow within the roadway ditches will need an analysis for lining requirements. Culvert outlets should be designed to discharge water to at grade terrain. This design will reduce erosion scour and sediment transport into the karst and other environments. Design of ditches and culverts should be based on INDOT's Drainage Design Manual. This will reduce soil erosion through karst features that could compromise the integrity of the roadway

- A spill response plan should be established with response equipment readily available during and after road construction. Karst groundwater systems have the potential for high groundwater flow velocities, which makes quick response to any spill a necessity. Drainage and runoff control mechanisms should be in place to prevent contaminants from entering the karst system. In the event that contaminants enter the karst system, use of response or mitigation measures at discharge points may be necessary

- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

Best Management Practices

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted no-salt/spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

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- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

Glossary of Relevant Terms
I -69 Tier 2 Section 4

General Terms

Corridor
The I-69 Tier 2 Section 4 corridor is a generally 2,000 ft wide area that begins near US 231 near Scotland, Indiana and extends northeast 27 miles to SR 37 just southwest of Bloomington, Indiana.

Karst Study Area
The Section 4 Karst Study Area includes the 27-mile long Section 4 corridor and appropriate areas outside of the corridor to encompass karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Section 5
The I-69 Section 5 corridor is a 2,000-ft wide area centered on State Route 37 (SR 37) beginning at the north terminus of the Section 4 corridor southwest of Bloomington in Monroe County, Indiana, and extending to just south of Martinsville in Morgan County, Indiana. The Section 5 Karst Study Area included both the I-69 Tier 1 and Tier 2 karst data that was determined to be relevant to Section 5, and extended from south of Section 5 north along SR 37 to roughly Chambers Pike.

Section 3
The I-69 Section 3 corridor is a generally 2,000-ft wide area, which begins just north of the proposed US 50 interchange, east of Washington, travels in a north by northeasterly direction along the east side of Elnora and turns east by northeasterly to the south Section 4 corridor terminus east of US 231, near Naval Surface Warfare Center (NSWC) - Crane Division.

Karst/Geologic Terms

Baseflow
The part of a stream discharge that is not attributable to direct runoff from precipitation or snow-melt. Baseflow is sustained by groundwater discharge (AGI Glossary, 2005, 5th edition).

Carbonate Rocks
Sedimentary rocks that contain large amount of carbonate (CO_3) such as limestone and dolomite.

Cave
A natural underground opening in rock that is large enough for human entry and exploration of an appreciable distance.

Cave System
An assemblage of karst features, which contain multiple passages, recharge areas and springs that may or may not be related.

Dip
The direction of the slope of geologic formations.

Discharge Feature
An opening in the bedrock and/or soil that allows water to flow from the subsurface onto the land surface. Examples of these features are springs, gaining streams, and in some instances caves.

Dye Detection/Dye Positive
A water or charcoal sample that contains fluorescent dye. This is a specific result in that it is a spring sample or stream crossing sample with no preexisting upstream source of fluorescent dye.

Dye Trace Test
Fluorescent dye was injected into recharge features with existing flow from surface sources or with supplemental flow from a tanker. All known springs in the area were then sampled for water and with charcoal samplers and analyzed for the presence of dye.

Epikarst
The upper portion of the soluble rock that has been highly weathered due to the dissolution of the carbonate rock by carbon dioxide from precipitation and acids dissolved from the organic zones in the soil. The area contains many fissures and enlarged fractures and joints. The epikarst can store water and transmit it to the saturated zone especially during wet periods.

Groundwater Flowpath
See Karst Flowpath.

Guano
Biological waste, often a reference to bat droppings.

High Infiltration Recharge Feature
A surface area where water and materials can move unimpeded to the subsurface.

ISCO Sampler
A commercial water sampler that can take 24 consecutive water samples over desired time intervals. ISCO samplers can be set at 1 hour intervals to take samples for a complete day. The continuous water sampling gives a more accurate time of travel and better idea of how long the dye pulse is discharging at the spring. Data obtained is useful in establishing mitigation plans.

Karst
A terrain with distinctive hydrology and landforms arising from a combination of high rock solubility, well developed secondary permeability and rock structure. The hydrology is usually manifested in internal drainage along solutionally enlarged passageways in the subsurface rock.

Karst Conduit
An underground solutionally enlarged opening, sometimes tubular in shape that is carrying or has carried water at some time. The opening may be too small for human entry but potentially accessible to smaller biota. Inward or outward airflow is a common attribute and can indicate connection to larger volume karst systems.

Karst Flowpath
Groundwater flow through a karst conduit within a karst groundwater system, also described as the distance and direction water travels from recharge to discharge.

Karst Valley
A valley in a karst terrain that is under-drained by sinkholes in the valley bottom. The sinkholes are often aligned along major joints, fractures or other structural features that determine the direction of the valley axis.

Losing Stream
In hydrology the common term is influent stream. This type of stream has the water table below the surface of the stream thus water seeps through the stream bottom due to the vertical gradient.

Low Infiltration Recharge Feature
A surface area where water and material movement to the subsurface is impeded by rock, soil, or other material.

Medium Infiltration Recharge Feature
A surface area where water and materials are impeded but still move relatively easily to the subsurface.

Non-specific Dye Positive/Dye Detection
A water or charcoal sample that contains fluorescent dye that has been attributed to an upstream source.

Recharge Area
The land surface that contributes water to a particular karst feature.

Recharge Feature
A surface area that channels water to the karst groundwater system. Examples of such features relevant to this report are sinkholes, swallets, sinking streams and in some situations caves.

Relevant Karst
The portion of karst within the 27-mile length of Section 4 corridor and associated areas outside of the corridor; that has been demonstrated to have corridor-derived water passing through it; or is linked by logical inference based on the best available geographic, geologic, and hydrologic data, including the Tier 2 investigation. It does not include areas outside the corridor that contribute water to the corridor.

Sampling Station
Sampling stations for this project consisted of a charcoal packet anchored in an area of active spring or stream flow. Water samples were taken when the charcoal packets were placed and each time the charcoal packets were changed. GPS locations were taken and the stations flagged with the spring identification number.

Silici-clastic
Sedimentary rock rich in quartz and other silicate minerals.

Sinking Stream
A surface stream that flows entirely into the subsurface with no noticeable swallet.

Sinkhole
A natural occurring bowl shaped feature that collects water from areas near the sinkhole. The water can infiltrate to the subsurface through openings at the sinkhole bottom and/or through the soil if openings do not occur. Collapse of sinkholes is common and can result in steeper irregular depressions.

Spring
An area where water from a karst groundwater system discharges to the surface.

Strike
The line perpendicular to the dip of geologic formations.

Swallet
The area where a stream sinks into the subsurface or an opening in the bottom of a sinkhole. The term swallet can be used interchangeably with the term swallowhole.

Land Use Terms

Agricultural
Includes all land such as pastures, row crops that are considered agricultural operations.

Nonresidential/industrial
Commercial and industrial complexes and other developed areas, excluding housing and developed uses such as churches and graveyards.

Public Lands
Land available for public use such as schools, libraries and hospitals.

Quarry
In Section 4 unless otherwise designated, the term quarry refers to currently active or abandoned limestone extraction sites.

Undeveloped Land
For the purposes of this report this term indicates wetlands and forested areas including state owned lands.

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1.0 INTRODUCTION

1.1 Purpose and Scope

This report has been prepared in conjunction with the I-69 Tier 2 Environmental Impact Statement (EIS) for Section 4, from US 231 near Scotland in Greene County to SR 37 near Bloomington in Monroe County. This report documents reviews of karst information relevant to the Section 4 corridor, field checks of previously recorded karst features, field investigations to identify previously unrecorded karst features, dye tracing of karst features, and recommendations for karst feature avoidance, impact minimization, and mitigation of unavoidable impacts. The Survey of Karst Features study methodology was developed and conducted to insure the project is consistent with the objectives of the 1993 Memorandum of Understanding delineating guidelines for the construction of transportation projects in karst regions of the state (Karst MOU) (**Appendix A**) between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM), and the U.S. Fish and Wildlife Service (USFWS). The first four items identified in the Karst MOU are addressed by this report in the following manner:

Research available public and private sources for information relative to karst features:

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey, Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. This data included the 1994 Karst Features in the Bloomington to Evansville Highway Report (USDOT, 1996) and associated data. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

During the study, coordination was maintained among the Project Team to review and exchange new information discovered by other project related studies. These included ongoing studies regarding caves as potential Indiana bat habitat, as well as karst studies and other field evaluations being conducted for the I-69 corridor within adjacent sections and within section 4. This included cross referencing all previous mapping collected with the field investigations and the IGS cave entrance surveys conducted in support of the Project Team's Section 7 Consultation with the USFWS for this project.

Field check karst and cave features that appear from the first task and identify any additional karst features:

Field checks were conducted to verify and map previously recorded karst features along the length of the Section 4 corridor. In addition, a field reconnaissance was conducted to determine the presence of, and map previously unrecorded karst features within the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off.

Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area and surface water drainage patterns of the area:

Drainage areas, drainage patterns, and land use specifically related to the karst features were determined and mapped. Additionally, dye tracing tests were conducted on karst features within the karst study area in order to determine and map the subsurface flow from recharge features (caves, sinkholes, swallets, and sinking streams) to discharge features (springs and gaining streams) and establish groundwater flow patterns within the study area.

Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be requested to review and comment on the findings at the early coordination phase of project development:

The project team has conducted ongoing coordination with the agencies signatory to the Karst MOU (signatory agencies), including a karst study progress update meeting for the agencies during the development of this report. This meeting and other coordination has addressed comments and questions raised by INDR, IDEM, and USFWS as well as other review agencies to date. In addition, this draft report will be distributed to the signatory agencies and other appropriate review agencies for their review and comments prior to development of the DEIS.

Indiana Department of Transportation, using the input from Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will begin to formulate appropriate measures to offset unavoidable impacts to the karst features:

The project team will determine the appropriate measures to offset unavoidable impacts to karst features through coordination with the signatory agencies and any other appropriate review agencies. Any future agency concerns or questions relating to the findings or recommendations presented in this report, or any other karst related issues will be addressed by the project team through ongoing coordination relative to addressing the Karst MOU.

1.2 Study Area

The Section 4 corridor, which is the section of the I-69 corridor from US 231 to SR 37, is approximately twenty-seven miles in length (**Figure 1**). Section 4 begins in Greene County at the US 231 intersection with SR 45/58 near Scotland and proceeds northeasterly to Monroe County, ending at SR 37 southwest of Bloomington, just north of the SR 37 intersection with Victor Pike. The Section 4 corridor, as defined in the I-69 Evansville to Indianapolis Tier 1 Record of Decision (ROD), is predominantly 2,000 ft in width, with the following exceptions. Beginning at approximately Greene CR 1260 E near Hobbieville, the corridor gradually widens (to the north) to approximately 5,500 ft (between Carmichael Road and Carter Road) and then tapers back to the 2,000 ft width just west of Breeden Road in Monroe County. Additionally, in the Tier 1 study three "notches" were cut out of the corridor to add further buffer for resources known, based on Tier 1 information, to be located near the corridor. North of Carter Road, and east of the Monroe/Greene County Line, the corridor was notched to provide further buffer for the area associated with the Virginia Iron Works. South of the Evans Road/Evans Lane intersection in Monroe County, and south of the Koontz/Rockport Road intersection the corridor was notched to provide further buffer to karst resources. The karst study area included the 27-mile length of Section 4 corridor and appropriate areas outside of the corridor to identify potentially related karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. For this study, relevant karst is the portion of karst within the 27-mile length of Section 4 corridor and associated areas outside of the corridor; that has been demonstrated to have corridor-derived water passing through it; or is linked by logical inference based on the best available geographic, geologic, and hydrologic data, including the Tier 2 investigation. It does not include areas outside the corridor that contribute water to the corridor.

The karst geology in the Section 4 karst study area is divided into the following three areas which are shown on **Figure 2**:

- Taylor Ridge to SR 54
- SR 54 to Harmony Road
- Harmony Road to SR 37.

The portion of the corridor without karst geology is shown on **Figure 2** and covers the following area:

- US 231 to Taylor Ridge.

1.3 Land Use

Land use in Section 4 consists primarily of forested and agricultural land, with limited residential and commercially developed areas (**Figure 3**). Within the Section 4 corridor there are 4,803 acres of upland habitat, which amount to 64% of the corridor area. There are 2,164 acres under agricultural uses, which amount to 29% of the corridor area. Wetland acres (42) and open water acres (94) amount to about one percent of Section 4 corridor. Residential, commercial and other developed land uses occupy the remaining 6% of the corridor area.

1.4 Physiographic Setting

Section 4 is divided into the Mitchell Plain and Crawford Upland Physiographic Regions (**Figure 4**). The mutual boundary of the Crawford Upland and Mitchell Plain is irregular, following the rugged escarpment of silici-clastic beds overlying limestone beds.

The Crawford Upland portion of Section 4 extends from US 231 to Harmony Road. The Crawford Upland is underlain by the upper Mississippian West Baden and Stephensport Groups. These two groups are composed of beds of shale, sandstones and limestone. The presence of these more silici-clastic rocks makes the Crawford Upland more resistant to dissolution. The silici-clastic rocks line the ridges forming a rugged topography with considerable relief (320 ft from SR45/58 to between the ridges and the valleys. The valleys are generally formed in the Beech Creek Limestone, which is the major hydrogeologic unit in the area.

The Mitchell Plain portion of Section 4 extends from Harmony Road to SR 37. The Mitchell Plain contains most of the karst features in Indiana and in the Section 4 corridor. The carbonate bedrock units of the Blue River Group, consisting of the St. Louis and Ste. Genevieve Limestones are the primary karst forming geologic units. The thinly bedded, highly jointed, nature of the St. Louis, Ste. Genevieve and Paoli Limestones makes them more prone to karst development. The Harrodsburg and Salem limestone of the Sanders Group and the Paoli Limestone of the Blue River Group also develop karst features in the Mitchell Plain.

1.5 Geologic Setting

The Section 4 study area is located within the Eastern Flank of the structural Illinois Basin. The bedrock dips to the southwest at approximately 30 ft per mile with local variations from 10 to 50 ft per mile. The Mount Carmel Fault lies approximately five miles east of SR 37 and there are no demonstrated faults within the karst study area.

The bedrock's structural strike, measured perpendicular to its dip, is northwest to southeast, with local variations. The bedrock is relatively shallow in the study area with thin soil sections on the ridges and thicker soil sections in the valleys. Older to younger bedrock is exposed from

northeast to southwest across the Section 4 corridor. The stratigraphic column relevant to Section 4 is illustrated in **Table 1**. The Mississippian Age carbonate bedrock units highlighted in **Table 1** are the source of karst development in Section 4.

1.5.1 US 231 to Taylor Ridge

Lower Pennsylvanian rocks that contain sandstone, shales, and interbedded coal layers are predominant. No karst forming rocks are exposed in this area.

1.5.2 Taylor Ridge to SR 54

Upper Mississippian rocks that contain inter-bedded limestone, sandstone and shale are predominant. The ridges are mostly sandstone and the valleys are limestone. The sandstone cap rock limits sinkhole development on the ridges. In this area the Big Clifty Sandstone is found on the ridges and the Beech Creek Limestone is exposed in the valleys.

1.5.3 SR 54 to Harmony Road

Upper Mississippian rocks that contain inter-bedded limestone, sandstone and shale are predominant. Recharge to springs is generally from swallets/sinking streams located in dry runs, with some minor contributions from the few sinkholes located in this area. The major karst forming units in this area are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones.

1.5.4 Harmony Road to SR 37

Lower Mississippian rocks that contain inter-bedded limestone and shales are predominant. This area is characterized by limestone ridges and valleys. Sinkhole and swallet development occurs in the cap rock on the ridges and in drainages. Recharge to springs in this area is generally from sinkholes located at the tops of ridges and to a lesser extent swallets in drainages. The major karst forming units in this area are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, Ste. Genevieve, and Paoli Limestones.

1.5.5 Mining Operations

Mining operations in the Section 4 study area include limestone quarrying for both dimension and aggregate stone. The active limestone quarries present in the vicinity of the study area include Victor Oolitic and Independent Limestone. Several small abandoned quarries are located in the vicinity of Tramway Road and Victor Pike. According to the IGS, abandoned coal mining operations are reported in the vicinity of Koleen. These mines have been characterized as very old, small, and abandoned shallow surface and slope excavations. No remnants of these

operations were identified in the field by the Project Team. The Project Team, in consultation with IDNR Division of Reclamation, has determined that these were small volume, short-lived mines used mainly for consumption by landowners. Some location data available from IGS and IDNR has not been field verified by these Agencies. Based on the results of field reconnaissance and coordination with IDNR and IGS, these excavations have apparently become overgrown and non-discernable due to their shallow nature.

Table 1: Section 4 Relevant Bedrock Units

System	Series	Group	Formation	Sub-Formation
Mississippian	Upper	Stephensport	Glen Dean Limestone	
			Hardinsburg Formation	
			Haney Limestone	
			Big Clifty	Indian Springs Shale
			Beech Creek Limestone	
		West Baden	Elwren Formation	
			Reelsville Limestone	
			Sample Formation	
			Beaver Bend Limestone	
			Bethel Formation	
	Lower	Blue River Group	Paoli Limestone	Downeys Bluff Member
				Yankeytown Member
				Shelterville Member
				Popcorn Member
			Ste. Genevieve Limestone	Byrantsville Breccia Bed
				Levias Member (Indian Creek Beds)
				Spar Mountain Member
				Fredonia Member
				Lost River Chert Bed
			St. Louis Limestone	
		Sanders Group	Salem Limestone	
			Harrodsburg Limestone	
			Ramp Creek Formation	
		Borden	Borden Formation	

Karst Forming Units
Confining Units
(Modified from Shaver et al, 1986)

1.6 Hydrogeologic Setting

1.6.1 Water Supply

Groundwater and surface water are used as potable water sources in the Section 4 study area. Groundwater wells are common throughout Section 4. Springs are also used as a water supply. Public water supplies in the study area include:

- City of Bloomington Utilities (Bloomington)
- Van Buren Water (Southwester Monroe County)
- Eastern Heights Water (Greene County)
- Eastern Water (Greene County)
- Ellis Water (Greene County).

1.6.2 Karst Groundwater

Carbonate rocks are prone to dissolution when contacted by infiltrating water. The partial pressure of carbon dioxide in the atmosphere is approximately $10^{-3.5}$ atmospheres. This carbon dioxide is absorbed into rainwater, which makes the rainwater slightly acidic with a pH of approximately 5.6. Anthropogenic sources such as industrial emissions can create other acids (hydrochloric, nitric, and sulfuric) that can lower the pH of rain below 5.6. Rainwater infiltrates through the soil zone which may contain additional carbon dioxide and other acid forming compounds. Organic acids may also contribute to the lower pH of the infiltrating water, but carbonic acid is the major source of acidity. Additional absorption of carbon dioxide and other acid forming compounds can lower the pH of the infiltrating water to 4 in extreme situations.

Acidic water infiltrates into the bedrock along bedding planes, fractures and joints; dissolving and widening those areas. Karst formed in this manner is referred to as epikarst and exhibits a shallow zone of enhanced secondary permeability. Secondary permeability of this nature creates the major pathways for groundwater flow in karst areas. The pathways receive recharge from sinkholes, swallets, sinking streams, caves, and infiltration through soil.

1.6.3 Section 4 Hydrogeologic Units

US 231 to Taylor Ridge

Springs in this area discharge water from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

Taylor Ridge to SR 54

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the West Baden, and Stephensport Groups. The Beech Creek Limestone is the major hydrogeologic unit with the Haney and Beaver Bend Limestones serving as minor hydrogeologic units.

SR 54 to Harmony Road

Recharge to springs is generally from swallets/sinking streams located in drainages. The major hydrogeologic units are limestones of the Upper Blue River, West Baden, and Lower Stephensport Groups, which include the Paoli, Beaver Bend, and Beech Creek Limestones. The Indian Creek Beds serve as an impermeable unit and are important in directing groundwater flow. Water moving vertically from permeable units (Paoli Limestone) encounters the impermeable unit (Indian Creek Beds) and will then flow horizontally along a hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of recharge features.

Harmony Road to SR 37

Recharge to springs generally comes from sinkholes located at the tops and flanks of the ridges. The major hydrogeologic units are limestones of the Sanders and Blue River Group, which include the Harrodsburg, Salem, St. Louis, and Ste. Genevieve Limestones. The Indian Creek Beds and Lost River Chert Bed both serve as impermeable units and are important in directing groundwater flow. Water moving vertically from permeable units encounters the impermeable units and will then flow horizontally along a hydraulic gradient. The contact between permeable limestones and impermeable shales and chert beds is the common location of recharge features.

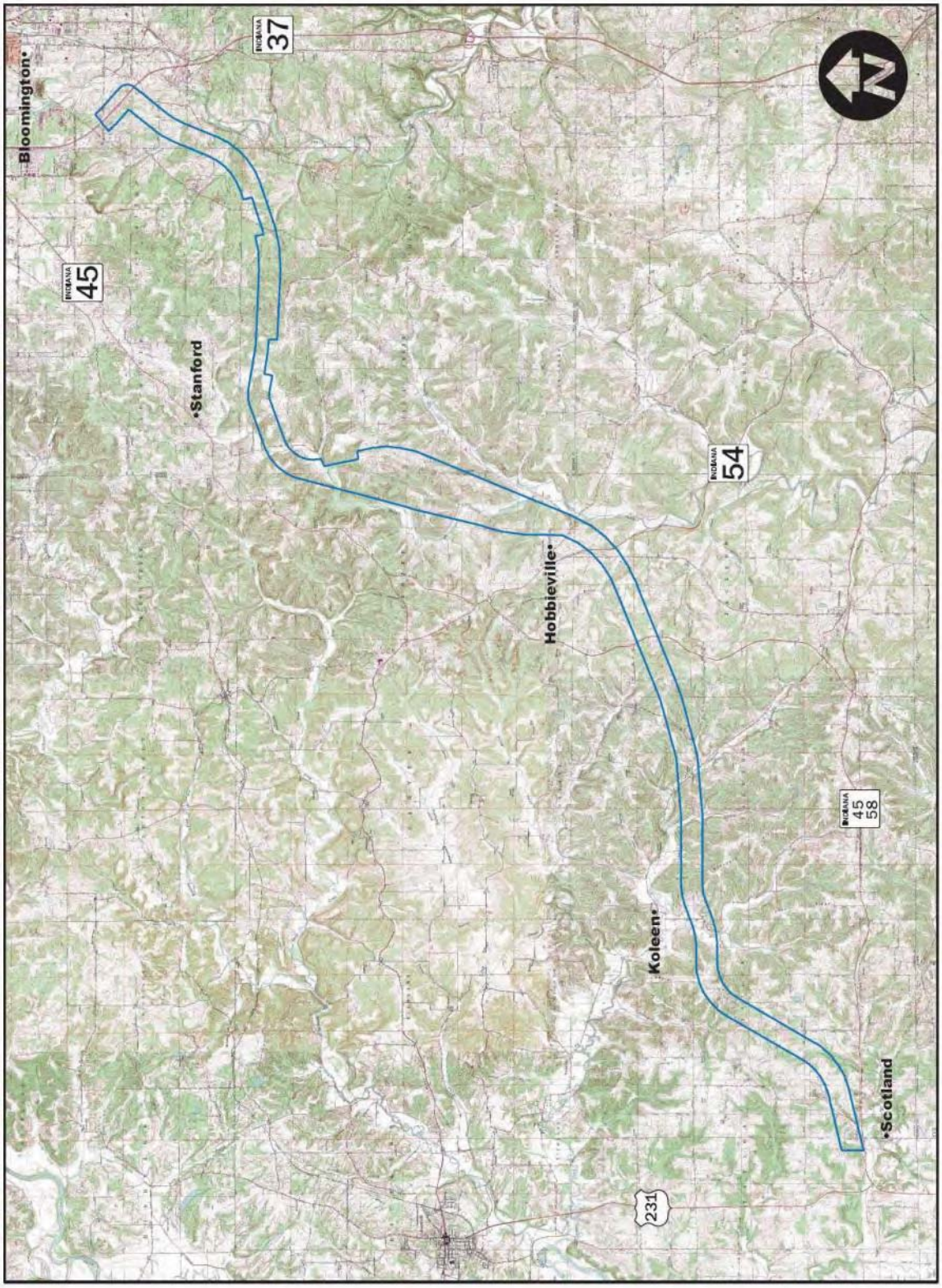


Figure 1: Section 4 Corridor and Karst Study Area
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4

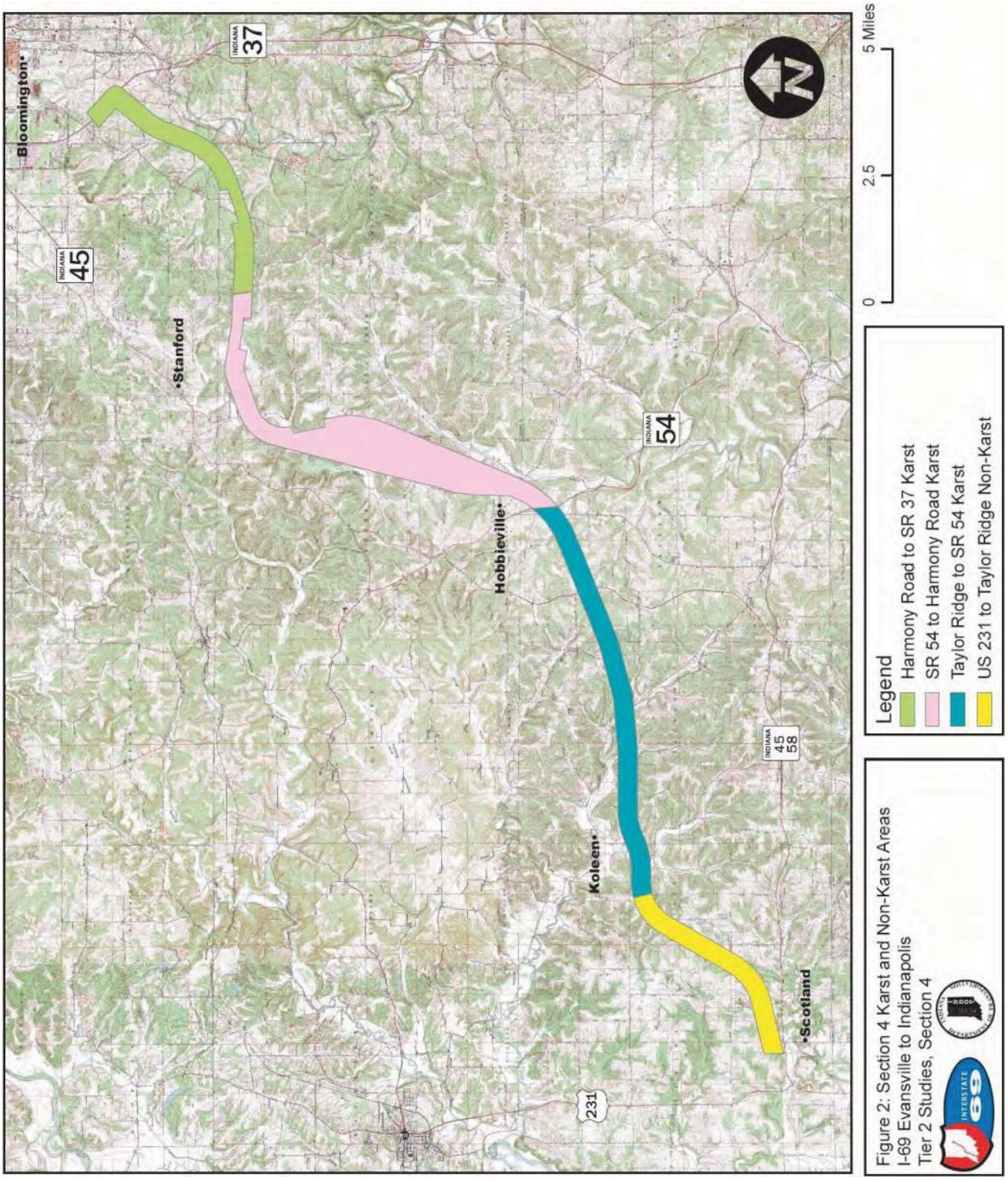
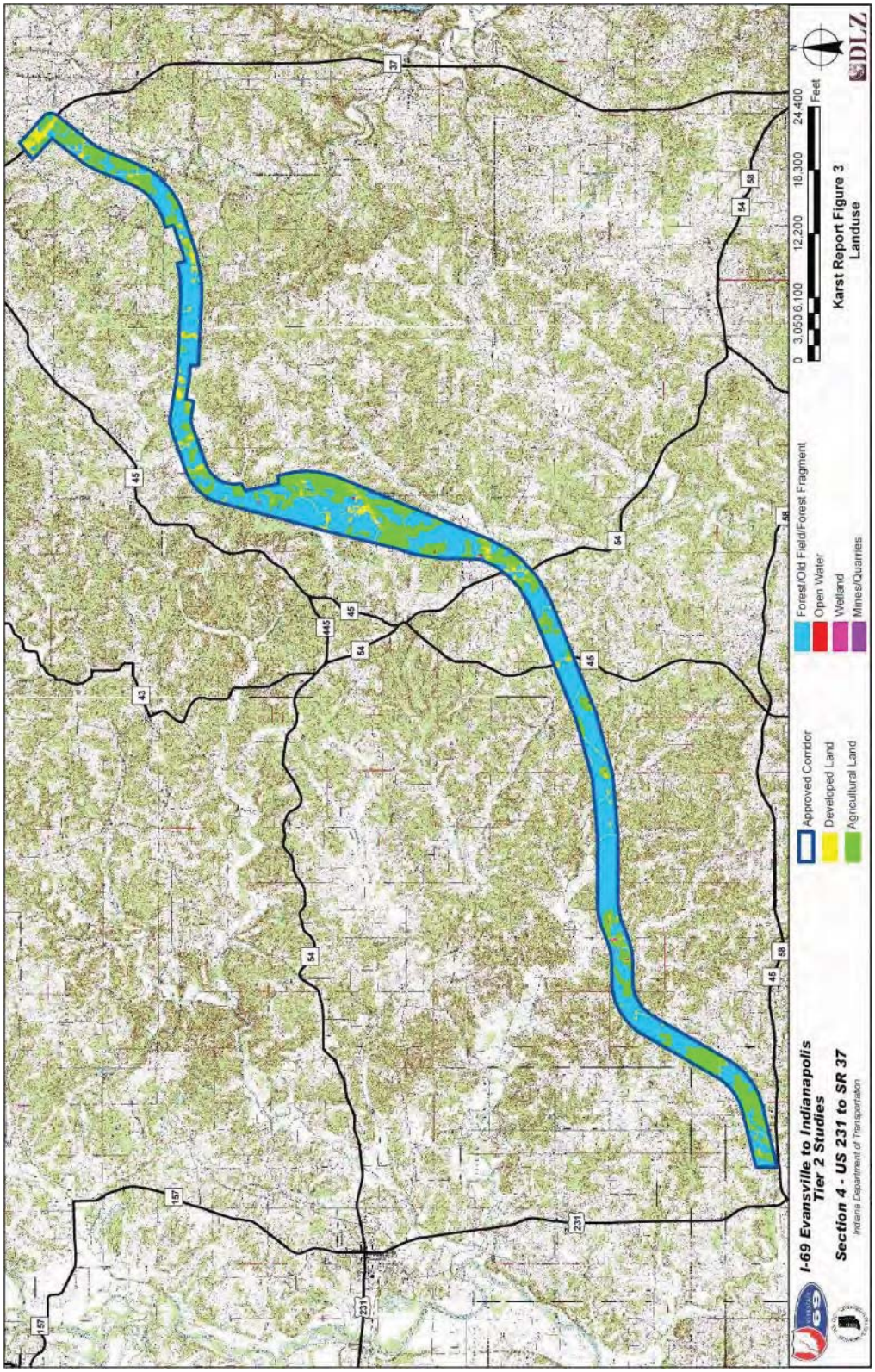


Figure 2: Section 4 Karst and Non-Karst Areas
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4


I-69 Evansville to Indianapolis
Tier 2 Studies
Section 4 - US 231 to SR 37
Indiana Department of Transportation
Approved Corridor
Developed Land
Agricultural Land
Forest/Old Field/Forest Fragment
Open Water
Wetland
Mines/Quarries
0 3,050 6,100 12,200 18,300 24,400
Feet
Karst Report Figure 3
Landuse
DLZ

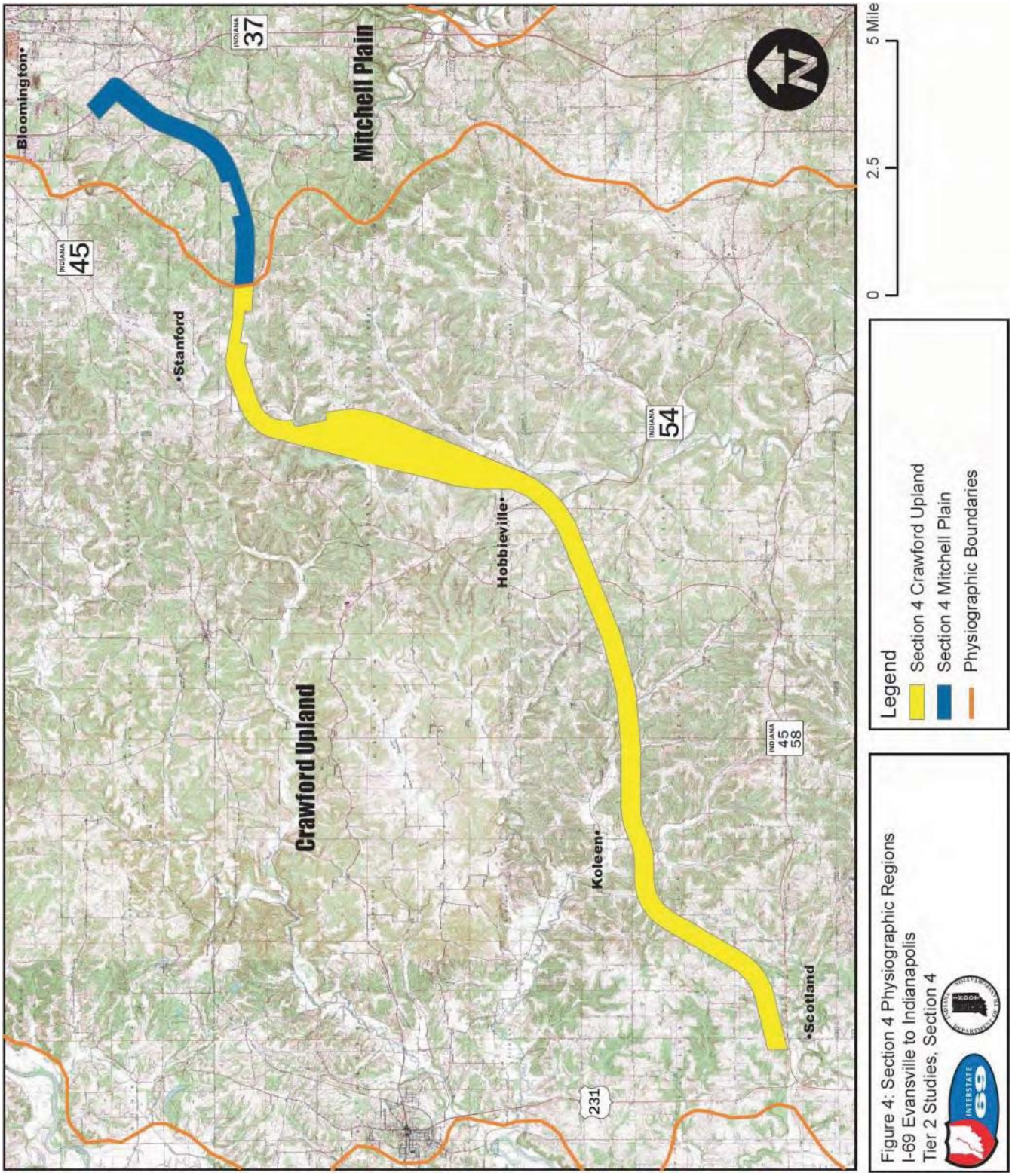


Figure 4: Section 4 Physiographic Regions
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4

2.0 METHODOLOGY

The Survey of Karst Features study methodology was developed and conducted to ensure the project is consistent with the objectives of the 1993 Karst Memorandum of Understanding (MOU) (**Appendix A**) between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM), and the U.S. Fish and Wildlife Service (USFWS). Analysis of the water chemistry of several karst and non-karst springs was conducted at the suggestion of the USEPA.

2.1 Public and Private Karst Resources

The Project Team compiled existing information on local karst features from a number of sources. These sources included: the Indiana Geological Survey, Indiana Cave Survey, Indiana Karst Conservancy, National Speleological Society, and karst experts knowledgeable about the area. Specific karst studies and mapping for the Section 4 corridor examined and field checked for this study included I-69 Tier I and Tier II public comments, including cave maps and other karst feature data and mapping, as well as all previous I-69 related karst study data. This included the 1994 Karst Features in the Bloomington to Evansville Highway Report and associated data. Additional resources included high resolution aerial photography, planimetric and topographic mapping in the corridor as well as USGS topographic maps and additional aerial photography.

2.2 Karst Feature Identification

A complete field reconnaissance was conducted to check previously mapped karst features and determine the presence of unrecorded visible karst features within the 27-mile length of the Section 4 corridor and potentially associated karst features outside of the corridor. Unidentified underground karst features are likely to be present within the project area. Dye tracing was conducted in order to determine groundwater flow patterns in the area. However, identifying the exact location of the subsurface features associated with this flow cannot be accomplished without invasive ground disturbance (e.g., excavation). Accordingly, otherwise unidentified subsurface karst features associated with observed surface features and underground flow paths were not identified in the karst survey methodology. The Karst MOU was developed with the understanding that it is possible that previously unknown subsurface karst features will be unearthed during construction and the MOU establishes procedures to be followed to address this potential. Under the Karst MOU, if during construction unknown features are identified, the MOU signatory agencies will be contacted and an agreement regarding the proposed treatment of the feature reached prior to work continuing in that specific area of the project.

Aerial photographs and topographic maps were also consulted prior to and during field work to assist in the locating karst features. Once in the field, teams (consisting of 2 to 6 people) walked

approximately 50ft wide transects to locate karst features. When karst features were located, they were given a unique field identification number (i.e. 4-0001) and were flagged with that number, described on a field form (**Appendix B**), located with a GPS (with sub-meter accuracy) unit, and photographed. Multiple visits were made to many areas including reconnaissance during leaf off periods of reduced vegetation and with varying surface/ground water conditions. The features identified were categorized in the following manner.

2.2.1 Recharge Features

A recharge feature is an area that channels water to karst groundwater systems. These features have an associated surface drainage area (recharge area), from which surface water is collected, and directed into the subsurface. In this study recharge features were categorized by their estimated infiltration capacity and divided with the following distinctions:

- High Infiltration - any recharge feature in which water and materials can be conducted unimpeded to the subsurface

- Medium Infiltration - any recharge feature in which transport to the subsurface of water and materials are impeded by material (rock, soil, other), but still possesses moderate infiltration potential

- Low Infiltration - any recharge feature in which water and materials are impeded by material (rock, soil, other) and possess a low infiltration potential.

The following are considered recharge features:

- Sinkholes

- Swallets

- Sinking Streams

- Caves (in some cases).

2.2.2 Discharge Features

Discharge features are openings in the bedrock and/or soil that allow water to flow from the subsurface onto the land surface. These features vary greatly in physical size and flow rate within the Section 4 study area.

The following are examples of discharge features:

- Springs
- Caves (in some cases)
- Gaining Streams
- Sinkholes (in rare cases where the sinkhole is below the water table).

2.2.3 Drainage Area

The drainage area for each karst feature was calculated by incorporating USGS 1/3 arc second Digital Elevation Model Dataset (10 meter resolution) for the study area into an ArcHydro GIS model. The drainage model calculates the up-gradient drainage area for each karst recharge feature. The drainage area is based on their point location from field reconnaissance.

2.2.4 Land Use

The land use for each karst feature was determined using the National Land Cover Dataset (NLCD, 2001 data) which is cooperative project between the USGS and the USEPA. The NLCD is based on 30-meter Landsat thematic mapper (TM) data.

2.3 Dye Tracing Methodology

Dye tracing tests were conducted on karst features within the study area in order to determine and map the subsurface flow from recharge features to discharge features. The criteria for the selection of dye injection and sampling sites were determined in the following manner:

- Based on data collected in the field, recharge features were determined to have high, medium or low infiltration potential. Features with a high infiltration potential are the most suitable dye injection points due to the relatively unimpeded access to the subsurface. Using features with low infiltration potential as injection sites increases the likelihood for injected dye to be impeded by subsurface sumps (fractures, soil, and organic matter). Injection sites were also selected based on their proximity to the Section 4 corridor and if drainage from the Section 4 corridor would contribute runoff to the associated feature

- A sampling network was determined that consisted of all discharge features relevant to the injection point. Sampling sites were also established where streams relevant to the

injection feature were crossed by existing roadways. Such stream crossings are appropriate as streams receive base-flow which could contain the injected dye

- Background samples prior to the dye injection were collected and analyzed for all sampling sites to check for pre-existing fluorescence

- ISCO automated water samplers were installed at springs with the high potential for dye positives

- The appropriate fluorescent dye was chosen from four different dyes (Fluorescein (Uranine), Rhodamine WT, Eosine, and Phloxine B). Dye selection was based on presence of fluorescence in background samples and other ongoing dye traces in the vicinity of injection point. All of the dyes used are environmentally safe in the amounts used for these studies (Smart, 1984)

- Dye was introduced to selected recharge features under natural flow or supplemental flow (the feature was flushed with potable water that was brought to the feature via water tanker). When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points

- All water and activated charcoal samples collected were analyzed using Karst Project Team guidelines (See Section 2.4).

2.3.1 Dye Tracing Program

2.3.1.1 Background Fluorescence

When dye traces are performed in developed areas, there is the potential for background levels of fluorescence in the local groundwater and streams. Sources of background fluorescence include the common use of Fluorescein (Uranine) and Rhodamine WT for sewer and drain pipe tracing by municipalities and local residents. Additional sources of background fluorescence include automotive coolants which are known to contain Fluorescein and Rhodamine WT. Only two previous dye tracing tests were known to have been conducted in the Section 4 Karst Study Area. The absence of known previous dye tracing tests decreases the likelihood of background fluorescence. In order to determine the presence of any background fluorescence, water and charcoal samples are collected and analyzed prior to dye injection.

2.3.1.2 Sampling Stations

Dye tracing sampling stations were established and the presence of background fluorescence was determined for each sampling station. Sampling stations were selected from discharge features identified during the course of the field reconnaissance. The sampling stations were identified in the manner described in Section 2.2. Prior to dye tracing tests the following steps were performed for relevant sampling stations:

- Collection of grab water sample
- Placement of activated charcoal samplers
- Collection of activated charcoal samplers after 1 week
- Placement of ISCO automatic water samplers if appropriate
- Analysis of background water and charcoal samples.

Use of ISCO automated water samplers allows for collection of continuous water samples at any sampling interval, the most common being 1 to 4 hour intervals. The use of ISCO samplers allows for more detailed breakthrough or arrival data of dye, which can be useful when establishing mitigation plans.

The dynamic nature of karst groundwater systems makes it highly likely that spring discharges have changed since the feature was initially documented. During high flow conditions there is the likelihood for ephemeral springs to be flowing which could have been dry during field reconnaissance. In order to assure all possible discharge points were located prior to dye injection the relevant areas were re-examined prior to dye injection for the presence of ephemeral springs. In the event that previously undocumented springs were found they were documented in the manner described in Section 2.2 and established as sampling stations in the manner described above.

2.3.1.3 Dye Injections

The dye tracing program was designed to trace groundwater flowpaths from karst features relevant to the Section 4 corridor. The dye introductions were selected with the following criteria:

- Relevance to the study area, i.e. the feature is within the study corridor or would receive run-off directly from the corridor

- Proximity to areas of importance, i.e. prominent caves and springs
- Size of the feature's drainage area
- The feature's infiltration capacity. Features with high infiltration capacity are more critical for roadway planning, and more suitable for dye tracing than low infiltration capacity recharge features.

2.4 Dye Trace Field and Laboratory Procedures

Quality Assurance/ Quality Control (**Appendix C**)

The following field sampling protocols are implemented to insure accuracy and reproducibility of dye tracing results:

- Collection of field duplicates, water and charcoal
- Collection of field blanks, water and charcoal.

The following lab sampling protocols are implemented to insure accuracy and reproducibility of dye tracing results:

- Testing of all sampling containers, amber bottles (water) polypro jars (charcoal)
- Daily fluorospectrophotometer calibration as per the manufacturers recommendations
- Daily standard analysis for all dyes in use
- Analysis of field blanks and field duplicates.

Dye positives must meet the following criteria

- Fluorescence peak must fall in the accepted range for the dye in question
- Fluorescence peak must have typical fluorescence shape
- Fluorescence peak must be 10 times the concentration of background fluorescence

- Fluorescence peak must be 3 times the detection limit of the machine or 9 times the signal to noise ratio.

2.5 Pollutant Load Estimates

2.5.1 Pollutant Loads from Highway and Right-of-Way

The pollutant loads were calculated for each karst feature within the right-of-way (ROW) but outside the construction limits of the I-69 preferred alternative. All features inside the construction limits are assumed to be filled and capped. Therefore pollutant loading for those features will be zero. Any springs inside the construction limits will be provided with a "spring box" as well as drainage culvert to perpetuate the natural flow of the stream discharge.

Pollutant loads were calculated for pre and post construction conditions. The calculation procedures are based upon models developed to predict pollutant loads without field measurements presented in a Federal Highway Administration (FHWA) training course. The first part of the model calculates pollutant load estimates, developed in the late 1970's using field data from monitoring programs in various states. The second part estimates the pollutant concentrations and compares them to water quality standards. The third part estimates the pollutant loads in the "background", or what occurs before the highway is built. This methodology is included in Appendix N of this document.

Since the construction phasing of Section 4 is not yet determined, during-construction load estimates will not be performed. As part of the construction and construction oversight, strict adherence to the erosion control measures is essential. Runoff and sediment control are to be performed during construction in accordance with the Erosion and Sediment Control plans developed in compliance with the Indiana Handbook for Erosion Control in Developing Areas (Division of Soil Conservation, Indiana Department of Natural Resources). According to the "Results of MOU-Related Karst Studies for Indiana State Road 37, Lawrence County, Indiana (1992-1995)" (EarthTech, 1997), there were elevated levels of Total Suspended Solids (TSS) and Total Recoverable Metals (TRM) to the subsurface associated with the during-construction activities for the SR 37 project. These levels returned to pre-construction conditions about two years after construction. This pattern is anticipated for the I-69 construction.

2.6 Review of IDNR Water Well Data

In their comment letter dated August 3, 2007 on the Section 4 Draft Karst Report the USEPA suggested that IDNR Division of Water water well database should be included in this study to document local water tables and to determine the flow conditions under which the dye traces were conducted.

Because karst groundwater is moving through conduits and flow paths may intersect within a given karst formation, there may be little correlation between the "water table" as measured in wells and a karst conduit flow system in the vicinity. Many assumptions would need to be made regarding well connectivity to and influence from a karst conduit system versus the consolidated formation system, as well as the status of the seasonal influence on these water levels across the wide ranging timeframe of the IDNR well dataset. The undissolved rock (in which wells are typically placed) usually has several orders of magnitude less hydraulic conductivity than does the turbulent flow regime in the karst conduits; and therefore, response times are quite different. These factors limit the usefulness of IDNR water well data for the analyses recommended. The data were reviewed on May 24, 2010 to identify references to karst voids, for assessment of major structural issues. Two references were found. One reference related to a well in Section 5 (the information will be passed along to Section 5). The well log for well No. 213669, located near the , indicates a "crevice" from 20 to 23 ft. Based on their knowledge of the area as well as terminology commonly used by drillers, the karst specialists feel that crevice is likely a fracture, and probably not a serious concern. The data may be reviewed and compared to geotechnical boring data utilized for final design of the project. Water well locations and logs in the vicinity of the Section 4 corridor are depicted in **Appendix L**.

3.0 RESULTS

This section summarizes the results of the karst feature mapping and evaluation, dye tracing, and recharge area delineation.

Karst is an ever-evolving landscape. Karst features can change rapidly and the field descriptions included in this report are accurate for the time the features were identified in the field. Subsequent opening or infilling of sinkholes, caves, conduits, and swallets is likely as are increases and/or decreases in spring discharges.

3.1 Karst Features

Karst features include caves, sinkholes, swallets, sinking streams, springs, and others. In accordance with the Karst MOU, the location, type area, and significant characteristics of karst features were researched, field checked, and documented. To evaluate these features relative to the corridor and potential alignments, these features were incorporated into a GIS database. Previously unrecorded karst features within the 27-mile length of corridor and potentially associated features outside of the corridor were included in the GIS database. The complete field mapping database can be found in **Appendix D** and the corresponding feature photographs are included in **Appendix I**. Drainage area (**Appendix E**) and land use (**Appendix F**) for appropriate karst features are included in the summary data tables for each feature type.

3.1.1 Caves

Reviews of the existing data obtained (see Section 2.1 Public and Private Karst Resources) and field mapping identified the locations of 63 caves within the study area. The entrances to fourteen of these caves are located within the corridor. Four caves located outside of the corridor have been linked to the corridor via dye tracing tests. All cave entrances located within the corridor were included in the development of alignment alternatives. Caves are identified as bedrock openings large enough for entry by a human. Many are blocked by infilling with sediments, collapsed bedrock, and waste materials. These caves include all those previously located for I-69 investigations and others that were investigated by Indiana Geological Survey and the Winter Action Area surveys for the endangered Indiana bat. The project team coordinated and shared this information during the time of the surveys, and information gathered during the course of these other surveys is included in the cave descriptions. A complete cave list with descriptions can be seen in **Appendix D - Table 2** and cave locations can be seen in **Figures 5, 6**, and **7**.

3.1.1.1 Named Caves

Cave

Cave was field located and is reported as 4-0749. This cave is located within an 11 ft diameter 30 ft deep sinkhole. It is also known as Cave. The vertical pit drops approximately 30 ft and leads to several hundred feet of cave passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was field located and is reported as 4-1427. The cave entrance is located miles east of the corridor boundary, and across . The entrance is a small vertical pit, about 20 ft deep, into a horizontal cave draining to the west to a collapsed spring along Little Indian Creek. The cave extends eastward under the ridge for an unknown length bearing a karst flowpath. This cave has a vertical range of approximately 50 ft passing downward from the Paoli Limestone into the Ste. Genevieve Limestone. Topography, limited recharge, and hydrogeologic range of this cave preclude connectivity with the corridor. The cave has a large drainage channel feeding it from the hill to the north and is categorized as a recharge feature. The drainage to this cave is located outside of the corridor and is not connected via surface drainage.

Cave was harp trapped in the fall of 2004 and a winter survey was conducted in 2005 as a part of an associated study of the Winter Action Area for the endangered Indiana bat. No Indiana bats were captured there during fall harp trapping or observed during the winter survey.

Suggested Abatement

This cave is located on the opposite side of from the Section 4 corridor. serves as a groundwater drain making it unlikely groundwater would flow from the corridor Cave. Additionally, the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was field located and is reported as 4-1527. The entrance to the cave is not located within the corridor. Cave is developed in the Beech Creek Limestone and would have a stratigraphic vertical extent of about 35 ft. Dye tracing tests (1 & 2, Clifty Chapel, Flick 1 and Flick 2 Traces) indicated the system is approximately 20,000 ft long with 200 ft of vertical relief. The cave has a 500 gpm spring flowing out of the entrance and is categorized as a discharge feature. Cave was not harp trapped in the fall 2004 or part of the winter 2005 survey for the endangered Indiana bat. Cave has been considered a hibernaculum for the Indiana bat by USFWS. However, IDNR surveys have found a decreasing population. The last count in 2005 was down to zero Indiana bats from a 1995 maximum population of 28.

Suggested Abatement

Cave is not located within the corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 1434, 4-1525, and 4-1524), four of which receive direct run-off from the corridor (**Figure 8**). The drainage areas associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) cross into the corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave was field located and is reported as 4-1665. The entrance is located within the corridor, and the cave was identified for avoidance during alternative development. The entrance located on an upper slope is 7 ft wide and 3 ft high. This cave extends a distance of approximately 150 ft. The cave entrance extends downward from the surface and is categorized as a recharge feature. The cave is sediment filled and stream abandoned, with a vertical extent of about 25 ft in the St. Louis Limestone. No Indiana bats were trapped or observed in Cave

during the Winter Action Area surveys. Two unidentified Myotis bats were observed during the winter survey, but could not be examined for differentiation.

Suggested Abatement
The entrance to Cave is located within the corridor and was avoided during alignment development. Surface drainage from the roadway to this feature should have as much natural treatment as possible and the mapped cave passage should be considered during construction planning (**Figure 9**). It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching this feature. Also, where appropriate and practicable special consideration should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave was not located during fieldwork for this study. This suspect cave location was also researched and looked for by the IGS during the Winter Action Area surveys, and was not located by IGS either. Discussion with the IGS suggests the cave location data is inaccurate for Cave, and that the actual location of the cave is likely outside of the study area. However, the previously documented location within the corridor was identified for avoidance during alternative development.

Suggested Abatement
No abatement recommended.

Cave

Cave was previously documented and identified during field reconnaissance. It is included in the database as 4-0405. The cave is located approximately ft east of the corridor boundary and within the general area that was excluded from the corridor due concerns related to the historic site. This cave entrance was corroborated by Indiana Geological Survey's cave reconnaissance as the entrance associated with the name Cave. It is located near, but not connected with lying one half mile to the east. The cave is located in a sinkhole with exposed bedrock and is categorized as a recharge feature. At the time of field description there was outward air movement at the entrance to the cave, which can be an indication of connection to a larger cave system. Cave entrance lies approximately 40 ft above the flood plain of Little Indian Creek, opposite from the corridor. The small opening through the Paoli Limestone could not be penetrated far, but any cave associated with is opening would extend eastward below the ridge, or westward immediately to the floodplain of Indian Creek. Any cave associated with this opening would have a vertical extent limited to approximately 50 ft extending through the Paoli Limestone and upper third of the Ste. Genevieve Limestone. This cave has no hydrological connectivity with the corridor.

Suggested Abatement
The drainage to this cave is located outside of the corridor. Additionally, the vertical extent of this cave is limited by the geology. No abatement measures are deemed necessary for this feature.

Cave

Cave entrance was field located and assigned 4-0061. Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. Swallet 4-0037 derives a portion of its recharge from the Section 4 corridor. The entrance to the Cave is a small opening about 2 ft square. This drops down into a larger conduit that curves around to the right and the flowpath discharges through a large spring approximately 20 ft wide and 5 ft high at the highest point. The flow volume from swallet 4-0037 is relatively low. To the left, upstream, the cave has a surveyed length of 2,600 ft ending, as a cave, to a small rise pool. This cave has a vertical range of approximately 40 ft extending through the lower one-third of the Ste. Genevieve Limestone, between the entrance and the rise pool. Several small conduits gather recharge from nearby sinkhole ponds. The flowpath extending beyond the rise pool has been dye traced from an input point 4,000 ft to the northeast, and lying below a pit inside of Cave (Conner, 2006). Cave and Cave are generally considered as separate caves, however their physical and hydrological interconnections informally provide for the consideration of and Cave System. Related information is found in the description of Cave in this Section. Cave was fall harp trapped and winter surveyed as part of the Winter Action Area surveys. Cave receives most of its recharge from recharge features a mile to the north in an area overlying Cave, and structurally up dip. Topographically there is a divide between Cave and the corridor lying to the south. Flowpath potential may extend downward from the Paoli Limestone to the lower Ste. Genevieve Limestone.

Suggested Abatement
Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave was field located and assigned 4-0282. The opening to this cave is located outside of the corridor. A 200 gpm spring flows out of the entrance of the cave, and is categorized as a discharge feature. Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from

four swallets (4-0166, 4-0173, 4-0175, 4-1504) which receive run-off from the Section 4 corridor (**Figure 11**). Three other recharge features (4-0174, 4-0203, and 4-0204), which were not dye traced, are potentially hydrogeologically linked to the cave. The surface drainage areas associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) cross into the Section 4 corridor. The spring outlet of Cave is inundated by ponding behind a stone damn built by the landowner for water withdrawal purposes. This precludes ingress for the Indiana bat and other terrestrial fauna.

Suggested Abatement
Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave
Cave is a suspect location that was not located during fieldwork. Indiana Geological Survey cave data indicates this cave is located at UTM (feet) coordinate of X= , Y= , which is located outside of the corridor. Communication with the landowner suggests this cave was filled with soil to prevent livestock from entering or falling into the cave. The Beech Creek Limestone is present below the upper ridge at this location. Any soil filled cave at this location would have a limited vertical extent of approximately 20 ft.

Suggested Abatement
Although the location of Cave was not definitively identified, the suspected location is located outside of the corridor and would not receive surface drainage from the corridor. No abatement is recommended for this feature.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-0674. The cave has a vertical pit entrance and is categorized as a recharge feature. Historical information indicates the pit entrance leads to a cave system approximately 400 ft long. However, dye tracing in the area suggests the system potentially associated with this cave receives underground drainage from as far away as 3,000 ft (See Section 3.2.2, Wright Road Trace).

Suggested Abatement
Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to spring 4-0678 is derived in part from a sinking stream 4-0661

which receives surface drainage from the corridor (**Figure 12**). Based on cave mapping of Cave, spring 4-0678 is the likely discharge point for groundwater flow from the cave. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover. Cave was fall harp trapped and winter surveyed finding no Indiana bats.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-0943. The cave entrance is located outside of the corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet (4-1035). Swallet 4-1035 derives a portion of its recharge from the Section 4 corridor. The cave has a 3 ft by 3 ft entrance that leads to a cave system approximately 1,000 ft in length. It is located south of the corridor and just west of . The cave has an approximately 30 gpm spring flowing out of the entrance and is categorized as a discharge feature. The 3 by 3 ft entrance is fitted with a length of corrugated pipe to capture water from this spring which floods to the ceiling after storms. Several hundred feet of small water pipe extends into the accessible conduit to reach a low water capture pool. The pipe appears to be no longer in use. Exploration and surveying has pushed beyond two “bathtub” obstacles to survey approximately 1,000 ft extending westward and southward away from the corridor. Approximately another 350 ft of conduit is reported to have been explored. This cave ranges vertically for approximately 50 ft through the lower St. Louis Limestone.

Suggested Abatement

Recharge to Cave is derived from the corridor. Construction in this area could result in decreased recharge and/or a decrease in the water quality of the cave, which is used as a water supply. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

Cave

Cave is a spring outlet previously documented and located during fieldwork and identified as 4-1743. It is located within the corridor and just east of . The mapped cave is known to extend approximately 150 ft through the St. Louis Limestone, with a vertical extent of 10 ft or less. This cave location was identified for avoidance during alternative development. A spring flows out of the entrance at approximately 15 to 20 gpm and the cave is

categorized as a discharge feature. The cave was included in the Winter Action Area surveys for the endangered Indiana bat. No bats were trapped during the fall of 2004. During the winter survey attempts to enter the cave found frost shattered collapse at the entrance. Inside approximately 10 ft the conduit is approximately 18 inches in diameter. A spring harp trapping during 2005 also captured no bats.

Suggested Abatement

The entrance to Cave is located within the corridor and was avoided during alignment development. Suitable dye injection locations for this cave were located southwest of the intersection of and . However, this karst area is avoided by a cut-out in the corridor that will prevent construction on or drainage to the potential recharge area for Cave. There are several large high infiltration sinkholes in this area and for that reason it was identified for avoidance during alternative development (**Figure 14**). Limited drainage to the cave is presumably derived from the corridor although the majority of drainage is most likely derived from outside the corridor. The location of the drainage in relation to the cave entrance suggests the cave system trends from the entrance to the northwest, although the mapped cave passage trends west and south. Construction planning in this area should consider the cave entrance and the potential for cave passage to the east, northwest and southwest of the cave entrance. Also, special consideration should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-1674. The cave has a 10 gpm spring flowing out of the entrance and is categorized as a discharge feature. The cave entrance is located outside of the corridor and drainage to this cave is located outside of the corridor. The cave passage extends away from the corridor to the southwest for approximately 2,000 ft.

Suggested Abatement

This cave is located on the opposite side of from the Section 4 corridor. serves as a groundwater drain making it unlikely groundwater would flow from the corridor to Cave. Additionally, the cave passage extends away from the corridor and the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave

Cave was previously documented and located during fieldwork. It is identified in this report as 4-0382. The cave entrance is located approximately ft south of the corridor boundary within an . The cave entrance is 2 ft by 2 ft and is partially obstructed by limestone quarry blocks. The cave is categorized as a discharge feature with a less than 1 gpm spring flowing out of the cave entrance. The cave extends as a narrow stream

abandoned conduit for approximately 200 feet where it connects to a larger room complex developed in the Popcorn Sandstone Bed. A lower conduit accessed in the back of the room extends eastward and northward into the ridge for an unknown distance. This cave has a vertical extent of approximately 50 ft, with recharge in the Paoli Limestone and Popcorn Sandstone Bed, and extends downward through one third of the thickness of the Ste. Genevieve Limestone. The downstream segment would be expected to discharge to the west within several hundred ft into Little Indian Creek based on the immediately local geology and hydrogeology. The Cave was fall trapped and winter surveyed as part of the Winter Action Area Surveys with no Indiana bats trapped or observed.

Suggested Abatement

The entrance to Cave is located outside of the corridor. There is a small (<0.5 gpm) spring below the cave entrance but the cave passage does not have flowing water. Due to the lack for flowing water it was determined the cave would not be a suitable sampling location for dye tracing tests. The source of the spring below the entrance is likely the result of soil drainage through the quarry walls where the entrance is located. The only area of concern with this cave is the possibility of encountering a cave passage during roadway construction. The cave passage is known to be approximately 200 feet with an unknown length of cave passage beyond that. The cave passage trends to the northeast towards the corridor. Encountering unmapped portions of this cave is a possibility and should be considered during roadway planning and construction. The use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor was recommended by the USEPA. Such methods are unlikely to yield definitive results in this karst setting. The clay rich soils developed above the bedrock and also the significant thickness of bedrock between the cave and the ground surface would hinder a geophysical study.

Cave

Cave was previously documented and located during fieldwork. Its entrance is identified in this report as 4-0058. Cave has a surveyed length of 23,760 ft. It is hydrologically connected to nearby Cave via a 4,000 ft dye trace connecting them. Cave has three active flowpaths. The spring entrance to the includes approximately 3,500 ft of passage. Recharge to the cave is derived from the area north and west of the cave entrance. This main flowpath passes below the Indiana bat hibernaculum identified by USFWS and surveyed by IDNR. The second flowpath extends from a drainage divide near the to a pit to the northeast, just south of . This system has several cutoffs where its water is carried downward to enter the third flowpath. The third flowpath is entered at the base of the pit. Upstream it continues north of . Downstream it is not passable, but was dye traced to Cave. The interconnectivity between and Caves allows water from to enter but not the opposite. Cave does not receive water from the corridor and corridor water does not pass through the Indiana bat hibernacula in Cave.

Cave was fall harp trapped as part of the Winter Action Area surveys, and was winter surveyed by IDNR as part of their biennial census counts.

Suggested Abatement
Previous dye tracing tests show that groundwater flows from Cave to Caves. Cave served as a monitoring point for the Cave Trace and there was no dye detection at Cave. These two traces suggest that it is highly unlikely that Cave would receive run-off from the corridor. Additionally, the drainage to this cave is located outside of the corridor. No abatement measures are deemed necessary for this feature.

Cave
was previously documented and located during fieldwork. It is identified in this report as 4-1518. Cave is located outside of the corridor and was identified for avoidance during alternative development. The cave is developed in the Beech Creek Limestone and is limited to 35 ft stratigraphic extent. The cave has two distinct springs flowing out of separate openings and is categorized as a discharge feature. The combined flow of these springs at high flow is approximately 500 gpm. Cave was fall harp trapped and winter surveyed finding no Indiana bats.

Suggested Abatement
Cave is not located within the Section 4 corridor. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. The probable flowpath for the Cave dye traces cross the potential recharge area for Cave (**Figure 15**). No dye positives were recovered at Cave. However, the groundwater flow direction determined from the Cave dye traces indicates groundwater flows from the corridor towards Cave.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-0279. The cave has a 10 foot wide by 3 ft high entrance that leads to a cave system approximately 600 ft long. The cave passage extends downward from the surface and is categorized as a recharge feature. However, the high location of the entrance on the hillside would limit the amount of drainage to the cave entrance. Dye tracing tests (Trace 1) indicate that recharge to the cave is derived from the corridor. Cave was fall harp trapped and winter surveyed for the Indiana bat. A female Indiana bat was harp trapped swarming at the entrance in autumn 2004. The winter survey found no Indiana bats inside. Because of its location along the corridor this cave was trapped and surveyed a second time the following year finding no Indiana bats.

Suggested Abatement

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to spring 4-1274 located 500 ft southwest and 40 ft lower in elevation than the cave entrance, is derived in part from sinking stream 4-1271 and 4-172 which receive surface drainage from the corridor (**Figure 16**). Cave lies between 4-1271 and spring 4-1274 and it is likely that Cave receives recharge from sinking stream 4-1271. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-1271 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever 4-1271 by sedimentation or impervious cover. Additionally, the mapped cave passage for Cave trends toward the corridor. The possibility of encountering unmapped portions of the cave passage during roadway construction exists and should be considered during roadway planning in this area.

Cave

Cave was not definitively located during the course of fieldwork. Four caves (4-0071, 4-0831, 4-0775, and 4-0735) were found in the vicinity of the Indiana Geological Survey reported location of Cave; however none were definitively determined to be Cave. The cave location data from the IGS corresponds to 4-0842, which is described for this study as a soil plugged sinkhole. It is possible that this is the feature previously reported as Cave and that the opening has become smaller due to sedimentation. This suspect location is outside of the corridor, approximately 1,000 ft south of the corridor boundary. The local terrain is developed on the St. Louis Limestone and any such cave in this area would likely have had a vertical extent of 50 ft or less.

Suggested Abatement

Although Cave was not definitively identified, its suspected location is located outside the corridor and does not receive surface drainage from the corridor. No abatement recommended for this feature.

Cave

Cave was previously documented and is located approximately east of the corridor and across Indian Creek. The cave was located during field reconnaissance and is identified in the database as 4-1306. The entrance to the cave is approximately 10 ft wide and 5 ft high. This spring features multiple discharges to the floodplain with an estimated discharge of 1,000 gpm during high flow. This surveyed cave extends eastward, into the ridge for 4,640 ft where the ceiling drops to the static water depth of approximately 18 inches, but the conduit continues for an unknown extent. This cave floods entirely to the ceiling during storm cycles. The vertical extent of the cave is approximately 40 ft. The probable source of recharge to this cave is karst features to the northeast of the cave entrance. is recognized by

USFWS as a hibernaculum for the endangered Indiana bat. A recent IDNR survey identified a population of 119 hibernating Indiana bats. Topography, limited recharge, and the channel of Indian Creek preclude any hydrological connection between Cave and the corridor.

Suggested Abatement
This cave is located on the opposite side of Indian Creek from the Section 4 corridor. Indian Creek serves as a groundwater drain making it unlikely groundwater would flow from the corridor to Cave. Additionally, the recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-1057. The entrance to the cave is 15 ft by 6 ft wide and extends 10 ft visibly from the surface.

Suggested Abatement
The entrance to Cave is located outside of the corridor and is not connected via surface drainage except under extreme high flow conditions (**Figure 17**). There is a channel located to the north and separated by a surface divide which does receive surface drainage from the corridor. Under extreme high flow conditions water can overflow this channel and enter Cave. Measures should be taken to address the high flow conditions that can result in drainage from the corridor entering Cave. Increasing the height and width of the bank separating the low flow channel and high flow channel of would prevent water from the corridor from entering the cave entrance.

Cave
Cave was previously documented and located during fieldwork. It is identified in this report as 4-1303. The entrance to the cave is 15 ft by 15 ft and extends downward from the surface. Cave and the associated adjacent spring discharge to the floodplain of Little Indian Creek and are located approximately miles east of the corridor boundary and are separated from the corridor by a south trending valley. The known cave has been surveyed for a distance of 2,283 ft to the northeast below the slope flanking Little Indian Creek. The cave has a reported surveyed height of 52 ft. This is in agreement with a recharge feature into the Paoli Limestone and a karst flowpath extending downward through the upper one-third of the Ste. Genevieve Limestone. A dye trace was completed in effort to determine if there is a hydrological connection between the corridor and Cave but no connection was identified.
Cave is in the Winter Action Area and was harp trapped in the fall of 2004 finding no endangered Indiana bats. An effort was made to make a winter survey, but access into the cave

was not granted. Further consultation with USFWS Bloomington Field Office (BFO) determined that this cave is not likely a hibernaculum for Indiana bats.

Suggested Abatement
The entrance and recharge area for Cave are located outside of the corridor. The entrance is not connected via surface drainage and there is no indication of subsurface connection with the corridor. No abatement measures are deemed necessary for this feature.

Cave
Cave was not definitively located during fieldwork. The suspected location lies outside of the corridor, approximately ft north of the corridor boundary at UTM (feet) coordinate of X , Y . One cave (4-0020) is located ft east and ft south of the suspected location. Several large sinkholes were identified within ft of this area and it is possible that one of these features might have had a cave opening at some point that is currently filled with sediment. This suspect location was also reviewed by the Indiana Geological Survey as part of the Winter Action Area surveys, with no cave opening identified.

Suggested Abatement
Although the location of Cave was not definitively identified, its suspected location is in an area with a high density of karst features (**Figure 18**). Dye tracing tests in this area (See Section 3.2.2, Koontz Duval Trace) suggest that there is a large underground system in this area. The possibility of encountering unmapped cave passage during roadway construction exists and should be considered during roadway planning in this area. As previously noted, the use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor are unlikely to yield definitive results due to clay rich soils developed over the bedrock and a significant thickness of bedrock between the cave and the ground surface.

Cave
Cave (IGS designation) was identified during field reconnaissance within the corridor just west of and south of . This feature was identified as 4-0089 in this report. This cave was included in the Winter Action Area survey. Fall harp trapping and winter surveys during 2005 as a part of an associated study identified no Indiana bats at this location. The survey team found the opening to extend downward vertically only a short distance into the St. Louis Limestone a short distance where further ingress is prevented by soil and rock.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave (**Figure 19**) is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where

appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

Cave

Cave (IGS designation, also known as Cave) was identified during field reconnaissance as a new cave located outside of the corridor, approximately ft south of the corridor boundary in Greene County, just west of . This feature is identified as 4-1479 and has a 5 ft by 3 ft opening to the Beech Creek Limestone. At the time of field description there was outward air movement at the entrance to the cave, which can be an indication of connection to a larger cave system. The Winter Action Area team fall trapped and then made a winter survey into this cave extending approximately 150 ft. No Indiana bats were found.

Suggested Abatement
The recharge area for this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

3.1.1.2 Unnamed Caves

Previously unnamed caves were identified during the course of field mapping. These caves can also be seen in **Figures 5, 6,** and **7** and in **Appendix D - Table 2**.

4-0020
This cave has a 2 ft diameter entrance and is located within a sinkhole. It appears to have passage leading away from the entrance. This cave is possibly Cave although it was not possible to definitively identify it as such.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The cave in a high density of other karst features that suggests there could be a large karst system present in this area. The possibility of encountering unmapped cave passages during roadway construction exists and should be considered during roadway planning in this area.

4-0047
This cave has an entrance 2.5 ft by 5.5 ft. The entrance drops 12 ft into a small room. There is a solutional entrance in the floor of the small room. This feature is located within a sinkhole.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0071
This cave has an entrance 2.5 ft in diameter and the passage visibly extends 3.5 ft from the entrance. The entrance is located within a 30 ft diameter sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0115
This cave has an entrance 4 ft by 2ft and the passage visibly extends 3 ft from the entrance.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0123
This cave has an entrance 6 ft by 4ft and the passage visibly extends 8 ft from the entrance. The entrance was moving cold air at the time of field location, which can be an indication of connection to a large volume cave system. Several areas of soil collapse were also observed around the entrance.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0135
This cave has an entrance 2 ft in diameter and the passage visibly extends 3 ft from the entrance. The entrance is located within a 30 ft diameter 15 ft deep sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0238
This cave entrance is located within 9 ft diameter 7 ft deep sinkhole. There is a cave (4-0254) with spring flow out of the passage, located 500 ft to the north and approximately 140 ft vertically lower than 4-0238. This could indicate the presence of a large karst system within the ridge that 4-0238 could be connected to.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0254
This cave has an entrance 4 ft by 1.5 ft. A small spring discharges below the entrance. The spring is ephemeral in nature and was not flowing at the time of field location but was observed to be flowing on subsequent visits to the location. The feature is a dye recovery location for Evans Road Trace 2. The length of this cave system based on the distance from dye injection at 4-0362 to detection at 4-0254 would be 2,818 ft.

Suggested Abatement
The entrance to this cave and the associated recharge feature (4-0362) are located outside of the corridor and are not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0255
This cave has a vertical entrance 3 ft in diameter that drops vertically 15 ft. The vertical entrance leads to passage that trends south into the ridge to an unknown distance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0283
This cave has a vertical entrance 3.5 ft by 1.5 ft that drops vertically 5 ft. The entrance moves significant quantities of air. There is a cave (4-0287) with spring flow out of the passage, located

80 ft to the northwest from 4-0283. Airflow from the entrance of 4-0283 and proximity to cave 4-0287 could indicate the presence of a large volume of cave passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement recommended.

4-0287
This cave has an entrance 10 ft by 2.5 ft and the passage visibly extends 10 ft from the entrance. A 1 gpm spring discharges below the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The probable recharge area for this cave is located northwest from the cave entrance, part of which would be within the corridor. The Section 4 Alternatives are not anticipated to impact the drainage areas of the suspected recharge features. Therefore no abatement is recommended.

4-0298
This cave has an entrance 3 ft by 2 ft and the passage visibly extends 3 ft from the entrance. There was no spring flow at the time of field location although reeds and ponded water indicate this feature does have intermittent spring flow.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement recommended.

4-0370
This cave is located within a 19 ft diameter 4 ft deep dual depression sinkhole.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0511
This cave has an entrance 3 ft by 1.5 ft and the passage visibly extends 4 ft from the entrance. It is located above a spring. The entrance was moving significant air when field located, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0695
This cave is reported to be over 300 ft long. At the time of field identification the entrance was filled in with gravel.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0706
This cave has a 5 ft by 8 ft entrance that visibly extends 20 ft. It is located on a ridge above a 100 gpm spring (4-0707). There are loose rocks and breakdown that would prevent further ingress just inside the cave entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0735
This cave has a 10 ft deep vertical entrance and what appears to be horizontal passage leading away from vertical entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0741
This cave is located within a 13 ft by 3 ft wide 6 ft deep sinkholes. The entrance was moving air at the time of field location, which can be an indication of connection to a large volume cave system. It is very close to Cave and may overly passage to the Cave.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0775
This cave has an entrance 2.5 ft by 2 ft and the passage visibly extends 15 ft from the entrance. The entrance is developed on a solutionally enlarged joint and a 1 gpm spring flows from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. It is doubtful this cave is connected to the corridor via groundwater flow, although dye tracing tests would be required to determine this.

4-0778
This cave has an entrance 1.5 ft in diameter and extends visibly 6 ft from the entrance. At the time of field location the entrance was moving fair amounts of air, which can be an indication of significant passage.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0780
This cave has an entrance 10 ft by 5 ft and the passage visibly extends 20 ft from the entrance. A 6 gpm spring flows out of the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. The probable recharge area for this cave is located northwest from the cave entrance, part of which could receive surface drainage from the corridor. The Section 4 Alternatives are not anticipated to impact the drainage areas of the suspected recharge features. Therefore no abatement is recommended.

4-0831
This cave has a 7 ft diameter entrance. This cave was a dye recovery location for Victor Oolitic Trace 3. The length of this cave system based on the distance from dye injection at 4-0807 to detection at 4-0831 would be 661 ft.

Suggested Abatement
The entrance to this cave is located outside of the corridor although dye tracing tests revealed it is connected via surface drainage to 4-0807 and groundwater flow from 4-0807 to 4-0831. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-0807 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-0875
This cave has an entrance 2 ft in diameter. The entrance is located within an 11 ft by 4 ft wide 6 ft deep sinkhole.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0918
This cave has an entrance 2.5 ft in diameter. The entrance is vertical and drops visibly 5 ft.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0977
This cave has an entrance 2 ft in diameter that drops visibly 40 ft downward from the entrance. At the time of field location this feature was blowing warm air. This feature overlies known passage area of Cave. It is probable that this feature would provide a connection to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-0978
This cave has an entrance that is 2.5 ft by 1.5 ft. The entrance drops 20 ft into a small room. At the time of field location the entrance was moving air. This feature overlies known passage of Cave. It is probable that this feature would provide entrance to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1039
This cave has an entrance 4 ft by 3 ft and the passage visibly extends 5 ft from the entrance. The entrance was sucking air at the time field location, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1108
This cave has an entrance that is 4 ft in diameter and the passage visibly extends 15 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1112
This cave has an entrance that is 4.5 ft in diameter and the passage visibly extends 20 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1131
This cave has an entrance 3 ft in diameter and the passage visibly extends 10 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1198
This cave has an entrance 12 ft by 3 ft. A 300 gpm spring flows out of the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1230
This cave has a 2 ft diameter entrance and a 3 gpm spring flowing from the entrance. At the time of field location the opening was moving air, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1231
This cave has an entrance 2 ft by 1 ft. At the time of field location cold air was blowing out of the entrance, which can be an indication of connection to a large volume cave system. There was guano present around the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1367
This cave has an entrance 3 ft in diameter and the passage visibly extends 15 ft vertically downward from the entrance. This feature is located in a drainage and was exposed during a rain event. The entrance to this feature is located 400 ft north of Cave and there is a strong possibility these two features are related.

Suggested Abatement
The entrance to this cave is located outside of the corridor but is connected via surface drainage. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1431
This feature is a cave with the entrance obstructed by breakdown. There is a significant quantity of air blowing from breakdown in the spring alcove, which can be an indication of connection to a large volume cave system. A 25 gpm spring flows out of the entrance. This feature is a dye recovery location for Kermit Inman Trace 1. Based on the results from that trace the cave system associated with this feature would be 739 ft in length.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Dye tracing tests show this cave also receives recharge from within the corridor. Where appropriate and practicable, special planning should be conducted to insure recharge to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover. The possibility of encountering unmapped cave passages during roadway construction exists and should be considered during roadway planning in this area. As previously noted, the use of unobtrusive geophysical techniques to determine the presence of this cave within the corridor are unlikely to yield definitive results due to clay rich soils developed over the bedrock and a significant thickness of bedrock between the cave and the ground surface.

4-1441
This feature is a cave that the land owner stated was filled in.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1470
This cave has an entrance 10 ft by 6 ft and the passage visibly extends 8 ft from the entrance.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1475
This cave has an entrance 3 ft in diameter and the passage visibly extends 30 ft vertically downward from the entrance. The landowner states that the entrance pit leads to more passage. This cave is in the vicinity of three dye injection locations that had dye recoveries at
Cave. Additional dye tracing studies would be needed to determine if this cave is connected to the Cave System.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1479
This cave has an entrance 3 ft by 5 ft and the passage visibly extends 20 ft from the entrance. There is a significant quantity of air blowing out the entrance, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located outside of the corridor and is not connected via surface drainage. No abatement measures are deemed necessary for this feature.

4-1522
This cave has an entrance 2 ft by 1 ft and the passage visibly extends 5 ft from the entrance. At the time of field location there was a significant quantity of air blowing out the entrance and steam was present, which can be an indication of connection to a large volume cave system.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. No recharge features could be identified for this feature. It is recommended that the entrance of this feature be avoided.

4-1624
This cave has an entrance 3 ft in diameter.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

4-1665
This cave has an entrance 7 ft by 2.5 ft.

Suggested Abatement
The entrance to this cave is located within the corridor and was avoided during alignment development. Where appropriate and practicable, special planning should be conducted to insure drainage to this cave is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not fill the entrance to this cave by sedimentation or with impervious cover.

3.1.2 Sinkholes

Field mapping identified the locations of 993 sinkholes within the karst study area. Of these, 305 are located within the corridor. Sinkholes were defined by infiltration capacities of high, medium, or low. A complete sinkhole list with descriptions can be seen in **Appendix D - Table 3** and sinkhole locations can be seen in **Figures 20, 21**, and **22**.

3.1.3 Swallets

Field mapping identified the locations of 62 swallets within the karst study area. Of these, 19 are located within the corridor. A complete swallet list with descriptions can be seen in **Appendix D - Table 4** and swallet locations can be seen in **Figures 23, 24**, and **25**.

3.1.4 Sinking Streams

Field mapping identified the locations of 15 sinking streams within the karst study area. Six (6) of these are located within the corridor. A complete sinking stream list with descriptions can be seen in **Appendix D - Table 5** and sinking stream locations can be seen in **Figures 26, 27**, and **28**.

3.1.5 Springs

Field mapping identified the locations of 331 springs within the karst study area. Of these, 103 are located within the corridor. A complete list with descriptions can be seen in **Appendix D - Table 6** and conduit locations can be seen in **Figures 29, 30,** and **31**.

Spring
Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-

1228) in a drainage located within the Section 4 corridor (**Figure 32**). During high flow periods water overflows 4-1228. It is likely in these conditions that the area downstream of 4-1228 acts as a losing stream and provides recharge to Spring. The feature 4-1228 and the potential losing down gradient from it would receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Spring. Where appropriate and practicable, special planning should be conducted to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

3.1.5.1 Spring Water Chemistry

The water chemisty of karst and non-karst springs was compared to determine chemical differences in the two spring types.

Methodology

Water was collected from five karst and five non-karst springs. The water was analyzed for major cations, major anions, specific conductance, temperature, and pH (**Appendix G-1**). After the samples were analyzed, the cation/anion data were plotted on tri-linear and stiff diagrams, and pH vs. conductivity plots for comparison. Additionally, the PHREEQC computer model was utilized to determine the saturation index of calcite and dolomite carbonate minerals.

The following karst springs were analyzed:

-
- Spring
- Spring
-
- 4-0067.

The following non-karst springs were analyzed:

- 4-1077
- 4-1081

- 4-1083
- 4-1084
- 4-1092.

Trilinear Diagrams

A trilinear diagram is a method for comparing the water chemistry of multiple water samples. The lower left triangle in the diagram is the plot for the major cations (Ca, Mg, Na+K). The triangle on the lower right is the plot for the major anions (HCO3, SO4, Cl). The cations and anions for each water sample were plotted in the cation/anion triangles and then projected on the diamond above to determine the water type classification (for example, Ca-HCO3). The karst and non-karst spring samples were plotted on a trilinear diagram (**Appendix G-2**). The karst springs are predominantly Ca-HCO3. The non-karst springs fall into the "no dominant type" category for cations and are predominantly HCO3 water with regard to anions.

The two outliers on the trilinear diagrams were and 4-10092. had higher concentrations of sulfate than the other karst springs. The high concentration of sulfate could be the result of agricultural activities in the recharge area for the spring or groundwater flow through gypsum bedrock. Spring 4-1092 also differs from the other non-karst springs, with higher concentrations of both Mg and Cl. This spring is located near Scotland, IN where the geology consists of Pennsylvanian aged inter-bedded coals and shales. This geology could potentially cause the difference in water chemistry seen at this spring.

Conductivity vs. pH

A plot of conductivity vs. pH was also used to compare the karst and non-karst springs (**Appendix G-3**). The pH for the karst springs ranged 6.75 to 7.65, with most above 7. The non-karst springs ranged from 4.26-6.38, with most below 6. The conductivity for the karst springs was higher on average, ranging from 160.2 to 661 µs/cm. The non-karst springs ranged 93-195.2 µs/cm.

Stiff Diagram

Stiff diagrams are another method to compare water chemistry. On a Stiff diagram the major cations (Na, Ca, Mg) and major anions (Cl, HCO3, SO4) are plotted on an area graph (**Appendix G-4**). As determined with the Trilinear Diagrams, the karst spring samples are Ca-HCO3 water and the non-karst spring samples had no predominant cation and were predominantly HCO3 water with regard to anions.

Saturation Index

The saturation index (SI) of a particular mineral in water is used to determine if that water will dissolve or precipitate that mineral. For example, water with a SI of 1.0 for calcite will precipitate calcite, while water with a calcite SI of -5.0 will dissolve calcite. For this study the SI for calcite and dolomite were compared for each karst and non-karst spring (**Appendix G-5**). The karst springs' calcite SI varied from 0.05 to -1.9. Non-karst springs were more under saturated with values from -2.51 to -5.14 (**Appendix G-6**). The karst spring dolomite SI ranged from -0.69 to -4.16. The non-karst springs were again more under saturated with SI from -5.15 to -10.3 (**Appendix G-6**). For both calcite and dolomite, Spring is more under saturated than the other karst springs. This is a reasonable finding as Spring discharges at the contact between the Beech Creek Limestone and Big Clifty Sandstone, and undoubtedly receives some recharge from the non-karst Big Clifty.

Conclusions

The purpose of the water chemistry study was to verify the karst or non-karst nature of springs located within Section 4. The springs deemed karst and non-karst had consistent differences in their water chemistry, which are summarized below:

Water Classification

- Karst: Ca-HCO3
- Non-karst: No dominant type/HCO3.

As expected the karst springs are classified as Ca-HCO3. As the carbonate bedrock (CaCO3) is dissolved, Ca is released into solution and CO3 reacts with free H+ to form HCO3. The non-karst springs fall into the "no dominant type" category for cations and are predominantly HCO3 waters with regard to anions.

pH

- Karst: ranged from 6.75 to 7.65 with most over 7
- Non-karst: ranged from 4.26 to 6.38 with most under 6.

The determined differences in pH are typical for karst and non-karst springs. As groundwater dissolves carbonate bedrock, the free H+ molecules combine with CO3 to form HCO3. As the free H+ reacts to form HCO3, there is less H+ in solution and the pH increases. The pH values for karst waters are typically around 7.

Conductivity

- Karst: ranged from 160.2 to 661 µs/cm
- Non-karst: ranged from 93-195.2 µs/cm

Carbonate bedrock is more readily dissolved than sandstones and shales. As a result, water that flows through carbonate bedrock tends to have high conductivity. The karst springs flow from carbonate bedrock while the non-karst springs flow from mostly sandstone and shales, which explains the difference in conductivity.

Saturation Index

- Karst: Calcite SI from 0.05 to -1.9, Dolomite SI from -0.69 to -4.16
- Non-Karst: Calcite SI from -2.51 to -5.14, Dolomite SI from -5.15 to -10.3.

With respect to calcite, the karst springs are either oversaturated or closer to equilibrium than the non-karst springs. Oversaturation or near equilibrium is expected for water flowing through carbonate bedrock. Under saturation is expected for water flowing through non-carbonate bedrock. With respect to dolomite, the karst springs are closer to equilibrium than the non-karst springs. The carbonate bedrock in the study area does contain some dolomite which explains the difference in SI with respect to dolomite for the karst and non-karst springs.

3.2 Dye Tracing Results

3.2.1 Previous Dye Tracing Tests

Two previous dye traces were conducted in the Cave area and are depicted in **Figure 33.**

3.2.2 Current Dye Tracing Tests

A total of 39 dye tracing tests were conducted in the Section 4 study area which resulted in 47 groundwater flowpaths (**Figures 34, 35,** and **36**). The dye tracing tests were designed to determine groundwater flowpaths from relevant karst features within the Section 4 study area. The summary of dye tracing tests can be seen in **Appendix H - Table 7**. Straight-line dye trace maps and a discussion of breakthrough curve data can be seen in **Appendix H**. The following are summaries of the dye tracing tests conducted as part of this study.

4/5 Interchange Trace 1

On July 11, 2005 at 0915 hours, 0.53 gallons of Eosine liquid dye was injected into sinkhole 4-1505, which is located within the corridor. 4-1505 has an 8.32 acre drainage area with 6.54 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 4000 gallons of potable water. First dye detection (water and charcoal samples) for this trace occurred at spring 4-1457, on July 15, 2005 at 1030 hours. This spring is located within the corridor. Eosine was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location was 485 ft which equates to a groundwater velocity of 120 ft/day. Dye was not detected at any other sampling locations.

4/5 Interchange Trace 2

On January 2, 2006 at 0940 hours, 1 gallon of Rhodamine WT dye was injected into sinkhole 4-1600, which is located within the corridor. 4-1600 has a 0.52 acre drainage area with 0.52 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. No water was pumped into this feature due to precipitation events the morning and afternoon of January 2, 2006. First dye detection for this trace occurred at Bolin Bridge sampling station, on January 4, 2006 at 1542 hours. Dye was also detected at spring 4-1530 on January 5, 2005 at 1212 hours. This spring located within the corridor and is upstream of the Bolin Bridge sampling station and was determined to be the source of the Rhodamine WT. Rhodamine WT was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location (4-1530) was 989 ft which equates to a groundwater velocity of 440 ft/day. Dye was not detected at any other sampling locations.

4/5 Interchange Trace 3

On January 26, 2006 at 0945 hours, 0.11 gallons of Fluorescein (Uranine) dye was injected into sinkhole 4-1496, which is located outside the Section 4 corridor. 4-1496 has a 0.16 acre drainage area with no drainage coming from the corridor. Although drainage to 4-1496 is located outside of the corridor, the drainage to 4-1496 will most likely be within the footprint of the Section 4/5 interchange. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 2,000 gallons of potable water. An ISCO automated water sampler was installed at spring 4-1501. First dye detection (ISCO water sample) for this trace occurred at 4-1501, on January 26, 2006 at 1708 hours. This spring is located outside of the corridor. Fluorescein was detected at this feature in both water and charcoal samples. The straight line distance from injection location to detection location was 3,993 ft which equates to a groundwater velocity of 13,690 ft/day. The breakthrough curve data for 4-1501 can be seen in **Appendix G-3B**. Dye was not detected at any other sampling locations.

Trace 1

On May 5, 2009 at 1130 hours, 1 gallon of Fluorescein liquid dye was injected into sinking stream 4-1434, which is located within the corridor. 4-1434 has a 237.2 acre drainage area with 25.7 of those acres coming from the corridor. This feature was receiving approximately 3 gpm natural recharge at the time of injection. The first dye detection (water sample) for this trace occurred at Cave (4-1527), on May 14, 2009 at 0558 hours. Cave is located outside of the corridor. Fluorescein was detected in water and charcoal samples for this trace. The straight line distance from injection location to detection location was 21,774 ft which equates to a groundwater velocity of 28,298 ft/day. After the injection approximately 4 inches of rain fell in the area over the next 24 hours. This resulted in extreme high flow conditions for this trace.

The second dye detection (water & charcoal samples) for this trace occurred at stream crossing A-5, on May 15, 2009 at 0926 hours. The straight line distance from injection location to detection location was 6,407 ft which equates to a groundwater velocity of 3,348 ft/day. This location is downstream of the injection site and following injection there was approximately 4 inches of precipitation. It is probable that during this rain event water and any dye remaining at the surface overflowed the injection site and resulted in this downstream detection.

Trace 2

On June 29, 2009 at 1040 hours, 1 gallon of Eosine liquid dye was injected into sinking stream 4-1432, which is located within the corridor. 4-1432 has a 297.2 acre drainage area with 281.5 of those acres coming from the corridor. This feature was receiving approximately 1 gpm natural recharge at the time of injection. The first dye detection (water sample) for this trace occurred at spring Cave (4-1527), on July 15, 2009 at 1115 hours. Cave is located outside of the corridor. Eosine was detected in both water and charcoal samples. The straight line distance from injection location to detection location was 21,318 ft which equates to a groundwater velocity of 1,330 ft/day. Dye was not detected at any other sampling locations.

Clifty Chapel Trace

On December 29, 2005 at 1500 hours, 0.75 gallons of Fluorescein liquid dye was injected into sinking stream 4-1240, which is outside of the corridor but receives surface drainage from the corridor. 4-1240 has a 65.99 acre drainage area with 52.88 of those acres coming from the corridor. This feature is located in drainage, and at the time of injection was receiving approximately 15-20 gpm of natural recharge. First dye detection (water and charcoal samples) occurred at Cave (4-1527), on January 2, 2005 at 1320 hours. Cave is located outside of the corridor. The straight line distance from injection location to detection location was 20,000 ft which equates to a groundwater velocity of 4,370 ft/day. Dye was not detected at any other sampling locations.

Clifty Road Trace
On January 4, 2010 at 0850 hours, 1 gallon of Fluorescein liquid dye was mixed with 25 gallons of potable water and injected into sinking stream 4-0685. Sinking stream 4-0685 is located inside the corridor. At the time of injection approximately 2 gpm of natural flow was sinking. The first dye detection (water sample) for this trace occurred at spring 4-1526, on January 5, 2009 at 0852 hours. Fluorescein was detected at 4-1526 in water and charcoal samples. The straight line distance from injection location to detection location was 1,367 ft which equates to a groundwater velocity of 998 ft/day. Dye was not detected at any other sampling locations.

Cooper Cemetery Trace 1
On June 10th, 2005 at 1630 hours, 0.53 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1227, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (water and charcoal samples) occurred on June 13, 2005 at 1055 hours at springs 4-1190 and 4-1191. These features are located within 30 ft of each other and are outside of the corridor. The straight-line travel distance from injection to discharge is 4,065 ft, which equates to a groundwater velocity of 1,478.2 ft/day. The flowpath for this dye trace crosses the corridor. Dye was not detected at any other sampling locations.

Cooper Cemetery Trace 2
On December 14, 2005 at 1100 hours, 0.26 gallons of Rhodamine WT was injected in swallet 4-1222, which is located within the corridor. 4-1222 has an 18.86 acre drainage area all of which is located within the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (water and charcoal samples) occurred at springs 4-1190 and 4-1191 on December 20, 2005 at 1130 hours. These features are located within 30 ft of each other and are outside of the corridor. The straight line distance from injection location to detection location is 1,735 ft, which equates to a groundwater velocity of 289.2 ft/day. Dye was not detected at any other sampling locations.

Dempshar Trace
On January 16, 2006 at 1545 hours 1.2 gallons of Fluorescein dye was injected in swallet 4-0521. 4-0521 has a 124.85 acre drainage area with 38.77 of those acres coming from the corridor. This feature was receiving 40 gpm of natural recharge at the time of injection. 4-0512 is located outside of the corridor but receives surface drainage from the corridor. First detection occurred on January 17, 2006 at 1233 hours at Dye 40 which is a bridge crossing on Little Indian Creek. Dye was detected in water and charcoal samples at this location. The straight line distance from injection location to detection location is 11,677 ft which equates to a groundwater velocity of 14,012 ft/day. Dye was also detected on January 19, 2006 at 1119 hours at Dye 41 which is a bridge crossing on Indian Creek. Dye was detected in water and charcoal samples at this location. The straight line distance from injection location to detection location is 13,463 ft which equates to a groundwater velocity of 4,823 ft/day. No springs were positive for

Fluorescein dye which indicated that groundwater is discharging via base flow into Indian Creek and Little Indian Creek. Upstream sampling locations (Dye 42, 43, 44) had no detection, which helps to define the length of Indian Creek and Little Indian Creek where flow from this injection is being discharged to Indian Creek and Little Indian Creek. Fluorescein dye was also detected at downstream sampling stations Dye 36 and Dye 50. Due to the upstream presence of dye it is not possible to determine if the dye positives at these locations were due to base flow into Indian Creek or surface flow along Indian Creek. All dye recovery locations are outside of the corridor.

Evans Road Trace 1

On September 8, 2005 at 1145 hours, 0.53 gallons of Eosine dye was injected in swallet 4-1504, which is outside of the corridor but receives surface drainage from the corridor. 4-1504 has a 25.01 acre drainage area with 4.39 of those acres coming from the corridor. This feature is located in drainage, and at the time of injection was not receiving any natural recharge. Due to lack of natural recharge into the feature, the 0.53 gallons of Eosine dye was flushed with 4,700 gallons of water. Eosine was detected at 4-0282 better known as Cave, in water and charcoal samples, on September 26, 2005 at 1520 hours. Cave is located outside of the corridor. The straight-line distance from injection at 4-1503 to detection at 4-0282 is 12,034 ft, which equates to a groundwater velocity of 663.9 ft/day. The flowpath for this dye trace crosses the corridor. Dye was also detected at Dye 02 which is downstream of 4-0282.

Evans Road Trace 2

On September 15, 2005 at 1050 hours, 0.53 gallons of Fluorescein (Uranine) dye was injected into feature 4-0362, which is located outside of the corridor and does not receive surface drainage from the corridor. This feature is a sinkhole and at the time of injection was not receiving any natural recharge. Due to the lack of natural recharge, the Fluorescein was flushed with 4,000 gallons of potable water. Fluorescein was detected in water and charcoal samples at cave 4-0254 on September 28, 2005, at 1354 hours. 4-0254 is located outside of the corridor. The straight line distance from injection point to detection point is 2,818 ft which equates to a groundwater velocity of 214.7 ft/day. Dye was also detected at Dye 01 which is downstream of 4-0254.

Evans Road Trace 3

On October 11, 2005 at 1700 hours, 0.40 gallons of Rhodamine WT dye was injected into swallet 4-0175, which is located within the corridor. 4-0175 has a 28.70 acre drainage area with 22.99 of those acres coming from the corridor. This feature is in a dry run and was receiving no natural recharge at the time of injection. Due to the lack of natural recharge, the dye was flushed with 2,000 gallons of potable water. Rhodamine detection (visual, and in water and charcoal samples) occurred at 4-0282 better known as Cave on November 10, 2005 at 1600 hours. Cave is located outside of the corridor. The straight line distance from injection location to detection location is 10,000 ft which equates to a groundwater velocity of

334.3 ft/day. The flowpath for this dye trace crosses the corridor. Dye was also detected at Dye 02 which is downstream of 4-0282.

Flick Trace 1
On December 16, 2005 at 1140 hours, 1 gallon of Eosine liquid dye was injected in sinking stream 4-1525, which is located within the corridor. 4-1525 has a 97.90 acre drainage area with 35.78 of those acres coming from the corridor. This feature was receiving 30-40 gpm of natural recharge at the time of injection. Eosine from this trace was detected in both water and charcoal samples at Cave (4-1527) on December 29, 2005 at 1307 hours. Cave is located outside of the corridor. Straight line distance from injection location to detection location is 19,500 ft which equates to a groundwater velocity of 1,495.2 ft/day. Dye was not detected at any other sampling locations.

Flick Trace 2
On December 16, 2005 at 1730 hours, 1 gallon of Rhodamine WT liquid dye was injected in sinking stream 4-1526, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 10 gpm of natural recharge at the time of injection. Rhodamine WT from this trace was detected in water and charcoal samples at Cave (4-1527) on December 29, 2005 at 1307 hours. Cave is located outside of the corridor. Straight line distance from injection location to detection location is 21,000 ft which equates to a groundwater velocity of 1,641.7 ft/day. The flowpath for this dye trace crosses the corridor. Dye was not detected at any other sampling locations.

Freeman Trace 1
On December 21, 2005 at 1000 hours, 0.08 gallons of Fluorescein (Uranine) liquid dye was injected into sinkhole 4-0421, which is located within the corridor. 4-0421 has a 0.08 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of recharge the dye was flushed with 2,750 gallons of potable water. Fluorescein from this trace was detected visually, and in water and charcoal samples at spring 4-1520 on December 23, 2005 at 1052 hours. This spring is located within the corridor. The straight line distance from injection location to detection location is 1,373 ft, which equates to a groundwater velocity of 686.5 ft/day. Dye was not detected at any other sampling locations.

Freeman Trace 2
On December 21, 2005 at 1030 hours, 0.08 gallons of Rhodamine WT was injected into sinkhole 4-0114, which is located within the corridor. 4-0114 has a 0.02 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of recharge the dye was flushed with 2,750 gallons of potable water. Rhodamine from this trace was detected in water and charcoal samples at spring 4-1520 on December 23, 2005 at 1052 hours. This spring is located within the corridor. The straight line distance from injection

location to detection location is 1,112 ft, which equates to a groundwater velocity of 556.0 ft/day. Dye was not detected at any other sampling locations.

Freeman Trace 3

On April 27, 2009 at 1115 hours, 1 liter of Phloxine B liquid dye was injected into sinkhole 4-0134, which is located within the corridor. 4-0134 has a 5.6 acre drainage area all within the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 1,500 gallons of potable water. The first dye detection (water sample) for this trace occurred at spring 4-1136, on April 27, 2009 at 2132 hours. Phloxine B was detected at this spring in water samples. The straight line distance from injection location to detection location was 1,811 ft which equates to a groundwater velocity of 4,227 ft/day. Dye was not detected at any other sampling locations.

Cave Trace

On July 21, 2009 at 1130 hours, 0.5 gallons of Fluorescein liquid dye was injected into swallet 4-0037, which is located outside the corridor. 4-0037 has a 407.2 acre drainage area with 77 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 2,500 gallons of potable water. The first dye detection (water sample) for this trace occurred at Cave (4-0061), on July 22, 2009 at 0721 hours. Fluorescein was detected in a single water sample at Cave. The straight line distance from injection location to detection location was 2,550 ft which equates to a groundwater velocity of 3,083 ft/day.

After injection of the dye on July 21 a rain event of approximately 4 inches occurred. This would be considered extreme high flow conditions. It is likely that under most flow conditions water entering 4-0037 does not travel to Cave. However, in high flow conditions like those that occurred after injection it is possible for water to travel from 4-0037 to Cave. Additionally, the large volume of water flowing into the Cave system at the time of trace likely diluted the Fluorescein dye and resulted in the single detection.

The second dye detection (water & charcoal samples) for this trace occurred at 4-1023, on July 23, 2009 at 0850 hours. The straight line distance from injection location to detection location was 4,000 ft which equates to a groundwater velocity of 2,118 ft/day.

The third dye detection (water & charcoal samples) for this trace occurred at 4-1023, on July 23, 2009 at 0850 hours. The straight line distance from injection location to detection location was 2,520 ft which equates to a groundwater velocity of 1,293 ft/day.

Cave Trace 1

On August 10, 2009 at 0955 hours, three pounds of Eosine powder dye was mixed with 600 gallons potable water and injected into swallet 4-0173, which is located within the corridor. 4-

0173 has a 340.9 acre drainage area with 175.5 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0282), on October 9, 2009 at 1430 hours. Eosine was detected at Cave in water and charcoal samples. The straight line distance from injection location to detection location was 10,500 ft which equates to a groundwater velocity of 360 ft/day. Dye was not detected at any other sampling locations.

Cave Trace 2

On August 4, 2009 at 1230 hours, 1 gallon of Fluorescein liquid dye was injected into swallet 4-0166 and flushed with 400 gallons potable water. 4-0166 is located within the corridor and has a 717.8 acre drainage area with 502.9 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0282), on September 27, 2009 at 0530 hours. Eosine was detected at Cave in water and charcoal samples. The straight line distance from injection location to detection location was 11,660 ft which equates to a groundwater velocity of 513 ft/day. Dye was not detected at any other sampling locations.

Hobbieville Trace

On August 23, 2009 at 0930 hours, 1 gallon of Fluorescein liquid dye was injected into sinking stream 4-1424 which is located within the corridor. 4-1424 has a 7,133.7 acre drainage area with 1,084.7 of those acres coming from the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge to the feature, the dye was flushed with 350 gallons of potable water. The first dye detection (water sample) for this trace occurred at stream crossing HV-5 on October 13, 2009 at 0949 hours. The straight line distance from injection location to detection location was 2,479 ft which equates to a groundwater velocity of 124 ft/day. HV-4 is located down gradient in the same drainage from 4-1424. This suggests water sinking in the streambed at 4-1424 re-emerges down gradient.

The second dye detection (water & charcoal samples) for this trace occurred at stream crossing HV-1, on October 13, 2009 at 1000 hours. The straight line distance from injection location to detection location was 2,849 ft which equates to a groundwater velocity of 142 ft/day.

The third dye detection (water & charcoal samples) for this trace occurred at 4-1298, on October 16, 2009 at 0830 hours. The straight line distance from injection location to detection location was 3,584 ft which equates to a groundwater velocity of 156 ft/day. It must be noted that spring 4-1298 is a wet weather spring and was not flowing during background sampling. It therefore cannot be consider a definitive detection. However, the detection of dye downstream at HV-1 supports the detection at 4-1298

Kermit Inman Trace
On October 13, 2005 at 1715 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected into sinkhole 4-1403, which is located within the corridor. 4-1403 has a 0.04 acre drainage area all of which is within the corridor. This feature was not receiving natural recharge at the time of injection. Due to the lack of natural recharge, 2,000 gallons of potable water was flushed with the dye. Fluorescein detection occurred at two locations for this trace. The first dye detection occurred at spring 4-1431 on October 17, 2005 at 0951 hours. This spring is within the corridor. The straight line distance from injection location to detection location is 739 ft, which equates to a groundwater velocity 201.5 ft/day. Dye was detected in both water and charcoal samples at this location. The second dye detection occurred at spring 4-1405 on October 24, 2005 at 1430 hours. This spring is located within the corridor. The straight line distance from injection location to detection location is 1,400 ft, which equates to a groundwater velocity 128.7 ft/day. Dye was detected in both water and charcoal samples at this location. Dye was not detected at any other sampling locations.

Koontz Duvall Trace 1
On August 2, 2005 at 0915 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected in sinkhole 4-1517, which is located within the corridor. 4-1517 has a 0.04 acre drainage area all of which is within the corridor. This feature was receiving no natural recharge at the time of injection. Due to the lack of natural recharge the dye was flushed with 4,000 gallons of potable water. The presence of the dye was not detected after one week of sampling. Due to the lack of any dye detection, an additional 0.26 gallons of Fluorescein (Uranine) and 6,000 gallons of water were injected into 4-1517 on August 9, 2005 at 1050 hours. During recovery of the field sampling network on August 15, 2005 at 1130, a Fluorescein visual was observed at spring 4-1528. This spring is located within the corridor. The straight-line travel distance from injection to detection point is 3,360 ft, which equates to a groundwater velocity of 256.8 ft/day. Dye was also detected in water and charcoal samples. Dye was not detected at any other sampling locations.

Lama Trace
On August 4, 2009 at 1020 hours, 0.5 gallons of Eosine liquid dye was injected into sinking stream 4-0269 and flushed with 4,800 gallons potable water, which is located outside the corridor. 4-0269 has a 540 acre drainage area with 227.2 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at spring 4-1513, on August 9, 2009 at 1123 hours. Eosine was detected at 4-1513 in water and charcoal samples. The straight line distance from injection location to detection location was 3,100 ft which equates to a groundwater velocity of 626 ft/day. Dye was not detected at any other sampling locations.

Mt. Zion Church Trace 1
On November 15, 2005 at 1715 hours, 0.53 gallons of Rhodamine WT liquid dye was injected into swallet 4-1656, which is located within the corridor. 4-1656 has a 0.08 acre drainage area all of which is within the corridor. This feature was receiving 15-20 gpm of natural recharge at the

time of injection. Rhodamine WT detection occurred at two locations for this trace. The first dye detection (water and charcoal samples) occurred at spring 4-1631 on November 21, 2005 at 1417 hours. The straight line distance from injection location to detection location is 3,840 ft, which equates to a groundwater velocity 635.6 ft/day. The second dye detection in both water and charcoal samples occurred at feature 4-1023 on November 30, 2005 at 1023 hours. The straight line distance from injection location to detection location is 5,164 ft, which equates to a groundwater velocity 347.2 ft/day. Both dye detection locations were outside of the corridor. Dye was not detected at any other sampling locations.

Mt. Zion Church Trace 2

On November 15, 2005 at 1100 hours, 0.26 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1030, which is outside of the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. First dye detection (water and charcoal samples) occurred on November 21, 2005 at 1450 hours at 4-0971 (Cave). Cave is located outside of the corridor. The straight-line travel distance from injection to detection is 3,230 ft, which equates to a groundwater velocity of 527.3 ft/day. Dye was not detected at any other sampling locations.

Cave Trace

On October 7, 2009 at 1030 hours, 0.5 gallons of Eosine liquid dye was injected into swallet 4-1035, which is located outside the corridor. There was no natural recharge to this feature and the dye was therefore flushed with 2,000 gallons potable water. 4-1035 has a 17.57 acre drainage area with 15.98 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at Cave (4-0943), on October 8, 2009 at 0715 hours. The straight line distance from injection location to detection location was 3,974 ft which equates to a groundwater velocity of 10,900 ft/day. Dye was not detected at any other sampling locations.

R400 Trace

On August 26, 2009 at 1045 hours, 0.5 gallons of Eosine liquid dye was injected into sinking streams 4-1272 and flushed with 150 gallons potable water, which is located outside the corridor. 4-1272 has a 194.4 acre drainage area with 158.2 of those acres coming from the corridor. The first dye detection (water sample) for this trace occurred at spring 4-1274, on August 27, 2009 at 1000 hours. Eosine was detected at 4-1274 in water and charcoal samples. The straight line distance from injection location to detection location was 482 ft which equates to a groundwater velocity of 498 ft/day. Dye was not detected at any other sampling locations.

Spring Trace

On June 10th, 2005 at 1630 hours, 0.53 gallons of Rhodamine WT dye was injected in sinking stream 4-1228, which is located within the corridor. 4-1228 has a 133.83 acre drainage area with 11.96 of those acres coming from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. The first dye detection (visual) occurred at Spring (4-

1516) on June 19, 2005 at 1311 hours. Spring is located within the corridor. The straight line travel distance from injection location to detection location is 5,870 ft, which equates to a groundwater velocity of 1,498.7 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Cave Trace

On August 30, 2005 at 1245 hours, 0.40 gallons of Fluorescein (Uranine) dye was injected in sinking stream 4-1271, which is outside of the corridor but receives surface drainage from the corridor. 4-1271 has a 29.98 acre drainage area with 29.96 of those acres coming from the corridor. This feature was receiving 10 gpm of natural recharge at the time of injection. Visual detection occurred at spring 4-1274 on September 1, 2005 at 1000 hours. This spring is located outside of the corridor. The straight-line travel distance from injection to discharge is 1,649 ft, which equates to a groundwater velocity of 879.5 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Smith Trace

On December 29, 2005 at 1050 hours 0.5 lbs of Phloxine B powder dye was mixed with 5 gallons of water and injected into feature 4-1275, which is located within the corridor. 4-1275 has a 33.25 acre drainage area with 24.24 of those acres coming from the corridor. This feature is a swallet and was receiving 10 gpm of natural recharge at the time of injection. Phloxine B was first detected (water and charcoal samples) at spring 4-1276 on December 30, 2005 at 1440 hours. This spring is located outside of the corridor. The straight-line distance from injection point to detection point is 360 ft, which equates to a groundwater velocity of 320 ft/day. Dye was detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Trace 1

On August 18, 2005 at 1030 hours, 0.26 gallons of Rhodamine WT dye was injected in cave 4-1057, also known as is located outside of the corridor. During low flow conditions it has a 0.08 acre drainage area with no contribution from the corridor. In extreme high flow conditions it has a 226.11 acre drainage with 6.67 of those acres coming from the corridor. 4-1057 was not receiving any natural recharge at the time of injection. Due to lack of natural recharge the 0.26 gallons of Rhodamine WT was flushed with 4,000 gallons of potable water. The first dye detection (water and charcoal samples) occurred on September 6, 2005 at 1115 hours at spring 4-0394. This spring is located outside of the corridor. The straight-line distance from injection at 4-1057 to detection at 4-0394 is 6,465 ft which equates to a groundwater velocity of 38.86 ft/day. Dye was not detected at any other sampling locations.

Valhalla Trace 1
On June 12, 2005 at 1216 hours, 0.53 gallons of Rhodamine WT dye was injected in swallet 4-0701, which is located within the corridor and does not receive surface drainage from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. An ISCO automated water sampler was installed at feature 4-1195. The first dye detection (water and charcoal samples) occurred at spring 4-1195 at 2045 hours on June12th, 2005. This spring is located outside of the corridor. The straight-line distance from injection at 4-0701 to detection at 4-1195 is 4,050 ft, which equates to a groundwater velocity of 12,150.0 ft/day. The flowpath for this dye trace crosses the corridor. The breakthrough curve data for 4-1195 can be seen in **Appendix G-24B**. The sharp leading edge of the breakthrough curve indicates conduit flow from the injection site. The trailing edge of the breakthrough curve is a broader curve, which indicates that the discharge point is also receiving diffusive flow. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 1
On May 12, 2005 at 1030 hours, 0.13 gallons of Fluorescein (Uranine) dye was injected in swallet 4-0731, which is outside of the corridor but receives surface drainage from corridor. 4-0731 has a 29.94 acre drainage area with 3.63 of those acres coming from the corridor. This feature was receiving 5 gpm of natural recharge at the time of injection. An ISCO automated water sampler was installed at feature 4-1055. The first dye detection (visual, water and charcoal samples) occurred at spring 4-1055 at 1430 hours on May 12, 2005. This spring is located outside of the corridor. The straight-line distance from injection at 4-0731 to detection at 4-1055 is 1,466 ft, which equates to a groundwater velocity of 11,728.0 ft/day. The breakthrough curve data for 4-1055 can be seen in **Appendix G-25B**. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 2
On July 21, 2005 at 0920 hours, 0.53 gallons of Rhodamine WT dye was injected in sinkhole 4-0716, which is located within the corridor. 4-0716 has a 3.68 acre drainage area with 1.98 of those acres coming from the corridor. This feature was not receiving any natural recharge at the time of injection. Due to lack of recharge the 0.53 gallons of Rhodamine WT was flushed with 4,000 gallons of potable water. The first dye detection occurred on July 22nd, 2005 at 0930 hours. This was a visual detection reported by a landowner downstream of 4-1510. Feature 4-1510 was visited at 1045 hours on July 22, 2005 and the presence of Rhodamine WT dye was visually confirmed. 4-1510 is located inside the corridor. The straight line distance from injection at 4-0716 to detection at 4-1510 is 1,692 ft, which equates to a groundwater velocity of 1,624.3 ft/day. This flowpath crosses the corridor. Dye was detected visually and in water and charcoal samples at 4-1055. Dye was also detected in feature 4-0720. 4-0720 is located outside of the corridor. First dye detection at 4-0720 occurred on August 4, 2005 at 1124 hours. The straight line distance from injection at 4-0716 to detection at 4-1510 is 1,692 ft, which equates to a groundwater velocity of 1,624.3/day. The straight line distance from injection at 4-0716 to

detection at 4-0720 is 1,092 ft, which equates to a groundwater velocity of 77.5 ft/day. Dye was also detected in water and charcoal samples. Dye was not detected at any other sampling locations.

Victor Oolitic Trace 3
On May 14, 2005 at 1300 hours, 0.13 gallons of Rhodamine WT dye was injected in swallet 4-0807, which is outside of the corridor but receives surface drainage from the corridor. 4-0807 has a 34.37 acre drainage area with 16.07 of those acres coming from the corridor. This feature was receiving 40gpm of natural recharge at the time of injection. The first dye detection (visual) occurred at spring 4-0831 on May 14, 2005 at 1315 hours. 4-0831 is located outside of the corridor. The straight-line distance from injection at 4-0807 to detection at 4-0830 is 781ft, which equates to a groundwater velocity 63,456 ft/day. Dye was detected visually and in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

Wright Road Trace 1
On October 23, 2005 at 1045 hours, 0.26 gallons of Rhodamine WT was injected in swallet 4-0661, which is outside of the corridor but receives surface drainage from the corridor. 4-0661 has a 133.83 acre drainage area with 10.95 of those acres coming from the corridor. This feature was receiving 2 gpm of natural recharge at the time of injection. The first dye detection (visual) for this trace occurred at feature 4-0678 on October 29, 2005 at 1100 hours. 4-0678 is located outside of the corridor. This feature is the discharge point for water that flows through Cave. The straight line distance from injection location to detection location is 3,540 ft, which equates to a groundwater velocity of 599 ft/day. Dye was also detected in water and charcoal samples for this trace. Dye was not detected at any other sampling locations.

3.3 Summary of Dye Tracing Tests

- A total of 39 dye tracing tests were conducted. The results of these tests show 47 groundwater flowpaths
- 9 groundwater flowpaths were shown to cross the Section 4 corridor
- The length of groundwater flowpaths varies greatly within Section 4 (340 ft to 21,774 ft). The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway
- Over 250 dye tracing sampling locations were established, and over 7000 samples were analyzed

- Groundwater flow was characterized based on the dye tracing tests. The karst groundwater flowpaths tend to be discrete in that recharge features discharge to a single point

- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point

- Cave, Cave, Cave, Cave, Cave, and Cave have all been hydrogeologically linked to the Section 4 corridor

- When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye traveling to all possible discharge points.

4.0 SURVEYS OF SECTION 4 CAVES

Six cave sites within and in proximity to the Section 4 corridor were sampled to determine the presence of invertebrates: Cave, Spring, Spring 4-1195, Cave, Cave and Spring 4-1501. Sites were selected based on hydrologic connections to the corridor confirmed by dye tracing. Sampling for this study was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling. Fourteen species with the ecological classification of troglobite or stygobite (obligate subterranean animals) and two species that are not obligate subterranean animals were found.

Table 2: Section 4 Cave Fauna

Species	Location	Listing Status
Sphalloplana weingartneri (Weingartner's cave flatworm)	Cave	IDNR Watch List
Pseudocandona jeanneli (Jeannel's groundwater ostracod)	Cave	IDNR Endangered
Caecidotea stygia (Northern cave isopod)	Cave	
Crangonyx packardi (Packard's groundwater amphipod)	Cave	IDNR Watch List
Crangonyx indianensis (Indiana cave amphipod)	Cave	IDNR Watch List
Conotyla bollmani (Bollman's cave millipede)	Cave	IDNR Watch List
Phanetta subterranea (Subterranean sheet-web spider)	Cave	
Porrhomma cavernicola (Cavernicolous sheet-web spider)	Cave	
Pseudosinella fonsa (Fountain cave springtail)	Cave	IDNR Threatened
Arrhopalites undescribed species (cave springtail)	Cave	IDNR Endangered Candidate
Pseudanophthalmus undescribed species (Ray's cave beetle)	Cave	IDNR Endangered

Table 2: Section 4 Cave Fauna		
Species	**Location**	**Listing Status**
Batrisodes krekeleri (Krekeler's cave ant beetle)	Cave	IDNR Endangered
Spelobia tenebrarum (Cave dung-fly)	Cave	
Sinella alata (Indiana cave springtail)	Cave	IDNR Watch List
Pseudosinella collina (Hilly springtail)*	Cave	IDNR Rare
Myotis sodalis (Indiana bat)*	Cave	USFWS Endangered

* Not obligate subterranean species

The entire known range of the cave springtail is a single cave located approximately one-half mile north of the Section 4 corridor in Greene County. The Ray's cave beetle is known only from three caves including one site in the proposed I-69 project area. Refer to **Appendix K** for documentation of the survey of Section 4 cave fauna.

A reconnaissance was conducted of all known caves within five miles of the Section 4 corridor. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat (*Myotis sodalis*) and make recommendations regarding further, more detailed investigations for bats that were to be conducted later by teams of biologists. There are 315 known caves located within five miles of the Section 4 corridor. Of these caves, 226 were judged by cave investigators to be potential Indiana bat hibernacula. Two-hundred and seven (207) of these caves were inspected to determine whether they are potential hibernacula. In addition, 41 caves were visited that were not part of the originally identified caves; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Access was denied to five sites, and 14 caves could not be located. As a result, 59 caves were recommended for intensive investigations as Indiana bat winter hibernacula. Refer to **Appendix M** for documentation of the cave reconnaissance for Indiana bat hibernacula. Results of the Indiana bat surveys can be found in the reports titled: *Surveys for Indiana Bats in Caves in Greene and Monroe Counties, Indiana* (BHE 2005), *Autumn, Winter, and Spring Habitat for the Indiana Bat (Myotis sodalis) Within the Crawford Upland and Mitchell Plain From Scotland to Bloomington, Indiana* (ESI, 2005), *Autumn 2005 and Winter 2006 Habitat for the Indiana Bat (Myotis sodalis) within the Crawford Upland and Mitchell Plain from Scotland to Bloomington* (ESI, 2006) and *Surveys for Indiana bats in Caves in Greene and Monroe Counties, Indiana* (BHE, 2006).

5.0 ANNUAL POLLUTANT LOAD ESTIMATES

The Karst Memorandum of Understanding (MOU) dated 1993 between INDOT, IDNR, IDEM, and the USFWS delineates guidelines for construction of transportation projects in karst regions of the state. As part of the I-69 project, the USEPA has also been invited to participate in the MOU activities review process. The MOU signatory agencies and the USEPA have been informed that Steps 1-4 of the Karst MOU will be followed as part of the National

Environmental Policy Act (NEPA) study for Sections 4 and 5 of the I-69 project. Step 2 of the Karst MOU states the following "….Calculations of estimates of annual pollutant loads from the highway and drainage within the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan…."

This section summarizes key points from the research gathered as part of the karst pollutant loading estimations for the Tier 2 EIS of I-69 Section 4 in Greene and Monroe Counties. It also discusses the attempts made and limitations to compute the pollutant loadings as a desk top exercise, or without actual field sampling, using a Federal Highway Administration (FHWA) published process.

INDOT's Previous Karst Study on SR 37

In April 1996, Earth Tech prepared "Results of MOU-Related Karst Studies for Indiana State Road 37, Lawrence County, Indiana (1992-1995)" for INDOT. This document described the Karst MOU and documented the results of the BMP's used both during and after construction. The project was to reconstruct SR 37 from a two-lane highway to four-lane divided between SR 60 (Mitchell) to US 50 (Bedford). In general, INDOT used the following steps to fulfill the Karst MOU:

1. Survey all karst features directly or indirectly affected by the project
2. Delineate sub-surface drainage routes using dye-tracing.
3. Install drainage structures (Best Management Practices (BMPs)) such as settlement basins, peat filters and rock filters to all karst features within the right-of-way. The size and type of each BMP was estimated based on the drainage area and type of karst feature. By all indication, the choice of the BMP was an estimation with the understanding that monitoring of the BMP is essential to assure its effectiveness.
4. Collect samples of runoff at the BMP's both during and after construction and test for pollutants (e.g. lead, zinc, copper, etc.). These samples were collected during six storm events between February 1993 and August 1995. The concentrations of pollutants were compared to Indiana's Water Quality Standards for aquatic life and drinking water.
5. Observe the BMP effectiveness at conveying stormwater during rain events. Most BMPs proved effective, although some need to be enlarged or their drainage basins enlarged to assure water was not going to pond onto the roadway.

The study concluded that less than 2 years after construction, the pollutant concentrations in the runoff were reduced to what one would expect prior to construction. As long as the filter systems operate as designed, no long term effects to karst features is expected.

In the short term (within two years after construction), high levels of Total Suspended Solids (TSS) and Total Recoverable Metals (TRM) (copper, lead, zinc, etc.) were found. This was likely due to the fact the BMPs were installed prior to earthwork and grading activities. Therefore, even though the BMP filters and normal erosion control measures were monitored, the filters were typically found to be clogged. The study does not give a recommendation on how to remediate this.

Kentucky's Previous Karst Study on I-69 at Mammoth Cave

As part of the literature research conducted, a report completed by the Kentucky Transportation Center, "Evaluation of Methods to Protect Water Quality in Karst Areas: Phase I" was reviewed. This study, done for the Kentucky Transportation Cabinet in October 2003, analyzed pollutant loads to karst features near an interchange of I-65 and an entrance to Mammoth Cave. The procedures detailed in the study match those of Indiana's Earth Tech report. Field samples were collected to find the pollutant concentrations and those values compared to national standards. Their findings were highway runoff pollutant loadings were minimal. Additional phases of the research report were to study other karst features throughout the state, and report a methodology that could be used for loading calculations and BMP design. One of the authors was contacted to check the status of additional phases to the study; however none have been completed at this time.

Karst Features to Analyze

The karst survey identified almost 1,500 karst features in the karst study area. About 450 features are located within the 2,000' wide corridor of Section 4, 106 inside the proposed right-of-way for Preferred Alternative 2 under the Initial design criteria and 87 for the Low Cost design criteria. The drainage areas for all these features were estimated in **Appendix N** of this report. It was assumed that any karst feature inside the construction limits would be capped, so its pollutant load estimate is zero. A karst feature had to be outside the construction limits yet inside the proposed right-of-way to be eligible for analysis. The number of features that fit this criterion for the initial criteria is 22 and for the low cost criteria is 20.

The first step was to identify an approximate station along the I-69 centerline for a feature. Using this station, the karst feature was then identified on a plan and profile drawing. Using the profile, the approximate limits of the right-of-way drainage area was estimated (i.e. runoff area). These limits were determined by beginning at the feature and going "uphill" along the profile until a crest or culvert was reached (whichever came first).

The calculation of the pollutant loadings into the karst features required some assumptions; primarily when delineating how much of the proposed right-of-way would drain into the karst

feature. Three main assumptions were made, all likely erring on the side of a higher pollutant loading than what will realistically occur after construction:

1. It was assumed that the entire right-of-way width would drain into the karst feature. In many cases, this is highly unlikely. For instance, if a karst feature is located on the backslope of a ditch along the southbound lane, there is no guarantee that highway run off from the median or ditch along the northbound lane would drain to the karst feature on the other side of the road. More often than not, the road acts as a barrier, preventing runoff from being conveyed from one ditch to the other. The only exception would be if a cross culvert or median drain would convey drainage to a karst basin.
2. Also, where multiple karst features are located within the same right-of-way drainage area, the pollutant loading calculation for each feature assumed no run off would drain into the other features. In all likelihood, the karst features would share the runoff volumes.
3. Finally, the roadside and median ditches are designed for conveyance and outlet into streams and creeks, not into karst features such as sinkholes or swallets. Therefore, it is reasonable to assume runoff may not find its way to a feature, instead traveling along the ditch grades and culverts as designed and constructed. The pollutant loading calculation assumed the entire right-of-way would drain into the karst feature, and not be conveyed elsewhere.

FHWA Highway Runoff Water Quality Training Course

FHWA conducted a class on water quality and storm water runoff from highways. Section 8 of this workshop dealt with models and studies that have been developed to predict pollutant loads without field measurements. The first part of the model calculates pollutant load estimates, developed in the late 1970's using field data from monitoring programs in various states. The second part estimates the pollutant concentrations and compares them to water quality standards. The third part estimates the pollutant loads in the "background", or what occurs before the highway is built. This methodology is included in **Appendix N** of this document.

Part 1: Pollutant Loadings from Highway Runoff

In order to estimate the pollutant loading from the highway runoff, the length of the road that would drain into the karst feature must be estimated. This was found by plotting the karst feature's station on a profile view, and then measuring upgrade from the feature to the nearest crest or cross culvert, whichever came first. The pollutant loading calculation assumes the *entire* highway right-of-way along this length would drain into the karst feature. This is unlikely, given

the three drainage ditches (two roadside and the median) are not designed to convey drainage to karst features. For instance, if a karst feature is located inside the roadside ditch along the southbound lanes, there is no guarantee (and in fact is very unlikely) that cross culverts would be installed to convey drainage from the other roadside ditch and the median under the road to the karst feature.

The model estimates the pollutant loading by first determining the load of total solids. Once that load is found, regression equations are used to determine the load for other various pollutants (lead, copper, zinc, etc.). The theory behind this is solids act as "carriers" for other pollutants, so the higher the solids the higher the metals and other pollutants. The estimated pollutant load prior to the rain event is calculated using the daily traffic estimate. It is assumed that the road has not been washed of pollutants in 20 days, which the study's analysis determined to be an adequate length of time for an accurate initial load estimate. The initial pollutant load is then modified to account for the runoff rate. This rate was calculated using National Oceanic and Atmospheric Administration (NOAA) data for the 1-year/1-hour, 2-year/24-hour and 5-year/24-hour rain frequencies. The rate also takes into account the drainage control on the highway, in this case, open median and ditches, and the length of highway within the drainage basin of the particular karst feature. The I-69 project was considered a Type III roadway, which is indicative of a rural highway with paved shoulders which uses grassy ditch conveyance for the surface runoff.

Once the runoff and rain data is taken into account, the pollutant loading of total solids at each karst feature was calculated. Regression models are then used to determine the pollutant load (pounds) for other pollutants. For karst features with very small drainage areas, some of the regression equations produce values in the negative. It should be assumed, for these cases, the load is zero. Table 1 in Exhibits 1-6 are included in **Appendix N** which displays the pollutant mass loadings for reach of the three rain events for both the Initial and Low Cost design criteria.

Part 2: Pollutant Concentrations from Highway Runoff

The pollutant loadings calculated in Part 1 can then be modified into concentrations. The loadings are divided by the volume of rain water (for a particular rain event) inside the right-of-way that would drain into the karst feature. Table 2 in Exhibits 1-6 in **Appendix N** shows the results of the pollutant concentration estimates (for each rain event using the Initial and Low Cost design criteria).

Concentrations of pollutants are then compared to Indiana's Water Quality Standards for aquatic life and drinking water. These standards are from Indiana Administrative Code (327 IAC 2-1-6) and assume a hardness of 250 mg/L. The four pollutants that are exceeded the most often are lead, total nitrogen, cadmium and mercury. **Table 3** and **Table 4** below summarize the results for those four pollutants for each rain event analyzed. The more intense the rain event, the more

wash-off of the highway will result and the less settling of solids in the ditches, hence the 1-year/1-hour event shows more pollutants exceeding the water quality standards. The FHWA course materials state that caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive equation was developed.

Table 3. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Preferred Alternative 2 - Initial Design Criteria[1]

Initial Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**
1year-1hour	15	22	22	22	0.033 (40532)	0.523 (41608)	0.053 (41608)	0.107 (41608)
2year-24hours	0	22	11	14	--	0.189 (41608)	0.020 (41608)	0.041 (41608)
5year-24hours	0	22	7	13	--	0.155 (41608)	0.016 (41608)	0.033 (41608)

Table 4. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Preferred Alternative 2 - Low Cost Design Criteria

Low Cost Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**	**Lead**	**Total Nitrogen**	**Cadmium**	**Mercury**
1year-1hour	17	20	20	21	0.168 (40620)	0.840 (40620)	0.043 (40132)	0.079 (40132)
2year-24hours	8	20	9	14	0.050 (40620)	0.257 (40620)	0.016 (40132)	0.030 (40132)
5year-24hours	4	20	8	9	0.044 (40620)	0.224 (40620)	0.013 (40132)	0.025 (40132)

Part 3: Pollutant Loadings from Karst Drainage Area (Prior to Highway Construction)

This section calculates how much pollutant would enter a water way upstream of the highway discharge. For this study, this is taken as the pre-construction calculation, or what is currently entering the karst feature prior to the highway's construction. Using the drainage area of each karst feature and the NOAA rainfall data, a runoff volume inside the drainage basin is calculated. The FHWA Water Quality Manual provides mean concentrations levels for certain pollutants, which are used with the runoff volume to determine the pollutant load. Some of the pollutants analyzed in Parts 1 and 2 were not included in this analysis because runoff concentrations were not provided. These concentrations are based on urban land uses, which is typically much higher than pollutant concentrations from rural areas. When comparing these pre-construction pollutant concentrations, three pollutants are shown to exceed the lowest of Indiana's water quality

[1] The lowest of the three Water Quality Standards listed in the IAC is 0.01 mg/L for lead, 0.01 mg/L for total nitrogen, 0.0023 mg/L for cadmium and 0.00014 mg/L for mercury.

standards: lead, total nitrogen and mercury. These are the same three that exceeded standards most often when looking at the highway runoff. Table 3 in Exhibits 1-6 in Appendix N lists the estimated pollutant mass loads for the pre-construction condition for each of the three rain events analyzed.

6.0 POTENTIAL MEASURES TO MINIMIZE IMPACTS TO KARST AREAS

A primary objective of the 1993 Memorandum of Understanding (MOU) is to minimize the effects of highway construction and operation on karst resources. The four preferred strategies to achieve this objective are listed below in order of priority and/or effectiveness. The strategies are avoidance, alternative drainage, mitigation/treatment and operation and maintenance.

6.1 Avoidance

Avoidance is the best strategy for minimizing karst resource impacts associated with highway construction and operation. Within Section 4, I-69 would be constructed on primarily undeveloped land. The proposed corridor does not follow an existing highway that could be improved to interstate standards. Therefore, the careful planning of the highway alignment is the best opportunity to avoid and minimize impacts to karst resources. Not all karst features can be avoided. Areas within the Section 4 corridor that need to be prioritized for avoidance and minimization are discussed in Section 7.4, Areas of Importance. Features that cannot be avoided will be addressed via alternative drainage and mitigation/treatment, or other appropriate measures.

6.2 Alternative Drainage

Alternative drainage is listed in the Karst MOU as the second most important strategy for minimizing karst resource impacts associated with highway construction and operation. Collection and management of highway runoff is an important consideration during the development of the roadway design. Dye tracing of Section 4 shows that, in some cases, flowpaths are as long as 4 miles from the dye injection point. Redirecting highway runoff is a concern due to the fact that directing highway runoff away from karst recharge features is not always a viable option within this study area. Additionally, redirecting run-off from karst features can negatively affect aquatic species within the karst system by decreasing the quantity of water entering the system. In some areas, Section 4 has karst features distributed across the corridor which would preclude diverting runoff from the highway away from karst features. This is especially true of the eastern part of Section 4. Identifying areas to divert runoff away from karst features may be easier to implement in the western part of Section 4 due to the different geology there.

6.3 Mitigation/Treatment

The third suggested measure in the Karst MOU is mitigation and treatment such as implementation of peat and sand filters, gravel filters, vegetative buffers, and lined spill or runoff containment structures. These structures could be constructed in appropriate locations along the highway to detain and/or treat highway runoff prior to discharge. Monitoring will be required to assure that the drainage discharged from these structures has minimal impact on karst features. Additional karst mitigation measures such as use of geosynthetic reinforced soils, void grouting, compaction grouting, concrete caps, reinforced bridging slabs, deep foundations etc., could be considered concurrently with drainage treatment alternatives so as not to impede drainage in recharge areas.

6.4 Operation and Maintenance

- Examination of the areas that receive runoff from the highway to detect soil piping or opening of buried karst features

- Implementation of no-mowing and no-spray zones to increase vegetative groundcover, to filter roadway runoff prior to leaving the right-of-way

- Routine maintenance and inspection of treatment/containment structures to check the capacity, integrity, and operational efficiency of the structure

- Improved technology should be used to update, maintain, and alter any treatment and containment structures when deemed necessary.

Figure 5 through Figure 40 have been removed from this document for confidentiality reasons related to karst.

7.0 SUMMARY AND CONCLUSIONS

The Section 4 Karst Study Area includes the 27-mile long Section 4 corridor and appropriate areas outside of the corridor, to encompass karst features that may be associated with the corridor via karst groundwater flowpaths or surface run-off. Karst resources in the Section 4 karst study area have been impacted during historical and recent development within Monroe and Greene Counties. Deforestation, row crop production, livestock grazing, and other drainage modification activities have had long term impacts on many of the recharge features and springs, primarily through increased sediment loads. Other human activity has also impacted these features hydraulically in some cases. Ridge top and slope land use modifications have periodically increased the short term addition of sediment to these caves that have very long term affects. Sinkhole filling with trash, hazardous materials, and animal carcasses has resulted in impacts to cave biota, sedimentation, and water quality.

This survey of karst features consisted of karst feature mapping and characterization, groundwater dye tracing of relevant karst features, and determination of the hydrogeologic characteristics of the Section 4 corridor. Due to the location and distribution of observed karst features and their potential connectivity to features outside of the corridor, it was determined that it was necessary to catalogue all relevant karst features in appropriate areas outside of the Section 4 Corridor.

All karst features and karst geology in general cannot be avoided by activities associated with the construction of an interstate highway within the Section 4 corridor; however, individual karst features can be avoided. Therefore, the focus of the alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features, alternative drainage, mitigation/treatment, and operation and maintenance measures.

7.1 Karst Features Mapping and Identification

This study identified the following karst features within the karst study area:

- 63 caves, 14 within the corridor
- 993 sinkholes, 305 within the corridor
- 62 swallets, 19 within the corridor
- 15 sinking streams, 6 within the corridor

- 331 springs, 103 within the corridor

7.2 Dye Tracing

Dye tracing tests characterized groundwater flowpaths in the following manner:

- 39 dye injections resulted in 47 distinct groundwater flowpaths
- 9 dye traces demonstrated groundwater flowpaths that cross the corridor
- The karst groundwater flowpaths in Section 4 tend to be discrete in that recharge features discharge to a single point.
- Six dye traces demonstrated flowpaths to multiple discharge points from a single injection point.
- The length of groundwater flowpaths varies greatly (340 ft to just over 20,000 ft) in length. The longer flowpaths have the potential to impact larger areas in the event that a spill occurs along the roadway.
- Cave, Cave, Cave, Cave, Cave, and Cave: have been hydrogeologically linked through dye tracing to the Section 4 corridor.

7.3 Karst Springs

Spring discharges within the study area varies greatly, due to the hydrogeologic nature of the springs and particular hydrologic conditions (i.e. high or low flow). The spring discharges range from less than 0.1 gpm to over 1000 gpm. Spring discharges were estimated by a field hydrogeologist and were not measured with gauging equipment. Water chemistry for karst and non-karst springs were analyzed and compared. The karst springs had lower pH, higher conductivity and high calcium concentration than the non-karst springs.

Characterization of springs by hydrogeologic unit is as follows:

- US 231 to Taylor Ridge: The springs in this area discharge from glacial related sediments exposed at the surface. The discharge comes from an unconsolidated sandy aquifer of medium to fine sand. This unit is part of the Jessup Formation. These springs are not karst related.

- Taylor Ridge to SR 54: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances are up to 4 miles, with travel times ranging from 4 days to 3 weeks. Groundwater generally flows west/southwest (along dip) and/or southeast/northwest (along strike).

- SR 54 to Harmony Road: Recharge to springs in this area generally enters the karst system through swallets/sinking streams located in drainages. Groundwater travel distances were up to 3 miles, and had travel times ranging from 1 to 6 weeks. Groundwater generally flows west/southwest (along dip) and/or southeast/northwest (along strike).

- Harmony Road to SR 37: Recharge to springs generally enters the karst system through sinkholes located at the tops and flanks of the ridges. Groundwater travel distances in this area were up to 3,000 ft, and had relatively short travel times, generally less than three days.

Based on dye tracing results two regional hydrogeologic no-flow boundaries were identified.

- SR 45 Ridge

- Kirksville Ridge

These two areas are topographic ridges and are depicted in **Figure 37**. The SR 45 Ridge is considered a hydrogeologic boundary for the following reasons:

- Groundwater flowpaths from recharge features on the west side of the SR 45 Ridge did not flow east across the ridge.

- Groundwater flowpaths from recharge features on the east side of the SR 45 Ridge did not flow west across the ridge.

The Kirksville Ridge is considered a hydrogeologic boundary for the following reasons:

- Groundwater flowpaths from recharge features on the west side of the Kirksville Ridge did not flow east across the ridge.

- Groundwater flowpaths from recharge features on the east side of the Kirksville Ridge did not flow west across the ridge.

7.4 Areas of Importance

7.4.1 Cave

Cave is not located within the Section 4 corridor. However, dye tracing tests revealed that recharge to Cave is derived in part from five sinking streams (4-1240, 4-1432, 4-1434, 4-1525, and 4-1524), four of which receive direct run-off from the Section 4 corridor. The drainage area associated with these recharge features (4-1240, 4-1432, 4-1434, and 4-1525) crosses into the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths (20,000 plus feet) which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicated the possibility that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario, the water could pass out of and back into the limestone one or more times. Construction in this area could impact the recharge to Cave. Where appropriate and practicable, special planning should be conducted to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.2 Cave

The entrance to Cave is located approximately 0.6 miles north of the corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from swallet 4-0037. The drainage area associated with 4-0037 crosses into the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with swallet 4-0037. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made such that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.3 Cave

Cave is not located within the Section 4 corridor. This cave will not be directly impacted by highway construction. The Section 4 Alternatives are located approximately miles from the cave. However, dye tracing tests revealed that recharge to Cave is derived in part from four swallets (4-0166, 4-0173, 4-0175, and 4-1504) which receive run-off from the Section 4 corridor. Three other recharge features (4-0174, 4-0203, and 4-0204), which

were not dye traced, are potentially hydrogeologically linked to Cave. The drainage area associated with these recharge features (4-0166, 4-0173, 4-0174, 4-0175, 4-0203, 4-0204, and 4-1504) crosses into the Section 4 corridor. The Section 4 Alternatives are on a common alignment in the vicinity of the above-noted features, and all Alternatives will impact the features and associated drainage areas in the same manner. Construction in this area could impact the recharge to Cave. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.4 Cave

Cave is located approximately feet south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to a spring, which is presumably connected to Cave based on best available data, is derived in part from a sinking stream (4-0661) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave and the associated spring. The Section 4 Alternatives are on a common alignment in this area, and will not encroach upon the drainage area associated with sinking stream 4-0661. Due to the relationship between the proposed road and existing topography, it is not anticipated that highway derived runoff would be directed toward sinking stream 4-0661. Special planning should be conducted, where appropriate and practicable, to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration,, where appropriate and practicable, should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.5 Cave

Cave is located approximately feet south of the Section 4 corridor. This cave will not be directly impacted by highway construction. However, dye tracing tests revealed that recharge to Cave is derived in part from a swallet (4-1035) which does receive run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives are on a common alignment, predominately down-gradient of swallet 4-1035 in this area. The Alternatives will impact the drainage area of swallet 4-1035 in a similar manner and therefore have the same potential to affect the cave spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to these recharge features is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where

appropriate and practicable, should be made to insure that construction does not sever these recharge features by sedimentation or impervious cover.

7.4.6 Spring

Spring (4-1516) is located within the Section 4 corridor. The spring is an important landmark as well as a supplemental source of water for a several acre wetland. The spring will not be directly impacted by highway construction. Dye tracing tests revealed that a portion of the recharge to Spring is derived from a sinking stream (4-1228) in a drainage east of Spring within the Section 4 corridor. It is likely that the area downstream of sinking stream 4-1228 acts as a sinking stream during high flow periods and also provides recharge to Spring. Sinking stream 4-1228 and the potential losing stream reach down gradient from it would receive run-off from the Section 4 Corridor. Construction in this area could impact the recharge to Spring. The Section 4 Alternatives are on a common alignment in this area and will unavoidably cross sinking stream 4-1228. They will not encroach upon the drainage area of sinking stream 4-1228. The Alternatives will cross sinking stream 4-1228 in a similar manner and therefore have the same potential to affect the spring's water quality or quantity. Special planning should be conducted, where appropriate and practicable, to insure drainage to 4-1228 and the downstream area is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, special consideration, where appropriate and practicable, should be made to insure that construction does not sever this recharge area by sedimentation or impervious cover.

7.4.7 Cave

Cave is not located within the Section 4 corridor. The cave will not be directly impacted by highway construction. However, dye tracing tests revealed recharge to Cave is derived in part from three sinking streams which receive run-off from the Section 4 corridor. Cave is located ft southeast of Cave and lies between it and the input features for the dye traces. The Section 4 Alternatives are about a half-mile south of the cave location and share a common alignment in this area. All Alternatives would result in the same impact upon the drainage areas of potential Cave recharge features located within the Section 4 corridor. It should be noted that the affected drainage areas are linked to this cave via unusually long flowpaths which include karst conduits in limestone. However, the elevation of the limestone and the streambeds indicates probability that the flowpath to this cave consists of a combination of conduit and surface flow. In this scenario the water could pass out of and back into the limestone one or more times. The majority of the recharge to the cave is derived from more proximal features. Therefore, it is not anticipated that the project will cause a material degradation of the cave spring's water quality or quantity.

7.4.8 Cave

Cave is located approximately feet south of the Section 4 corridor. Cave has been mapped and the cave passage trends toward the Section 4 corridor. The mapped extent of this cave terminates outside the Section 4 corridor, over feet south of the Section 4 Alternatives. Dye tracing tests revealed that recharge to Cave is derived in part from a sinking stream (4-1271) which receives run-off from the Section 4 corridor. Construction in this area could impact the recharge to Cave. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same impacts along the northern edge of the drainage area of sinking stream 4-1271. Where appropriate and practicable, special planning should be conducted to insure drainage to this recharge feature is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special consideration should be made to insure that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.9 SR 37 Interchange

Dye tracing tests reveal the northeastern side of SR 37 near its intersection with Victor Pike to be part of the recharge area for one significant spring (4-1501). The southwestern side of SR 37 near its intersection with Victor Pike is a concern from an engineering standpoint due to the high density of karst features. The bedrock is likely highly fractured and could pose unique design and construction issues. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. Additionally, the construction of SR 37 and surrounding development has already altered the land surface and drainage patterns. Sinkholes have been filled and altered which could be problematic during construction. Drainages and conduits have also been altered which present problems in studying the hydrogeology. The Section 4 Alternatives share a common alignment in this area. All Alternatives would result in the same encroachment within the recharge area along the northeastern side of SR 37 near Victor Pike. Special planning, where appropriate and practicable, should be conducted to insure that highway derived runoff within the drainage area of sinkhole 4-1496 is dispersed through natural vegetation and/or an engineered treatment system before entering the groundwater system. Also, where appropriate and practicable, special planning should be conducted so that construction does not sever this recharge feature by sedimentation or impervious cover.

7.4.10 Tramway Road Karst Area

This area is located within the corridor, north of Tramway Road and west of Victor Pike. Dye tracing tests reveal short isolated groundwater systems and the karst features do not provide recharge to any significant springs. Dye tracing did not identify a potential hydrologic link to nearby quarries, suggesting that quarrying in the area has not contributed to sinkhole

development. This area will need additional engineering measures to account for the high density of karst features and the highly fractured bedrock. This area lacks the non-carbonate cap rock that channels surface water off and away from karst forming bedrock. The instability of the bedrock was highlighted by a sinkhole collapse documented by the project team. This collapsed occurred on the edge of a sinkhole (4-0133) identified during field mapping. The review did not identify that an alternative outside the corridor would provide substantial karst impact and/or roadway stability benefits compared to alternatives within the corridor. The Section 4 Alternatives utilize three alignments in this area and would affect a similar overall number of features. The Preferred Alternative (Alternative 2) as well as Alternatives 3 and 4 minimize impacts to higher infiltration features and minimize anticipated stability concerns in the area by cresting the hill north of Tramway Road on its east side, approximately 30 feet lower in elevation in comparison to Alternative 1.

7.5 General Environmental Concerns

- Karst groundwater systems can transport sediment and contaminants virtually unimpeded into cave and spring systems. Dye tracing studies show the groundwater systems within the Section 4 corridor have the potential to impact areas a long distance (up to 4 miles) from the source

- Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides is common. If contaminants enter the karst system the location for establishing a response could be difficult to predict.

7.6 General Engineering Concerns

- Collapse of filled (naturally and otherwise) sinkholes and cave passages can compromise adjacent and overlying structures. These failures can occur without surface expression prior to collapse. There are sinkholes within the Section 4 corridor that have been filled by natural and man-made processes

- Impervious surfaces, such as roads, alter the natural patterns of run-off and infiltration. Concentrated and redirected runoff into open sinkholes or over sinkholes without surface expression can result in sinkhole collapse. Unlined retention or detention structures can increase the localized head, which could result in collapse of adjacent sinkholes. Alteration of surface run-off can also increase erosion which can effectively sever recharge features by sedimentation

- Impervious surfaces, such as roads, can sever recharge features by covering or filling. This can result in decrease spring discharges and alteration of habitat for any biological communities within the karst system

- The karst landscape is an ever evolving landscape. Karst features can change rapidly with subsequent opening and infilling of sinkholes, caves and swallets as well as increase and decrease in spring discharges.

8.0 Recommendations

8.1 Best Management Practices

- Strict runoff/erosion control must be planned, with staging and materials set up outside of karst areas or on impervious surfaces with controlled drainage. Same season re-vegetation of land disturbed during the construction process should occur when possible

- Road maintenance should include posted low-salt/no spray areas to prevent contaminants from entering karst systems. Mowing should be restricted to appropriate times, and repairing damaged vegetation and drainages should be required

- Some of the channels that cross the corridor may be under-drained in karst areas and appear to transmit water infrequently. Culverts and bridge openings must be sized to accommodate the required rainfall events as defined by the INDOT Drainage Design Manual. Unique backwater conditions created by sinking streams and other insurgence features will require further evaluation during subsequent design stages to assure that adequate detention storage volume is available

- The drainage design for I-69 should provide for proper energy dissipation devices at the culvert and storm sewer system outlet locations to prevent erosion to existing channels. Energy dissipater devices include such items as scour holes, riprap linings and stilling basins. Design of energy dissipater devices and ditch linings should be based on INDOT's Drainage Design Manual

- Run-off from the roadway should have as much natural treatment as is possible. It is recommended that run-off be dispersed through natural vegetation and/or an engineered treatment system before reaching potential karst recharge features

- The roadway construction, when possible, should be planned to maintain the drainage to karst recharge features

- Utilization of lined ditches to the outfall discharge points are recommended within the karst areas designed to prevent erosion. Water flow within the roadway ditches will need an analysis for lining requirements. Culvert outlets should be designed to discharge water to at grade terrain. This design will reduce erosion scour and sediment transport into the karst and other environments. Design of ditches and culverts should be based on INDOT's Drainage Design Manual. This will reduce soil erosion through karst features that could compromise the integrity of the roadway

- A spill response plan should be established with response equipment readily available during and after road construction. Karst groundwater systems have the potential for high groundwater flow velocities, which makes quick response to any spill a necessity. Drainage and runoff control mechanisms should be in place to prevent contaminants from entering the karst system. In the event that contaminants enter the karst system, use of response or mitigation measures at discharge points may be necessary

- If a karst recharge feature cannot be avoided or appropriately filled and capped, the roadway should span the feature and be anchored into competent bedrock. This will avoid the problem of instability and roadway runoff entering the recharge feature

- If a spring cannot be avoided or the drainage adequately accommodated by a structure, the roadway should span the spring and be anchored into competent bedrock. This will avoid the potential undermining of the roadbed by excess head pressure and discharge

- Cuts into bedrock should be minimized when possible to decrease the potential to expose caves and other karst conduits

- If a cave is exposed during construction, karst experts should be consulted to determine the significance of the cave

- Per the 1993 Karst MOU, if any federal and/or state listed species are encountered during construction that were not previously noted and evaluated, construction in that area should be halted until the species can be evaluated.

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U.S. Geologic Survey. 1980d. Owensburg Quadrangle, Indiana-Greene County: 7.5-minute series (topographic).

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APPENDIX A – KARST MOU

Memorandum of Understanding

(Retyped of original text 3/14/2007)

This Memorandum of Understanding is made and entered into this thirteenth day of October, 1993, between the Indiana Department of Transportation (INDOT), the Indiana Department of Natural Resources (IDNR), the Indiana Department of Environmental Management (IDEM) and the U.S. Fish and Wildlife Service (USFWS) for the purpose of delineating guidelines for construction of transportation projects in karst regions of the State.

Whereas, INDOT, IDNR, IDEM and the USFWS wish to cooperate in the identification, study and treatment of drainage in karst regions related to the construction of transportation projects and

Whereas, INDOT, IDNR, IDEM and the USFWS accept responsibility to ensure the transportation needs of Indiana are met in an environmentally sensitive manner that protects the habitat of all species and

Whereas, design and construction practices must protect ground water quality, public health and safety, and the environment.

Whereas, the Indiana Department of Natural Resources will conform to the terms and conditions within this MOU for their transportation projects. Likewise, it will be IDNR's responsibility to provide standard biological review for projects in the karst region.

Therefore, in consideration of the terms and conditions set forth herein the INDOT, IDNR, IDEM and USFWS agree as follows:

1. INDOT in cooperation with the IDNR, IDEM and USFWS shall determine the location of sinkholes, caves, underground streams, and other related karst features and their relationship prior to proposed alterations or construction in karst regions of the state, a consultant with expertise in karst geology/hydrology may assist in the identification and characterization of the karst features. The choice of the consultant retained by INDOT will be subject to the review of IDNR, USFWS and IDEM.

2. Tasks to accomplish this work will include:

   Research public and private information sources for information relative to karst features.

   Conduct field check karst and cave features that appear from the first task and identify any additional karst features.

   Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area

and surface water drainage patterns of the area. Calculations of estimates of annual pollutant loads from the highway and drainage with the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan.

That report will be used as a tool to assist in determining the proposed highway alignment. The intent of INDOT is to avoid karst areas and use alternate drainage where possible.

3. IDNR, IDEM and USFWS will be requested to review and comment on the findings at the early coordination phase of project development.

4. INDOT, using the input from IDNR, IDEM and USFWS will begin to formulate appropriate measures to offset unavoidable impacts to the karst features. It is understood by all parties that some of the methods proposed at this time will be generic and could be applied throughout the length of the corridor. Other methods may be specific to a particular cave or karst feature. Some of the approaches may require additional investigations to determine their necessity and/or their feasibility. A revised draft report will be prepared by INDOT's consultant and provided to the IDNR, IDEM and the USFWS as part of the design review process.

5. Drainage entering from beyond the right-of-way will be treated according to the same process as drainage generated by the project.

6. As the project progresses further into the design phase, the IDNR, IDEM and USFWS will be invited and will attend field checks and meetings dealing with efforts to negate or minimize adverse impacts.

7. Hazardous materials traps (HMT's) will be constructed at storm water outfalls and other locations that will protect karst features from spill contamination.

8. INDOT agrees to develop a monitoring and maintenance plan for the affected karst features. IDNR, IDEM and USFWS will be provided an opportunity to review this plan. The establishment of water quality and a point at which a standard is established for remediation will be a part of each monitoring plan. The results of the monitoring will be submitted to IDNR, USFWS and IDEM on a regular basis.

9. A low salt and no spray strategy will be developed for each future project. A signing strategy for these items will also be developed for each project.

10. Prior to acceptance of the final design plans an agreement will be developed which will set out t6he appropriate and practicable measures to offset unavoidable impacts to karst features. This agreement will be signed by the Department Director of IDNR, the Commissioner of the IDEM, the Commissioner of INDOT and the Supervisor of the USFWS Bloomington, Indiana Field Office. The agreement will become a part of

the contract documents for the project, will be discussed at the pre-construction conference and will be on file at the office of the project administrator.

11. INDOT will assure that the terms of the agreement will be completed with all safeguards given to the karst area. Special provisions, which are binding provisions that are a part of the contract, will be included outlining the precautions to be taken. Construction and design strategies for handling karst features will be discussed with the contractor(s) and project administrator during the pre-construction conference. Project administrator shall ensure that the contractor is following the new erosion control standards that meet Rule 5 of 327 IAC 13 and any special precautions outlined in the design plans that the sinkhole treatment is being handled correctly. The erosion control plan must be available at the project administrator's office. An emergency response plan will be made a part of the contract documents. In addition, the contract documents will contain a strategy for signing to alert the public to the fact that all types of spills are potentially hazardous to the karst environment. For INDOT, this plan would be procedure 20 of the Field Operations Manual dated 6/24/1992. [Currently in the Construction Activities Environmental Manual].

12. The location and nature of the sinkholes and drainage schematic will be provided to the IDEM. They will provide the information to the appropriate local authorities and the Hazmat teams. An emergency response plan will be followed. This constitutes procedure 20. Included in this information is an understanding that all types of spills are potentially hazardous to karst regions.

13. IDNR, IDEM and USFWS personnel will monitor construction and maintenance to the agreed upon terms, as deemed necessary.

14. If during construction it is found that the mitigation agreement must be altered, all of the agencies will be contacted and agreement reached prior to work continuing in that specific area of the project. In order to not unduly delay projects, a two working days response time is needed from the resource agencies.

15. Treatments will be maintained during construction by means of a visual inspection on a weekly basis or after every rain. Corrective action will be taken as needed.

16. If after the above procedure is followed and a state/federal endangered/threatened species is found during construction, work in that area of the project will stop. The IDNR and USFWS will be immediately notified. The IDNR and USFWS will promptly investigate the situation, advise the project administrator and assume responsibility for protecting the endangered species and taking the appropriate action.

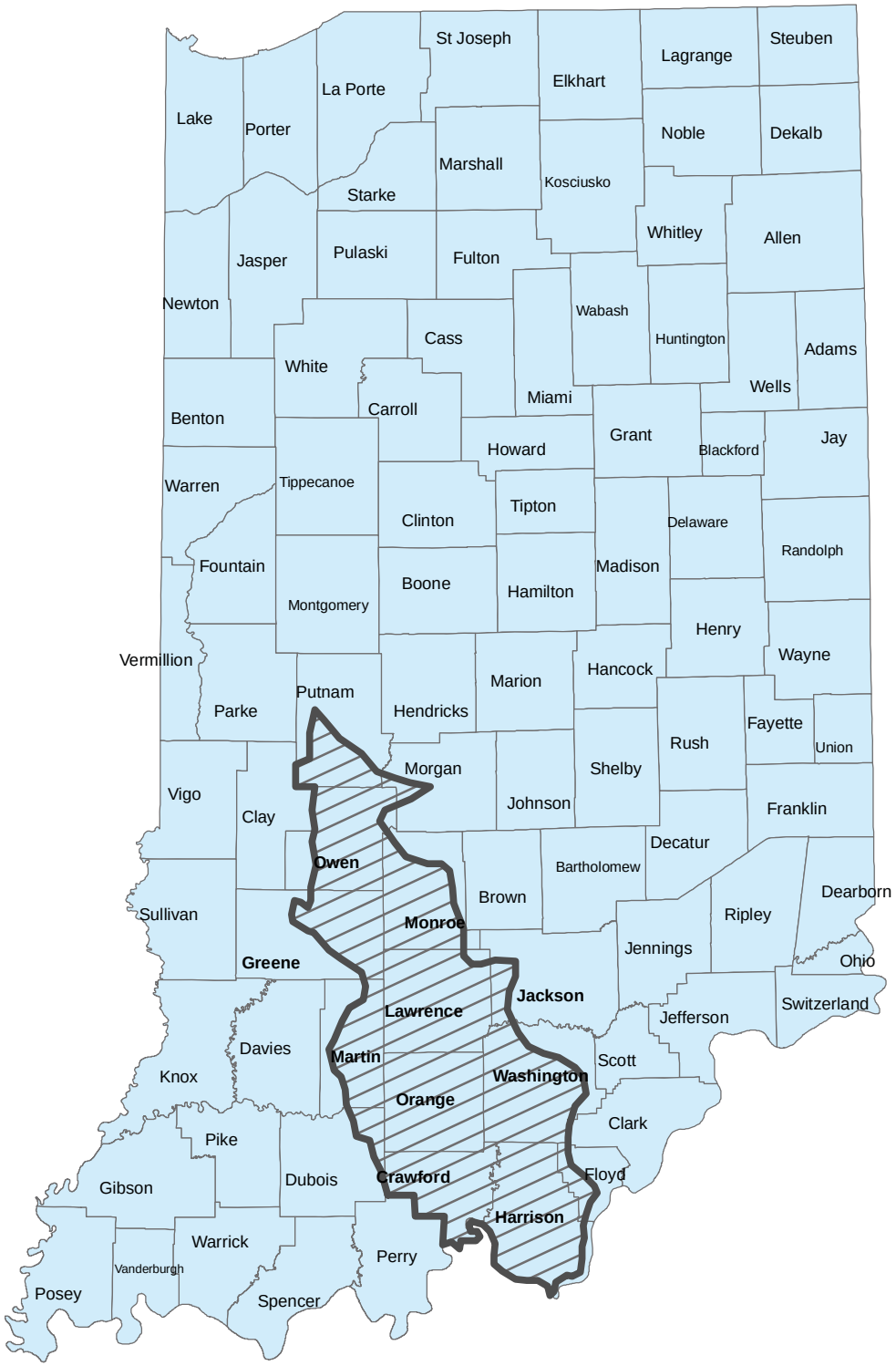
17. This document will be reviewed annually or more frequently at the request of any of the foregoing agencies.

MR. FREDERICK C. P'POOL, COMMISSIONER
INDIANA DEPARTMENT OF TRANSPORTATION

MR. PATRICK R. RALSTON, DIRECTOR
INDIANA DEPARTMENT OF NATURAL RESOURCES

MS. KATHY PROSSER, COMMISSIONER
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

MR. DAVID C HUDAK, FIELD SUPERVISOR, BLOOMINGTON FIELD OFFICE
U. S. FISH AND WILDLIFE SERVICE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Boone
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Montgomery
Henry
Wayne
Vermillion
Hancock
Marion
Putnam
Parke
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Shelby
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Bartholomew
Brown
Dearborn
Sullivan
Monroe
Ripley
Jennings
Greene
Ohio
Jackson
Switzerland
Lawrence
Jefferson
Davies
Martin
Scott
Knox
Washington
Orange
Clark
Pike
Dubois
Crawford
Floyd
Gibson
Harrison
Warrick
Perry
Vanderburgh
Posey
Spencer
Potential Karst Features Region

APPENDIX B – KARST FEATURE FORM

hydrogeology inc.

1211 S Walnut St
Bloomington, IN 47401

Observed by:

Karst Feature Form

Feature ID:		County:	
Date:	Time:	USGS Quadrangle	
Picture #:	Township:	Section:	Range:

Location

Quarter Sections:	Elevation (ft)
UTM (10m) North:	UTM (10m) East:

Feature Description

Feature Type:	Topography:	Rock Type/Unit:
Length:	Width:	Depth:
Catchment Area: <1 <5 <10 <20 <30 <40 <50 <75 <100	Infiltration: low med high	Infill: soil org trash Bedrock: yes no
Opening:	Airflow:	Spring Discharge:

Notes:

Feature Types

C	Cave	MB	Manmade feature in bedrock
SC	Solution cavity	SW	Swallow hole
SF	Solution-enlarged fracture(s)	SH	Sinkhole
F	Fault	CD	Non-karst closed depression
SP	Spring	Z	Zone, clustered or aligned features

Figure 3.1: Karst feature field form

APPENDIX C – Dye Tracing Field and Lab QAQC

hydrogeology inc.
1211 S Walnut St
Bloomington, IN 47401

FIELD AND LABORATORY PROCEDURES FOR COLLECTION/ANALYSIS OF WATER AND CHARCOAL SAMPLES FOR THE PRESENCE OF FLUORESCENT DYES

December 19, 2005

Dr. Noel C. Krothe, RPG
President
Hydrogeology Inc.

Introduction

This document describes the standard field and laboratory operating procedures used by Hydrogeology Inc. for the analysis of water and charcoal samples for the presence of fluorescent dyes. In some situations these procedures are altered, and are noted as such in the lab results.

Fluorescent Dyes

Fluorescein
Common Name: Uranine HS (Fluorescein)
Chemical Name: Acid Yellow 73

Rhodamine WT
Common Name: Rhodmaine WT
Chemical Name: None

Eosine
Common Name: Eosine, Eosin
Chemical Name: Acid Red 87

Procedures

Description of Samplers

Water and charcoal samples are collected and analyzed at all sampling locations.

Water Samples

Water samples are collected in Cincinnati Container brand amber round bottles. Amber bottles are used in order to decrease UV exposure. Samples are refrigerated immediately upon return from collection.

Water Sample Collection

All water sampler collected are analyzed for the presence of fluorescent dye. Water samples are collected at springs, stream crossings and in wells. Water samples collected at springs are collected at the mouth of the spring and in the area with the highest flow. Water samples from wells are collected using a detected disposable plastic bailer. Typically the bailer is hung above water and lowered into the well to retrieve the sample. If the bailer is suspended below the water level the bailer is retrieved and emptied and then lowered again to obtain a fresh water sample. Water samples are collected at various frequencies, but at a minimum of once per week. Typically, ISCO automated water samplers are used to collect water samples at frequencies of as often as every fifteen. The information gained from using automated samplers is useful for establishing a dye breakthrough curve.

Charcoal Samplers

Charcoal samples are constructed using fiberglass screen. The screen is formed into approximately 2 inch by 4 inch pouches. The pouches are filled with approximately 4-5

grams of Calgon Carbon Corporation activated charcoal. Prior to being placed in the field all charcoal packets are washed in de-ionized water. The charcoal packets are placed in plastic containers and rinsed with de-ionized water until the packets are completely submerged. The charcoals are then agitated for approximately 2 minutes and then allowed to sit for fifteen minutes. This process is repeated three times. The charcoals are then placed in Parkway Plastic 4oz polypro jars and are used that day.

Charcoal Sample Collection

Charcoal samplers are attached to various items including bricks, stones, trees, and other stationary items. Charcoal samplers are attached with heavy duty rope and/or wire. If possible the charcoal is completely submerged and placed in the area with the fastest flow. When samplers are placed in a well, the charcoal packet is suspended on heavy duty rope with several weights attached to ensure the packet is completely submerged.. When charcoal samples are collected they are collected in Parkway Plastic 4oz polypro jars. If there is sufficient flow the charcoal is rinsed in the source water prior to being placed in the container. Samples are placed in a freezer immediately upon return from collection.

Charcoal Sample Elution

After collection the charcoal packets are rinsed in de-ionized to remove all excess sediment and particulates that can interfere with analysis. Once the charcoal is properly rinsed the packet is cut and the contents are dumped back into the original plastic sampling container. The charcoal container is then filled with eluting solution which is composed of 5 parts isopropyl alcohol, 3 parts de-ionized water, and 2 parts aqueous ammonia. The samples are allowed to sit for approximately 2 hours in the elutant.

Analysis on the Shimadzu RF-5301

The Shimadzu RF-5301 spectrofluorophotometer is used for samples analysis. This is a synchronous scanning model and is controlled by a MPC ClientPro desktop computer. Our Shimadzu RF-5301 is operated and maintained in accordance with the manufacturer's recommendations. Shimadzu Scientific Instrument technicians were responsible for installation and training for use of the RF-5301 to Hydrogeology Inc personal.

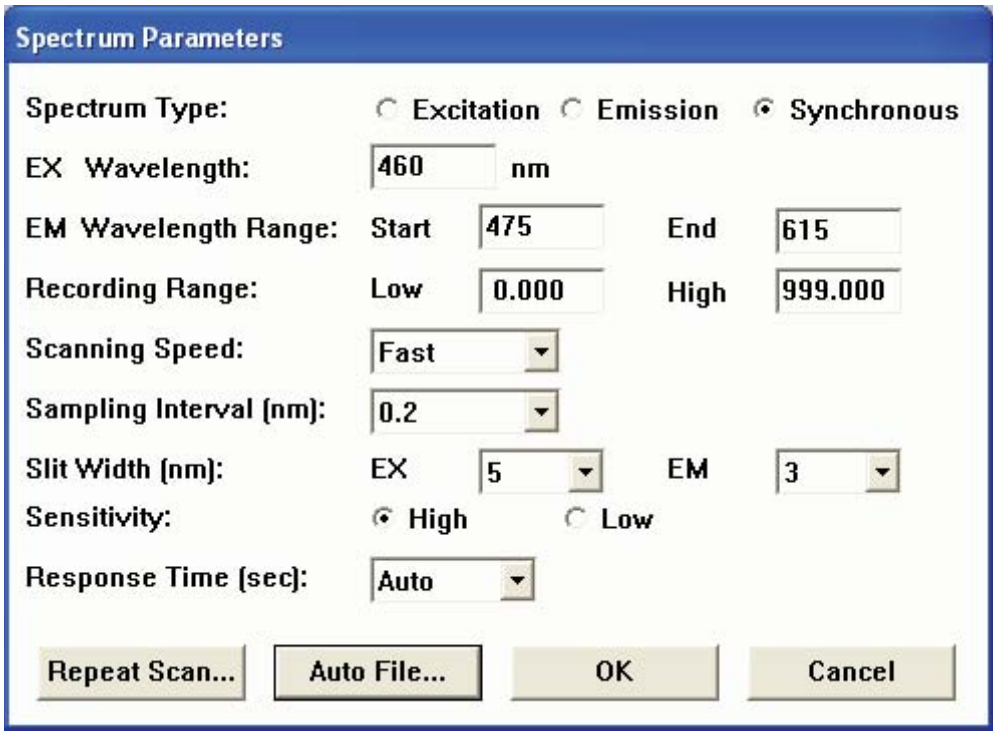
Charcoal Sample Analysis

After two hours of elutriating approximately 4 ml of the elutant is poured into a disposable polyethylene cuvette. These cuvettes are designed for fluorometric analysis and are clear on all four sides. The cuvettes have a spectral range of 340 to 800mm. The cuvette is then placed in the Shimadzu RF-5301 and run at the following settings.

Table 1: Typical excitation and emission slit widths for dye analysis

Dye and matrix	Excitation (EX)	Emission (EM)
Fluorescein in water	5	5
Fluorescein in elutant	5	3
Rhodamine WT in water	5	5
Rhodamine WT in elutant	5	3
Eosine in water	5	5
Eosine in elutant	5	3

Figure 1: Typical instrument settings for elutant analysis



After analysis the cuvettes are discarded. If the sample has no detected dye it is disposed of. If the sample reveals a dye positive the samples is placed in a freezer for possible further analysis.

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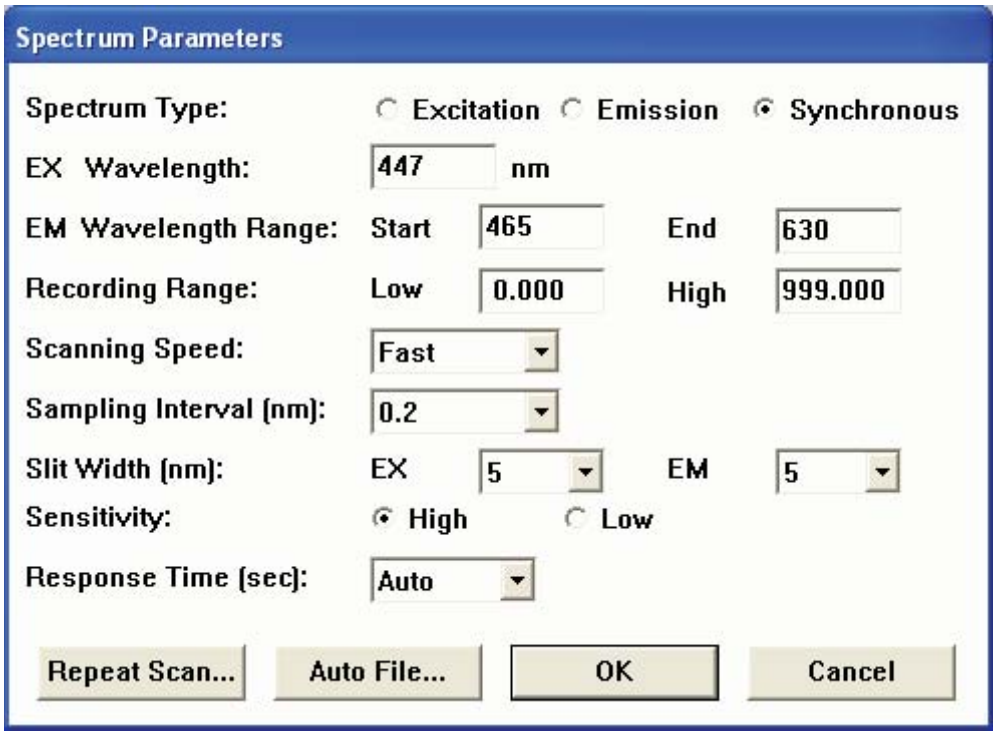
Figure 2: Typical instrument settings for water analysis



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Quantification

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1. Fluorescein in water at concentrations of 0.1 & .01 ppb
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5. Eosine in water at concentrations of 0.1 & .01 ppb
6. Eosine in elutant at concentrations of 0.1 & .01 ppb

Quality Control

Laboratory water and elutant and water blanks are run prior to after all lab sessions. Additionally, charcoal packets are allowed to soak in de-ionized water for 1 hr, then elutriated for two hours, and then analyzed.

Determination of Positive Dye Hits

The fluorescent emission wavelength ranges for all the dyes used have been established and are listed in Table 2 (add table). The following criteria are used to determine a dye positive in water and elutant samples:

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2. The peak must be indicative of fluorescence, meaning a sharp narrow peak indicative of Fluorescein, Rhodamine WT, and Eosine as opposed to broad peaks not associated with these dyes.
3. If any background fluorescence existed at the sample station the new peak must be 10 times the background level
4. The peak must have a concentration of three times the detection limit of the machine.

Table 2: Established fluorescent ranges

Dye and matrix	Range
Eosine in Water	532 to 540
Eosine in Elutant	530 to 540
Fluorescein in Water	504 to 511
Fluorescein in Elutant	510 to 515.6
Rhodamine WT in Water	562 to 568
Rhodamine WT in Elutant	569 to 575

Breakthrough Curve Data

The most accurate way to design a dye trace test is to use an continuous water sampler at the spring or spring that are the most likely major discharge point for the dye injection. The sampler can be programmed to collect water samples on a continuous interval. The most common procedure is to set the sampler at a one hour interval until the dye is detected. The water samples are then analyzed for the concentration of dye and plotted versus time. The first detection of dye indicates the approximate travel time from the injection point of the dye to the discharging spring. Samples following first detection are analyzed for concentration. The highest concentration is the peak of the graph. All samples from the first detection are analyzed and plotted until the dye can not be detected. This produces a concentration versus time curve which gives not only the time

of arrival but also how long it will take for the dye pulse to move through the system. The time of arrival and the duration of the peak will differ at different flow regimes. If a minimum flow time is desired then high flow conditions are necessary. The break through curve can be important to mitigation.

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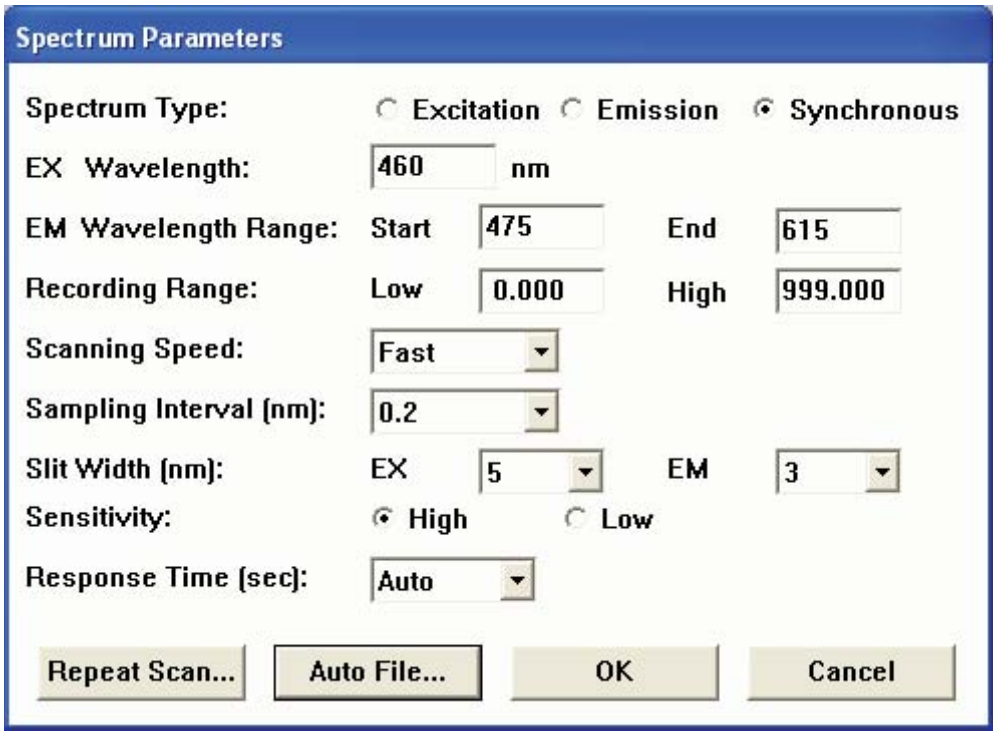

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Rhodamine WT in elutant	5	3
Eosine in water	5	5
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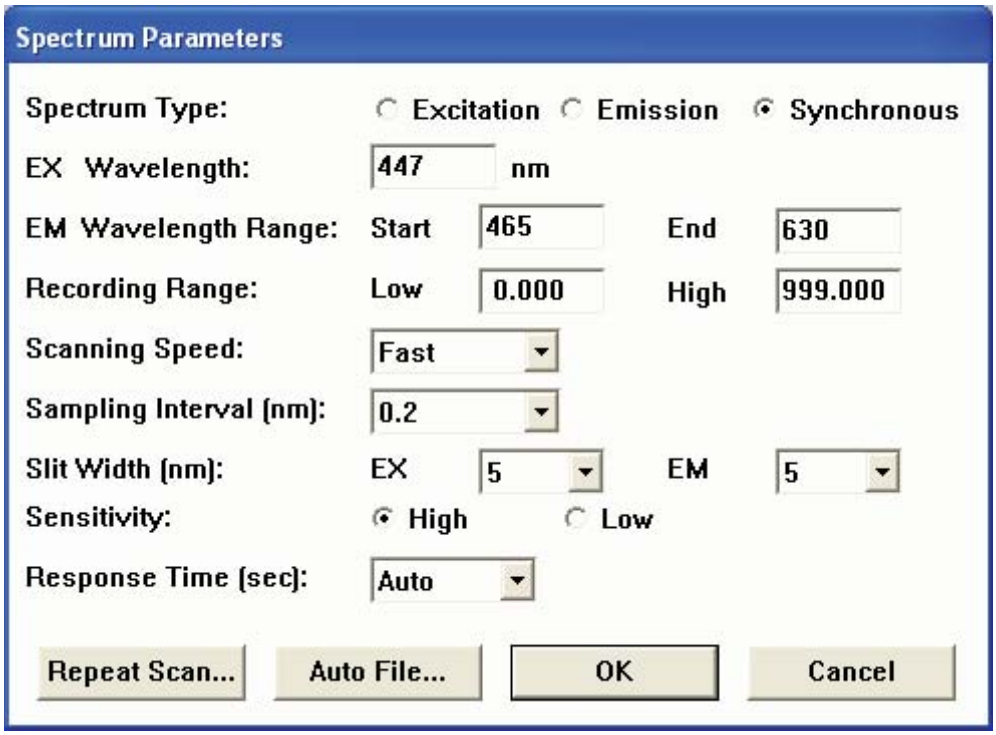
Figure 2: Typical instrument settings for water analysis



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Rhodamine WT in Elutant	569 to 575

Breakthrough Curve Data

The most accurate way to design a dye trace test is to use an continuous water sampler at the spring or spring that are the most likely major discharge point for the dye injection. The sampler can be programmed to collect water samples on a continuous interval. The most common procedure is to set the sampler at a one hour interval until the dye is detected. The water samples are then analyzed for the concentration of dye and plotted versus time. The first detection of dye indicates the approximate travel time from the injection point of the dye to the discharging spring. Samples following first detection are analyzed for concentration. The highest concentration is the peak of the graph. All samples from the first detection are analyzed and plotted until the dye can not be detected. This produces a concentration versus time curve which gives not only the time

of arrival but also how long it will take for the dye pulse to move through the system. The time of arrival and the duration of the peak will differ at different flow regimes. If a minimum flow time is desired then high flow conditions are necessary. The break through curve can be important to mitigation.

APPENDIX D – KARST FEATURE FIELD DATABASE

Table 2 has been removed for confidentiality reasons related to karst.

Table 3 has been removed for confidentiality reasons related to karst.

Table 4 has been removed for confidentiality reasons related to karst.

Table 5 has been removed for confidentiality reasons related to karst.

Table 6 has been removed for confidentiality reasons related to karst.

APPENDIX E – KARST FEATURE DRAINAGE AREA

able E-1: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40001	970.11	0.24	
40002	242.30	0.06	
40004	242.38	0.06	
40005	807.97	0.20	
40006	646.24	0.16	
40007	80.91	0.02	
40008	323.37	0.08	
40009	565.33	0.14	
40010	80.82	0.02	
40011	970.11	0.24	
40012	242.30	0.06	
40016	80.82	0.02	
40017	80.74	0.02	
40018	565.25	0.14	
40019	161.73	0.04	
40020	888.70	0.22	
40021	242.21	0.06	
40022	7189.53	1.78	
40023	242.38	0.06	
40024	485.10	0.12	
40025	80.91	0.02	
40026	1938.88	0.48	
40027	80.82	0.02	
40028	80.74	0.02	
40029	80.74	0.02	
40030	888.45	0.22	
40031	242.30	0.06	
40032	646.16	0.16	
40033	323.12	0.08	
40034	323.12	0.08	
40036	80.74	0.02	
40037	161.48	0.04	
40038	484.68	0.12	
40039	323.04	0.08	
40040	646.07	0.16	
40041	888.37	0.22	
40042	161.48	0.04	
40043	403.86	0.10	
40044	80.74	0.02	
40045	80.82	0.02	
40046	484.60	0.12	
40047	80.82	0.02	
40048	323.12	0.08	
40049	3958.17	0.98	
40050	161.48	0.04	
40051	19063.46	4.71	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40052	403.77	0.10	
40053	969.02	0.24	
40054	1211.82	0.30	
40055	80.74	0.02	
40056	10662.61	2.63	
40057	1211.41	0.30	
40058	242.30	0.06	
40061	1292.14	0.32	
40062	726.81	0.18	
40063	1615.35	0.40	
40064	403.86	0.10	
40065	80.82	0.02	
40066	1130.67	0.28	
40068	2342.57	0.58	
40069	1373.05	0.34	
40070	80.74	0.02	
40071	80.74	0.02	
40072	888.54	0.22	
40073	16559.49	4.09	
40074	80.82	0.02	
40076	80.74	0.02	
40080	807.71	0.20	
40081	323.04	0.08	
40082	242.38	0.06	
40084	323.04	0.08	
40086	888.29	0.22	
40087	3392.25	0.84	
40088	1212.41	0.30	
40089	1050.68	0.26	
40090	161.48	0.04	
40091	323.04	0.08	
40092	888.62	0.22	
40093	161.56	0.04	
40094	17367.71	4.29	
40095	80.74	0.02	
40096	2180.68	0.54	
40097	1049.93	0.26	
40099	969.27	0.24	
40100	727.06	0.18	
40101	242.30	0.06	
40103	242.21	0.06	
40104	80.74	0.02	
40105	80.74	0.02	
40106	242.55	0.06	
40107	242.30	0.06	
40108	646.24	0.16	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40109	403.86	0.10	
40110	161.64	0.04	
40111	727.06	0.18	
40112	80.74	0.02	
40113	726.98	0.18	
40114	80.74	0.02	
40115	80.74	0.02	
40117	323.12	0.08	
40119	80.74	0.02	
40121	323.04	0.08	
40123	484.60	0.12	
40125	403.94	0.10	
40127	1776.91	0.44	
40129	242.30	0.06	
40130	161.48	0.04	
40131	565.33	0.14	
40132	2746.85	0.68	
40133	1453.87	0.36	
40134	2261.84	0.56	
40135	403.77	0.10	
40136	1050.51	0.26	
40137	242.30	0.06	
40138	80.82	0.02	
40139	242.38	0.06	
40140	161.56	0.04	
40141	80.74	0.02	
40142	161.64	0.04	
40143	646.07	0.16	
40144	161.56	0.04	
40145	161.56	0.04	
40146	807.97	0.20	
40147	323.04	0.08	
40148	565.92	0.14	
40149	80.91	0.02	
40151	485.10	0.12	
40152	403.86	0.10	
40153	403.94	0.10	
40154	323.12	0.08	
40155	17367.46	4.29	
40157	242.21	0.06	
40158	11874.35	2.93	
40159	565.42	0.14	
40160	80.82	0.02	
40161	484.60	0.12	
40162	403.86	0.10	
40163	646.24	0.16	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40167	403.77	0.10	
40168	1292.39	0.32	
40169	403.86	0.10	
40170	161.56	0.04	
40171	726.98	0.18	
40172	403.77	0.10	
40172	565.33	0.14	
40177	646.24	0.16	
40178	1130.83	0.28	
40179	80.74	0.02	
40182	484.60	0.12	
40183	3068.71	0.76	
40184	888.45	0.22	
40185	80.74	0.02	
40186	242.30	0.06	
40187	323.20	0.08	
40188	3795.61	0.94	
40189	323.04	0.08	
40190	565.92	0.14	
40191	5655.18	1.40	
40192	888.54	0.22	
40193	161.48	0.04	
40194	1130.75	0.28	
40195	1292.65	0.32	
40196	565.33	0.14	
40198	323.04	0.08	
40199	403.77	0.10	
40200	807.97	0.20	
40201	1050.10	0.26	
40202	11631.71	2.87	
40205	484.68	0.12	
40206	484.60	0.12	
40207	161.56	0.04	
40208	2908.58	0.72	
40209	403.77	0.10	
40210	1292.14	0.32	
40211	4362.36	1.08	
40212	80.74	0.02	
40213	565.33	0.14	
40215	1292.14	0.32	
40216	161.56	0.04	
40217	161.48	0.04	
40221	888.54	0.22	
40222	403.77	0.10	
40223	2099.77	0.52	
40224	242.30	0.06	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40225	484.68	0.12	
40226	1454.12	0.36	
40227	727.56	0.18	
40228	80.74	0.02	
40229	242.30	0.06	
40230	888.29	0.22	
40231	565.33	0.14	
40232	1131.00	0.28	
40233	1938.80	0.48	
40234	161.48	0.04	
40235	323.12	0.08	
40236	242.30	0.06	
40237	1049.85	0.26	
40238	1939.30	0.48	
40239	4765.64	1.18	
40240	323.04	0.08	
40241	161.56	0.04	
40242	242.30	0.06	
40243	403.94	0.10	
40244	1534.44	0.38	
40245	565.50	0.14	
40246	161.56	0.04	
40247	646.07	0.16	
40248	403.86	0.10	
40249	161.73	0.04	
40250	80.74	0.02	
40251	1372.88	0.34	
40252	323.04	0.08	
40255	646.07	0.16	
40256	80.74	0.02	
40257	323.12	0.08	
40258	242.38	0.06	
40260	565.33	0.14	
40261	403.77	0.10	
40272	80.74	0.02	
40273	1211.32	0.30	
40274	1211.41	0.30	
40275	2261.25	0.56	
40276	161.56	0.04	
40277	888.62	0.22	
40278	161.48	0.04	
40279	646.16	0.16	
40283	565.50	0.14	
40284	80.74	0.02	
40285	646.24	0.16	
40286	807.71	0.20	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40288	242.30	0.06	
40290	1373.13	0.34	
40291	484.76	0.12	
40292	1373.30	0.34	
40293	969.44	0.24	
40295	404.19	0.10	
40296	1695.92	0.42	
40297	1534.44	0.38	
40299	807.55	0.20	
40362	6704.35	1.66	
40363	807.71	0.20	
40365	403.86	0.10	
40366	323.04	0.08	
40367	161.48	0.04	
40368	403.94	0.10	
40369	80.82	0.02	
40370	403.94	0.10	
40371	888.45	0.22	
40373	727.14	0.18	
40374	2665.28	0.66	
40375	1455.21	0.36	
40376	161.56	0.04	
40377	2342.16	0.58	
40378	80.82	0.02	
40379	161.56	0.04	
40380	242.30	0.06	
40381	242.38	0.06	
40382	242.30	0.06	
40383	888.62	0.22	
40384	1130.58	0.28	
40385	80.74	0.02	
40386	888.45	0.22	
40387	242.30	0.06	
40388	323.04	0.08	
40389	322.95	0.08	
40390	242.38	0.06	
40391	242.38	0.06	
40392	242.21	0.06	
40393	565.33	0.14	
40395	242.30	0.06	
40396	969.27	0.24	
40397	565.25	0.14	
40398	888.29	0.22	
40399	726.98	0.18	
40400	1454.04	0.36	
40401	1050.10	0.26	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40403	2503.63	0.62	
40404	80.74	0.02	
40405	2342.07	0.58	
40406	646.07	0.16	
40408	242.30	0.06	
40409	484.60	0.12	
40410	807.63	0.20	
40411	80.74	0.02	
40412	1130.75	0.28	
40413	1453.95	0.36	
40414	16236.54	4.01	
40415	161.64	0.04	
40416	1696.59	0.42	
40420	969.27	0.24	
40421	323.04	0.08	
40422	242.55	0.06	
40423	323.12	0.08	
40425	565.42	0.14	
40426	80.74	0.02	
40427	161.48	0.04	
40432	888.62	0.22	
40433	1453.95	0.36	
40434	80.74	0.02	
40435	80.82	0.02	
40436	323.12	0.08	
40437	1050.26	0.26	
40438	161.56	0.04	
40439	161.56	0.04	
40440	161.64	0.04	
40441	242.38	0.06	
40442	80.82	0.02	
40443	161.64	0.04	
40444	80.74	0.02	
40445	80.82	0.02	
40446	242.47	0.06	
40447	484.68	0.12	
40448	242.47	0.06	
40449	161.56	0.04	
40450	565.42	0.14	
40451	323.04	0.08	
40452	726.98	0.18	
40453	888.45	0.22	
40454	80.74	0.02	
40455	1534.69	0.38	
40456	726.81	0.18	
40457	969.27	0.24	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40458	726.98	0.18	
40459	80.91	0.02	
40460	161.73	0.04	
40461	484.60	0.12	
40462	484.51	0.12	
40463	969.19	0.24	
40464	888.45	0.22	
40465	726.81	0.18	
40466	101617.80	25.11	
40467	484.68	0.12	
40469	565.33	0.14	
40470	242.30	0.06	
40471	242.38	0.06	
40473	242.47	0.06	
40474	1049.85	0.26	
40475	80.91	0.02	
40476	80.82	0.02	
40477	1050.18	0.26	
40478	242.21	0.06	
40479	1938.38	0.48	
40480	403.86	0.10	
40481	565.50	0.14	
40482	565.50	0.14	
40483	807.55	0.20	
40484	80.74	0.02	
40485	565.42	0.14	
40486	565.42	0.14	
40487	242.30	0.06	
40488	726.89	0.18	
40489	646.07	0.16	
40500	969.36	0.24	
40501	807.63	0.20	
40502	1293.48	0.32	
40506	1857.39	0.46	
40507	888.62	0.22	
40508	161.64	0.04	
40510	2746.52	0.68	
40511	726.98	0.18	
40512	1211.49	0.30	
40514	323.04	0.08	
40515	726.98	0.18	
40516	242.21	0.06	
40520	484.60	0.12	
40523	1049.85	0.26	
40524	403.77	0.10	
40525	80.82	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40530	5493.11	1.36	
40531	323.37	0.08	
40532	726.98	0.18	
40533	161.48	0.04	
40535	323.04	0.08	
40536	80.74	0.02	
40537	80.82	0.02	
40538	242.30	0.06	
40539	80.74	0.02	
40540	161.48	0.04	
40541	484.68	0.12	
40542	888.45	0.22	
40543	484.60	0.12	
40544	1211.57	0.30	
40545	80.74	0.02	
40546	1050.01	0.26	
40547	242.47	0.06	
40548	403.86	0.10	
40549	161.48	0.04	
40550	403.77	0.10	
40551	161.56	0.04	
40552	80.74	0.02	
40553	242.30	0.06	
40554	80.82	0.02	
40555	80.74	0.02	
40556	484.60	0.12	
40557	3715.79	0.92	
40558	403.86	0.10	
40559	726.98	0.18	
40560	323.04	0.08	
40561	161.56	0.04	
40561	1131.00	0.28	
40562	242.30	0.06	
40563	1050.18	0.26	
40564	161.48	0.04	
40565	323.12	0.08	
40566	323.12	0.08	
40567	323.04	0.08	
40568	484.60	0.12	
40569	323.20	0.08	
40570	565.42	0.14	
40572	969.11	0.24	
40573	57998.68	14.33	
40574	80.82	0.02	
40575	403.94	0.10	
40576	80.74	0.02	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40577	404.02	0.10	
40578	242.30	0.06	
40579	242.30	0.06	
40580	727.56	0.18	
40581	1454.04	0.36	
40583	242.38	0.06	
40584	726.98	0.18	
40585	403.86	0.10	
40586	161.48	0.04	
40587	726.98	0.18	
40588	161.64	0.04	
40589	646.74	0.16	
40590	161.48	0.04	
40591	80.74	0.02	
40592	4442.77	1.10	
40593	242.55	0.06	
40595	484.51	0.12	
40596	323.12	0.08	
40597	323.12	0.08	
40598	808.13	0.20	
40599	80.74	0.02	
40600	2988.31	0.74	
40601	80.74	0.02	
40602	80.74	0.02	
40603	404.02	0.10	
40604	242.38	0.06	
40605	323.12	0.08	
40606	161.48	0.04	
40607	242.30	0.06	
40608	242.30	0.06	
40609	484.68	0.12	
40610	161.56	0.04	
40611	484.68	0.12	
40612	161.56	0.04	
40613	323.04	0.08	
40614	565.42	0.14	
40615	1050.01	0.26	
40616	161.56	0.04	
40617	1292.23	0.32	
40619	484.60	0.12	
40620	646.74	0.16	
40621	484.51	0.12	
40622	242.30	0.06	
40623	80.74	0.02	
40624	888.54	0.22	
40625	323.12	0.08	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40626	161.56	0.04	
40627	323.04	0.08	
40628	242.21	0.06	
40629	242.21	0.06	
40630	161.48	0.04	
40631	80.74	0.02	
40632	1292.31	0.32	
40633	323.12	0.08	
40634	80.74	0.02	
40635	565.33	0.14	
40636	242.21	0.06	
40637	80.74	0.02	
40638	484.51	0.12	
40640	80.74	0.02	
40641	242.30	0.06	
40642	161.56	0.04	
40643	242.38	0.06	
40645	242.30	0.06	
40646	726.98	0.18	
40647	403.94	0.10	
40649	888.54	0.22	
40650	161.48	0.04	
40651	1049.85	0.26	
40652	1049.85	0.26	
40653	484.60	0.12	
40654	323.12	0.08	
40655	1130.67	0.28	
40656	80.74	0.02	
40658	484.60	0.12	
40659	80.74	0.02	
40660	80.82	0.02	
40664	807.80	0.20	
40667	80.82	0.02	
40668	403.94	0.10	
40670	565.33	0.14	
40671	565.25	0.14	
40672	80.82	0.02	
40673	323.12	0.08	
40674	1130.92	0.28	
40675	1211.57	0.30	
40676	565.25	0.14	
40677	403.77	0.10	
40680	403.77	0.10	
40681	403.86	0.10	
40682	323.20	0.08	
40683	6946.82	1.72	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40685	161.56	0.04	
40689	161.48	0.04	
40690	161.48	0.04	
40692	80.74	0.02	
40693	80.74	0.02	
40694	323.12	0.08	
40695	484.68	0.12	
40698	242.21	0.06	
40703	80.74	0.02	
40706	80.82	0.02	
40708	242.30	0.06	
40709	161.48	0.04	
40710	80.74	0.02	
40711	888.45	0.22	
40712	161.56	0.04	
40713	484.68	0.12	
40714	323.04	0.08	
40715	323.12	0.08	
40716	14909.02	3.68	
40717	404.19	0.10	
40718	1211.66	0.30	
40719	323.04	0.08	
40721	726.98	0.18	
40722	565.33	0.14	
40723	242.30	0.06	
40724	565.33	0.14	
40725	646.07	0.16	
40726	161.48	0.04	
40727	323.12	0.08	
40728	173994.13	42.99	
40729	80.74	0.02	
40730	242.30	0.06	
40731	888.54	0.22	
40732	80.74	0.02	
40733	484.85	0.12	
40734	161.48	0.04	
40735	80.82	0.02	
40736	242.38	0.06	
40737	484.60	0.12	
40738	888.37	0.22	
40739	161.48	0.04	
40740	4685.23	1.16	
40741	242.30	0.06	
40742	484.93	0.12	
40746	323.04	0.08	
40747	80.74	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40749	161.56	0.04	
40750	242.30	0.06	
40751	807.88	0.20	
40752	80.91	0.02	
40753	242.30	0.06	
40754	161.56	0.04	
40755	242.21	0.06	
40756	565.58	0.14	
40757	1211.74	0.30	
40758	565.50	0.14	
40759	242.30	0.06	
40760	242.21	0.06	
40763	80.82	0.02	
40764	161.56	0.04	
40765	646.16	0.16	
40766	80.82	0.02	
40767	80.82	0.02	
40768	242.30	0.06	
40769	80.82	0.02	
40770	484.60	0.12	
40771	323.12	0.08	
40772	161.64	0.04	
40773	565.33	0.14	
40774	161.56	0.04	
40777	565.33	0.14	
40778	13327.88	3.29	
40779	403.86	0.10	
40783	242.38	0.06	
40784	80.74	0.02	
40786	484.68	0.12	
40787	80.82	0.02	
40789	215513.05	53.25	
40790	403.86	0.10	
40791	161.56	0.04	
40792	80.74	0.02	
40793	403.77	0.10	
40795	484.93	0.12	
40796	323.04	0.08	
40797	242.47	0.06	
40798	323.37	0.08	
40801	565.92	0.14	
40802	403.86	0.10	
40803	80.82	0.02	
40804	80.74	0.02	
40805	2342.74	0.58	
40809	565.33	0.14	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40818	242.30	0.06	
40819	80.74	0.02	
40820	242.30	0.06	
40821	323.12	0.08	
40822	484.60	0.12	
40823	404.19	0.10	
40824	161.56	0.04	
40825	242.30	0.06	
40826	242.30	0.06	
40827	80.74	0.02	
40828	80.74	0.02	
40829	80.74	0.02	
40831	646.74	0.16	
40832	484.60	0.12	
40833	323.04	0.08	
40834	646.24	0.16	
40835	323.04	0.08	
40836	80.74	0.02	
40837	646.07	0.16	
40838	2180.85	0.54	
40840	484.68	0.12	
40841	80.91	0.02	
40842	242.38	0.06	
40844	80.82	0.02	
40847	403.86	0.10	
40848	1130.58	0.28	
40849	242.38	0.06	
40850	484.51	0.12	
40851	80.82	0.02	
40852	242.55	0.06	
40856	7027.64	1.74	
40857	323.04	0.08	
40858	726.81	0.18	
40859	323.12	0.08	
40860	80.91	0.02	
40861	323.37	0.08	
40862	161.48	0.04	
40863	646.24	0.16	
40864	80.74	0.02	
40865	807.63	0.20	
40869	888.45	0.22	
40870	646.24	0.16	
40872	1453.62	0.36	
40873	323.20	0.08	
40874	1130.58	0.28	
40875	2181.68	0.54	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40876	80.82	0.02	
40877	403.77	0.10	
40880	242.30	0.06	
40888	323.12	0.08	
40889	323.12	0.08	
40892	28353.02	7.01	
40893	888.54	0.22	
40894	1696.34	0.42	
40895	1777.07	0.44	
40896	807.71	0.20	
40897	323.12	0.08	
40898	403.77	0.10	
40899	888.37	0.22	
40900	80.74	0.02	
40901	242.21	0.06	
40902	484.68	0.12	
40903	161.56	0.04	
40904	242.38	0.06	
40906	80.82	0.02	
40907	1534.86	0.38	
40909	726.81	0.18	
40912	242.30	0.06	
40913	403.86	0.10	
40914	646.16	0.16	
40915	484.60	0.12	
40916	565.42	0.14	
40917	565.42	0.14	
40918	484.60	0.12	
40920	323.12	0.08	
40922	80.74	0.02	
40923	403.86	0.10	
40924	9693.25	2.40	
40926	969.27	0.24	
40927	888.37	0.22	
40928	565.33	0.14	
40930	80.82	0.02	
40931	1372.88	0.34	
40932	322.95	0.08	
40933	161.48	0.04	
40934	242.38	0.06	
40936	1615.43	0.40	
40937	485.01	0.12	
40938	161.56	0.04	
40939	80.74	0.02	
40940	403.77	0.10	
40941	85704.88	21.18	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40942	565.75	0.14	
40947	2019.37	0.50	
40948	80.74	0.02	
40949	1292.23	0.32	
40950	322.95	0.08	
40951	646.74	0.16	
40952	242.38	0.06	
40954	808.38	0.20	
40955	161.48	0.04	
40956	161.73	0.04	
40957	646.24	0.16	
40959	646.16	0.16	
40960	242.47	0.06	
40961	970.03	0.24	
40962	27140.53	6.71	
40963	807.63	0.20	
40964	6623.53	1.64	
40966	1131.00	0.28	
40967	242.21	0.06	
40968	161.64	0.04	
40969	727.40	0.18	
40970	242.38	0.06	
40972	80.74	0.02	
40973	80.82	0.02	
40974	807.71	0.20	
40975	484.68	0.12	
40976	646.24	0.16	
40977	565.33	0.14	
40978	646.24	0.16	
40979	80.74	0.02	
40980	1938.72	0.48	
40981	484.68	0.12	
40982	646.16	0.16	
40983	6865.49	1.70	
40984	565.33	0.14	
40985	484.76	0.12	
40986	2100.86	0.52	
40987	3473.32	0.86	
40988	161.56	0.04	
40989	3150.04	0.78	
40990	5008.02	1.24	
40991	3231.03	0.80	
40992	1292.23	0.32	
40993	80.74	0.02	
40994	80.74	0.02	
40995	80.82	0.02	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40996	242.21	0.06	
40997	80.91	0.02	
40998	565.50	0.14	
40999	565.33	0.14	
41000	807.88	0.20	
41001	1049.85	0.26	
41002	1534.86	0.38	
41003	1211.41	0.30	
41004	1534.78	0.38	
41005	2261.67	0.56	
41006	403.94	0.10	
41007	3554.40	0.88	
41008	807.63	0.20	
41009	1131.75	0.28	
41010	323.12	0.08	
41011	1292.14	0.32	
41012	161.56	0.04	
41013	565.25	0.14	
41014	80.82	0.02	
41015	1697.59	0.42	
41016	485.01	0.12	
41017	1292.23	0.32	
41018	323.12	0.08	
41019	888.96	0.22	
41021	484.51	0.12	
41022	323.12	0.08	
41025	403.77	0.10	
41026	80.74	0.02	
41027	161.56	0.04	
41029	807.88	0.20	
41032	80.82	0.02	
41033	403.94	0.10	
41034	565.50	0.14	
41036	80.74	0.02	
41039	1130.83	0.28	
41041	323.12	0.08	
41042	242.30	0.06	
41043	323.20	0.08	
41057	323.04	0.08	low flow
41057	915042.17	226.11	high flow
41058	5411.96	1.34	
41059	161.56	0.04	
41063	969.11	0.24	
41072	242.21	0.06	
41101	484.60	0.12	
41102	1131.50	0.28	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41103	80.74	0.02	
41104	80.74	0.02	
41105	1292.14	0.32	
41106	726.98	0.18	
41108	323.04	0.08	
41109	323.12	0.08	
41111	565.42	0.14	
41112	565.25	0.14	
41117	1776.65	0.44	
41120	1857.48	0.46	
41121	242.30	0.06	
41122	646.07	0.16	
41123	2665.36	0.66	
41124	242.47	0.06	
41125	403.77	0.10	
41126	80.82	0.02	
41127	807.63	0.20	
41128	80.74	0.02	
41130	23021.47	5.69	
41131	3553.98	0.88	
41132	726.89	0.18	
41133	242.38	0.06	
41134	161.56	0.04	
41135	80.74	0.02	
41137	646.07	0.16	
41138	565.67	0.14	
41142	242.38	0.06	
41144	484.60	0.12	
41156	2261.50	0.56	
41159	808.47	0.20	
41160	80.74	0.02	
41161	80.91	0.02	
41162	242.21	0.06	
41163	242.21	0.06	
41164	646.24	0.16	
41165	403.94	0.10	
41166	323.12	0.08	
41167	646.16	0.16	
41168	484.76	0.12	
41169	80.74	0.02	
41170	1211.66	0.30	
41171	16559.49	4.09	
41172	1373.22	0.34	
41173	484.68	0.12	
41174	403.77	0.10	
41175	403.77	0.10	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41176	161.48	0.04	
41177	161.64	0.04	
41178	484.68	0.12	
41179	403.94	0.10	
41180	80.74	0.02	
41181	403.77	0.10	
41182	726.98	0.18	
41183	161.48	0.04	
41184	1615.60	0.40	
41185	888.70	0.22	
41199	807.80	0.20	
41210	80.82	0.02	
41212	161.64	0.04	
41231	593790.37	146.73	
41238	888.37	0.22	
41239	2342.24	0.58	
41261	1534.86	0.38	
41268	807.63	0.20	
41270	565.50	0.14	
41277	161.48	0.04	
41278	807.63	0.20	
41279	969.36	0.24	
41280	1131.00	0.28	
41281	2504.05	0.62	
41282	1050.18	0.26	
41283	161.56	0.04	
41284	1292.23	0.32	
41285	1615.35	0.40	
41286	565.50	0.14	
41287	161.48	0.04	
41288	2100.11	0.52	
41289	726.81	0.18	
41299	1211.32	0.30	
41300	323.04	0.08	
41301	323.12	0.08	
41367	845250.09	208.86	
41401	2100.61	0.52	
41402	404.02	0.10	
41403	161.48	0.04	
41404	161.48	0.04	
41406	161.64	0.04	
41407	242.30	0.06	
41408	565.42	0.14	
41415	969.27	0.24	
41416	888.54	0.22	
41417	727.06	0.18	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41419	969.19	0.24	
41420	161.56	0.04	
41425	6058.53	1.50	
41426	80.91	0.02	
41427	1130.83	0.28	
41428	969.36	0.24	
41429	323.04	0.08	
41430	646.32	0.16	
41433	80.82	0.02	
41435	726.98	0.18	
41436	242.30	0.06	
41437	14297.49	3.53	
41438	646.74	0.16	
41439	807.55	0.20	
41440	646.16	0.16	
41441	322.95	0.08	
41442	726.98	0.18	
41443	5896.47	1.46	
41444	403.86	0.10	
41445	80.82	0.02	
41446	1453.62	0.36	
41447	970.11	0.24	
41448	969.11	0.24	
41449	808.05	0.20	
41450	242.38	0.06	
41451	807.97	0.20	
41452	161.56	0.04	
41453	10581.53	2.61	
41454	646.41	0.16	
41455	565.33	0.14	
41459	80.91	0.02	
41460	80.74	0.02	
41461	242.30	0.06	
41462	565.33	0.14	
41463	484.60	0.12	
41464	323.12	0.08	
41465	484.60	0.12	
41466	889.29	0.22	
41467	161.64	0.04	
41468	1373.22	0.34	
41469	323.04	0.08	
41470	161.48	0.04	
41471	242.21	0.06	
41472	969.94	0.24	
41473	807.55	0.20	
41474	484.51	0.12	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41475	2423.90	0.60	
41478	161.48	0.04	
41479	807.80	0.20	
41493	242.30	0.06	
41494	161.64	0.04	
41495	807.63	0.20	
41496	646.16	0.16	
41497	1454.04	0.36	
41505	33684.49	8.32	
41515	565.25	0.14	
41517	80.74	0.02	
41522	727.48	0.18	
41600	2100.19	0.52	
41601	322.95	0.08	
41602	242.30	0.06	
41603	1211.74	0.30	
41604	1211.74	0.30	
41605	1211.74	0.30	
41606	403.94	0.10	
41607	403.86	0.10	
41608	888.45	0.22	
41609	242.38	0.06	
41610	1049.85	0.26	
41611	888.96	0.22	
41612	403.86	0.10	
41613	727.06	0.18	
41614	726.98	0.18	
41615	565.92	0.14	
41616	565.33	0.14	
41617	1130.83	0.28	
41618	969.36	0.24	
41619	646.74	0.16	
41620	485.10	0.12	
41621	485.10	0.12	
41622	726.81	0.18	
41623	242.21	0.06	
41624	66560.18	16.45	
41625	161.48	0.04	
41626	161.56	0.04	
41627	13327.55	3.29	
41628	80.74	0.02	
41629	80.74	0.02	
41630	403.94	0.10	
41633	242.38	0.06	
41634	646.07	0.16	
41635	10904.65	2.69	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41637	59451.47	14.69	
41638	1858.23	0.46	
41639	726.89	0.18	
41640	565.33	0.14	
41641	484.60	0.12	
41642	323.12	0.08	
41643	80.74	0.02	
41644	565.33	0.14	
41645	322.95	0.08	
41646	161.64	0.04	
41647	84331.83	20.84	
41648	1211.66	0.30	
41649	484.51	0.12	
41650	80.74	0.02	
41651	2019.12	0.50	
41652	1859.32	0.46	
41653	1130.67	0.28	
41654	80.82	0.02	
41655	80.74	0.02	
41656	323.12	0.08	
41657	80.82	0.02	
41658	80.82	0.02	
41659	242.55	0.06	
41660	969.11	0.24	
41661	484.51	0.12	
41662	242.30	0.06	
41663	242.38	0.06	
41664	726.98	0.18	
41665	807.55	0.20	
41666	1211.41	0.30	
41667	404.19	0.10	
41668	1050.77	0.26	
41669	80.82	0.02	
41670	484.68	0.12	
41671	403.86	0.10	
41672	969.11	0.24	
41673	1212.41	0.30	
41700	2584.79	0.64	
41701	726.89	0.18	
41702	2342.57	0.58	
41703	1212.58	0.30	
41704	2423.40	0.60	
41705	1049.93	0.26	
41706	807.63	0.20	
41707	6382.74	1.58	
41708	484.76	0.12	

Table E-1 Continued: Karst Recharge Features Drainage Areas

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
41709	1292.06	0.32	
41710	2746.35	0.68	
41711	484.60	0.12	
41714	403.94	0.10	
41715	1615.60	0.40	
41716	403.86	0.10	
41720	80.74	0.02	
41721	646.66	0.16	
41722	565.33	0.14	
41725	484.68	0.12	
41728	242.21	0.06	
41729	323.12	0.08	
41730	484.93	0.12	
41731	323.12	0.08	
41733	484.76	0.12	
41734	80.74	0.02	
41735	323.12	0.08	
41736	80.82	0.02	
41749	565.33	0.14	
41750	80.82	0.02	
41752	484.68	0.12	
40037	164803.77	40.72	
40166	290474.34	71.78	
40173	137966.73	34.09	
40174	519394.80	128.34	
40175	116157.93	28.70	
40180	379490.48	93.77	
40181	347906.18	85.97	
40203	102506.67	25.33	
40204	85463.34	21.12	
40219	76656.62	18.94	
40220	969.27	0.24	
40253	206222.83	50.96	
40259	242.38	0.06	
40269	218501.03	53.99	
40289	646.24	0.16	
40294	323.12	0.08	
40364	1938.13	0.48	
40417	3311.77	0.82	
40419	510427.44	126.13	
40430	1373.22	0.34	
40468	100567.96	24.85	
40472	197824.73	48.88	
40490	108645.52	26.85	
40521	505261.33	124.85	
40522	323.12	0.08	

Feature ID	Drainage Area (m^2)	Drainage Area (acres)	Flow Notation
40657	242.55	0.06	
40701	89420.92	22.10	
40731	137262.51	33.92	
40743	105332.08	26.03	
40744	80.74	0.02	
40745	403.94	0.10	
40748	646.07	0.16	
40761	1211.41	0.30	
40785	82795.80	20.46	
40800	79161.42	19.56	
40806	2261.42	0.56	
40807	323.04	0.08	
40808	565.42	0.14	
40881	161.56	0.04	
40910	646.07	0.16	
40911	323.04	0.08	
40935	5896.97	1.46	
40958	167773.37	41.46	
40965	8642.82	2.14	
41030	157757.34	38.98	
41031	78434.36	19.38	
41035	161.56	0.04	
41100	808.47	0.20	
41113	19467.57	4.81	
41114	148791.40	36.77	
41115	627234.87	154.99	
41143	565.50	0.14	
41145	888.45	0.22	
41222	76334.75	18.86	
41226	128920.98	31.86	
41227	324803.90	80.26	
41228	541609.97	133.83	
41232	447260.89	110.52	
41367	845250.09	208.86	
41421	969.27	0.24	
41456	726.98	0.18	
41504	101214.03	25.01	
41531	267612.51	66.13	

APPENDIX F – KARST FEATURE LAND USE

Table F-1: Section 4 Corridor and Karst Feature Land Use

Section 4 Corridor

ACRES	LANDUSE
4.8039	Water
4.2344	Developed Land
9.2956	Developed Land
4281.7792	Upland Habitat
57.1281	Upland Habitat
0.6568	Upland Habitat
1780.6349	Agricultural Land
1370.7780	Agricultural Land
5.6567	Wetland Habitat
0.4448	Wetland Habitat

Karst Features

ID	ACRES	LANDUSE
40001	0.13	Agricultural Land
40001	0.11	Agricultural Land
40002	0.02	Agricultural Land
40002	0.04	Agricultural Land
40004	0.01	Agricultural Land
40004	0.05	Agricultural Land
40005	0.07	Upland Habitat
40005	0.00	Agricultural Land
40005	0.13	Agricultural Land
40006	0.09	Upland Habitat
40006	0.01	Agricultural Land
40006	0.07	Agricultural Land
40007	0.02	Upland Habitat
40008	0.08	Upland Habitat
40008	0.00	Agricultural Land
40009	0.12	Upland Habitat
40009	0.02	Agricultural Land
40010	0.02	Agricultural Land
40011	0.13	Agricultural Land
40011	0.11	Agricultural Land
40012	0.02	Agricultural Land
40012	0.04	Agricultural Land
40016	0.00	Upland Habitat
40016	0.02	Agricultural Land
40017	0.02	Upland Habitat
40018	0.14	Upland Habitat
40019	0.04	Upland Habitat
40020	0.22	Upland Habitat
40021	0.06	Upland Habitat
40022	1.78	Upland Habitat
40023	0.06	Upland Habitat

ID	ACRES	LANDUSE
40024	0.12	Upland Habitat
40025	0.02	Upland Habitat
40026	0.48	Upland Habitat
40027	0.02	Agricultural Land
40028	0.02	Upland Habitat
40028	0.00	Agricultural Land
40029	0.02	Upland Habitat
40029	0.00	Agricultural Land
40030	0.14	Upland Habitat
40030	0.08	Upland Habitat
40031	0.06	Upland Habitat
40032	0.16	Upland Habitat
40033	0.06	Upland Habitat
40033	0.02	Upland Habitat
40034	0.08	Upland Habitat
40036	0.00	Upland Habitat
40036	0.02	Agricultural Land
40037	0.04	Agricultural Land
40038	0.12	Upland Habitat
40039	0.08	Upland Habitat
40040	0.16	Upland Habitat
40041	0.22	Upland Habitat
40042	0.04	Upland Habitat
40043	0.10	Upland Habitat
40044	0.02	Upland Habitat
40045	0.02	Upland Habitat
40046	0.12	Upland Habitat
40047	0.02	Upland Habitat
40048	0.08	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40049	0.80	Upland Habitat
40049	0.14	Agricultural Land
40049	0.04	Agricultural Land
40050	0.04	Upland Habitat
40051	3.33	Upland Habitat
40051	1.19	Agricultural Land
40051	0.19	Agricultural Land
40052	0.10	Upland Habitat
40053	0.12	Upland Habitat
40053	0.12	Agricultural Land
40054	0.28	Upland Habitat
40054	0.02	Agricultural Land
40055	0.02	Upland Habitat
40056	2.19	Upland Habitat
40056	0.44	Agricultural Land
40057	0.16	Upland Habitat
40057	0.14	Agricultural Land
40058	0.06	Upland Habitat
40058	0.00	Agricultural Land
40061	0.32	Agricultural Land
40062	0.18	Agricultural Land
40063	0.40	Agricultural Land
40064	0.03	Upland Habitat
40064	0.07	Agricultural Land
40065	0.02	Agricultural Land
40066	0.14	Upland Habitat
40066	0.07	Agricultural Land
40066	0.07	Agricultural Land
40068	0.58	Agricultural Land
40069	0.11	Upland Habitat
40069	0.20	Agricultural Land
40069	0.03	Agricultural Land
40070	0.02	Upland Habitat
40071	0.02	Upland Habitat
40072	0.05	Upland Habitat
40072	0.16	Agricultural Land
40073	3.74	Agricultural Land
40073	0.35	Agricultural Land
40074	0.02	Agricultural Land
40076	0.02	Agricultural Land
40080	0.16	Agricultural Land
40080	0.04	Agricultural Land
40081	0.08	Agricultural Land
40082	0.06	Agricultural Land

ID	ACRES	LANDUSE
40084	0.05	Agricultural Land
40084	0.03	Agricultural Land
40086	0.00	Developed Land
40086	0.13	Upland Habitat
40086	0.07	Agricultural Land
40086	0.02	Agricultural Land
40087	0.84	Agricultural Land
40088	0.30	Agricultural Land
40089	0.26	Agricultural Land
40090	0.00	Agricultural Land
40090	0.04	Agricultural Land
40091	0.07	Agricultural Land
40091	0.01	Agricultural Land
40092	0.22	Agricultural Land
40093	0.04	Agricultural Land
40094	0.24	Upland Habitat
40094	0.56	Agricultural Land
40094	3.48	Agricultural Land
40095	0.02	Agricultural Land
40096	0.54	Agricultural Land
40097	0.23	Agricultural Land
40097	0.03	Agricultural Land
40099	0.15	Agricultural Land
40099	0.09	Agricultural Land
40100	0.09	Agricultural Land
40100	0.09	Agricultural Land
40101	0.06	Agricultural Land
40103	0.06	Agricultural Land
40104	0.02	Agricultural Land
40105	0.02	Agricultural Land
40106	0.06	Agricultural Land
40107	0.06	Agricultural Land
40108	0.15	Agricultural Land
40108	0.01	Agricultural Land
40109	0.10	Agricultural Land
40110	0.04	Agricultural Land
40111	0.18	Agricultural Land
40112	0.02	Agricultural Land
40113	0.18	Agricultural Land
40114	0.02	Agricultural Land
40115	0.02	Agricultural Land
40117	0.08	Agricultural Land
40119	0.02	Agricultural Land
40121	0.08	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40123	0.12	Agricultural Land
40125	0.10	Agricultural Land
40127	0.44	Agricultural Land
40129	0.06	Agricultural Land
40130	0.01	Agricultural Land
40130	0.03	Agricultural Land
40131	0.13	Agricultural Land
40131	0.01	Agricultural Land
40132	0.62	Agricultural Land
40132	0.06	Agricultural Land
40133	0.19	Agricultural Land
40133	0.17	Agricultural Land
40134	0.50	Agricultural Land
40134	0.06	Agricultural Land
40135	0.09	Agricultural Land
40135	0.01	Agricultural Land
40136	0.21	Agricultural Land
40136	0.05	Agricultural Land
40137	0.06	Agricultural Land
40138	0.02	Agricultural Land
40139	0.04	Agricultural Land
40139	0.02	Agricultural Land
40140	0.03	Agricultural Land
40140	0.01	Agricultural Land
40141	0.02	Agricultural Land
40142	0.04	Agricultural Land
40143	0.12	Upland Habitat
40143	0.04	Agricultural Land
40144	0.04	Agricultural Land
40145	0.04	Agricultural Land
40146	0.20	Agricultural Land
40147	0.04	Agricultural Land
40147	0.04	Agricultural Land
40148	0.13	Agricultural Land
40148	0.01	Agricultural Land
40149	0.02	Agricultural Land
40151	0.09	Agricultural Land
40151	0.03	Agricultural Land
40152	0.02	Agricultural Land
40152	0.08	Agricultural Land
40153	0.10	Agricultural Land
40154	0.08	Agricultural Land
40155	0.06	Upland Habitat
40155	1.28	Agricultural Land
40155	2.96	Agricultural Land

ID	ACRES	LANDUSE
40157	0.06	Agricultural Land
40158	2.93	Agricultural Land
40159	0.14	Agricultural Land
40160	0.02	Agricultural Land
40161	0.12	Agricultural Land
40162	0.10	Agricultural Land
40163	0.16	Agricultural Land
40167	0.10	Upland Habitat
40168	0.32	Upland Habitat
40169	0.10	Agricultural Land
40170	0.04	Agricultural Land
40171	0.18	Upland Habitat
40172	0.24	Upland Habitat
40177	0.16	Upland Habitat
40178	0.23	Upland Habitat
40178	0.05	Agricultural Land
40179	0.02	Upland Habitat
40182	0.12	Upland Habitat
40183	0.71	Upland Habitat
40183	0.05	Agricultural Land
40184	0.22	Upland Habitat
40184	0.00	Agricultural Land
40185	0.02	Upland Habitat
40186	0.06	Upland Habitat
40187	0.08	Upland Habitat
40188	0.56	Upland Habitat
40188	0.38	Agricultural Land
40189	0.08	Upland Habitat
40190	0.14	Upland Habitat
40191	0.94	Upland Habitat
40191	0.45	Agricultural Land
40192	0.22	Upland Habitat
40193	0.04	Upland Habitat
40194	0.28	Upland Habitat
40195	0.32	Upland Habitat
40196	0.14	Upland Habitat
40198	0.08	Upland Habitat
40199	0.10	Upland Habitat
40200	0.20	Upland Habitat
40201	0.26	Upland Habitat
40202	2.39	Upland Habitat
40202	0.48	Agricultural Land
40205	0.07	Upland Habitat
40205	0.05	Upland Habitat
40206	0.12	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40207	0.01	Agricultural Land
40207	0.03	Agricultural Land
40208	0.57	Upland Habitat
40208	0.02	Upland Habitat
40208	0.11	Agricultural Land
40208	0.01	Agricultural Land
40209	0.08	Upland Habitat
40209	0.02	Agricultural Land
40210	0.17	Upland Habitat
40210	0.15	Agricultural Land
40211	0.87	Upland Habitat
40211	0.20	Agricultural Land
40212	0.02	Upland Habitat
40213	0.14	Upland Habitat
40215	0.20	Upland Habitat
40215	0.10	Agricultural Land
40215	0.02	Agricultural Land
40216	0.03	Upland Habitat
40216	0.01	Agricultural Land
40217	0.04	Agricultural Land
40221	0.16	Upland Habitat
40221	0.00	Agricultural Land
40221	0.05	Agricultural Land
40222	0.10	Agricultural Land
40223	0.25	Upland Habitat
40223	0.27	Agricultural Land
40224	0.00	Upland Habitat
40224	0.06	Agricultural Land
40225	0.03	Upland Habitat
40225	0.07	Agricultural Land
40225	0.01	Agricultural Land
40226	0.36	Upland Habitat
40227	0.18	Upland Habitat
40228	0.02	Upland Habitat
40229	0.06	Upland Habitat
40230	0.22	Upland Habitat
40231	0.14	Upland Habitat
40232	0.14	Upland Habitat
40232	0.02	Agricultural Land
40232	0.11	Agricultural Land
40233	0.48	Upland Habitat
40234	0.04	Upland Habitat
40235	0.08	Upland Habitat
40236	0.06	Upland Habitat

ID	ACRES	LANDUSE
40237	0.26	Upland Habitat
40237	0.00	Agricultural Land
40238	0.47	Upland Habitat
40238	0.00	Agricultural Land
40239	0.20	Upland Habitat
40239	0.49	Agricultural Land
40239	0.49	Agricultural Land
40240	0.08	Upland Habitat
40241	0.04	Upland Habitat
40242	0.06	Upland Habitat
40243	0.10	Upland Habitat
40244	0.37	Upland Habitat
40244	0.01	Agricultural Land
40245	0.14	Upland Habitat
40246	0.04	Upland Habitat
40247	0.14	Upland Habitat
40247	0.02	Agricultural Land
40248	0.10	Upland Habitat
40249	0.04	Upland Habitat
40250	0.01	Upland Habitat
40250	0.01	Agricultural Land
40251	0.22	Upland Habitat
40251	0.12	Agricultural Land
40252	0.08	Upland Habitat
40255	0.16	Upland Habitat
40256	0.02	Upland Habitat
40257	0.04	Upland Habitat
40257	0.04	Agricultural Land
40258	0.06	Agricultural Land
40260	0.14	Upland Habitat
40261	0.07	Upland Habitat
40261	0.03	Agricultural Land
40272	0.02	Agricultural Land
40273	0.21	Upland Habitat
40273	0.09	Agricultural Land
40274	0.23	Upland Habitat
40274	0.07	Agricultural Land
40275	0.30	Agricultural Land
40275	0.26	Agricultural Land
40276	0.04	Agricultural Land
40277	0.22	Agricultural Land
40278	0.04	Agricultural Land
40279	0.06	Upland Habitat
40279	0.10	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40283	0.13	Upland Habitat
40283	0.01	Agricultural Land
40284	0.02	Upland Habitat
40285	0.16	Upland Habitat
40286	0.20	Upland Habitat
40288	0.02	Agricultural Land
40288	0.04	Agricultural Land
40289	0.12	Agricultural Land
40289	0.04	Agricultural Land
40290	0.29	Upland Habitat
40290	0.05	Agricultural Land
40291	0.12	Upland Habitat
40292	0.31	Upland Habitat
40292	0.03	Agricultural Land
40293	0.13	Upland Habitat
40293	0.09	Agricultural Land
40293	0.02	Agricultural Land
40295	0.10	Upland Habitat
40296	0.37	Upland Habitat
40296	0.04	Agricultural Land
40297	0.37	Upland Habitat
40297	0.00	Agricultural Land
40299	0.20	Upland Habitat
40362	1.42	Agricultural Land
40362	0.24	Agricultural Land
40363	0.20	Upland Habitat
40365	0.09	Upland Habitat
40365	0.01	Agricultural Land
40366	0.08	Upland Habitat
40367	0.04	Upland Habitat
40368	0.07	Upland Habitat
40368	0.03	Agricultural Land
40369	0.02	Upland Habitat
40370	0.10	Upland Habitat
40371	0.16	Upland Habitat
40371	0.06	Agricultural Land
40373	0.01	Upland Habitat
40373	0.17	Agricultural Land
40374	0.33	Upland Habitat
40374	0.33	Agricultural Land
40375	0.31	Upland Habitat
40375	0.05	Agricultural Land
40376	0.04	Upland Habitat
40377	0.45	Upland Habitat
40377	0.13	Agricultural Land

ID	ACRES	LANDUSE
40378	0.02	Upland Habitat
40379	0.04	Upland Habitat
40380	0.06	Agricultural Land
40381	0.06	Upland Habitat
40382	0.06	Upland Habitat
40383	0.20	Upland Habitat
40383	0.02	Agricultural Land
40384	0.28	Upland Habitat
40385	0.02	Upland Habitat
40386	0.22	Upland Habitat
40387	0.06	Upland Habitat
40387	0.00	Agricultural Land
40388	0.08	Upland Habitat
40389	0.08	Upland Habitat
40390	0.06	Upland Habitat
40391	0.06	Upland Habitat
40392	0.06	Upland Habitat
40393	0.14	Upland Habitat
40395	0.06	Upland Habitat
40396	0.11	Upland Habitat
40396	0.13	Agricultural Land
40397	0.14	Upland Habitat
40398	0.22	Upland Habitat
40399	0.12	Upland Habitat
40399	0.06	Agricultural Land
40400	0.36	Upland Habitat
40400	0.00	Agricultural Land
40401	0.26	Upland Habitat
40403	0.30	Upland Habitat
40403	0.32	Agricultural Land
40404	0.02	Upland Habitat
40405	0.58	Upland Habitat
40406	0.16	Upland Habitat
40408	0.06	Upland Habitat
40409	0.12	Upland Habitat
40410	0.18	Upland Habitat
40410	0.02	Agricultural Land
40411	0.02	Upland Habitat
40412	0.28	Upland Habitat
40413	0.36	Upland Habitat
40414	4.01	Upland Habitat
40415	0.04	Upland Habitat
40416	0.37	Upland Habitat
40416	0.02	Agricultural Land
40416	0.02	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40420	0.24	Upland Habitat
40421	0.07	Upland Habitat
40421	0.01	Agricultural Land
40422	0.06	Upland Habitat
40423	0.08	Upland Habitat
40425	0.06	Upland Habitat
40425	0.08	Agricultural Land
40426	0.02	Upland Habitat
40427	0.04	Agricultural Land
40430	0.05	Upland Habitat
40430	0.29	Agricultural Land
40432	0.20	Upland Habitat
40432	0.01	Agricultural Land
40433	0.29	Upland Habitat
40433	0.07	Agricultural Land
40434	0.02	Agricultural Land
40435	0.02	Agricultural Land
40436	0.04	Upland Habitat
40436	0.04	Agricultural Land
40437	0.12	Upland Habitat
40437	0.00	Upland Habitat
40437	0.14	Agricultural Land
40438	0.04	Upland Habitat
40439	0.04	Upland Habitat
40440	0.04	Agricultural Land
40441	0.06	Agricultural Land
40442	0.02	Agricultural Land
40443	0.04	Agricultural Land
40444	0.02	Agricultural Land
40445	0.02	Agricultural Land
40446	0.06	Agricultural Land
40447	0.05	Upland Habitat
40447	0.07	Agricultural Land
40448	0.03	Upland Habitat
40448	0.02	Upland Habitat
40448	0.00	Agricultural Land
40449	0.01	Upland Habitat
40449	0.03	Agricultural Land
40450	0.14	Agricultural Land
40451	0.08	Agricultural Land
40452	0.09	Upland Habitat
40452	0.09	Agricultural Land
40453	0.07	Upland Habitat
40453	0.15	Agricultural Land

ID	ACRES	LANDUSE
40454	0.02	Agricultural Land
40455	0.18	Agricultural Land
40455	0.20	Agricultural Land
40456	0.18	Upland Habitat
40457	0.24	Upland Habitat
40458	0.18	Upland Habitat
40459	0.00	Upland Habitat
40459	0.02	Agricultural Land
40460	0.02	Upland Habitat
40460	0.02	Agricultural Land
40461	0.09	Upland Habitat
40461	0.03	Agricultural Land
40462	0.12	Upland Habitat
40463	0.24	Upland Habitat
40464	0.22	Upland Habitat
40465	0.13	Upland Habitat
40465	0.05	Agricultural Land
40466	18.25	Upland Habitat
40466	0.87	Agricultural Land
40466	5.99	Agricultural Land
40467	0.10	Upland Habitat
40467	0.02	Agricultural Land
40469	0.14	Upland Habitat
40470	0.06	Upland Habitat
40471	0.05	Upland Habitat
40471	0.01	Agricultural Land
40473	0.06	Upland Habitat
40473	0.00	Agricultural Land
40474	0.26	Upland Habitat
40475	0.02	Upland Habitat
40476	0.02	Upland Habitat
40477	0.10	Upland Habitat
40477	0.15	Agricultural Land
40477	0.01	Agricultural Land
40478	0.06	Upland Habitat
40479	0.48	Upland Habitat
40480	0.10	Upland Habitat
40481	0.14	Upland Habitat
40482	0.14	Upland Habitat
40483	0.20	Upland Habitat
40484	0.02	Upland Habitat
40485	0.14	Upland Habitat
40486	0.14	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40487	0.05	Upland Habitat
40487	0.01	Agricultural Land
40488	0.13	Upland Habitat
40488	0.05	Agricultural Land
40489	0.07	Upland Habitat
40489	0.09	Agricultural Land
40500	0.24	Upland Habitat
40501	0.20	Upland Habitat
40502	0.29	Upland Habitat
40502	0.03	Wetland Habitat
40506	0.46	Upland Habitat
40507	0.22	Upland Habitat
40508	0.01	Upland Habitat
40508	0.03	Agricultural Land
40510	0.68	Upland Habitat
40511	0.18	Upland Habitat
40512	0.30	Upland Habitat
40514	0.08	Upland Habitat
40515	0.18	Upland Habitat
40516	0.06	Upland Habitat
40520	0.11	Upland Habitat
40520	0.01	Agricultural Land
40523	0.25	Upland Habitat
40523	0.01	Agricultural Land
40524	0.10	Upland Habitat
40525	0.02	Upland Habitat
40530	0.04	Upland Habitat
40530	0.70	Agricultural Land
40530	0.61	Agricultural Land
40531	0.06	Upland Habitat
40531	0.02	Agricultural Land
40532	0.05	Upland Habitat
40532	0.12	Agricultural Land
40533	0.03	Upland Habitat
40533	0.01	Agricultural Land
40535	0.08	Upland Habitat
40535	0.00	Agricultural Land
40536	0.02	Agricultural Land
40537	0.02	Upland Habitat
40538	0.06	Upland Habitat
40539	0.02	Upland Habitat
40540	0.04	Upland Habitat
40541	0.12	Upland Habitat
40542	0.15	Upland Habitat
40542	0.07	Agricultural Land

ID	ACRES	LANDUSE
40543	0.12	Upland Habitat
40544	0.30	Upland Habitat
40545	0.02	Upland Habitat
40546	0.26	Upland Habitat
40547	0.06	Upland Habitat
40548	0.05	Upland Habitat
40548	0.04	Agricultural Land
40549	0.03	Upland Habitat
40549	0.01	Agricultural Land
40550	0.03	Upland Habitat
40550	0.07	Agricultural Land
40551	0.04	Upland Habitat
40552	0.02	Upland Habitat
40553	0.03	Upland Habitat
40553	0.03	Agricultural Land
40554	0.01	Upland Habitat
40554	0.01	Agricultural Land
40555	0.02	Agricultural Land
40556	0.12	Agricultural Land
40557	0.17	Upland Habitat
40557	0.75	Agricultural Land
40558	0.10	Agricultural Land
40559	0.02	Upland Habitat
40559	0.04	Upland Habitat
40559	0.12	Agricultural Land
40560	0.00	Upland Habitat
40560	0.08	Agricultural Land
40561	0.32	Agricultural Land
40562	0.06	Agricultural Land
40563	0.14	Upland Habitat
40563	0.12	Agricultural Land
40564	0.04	Agricultural Land
40565	0.06	Upland Habitat
40565	0.02	Agricultural Land
40566	0.02	Upland Habitat
40566	0.06	Agricultural Land
40567	0.04	Upland Habitat
40567	0.04	Agricultural Land
40568	0.07	Upland Habitat
40568	0.05	Agricultural Land
40569	0.08	Agricultural Land
40570	0.06	Upland Habitat
40570	0.08	Agricultural Land
40572	0.16	Upland Habitat
40572	0.08	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40573	6.72	Upland Habitat
40573	5.77	Agricultural Land
40573	1.85	Agricultural Land
40574	0.02	Upland Habitat
40575	0.05	Upland Habitat
40575	0.05	Agricultural Land
40576	0.01	Upland Habitat
40576	0.01	Agricultural Land
40576	0.01	Agricultural Land
40577	0.10	Upland Habitat
40578	0.03	Upland Habitat
40578	0.03	Agricultural Land
40579	0.06	Upland Habitat
40580	0.16	Upland Habitat
40580	0.02	Agricultural Land
40581	0.36	Agricultural Land
40581	0.00	Agricultural Land
40583	0.06	Upland Habitat
40584	0.09	Upland Habitat
40584	0.09	Agricultural Land
40584	0.00	Agricultural Land
40585	0.06	Upland Habitat
40585	0.04	Agricultural Land
40586	0.02	Upland Habitat
40586	0.02	Agricultural Land
40587	0.13	Upland Habitat
40587	0.05	Agricultural Land
40588	0.04	Upland Habitat
40589	0.15	Upland Habitat
40589	0.01	Agricultural Land
40590	0.04	Upland Habitat
40591	0.02	Agricultural Land
40592	0.05	Agricultural Land
40592	1.05	Agricultural Land
40593	0.00	Upland Habitat
40593	0.06	Agricultural Land
40595	0.12	Agricultural Land
40596	0.04	Upland Habitat
40596	0.04	Agricultural Land
40597	0.00	Upland Habitat
40597	0.04	Agricultural Land
40597	0.04	Agricultural Land
40598	0.20	Agricultural Land
40599	0.02	Agricultural Land

ID	ACRES	LANDUSE
40600	0.49	Upland Habitat
40600	0.05	Agricultural Land
40600	0.20	Agricultural Land
40601	0.02	Upland Habitat
40601	0.00	Agricultural Land
40602	0.02	Upland Habitat
40603	0.10	Upland Habitat
40604	0.03	Upland Habitat
40604	0.03	Agricultural Land
40605	0.03	Upland Habitat
40605	0.05	Agricultural Land
40606	0.03	Upland Habitat
40606	0.01	Agricultural Land
40607	0.06	Upland Habitat
40608	0.06	Upland Habitat
40609	0.12	Upland Habitat
40610	0.04	Upland Habitat
40611	0.12	Upland Habitat
40612	0.04	Upland Habitat
40613	0.08	Upland Habitat
40614	0.14	Upland Habitat
40615	0.26	Upland Habitat
40616	0.04	Upland Habitat
40617	0.25	Upland Habitat
40617	0.07	Upland Habitat
40619	0.05	Upland Habitat
40619	0.07	Upland Habitat
40620	0.11	Upland Habitat
40620	0.05	Upland Habitat
40621	0.12	Upland Habitat
40622	0.06	Upland Habitat
40623	0.02	Upland Habitat
40624	0.19	Upland Habitat
40624	0.03	Agricultural Land
40625	0.08	Upland Habitat
40626	0.04	Upland Habitat
40627	0.08	Upland Habitat
40628	0.06	Upland Habitat
40629	0.06	Upland Habitat
40630	0.04	Upland Habitat
40631	0.00	Upland Habitat
40631	0.02	Agricultural Land
40632	0.24	Upland Habitat
40632	0.07	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40633	0.02	Upland Habitat
40633	0.06	Agricultural Land
40634	0.02	Upland Habitat
40634	0.00	Agricultural Land
40635	0.12	Upland Habitat
40635	0.02	Agricultural Land
40636	0.06	Upland Habitat
40637	0.02	Upland Habitat
40638	0.12	Upland Habitat
40640	0.02	Upland Habitat
40641	0.06	Upland Habitat
40642	0.04	Upland Habitat
40643	0.06	Upland Habitat
40645	0.06	Upland Habitat
40646	0.18	Upland Habitat
40647	0.10	Upland Habitat
40649	0.18	Upland Habitat
40649	0.04	Agricultural Land
40650	0.04	Upland Habitat
40651	0.22	Upland Habitat
40651	0.04	Agricultural Land
40652	0.22	Upland Habitat
40652	0.04	Agricultural Land
40653	0.07	Upland Habitat
40653	0.05	Agricultural Land
40654	0.08	Upland Habitat
40655	0.28	Agricultural Land
40656	0.02	Agricultural Land
40658	0.07	Upland Habitat
40658	0.05	Agricultural Land
40659	0.01	Upland Habitat
40659	0.01	Agricultural Land
40660	0.02	Upland Habitat
40664	0.20	Upland Habitat
40667	0.02	Upland Habitat
40668	0.06	Upland Habitat
40668	0.01	Upland Habitat
40668	0.03	Agricultural Land
40670	0.14	Upland Habitat
40671	0.14	Upland Habitat
40672	0.02	Upland Habitat
40673	0.08	Upland Habitat
40674	0.28	Upland Habitat
40675	0.30	Upland Habitat
40676	0.14	Upland Habitat

ID	ACRES	LANDUSE
40677	0.10	Upland Habitat
40680	0.10	Upland Habitat
40681	0.10	Upland Habitat
40682	0.08	Upland Habitat
40683	1.59	Upland Habitat
40683	0.06	Agricultural Land
40683	0.07	Agricultural Land
40685	0.04	Upland Habitat
40689	0.02	Upland Habitat
40689	0.02	Agricultural Land
40690	0.02	Upland Habitat
40690	0.02	Agricultural Land
40692	0.02	Upland Habitat
40693	0.02	Agricultural Land
40694	0.08	Upland Habitat
40695	0.12	Upland Habitat
40695	0.00	Agricultural Land
40698	0.06	Upland Habitat
40703	0.02	Upland Habitat
40706	0.02	Upland Habitat
40708	0.06	Upland Habitat
40709	0.04	Upland Habitat
40710	0.02	Upland Habitat
40711	0.15	Upland Habitat
40711	0.07	Agricultural Land
40712	0.04	Upland Habitat
40713	0.12	Upland Habitat
40714	0.08	Upland Habitat
40715	0.08	Upland Habitat
40716	0.44	Agricultural Land
40716	0.02	Agricultural Land
40717	0.07	Agricultural Land
40717	0.03	Agricultural Land
40718	0.12	Upland Habitat
40718	0.12	Agricultural Land
40718	0.06	Agricultural Land
40719	0.05	Upland Habitat
40719	0.03	Agricultural Land
40721	0.05	Upland Habitat
40721	0.06	Agricultural Land
40721	0.07	Agricultural Land
40722	0.07	Upland Habitat
40722	0.07	Agricultural Land
40722	0.00	Agricultural Land
40723	0.06	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40724	0.14	Agricultural Land
40725	0.04	Upland Habitat
40725	0.12	Agricultural Land
40726	0.04	Agricultural Land
40727	0.01	Upland Habitat
40727	0.05	Agricultural Land
40727	0.02	Agricultural Land
40728	22.72	Upland Habitat
40728	12.06	Agricultural Land
40728	8.22	Agricultural Land
40729	0.02	Agricultural Land
40730	0.05	Agricultural Land
40730	0.01	Agricultural Land
40731	0.20	Agricultural Land
40731	0.02	Agricultural Land
40732	0.02	Upland Habitat
40733	0.10	Upland Habitat
40733	0.02	Agricultural Land
40734	0.04	Upland Habitat
40735	0.02	Upland Habitat
40736	0.06	Upland Habitat
40737	0.12	Upland Habitat
40738	0.22	Upland Habitat
40739	0.04	Agricultural Land
40740	0.16	Upland Habitat
40740	0.48	Agricultural Land
40740	0.52	Agricultural Land
40741	0.06	Agricultural Land
40742	0.12	Agricultural Land
40746	0.08	Upland Habitat
40747	0.02	Upland Habitat
40749	0.04	Agricultural Land
40750	0.05	Upland Habitat
40750	0.01	Agricultural Land
40751	0.03	Upland Habitat
40751	0.08	Agricultural Land
40751	0.09	Agricultural Land
40752	0.02	Upland Habitat
40752	0.00	Agricultural Land
40753	0.06	Upland Habitat
40753	0.00	Agricultural Land
40754	0.00	Upland Habitat
40754	0.04	Agricultural Land
40755	0.04	Upland Habitat
40755	0.02	Agricultural Land

ID	ACRES	LANDUSE
40756	0.07	Upland Habitat
40756	0.07	Agricultural Land
40757	0.19	Upland Habitat
40757	0.11	Agricultural Land
40758	0.14	Upland Habitat
40759	0.05	Upland Habitat
40759	0.01	Agricultural Land
40759	0.00	Agricultural Land
40760	0.04	Upland Habitat
40760	0.02	Agricultural Land
40763	0.01	Upland Habitat
40763	0.01	Agricultural Land
40764	0.04	Upland Habitat
40765	0.04	Upland Habitat
40765	0.12	Agricultural Land
40766	0.02	Upland Habitat
40767	0.02	Agricultural Land
40768	0.06	Agricultural Land
40769	0.02	Agricultural Land
40770	0.08	Upland Habitat
40770	0.04	Agricultural Land
40771	0.02	Upland Habitat
40771	0.06	Agricultural Land
40772	0.02	Upland Habitat
40772	0.02	Agricultural Land
40773	0.14	Upland Habitat
40774	0.04	Upland Habitat
40777	0.14	Upland Habitat
40778	1.86	Upland Habitat
40778	0.68	Agricultural Land
40778	0.75	Agricultural Land
40779	0.09	Upland Habitat
40779	0.01	Agricultural Land
40783	0.06	Upland Habitat
40784	0.02	Upland Habitat
40786	0.07	Upland Habitat
40786	0.05	Agricultural Land
40787	0.02	Agricultural Land
40789	23.93	Upland Habitat
40789	13.99	Agricultural Land
40789	15.33	Agricultural Land
40790	0.10	Upland Habitat
40791	0.04	Agricultural Land
40792	0.02	Upland Habitat
40793	0.10	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40795	0.06	Upland Habitat
40795	0.06	Agricultural Land
40796	0.08	Agricultural Land
40797	0.06	Upland Habitat
40798	0.08	Upland Habitat
40801	0.02	Upland Habitat
40801	0.07	Agricultural Land
40801	0.05	Agricultural Land
40802	0.00	Upland Habitat
40802	0.07	Agricultural Land
40802	0.03	Agricultural Land
40803	0.02	Agricultural Land
40804	0.01	Upland Habitat
40804	0.01	Agricultural Land
40805	0.55	Agricultural Land
40805	0.03	Agricultural Land
40809	0.14	Upland Habitat
40818	0.02	Upland Habitat
40818	0.04	Agricultural Land
40819	0.02	Agricultural Land
40820	0.06	Agricultural Land
40821	0.04	Upland Habitat
40821	0.04	Agricultural Land
40822	0.00	Agricultural Land
40822	0.12	Agricultural Land
40823	0.00	Agricultural Land
40823	0.10	Agricultural Land
40824	0.02	Agricultural Land
40824	0.02	Agricultural Land
40825	0.02	Agricultural Land
40825	0.04	Agricultural Land
40826	0.04	Agricultural Land
40826	0.02	Agricultural Land
40827	0.02	Agricultural Land
40828	0.02	Agricultural Land
40829	0.02	Agricultural Land
40831	0.10	Upland Habitat
40831	0.01	Agricultural Land
40831	0.05	Agricultural Land
40832	0.12	Upland Habitat
40833	0.08	Upland Habitat
40834	0.15	Upland Habitat
40834	0.01	Agricultural Land
40835	0.08	Agricultural Land
40836	0.02	Agricultural Land

ID	ACRES	LANDUSE
40837	0.09	Agricultural Land
40837	0.07	Agricultural Land
40838	0.42	Agricultural Land
40838	0.12	Agricultural Land
40840	0.10	Agricultural Land
40840	0.02	Agricultural Land
40841	0.02	Agricultural Land
40842	0.06	Upland Habitat
40844	0.02	Agricultural Land
40847	0.03	Upland Habitat
40847	0.07	Upland Habitat
40848	0.28	Upland Habitat
40849	0.06	Agricultural Land
40850	0.12	Agricultural Land
40851	0.02	Agricultural Land
40852	0.00	Upland Habitat
40852	0.06	Agricultural Land
40856	0.19	Upland Habitat
40856	1.12	Agricultural Land
40856	0.42	Agricultural Land
40857	0.08	Upland Habitat
40858	0.04	Upland Habitat
40858	0.06	Agricultural Land
40858	0.08	Agricultural Land
40859	0.08	Agricultural Land
40860	0.02	Agricultural Land
40861	0.08	Agricultural Land
40862	0.04	Agricultural Land
40863	0.02	Upland Habitat
40863	0.07	Agricultural Land
40863	0.07	Agricultural Land
40864	0.02	Agricultural Land
40865	0.01	Upland Habitat
40865	0.19	Agricultural Land
40869	0.10	Upland Habitat
40869	0.12	Agricultural Land
40870	0.13	Upland Habitat
40870	0.02	Agricultural Land
40870	0.01	Agricultural Land
40872	0.26	Upland Habitat
40872	0.10	Agricultural Land
40873	0.08	Agricultural Land
40873	0.00	Agricultural Land
40874	0.27	Upland Habitat
40874	0.01	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40875	0.54	Upland Habitat
40876	0.02	Agricultural Land
40877	0.10	Upland Habitat
40880	0.06	Agricultural Land
40888	0.08	Agricultural Land
40889	0.03	Upland Habitat
40889	0.05	Agricultural Land
40892	6.92	Upland Habitat
40892	0.08	Agricultural Land
40893	0.22	Upland Habitat
40894	0.42	Upland Habitat
40895	0.42	Upland Habitat
40895	0.01	Agricultural Land
40896	0.20	Upland Habitat
40897	0.08	Upland Habitat
40898	0.10	Upland Habitat
40899	0.22	Upland Habitat
40900	0.02	Upland Habitat
40901	0.06	Upland Habitat
40902	0.12	Upland Habitat
40903	0.04	Upland Habitat
40904	0.05	Upland Habitat
40904	0.01	Agricultural Land
40904	0.00	Agricultural Land
40906	0.02	Upland Habitat
40906	0.00	Agricultural Land
40907	0.38	Upland Habitat
40909	0.18	Upland Habitat
40912	0.06	Upland Habitat
40913	0.10	Upland Habitat
40914	0.06	Upland Habitat
40914	0.10	Upland Habitat
40915	0.11	Upland Habitat
40915	0.01	Agricultural Land
40916	0.10	Upland Habitat
40916	0.04	Upland Habitat
40917	0.10	Upland Habitat
40917	0.04	Upland Habitat
40918	0.04	Upland Habitat
40918	0.08	Upland Habitat
40920	0.08	Upland Habitat
40922	0.02	Upland Habitat
40923	0.02	Upland Habitat
40923	0.08	Agricultural Land
40923	0.01	Agricultural Land

ID	ACRES	LANDUSE
40924	1.65	Upland Habitat
40924	0.69	Agricultural Land
40924	0.06	Agricultural Land
40926	0.24	Upland Habitat
40927	0.22	Upland Habitat
40928	0.14	Upland Habitat
40930	0.02	Upland Habitat
40931	0.34	Upland Habitat
40932	0.08	Upland Habitat
40933	0.04	Upland Habitat
40934	0.06	Upland Habitat
40936	0.40	Upland Habitat
40937	0.12	Upland Habitat
40938	0.04	Upland Habitat
40939	0.02	Upland Habitat
40940	0.10	Upland Habitat
40941	19.61	Upland Habitat
40941	0.95	Agricultural Land
40941	0.61	Agricultural Land
40942	0.14	Upland Habitat
40947	0.50	Agricultural Land
40948	0.02	Upland Habitat
40949	0.32	Upland Habitat
40950	0.08	Upland Habitat
40951	0.16	Upland Habitat
40952	0.06	Upland Habitat
40954	0.20	Upland Habitat
40955	0.04	Upland Habitat
40956	0.04	Upland Habitat
40957	0.16	Upland Habitat
40959	0.13	Upland Habitat
40959	0.03	Agricultural Land
40960	0.03	Upland Habitat
40960	0.03	Agricultural Land
40961	0.24	Agricultural Land
40962	1.93	Upland Habitat
40962	3.45	Agricultural Land
40962	1.32	Agricultural Land
40963	0.17	Agricultural Land
40963	0.03	Agricultural Land
40964	0.12	Upland Habitat
40964	0.54	Agricultural Land
40964	0.98	Agricultural Land
40966	0.28	Agricultural Land
40967	0.06	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
40968	0.04	Agricultural Land
40969	0.18	Agricultural Land
40970	0.06	Agricultural Land
40972	0.02	Upland Habitat
40973	0.02	Upland Habitat
40974	0.20	Upland Habitat
40975	0.12	Upland Habitat
40976	0.16	Upland Habitat
40977	0.14	Upland Habitat
40978	0.16	Upland Habitat
40979	0.02	Upland Habitat
40980	0.48	Upland Habitat
40981	0.12	Upland Habitat
40982	0.16	Upland Habitat
40983	1.70	Upland Habitat
40984	0.06	Agricultural Land
40984	0.08	Agricultural Land
40985	0.01	Upland Habitat
40985	0.11	Agricultural Land
40986	0.41	Upland Habitat
40986	0.11	Agricultural Land
40987	0.44	Upland Habitat
40987	0.41	Agricultural Land
40988	0.04	Agricultural Land
40989	0.04	Upland Habitat
40989	0.74	Agricultural Land
40990	0.55	Upland Habitat
40990	0.69	Agricultural Land
40991	0.74	Upland Habitat
40991	0.05	Agricultural Land
40992	0.17	Upland Habitat
40992	0.14	Agricultural Land
40993	0.02	Upland Habitat
40994	0.02	Upland Habitat
40995	0.02	Upland Habitat
40996	0.06	Upland Habitat
40997	0.02	Upland Habitat
40998	0.14	Upland Habitat
40999	0.14	Upland Habitat
41000	0.20	Upland Habitat
41001	0.20	Upland Habitat
41001	0.06	Agricultural Land
41002	0.01	Upland Habitat
41002	0.16	Agricultural Land
41002	0.21	Agricultural Land

ID	ACRES	LANDUSE
41003	0.26	Upland Habitat
41003	0.04	Agricultural Land
41004	0.07	Upland Habitat
41004	0.28	Agricultural Land
41004	0.03	Agricultural Land
41005	0.12	Upland Habitat
41005	0.36	Agricultural Land
41005	0.08	Agricultural Land
41006	0.10	Upland Habitat
41007	0.67	Upland Habitat
41007	0.21	Agricultural Land
41008	0.20	Upland Habitat
41009	0.23	Upland Habitat
41009	0.05	Agricultural Land
41010	0.08	Upland Habitat
41011	0.25	Upland Habitat
41011	0.07	Agricultural Land
41012	0.04	Upland Habitat
41013	0.14	Upland Habitat
41014	0.02	Upland Habitat
41015	0.41	Upland Habitat
41015	0.01	Agricultural Land
41016	0.12	Upland Habitat
41017	0.32	Upland Habitat
41018	0.08	Upland Habitat
41019	0.14	Upland Habitat
41019	0.08	Agricultural Land
41021	0.12	Upland Habitat
41022	0.08	Upland Habitat
41025	0.10	Upland Habitat
41026	0.02	Upland Habitat
41027	0.04	Upland Habitat
41029	0.12	Upland Habitat
41029	0.07	Agricultural Land
41029	0.01	Agricultural Land
41032	0.02	Upland Habitat
41033	0.10	Upland Habitat
41034	0.14	Upland Habitat
41036	0.02	Upland Habitat
41039	0.24	Upland Habitat
41039	0.03	Upland Habitat
41039	0.02	Agricultural Land
41041	0.08	Upland Habitat
41042	0.06	Upland Habitat
41043	0.08	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41057	0.08	Upland Habitat
41057	166.51	Upland Habitat
41057	1.33	Upland Habitat
41057	42.42	Agricultural Land
41057	15.85	Agricultural Land
41058	1.34	Upland Habitat
41059	0.04	Upland Habitat
41063	0.24	Upland Habitat
41072	0.06	Upland Habitat
41101	0.12	Upland Habitat
41102	0.28	Upland Habitat
41103	0.02	Upland Habitat
41103	0.00	Agricultural Land
41104	0.02	Upland Habitat
41105	0.32	Upland Habitat
41106	0.18	Upland Habitat
41108	0.08	Upland Habitat
41109	0.08	Upland Habitat
41111	0.14	Upland Habitat
41112	0.14	Upland Habitat
41117	0.22	Upland Habitat
41117	0.12	Agricultural Land
41117	0.09	Agricultural Land
41120	0.17	Upland Habitat
41120	0.04	Agricultural Land
41120	0.26	Agricultural Land
41121	0.00	Upland Habitat
41121	0.06	Agricultural Land
41122	0.00	Upland Habitat
41122	0.16	Agricultural Land
41123	0.17	Upland Habitat
41123	0.05	Agricultural Land
41123	0.43	Agricultural Land
41124	0.06	Agricultural Land
41125	0.10	Agricultural Land
41126	0.02	Upland Habitat
41126	0.00	Agricultural Land
41127	0.20	Upland Habitat
41128	0.01	Upland Habitat
41128	0.01	Agricultural Land
41130	4.56	Upland Habitat
41130	0.01	Upland Habitat
41130	1.12	Agricultural Land

ID	ACRES	LANDUSE
41131	0.79	Upland Habitat
41131	0.02	Agricultural Land
41131	0.06	Agricultural Land
41132	0.09	Upland Habitat
41132	0.09	Agricultural Land
41133	0.06	Agricultural Land
41134	0.04	Agricultural Land
41135	0.02	Agricultural Land
41137	0.15	Upland Habitat
41137	0.01	Agricultural Land
41138	0.13	Upland Habitat
41138	0.01	Agricultural Land
41142	0.06	Agricultural Land
41144	0.12	Upland Habitat
41156	0.36	Developed Land
41156	0.05	Upland Habitat
41156	0.15	Agricultural Land
41159	0.10	Developed Land
41159	0.10	Agricultural Land
41160	0.02	Agricultural Land
41161	0.02	Agricultural Land
41162	0.02	Agricultural Land
41162	0.04	Agricultural Land
41163	0.05	Agricultural Land
41163	0.01	Agricultural Land
41164	0.09	Agricultural Land
41164	0.07	Agricultural Land
41165	0.07	Agricultural Land
41165	0.03	Agricultural Land
41166	0.01	Agricultural Land
41166	0.07	Agricultural Land
41167	0.08	Developed Land
41167	0.06	Upland Habitat
41167	0.03	Agricultural Land
41168	0.12	Agricultural Land
41169	0.01	Agricultural Land
41169	0.01	Agricultural Land
41170	0.15	Developed Land
41170	0.15	Agricultural Land
41171	1.52	Developed Land
41171	0.01	Upland Habitat
41171	2.56	Agricultural Land
41172	0.06	Upland Habitat
41172	0.28	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41173	0.12	Agricultural Land
41174	0.04	Upland Habitat
41174	0.06	Agricultural Land
41175	0.10	Agricultural Land
41176	0.00	Upland Habitat
41176	0.04	Agricultural Land
41177	0.04	Agricultural Land
41178	0.09	Upland Habitat
41178	0.03	Agricultural Land
41179	0.08	Upland Habitat
41179	0.01	Agricultural Land
41179	0.01	Agricultural Land
41180	0.02	Upland Habitat
41181	0.05	Upland Habitat
41181	0.05	Agricultural Land
41182	0.15	Upland Habitat
41182	0.03	Agricultural Land
41183	0.00	Upland Habitat
41183	0.04	Agricultural Land
41184	0.07	Upland Habitat
41184	0.30	Agricultural Land
41184	0.03	Agricultural Land
41185	0.02	Developed Land
41185	0.08	Developed Land
41185	0.01	Agricultural Land
41185	0.10	Agricultural Land
41199	0.20	Upland Habitat
41210	0.02	Upland Habitat
41212	0.04	Upland Habitat
41231	141.48	Upland Habitat
41231	4.86	Upland Habitat
41231	0.22	Upland Habitat
41231	0.16	Agricultural Land
41238	0.22	Upland Habitat
41239	0.58	Upland Habitat
41261	0.11	Upland Habitat
41261	0.27	Agricultural Land
41268	0.20	Upland Habitat
41270	0.14	Upland Habitat
41277	0.04	Agricultural Land
41278	0.07	Upland Habitat
41278	0.13	Agricultural Land
41279	0.24	Upland Habitat
41280	0.28	Upland Habitat

ID	ACRES	LANDUSE
41281	0.34	Upland Habitat
41281	0.17	Agricultural Land
41281	0.11	Agricultural Land
41282	0.14	Upland Habitat
41282	0.12	Agricultural Land
41283	0.03	Upland Habitat
41283	0.00	Agricultural Land
41284	0.32	Upland Habitat
41285	0.40	Upland Habitat
41286	0.14	Upland Habitat
41287	0.04	Upland Habitat
41288	0.52	Upland Habitat
41289	0.14	Upland Habitat
41289	0.04	Agricultural Land
41299	0.30	Upland Habitat
41300	0.08	Upland Habitat
41301	0.08	Upland Habitat
41303	0.02	Upland Habitat
41367	150.00	Upland Habitat
41367	1.33	Upland Habitat
41367	42.16	Agricultural Land
41367	15.37	Agricultural Land
41401	0.52	Agricultural Land
41402	0.10	Agricultural Land
41403	0.04	Agricultural Land
41404	0.04	Agricultural Land
41406	0.04	Agricultural Land
41407	0.05	Agricultural Land
41407	0.01	Agricultural Land
41408	0.14	Agricultural Land
41415	0.24	Upland Habitat
41416	0.22	Upland Habitat
41417	0.18	Upland Habitat
41419	0.24	Upland Habitat
41420	0.04	Upland Habitat
41425	1.50	Upland Habitat
41426	0.02	Upland Habitat
41427	0.28	Upland Habitat
41428	0.24	Upland Habitat
41429	0.08	Upland Habitat
41430	0.09	Upland Habitat
41430	0.07	Agricultural Land
41433	0.02	Upland Habitat
41435	0.18	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41436	0.04	Upland Habitat
41436	0.02	Agricultural Land
41437	1.24	Upland Habitat
41437	1.06	Agricultural Land
41437	1.23	Agricultural Land
41438	0.01	Upland Habitat
41438	0.15	Agricultural Land
41439	0.20	Agricultural Land
41440	0.01	Upland Habitat
41440	0.08	Agricultural Land
41440	0.07	Agricultural Land
41441	0.08	Upland Habitat
41442	0.11	Upland Habitat
41442	0.06	Agricultural Land
41443	0.49	Upland Habitat
41443	0.50	Agricultural Land
41443	0.47	Agricultural Land
41444	0.07	Upland Habitat
41444	0.03	Agricultural Land
41445	0.02	Upland Habitat
41446	0.36	Agricultural Land
41447	0.13	Agricultural Land
41447	0.11	Agricultural Land
41448	0.24	Agricultural Land
41449	0.07	Upland Habitat
41449	0.03	Agricultural Land
41449	0.10	Agricultural Land
41450	0.01	Agricultural Land
41450	0.05	Agricultural Land
41451	0.07	Upland Habitat
41451	0.00	Agricultural Land
41451	0.13	Agricultural Land
41452	0.00	Agricultural Land
41452	0.04	Agricultural Land
41453	1.14	Upland Habitat
41453	0.65	Agricultural Land
41453	0.82	Agricultural Land
41454	0.16	Agricultural Land
41455	0.14	Agricultural Land
41459	0.02	Upland Habitat
41460	0.02	Upland Habitat
41461	0.06	Upland Habitat
41462	0.12	Upland Habitat
41462	0.02	Agricultural Land

ID	ACRES	LANDUSE
41463	0.12	Upland Habitat
41464	0.04	Upland Habitat
41464	0.04	Agricultural Land
41465	0.02	Upland Habitat
41465	0.04	Agricultural Land
41465	0.06	Agricultural Land
41466	0.20	Agricultural Land
41466	0.02	Agricultural Land
41467	0.04	Agricultural Land
41468	0.15	Upland Habitat
41468	0.17	Agricultural Land
41468	0.02	Agricultural Land
41469	0.08	Agricultural Land
41470	0.04	Upland Habitat
41471	0.06	Upland Habitat
41472	0.24	Upland Habitat
41473	0.20	Upland Habitat
41474	0.12	Upland Habitat
41475	0.60	Upland Habitat
41478	0.00	Upland Habitat
41478	0.00	Agricultural Land
41478	0.03	Agricultural Land
41479	0.20	Upland Habitat
41493	0.06	Agricultural Land
41494	0.00	Upland Habitat
41494	0.04	Agricultural Land
41495	0.09	Developed Land
41495	0.11	Agricultural Land
41496	0.05	Developed Land
41496	0.11	Agricultural Land
41497	0.36	Agricultural Land
41505	3.85	Developed Land
41505	0.12	Upland Habitat
41505	0.79	Agricultural Land
41505	3.55	Agricultural Land
41515	0.00	Upland Habitat
41515	0.07	Agricultural Land
41515	0.07	Agricultural Land
41517	0.02	Upland Habitat
41522	0.02	Upland Habitat
41522	0.15	Agricultural Land
41600	0.22	Agricultural Land
41600	0.29	Agricultural Land
41601	0.08	Upland Habitat
41601	0.00	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41602	0.06	Upland Habitat
41602	0.00	Agricultural Land
41603	0.19	Upland Habitat
41603	0.11	Agricultural Land
41604	0.19	Upland Habitat
41604	0.11	Agricultural Land
41605	0.19	Upland Habitat
41605	0.11	Agricultural Land
41606	0.04	Agricultural Land
41606	0.06	Agricultural Land
41607	0.10	Agricultural Land
41608	0.02	Upland Habitat
41608	0.04	Agricultural Land
41608	0.17	Agricultural Land
41609	0.03	Agricultural Land
41609	0.03	Agricultural Land
41610	0.26	Agricultural Land
41611	0.07	Upland Habitat
41611	0.03	Agricultural Land
41611	0.12	Agricultural Land
41612	0.06	Upland Habitat
41612	0.04	Agricultural Land
41613	0.14	Upland Habitat
41613	0.04	Agricultural Land
41614	0.03	Upland Habitat
41614	0.04	Agricultural Land
41614	0.11	Agricultural Land
41615	0.05	Upland Habitat
41615	0.09	Agricultural Land
41616	0.09	Upland Habitat
41616	0.05	Agricultural Land
41617	0.21	Agricultural Land
41617	0.07	Agricultural Land
41618	0.20	Agricultural Land
41618	0.04	Agricultural Land
41619	0.07	Upland Habitat
41619	0.09	Agricultural Land
41620	0.10	Upland Habitat
41620	0.02	Agricultural Land
41621	0.10	Upland Habitat
41621	0.02	Agricultural Land
41622	0.13	Upland Habitat
41622	0.05	Agricultural Land
41623	0.06	Upland Habitat

ID	ACRES	LANDUSE
41624	1.15	Upland Habitat
41624	12.36	Agricultural Land
41624	2.94	Agricultural Land
41625	0.04	Agricultural Land
41626	0.04	Agricultural Land
41627	3.07	Agricultural Land
41627	0.22	Agricultural Land
41628	0.02	Agricultural Land
41629	0.02	Upland Habitat
41630	0.02	Developed Land
41630	0.08	Agricultural Land
41633	0.06	Agricultural Land
41634	0.08	Upland Habitat
41634	0.07	Upland Habitat
41634	0.02	Agricultural Land
41635	0.43	Upland Habitat
41635	2.07	Agricultural Land
41635	0.19	Agricultural Land
41637	5.06	Upland Habitat
41637	6.97	Agricultural Land
41637	2.66	Agricultural Land
41638	0.46	Upland Habitat
41639	0.18	Upland Habitat
41640	0.14	Upland Habitat
41641	0.12	Upland Habitat
41642	0.08	Upland Habitat
41643	0.02	Upland Habitat
41644	0.09	Upland Habitat
41644	0.05	Agricultural Land
41645	0.08	Upland Habitat
41646	0.04	Agricultural Land
41647	16.69	Upland Habitat
41647	3.96	Agricultural Land
41647	0.20	Agricultural Land
41648	0.30	Upland Habitat
41649	0.12	Upland Habitat
41650	0.02	Upland Habitat
41651	0.50	Upland Habitat
41652	0.46	Upland Habitat
41653	0.28	Upland Habitat
41654	0.02	Upland Habitat
41655	0.02	Upland Habitat
41656	0.08	Upland Habitat
41657	0.02	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

ID	ACRES	LANDUSE
41658	0.02	Upland Habitat
41659	0.06	Upland Habitat
41660	0.24	Upland Habitat
41661	0.12	Upland Habitat
41662	0.06	Upland Habitat
41663	0.06	Upland Habitat
41664	0.18	Upland Habitat
41665	0.20	Upland Habitat
41666	0.10	Upland Habitat
41666	0.20	Agricultural Land
41667	0.10	Upland Habitat
41668	0.26	Upland Habitat
41669	0.01	Upland Habitat
41669	0.01	Agricultural Land
41670	0.12	Upland Habitat
41671	0.08	Agricultural Land
41671	0.02	Agricultural Land
41672	0.24	Upland Habitat
41673	0.30	Upland Habitat
41700	0.06	Developed Land
41700	0.33	Agricultural Land
41700	0.25	Agricultural Land
41701	0.02	Developed Land
41701	0.07	Upland Habitat
41701	0.09	Agricultural Land
41702	0.15	Upland Habitat
41702	0.42	Agricultural Land
41702	0.00	Agricultural Land
41703	0.17	Upland Habitat
41703	0.07	Agricultural Land
41703	0.07	Agricultural Land
41704	0.49	Agricultural Land
41704	0.11	Agricultural Land
41705	0.19	Upland Habitat
41705	0.07	Agricultural Land
41706	0.20	Upland Habitat
41707	1.58	Upland Habitat
41708	0.12	Upland Habitat
41709	0.31	Upland Habitat
41709	0.01	Agricultural Land
41710	0.68	Upland Habitat
41711	0.12	Upland Habitat
41714	0.00	Developed Land
41714	0.01	Upland Habitat
41714	0.07	Agricultural Land
41714	0.01	Agricultural Land

ID	ACRES	LANDUSE
41715	0.21	Developed Land
41715	0.18	Agricultural Land
41716	0.00	Developed Land
41716	0.06	Agricultural Land
41716	0.03	Agricultural Land
41720	0.02	Agricultural Land
41721	0.05	Upland Habitat
41721	0.11	Agricultural Land
41722	0.11	Upland Habitat
41722	0.02	Agricultural Land
41722	0.01	Agricultural Land
41725	0.12	Agricultural Land
41728	0.05	Upland Habitat
41728	0.01	Agricultural Land
41728	0.00	Agricultural Land
41729	0.02	Upland Habitat
41729	0.06	Agricultural Land
41730	0.12	Agricultural Land
41731	0.02	Upland Habitat
41731	0.05	Agricultural Land
41731	0.01	Agricultural Land
41733	0.09	Upland Habitat
41733	0.03	Agricultural Land
41734	0.00	Upland Habitat
41734	0.02	Agricultural Land
41735	0.06	Upland Habitat
41735	0.02	Agricultural Land
41736	0.02	Agricultural Land
41749	0.14	Upland Habitat
41750	0.02	Upland Habitat
41752	0.12	Upland Habitat

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
40098	19.96	Developed Land
40098	0.89	Developed Land
40098	18.30	Developed Land
40098	79.03	Upland Habitat
40098	0.22	Upland Habitat
40098	213.18	Agricultural Land
40098	115.28	Agricultural Land
40098	0.44	Wetland Habitat
40166	56.57	Upland Habitat
40166	12.53	Agricultural Land
40166	2.68	Agricultural Land
40173	24.74	Upland Habitat
40173	1.07	Upland Habitat
40173	7.15	Agricultural Land
40173	1.14	Agricultural Land
40174	94.84	Upland Habitat
40174	28.18	Agricultural Land
40174	5.33	Agricultural Land
40175	24.84	Upland Habitat
40175	3.22	Agricultural Land
40175	0.65	Agricultural Land
40180	34.13	Upland Habitat
40180	35.25	Agricultural Land
40180	24.40	Agricultural Land
40181	20.76	Upland Habitat
40181	45.48	Agricultural Land
40181	19.73	Agricultural Land
40203	21.98	Upland Habitat
40203	2.94	Agricultural Land
40203	0.41	Agricultural Land
40204	18.95	Upland Habitat
40204	2.03	Agricultural Land
40204	0.13	Agricultural Land
40219	0.22	Water
40219	7.75	Upland Habitat
40219	7.22	Agricultural Land
40219	3.76	Agricultural Land
40220	0.17	Upland Habitat
40220	0.01	Agricultural Land
40220	0.06	Agricultural Land
40253	21.28	Upland Habitat
40253	23.13	Agricultural Land
40253	6.55	Agricultural Land
40259	0.06	Upland Habitat

Swal2

NAME	ACRES	LAND USE
40269	17.89	Upland Habitat
40269	6.78	Agricultural Land
40269	29.32	Agricultural Land
40294	0.06	Upland Habitat
40294	0.02	Agricultural Land
40364	0.32	Upland Habitat
40364	0.16	Agricultural Land
40417	0.69	Upland Habitat
40417	0.10	Agricultural Land
40417	0.03	Agricultural Land
40419	0.22	Water
40419	0.03	Developed Land
40419	0.17	Developed Land
40419	79.71	Upland Habitat
40419	25.49	Agricultural Land
40419	20.50	Agricultural Land
40468	18.02	Upland Habitat
40468	0.84	Agricultural Land
40468	5.99	Agricultural Land
40472	25.40	Upland Habitat
40472	0.22	Upland Habitat
40472	0.22	Upland Habitat
40472	13.24	Agricultural Land
40472	9.80	Agricultural Land
40490	19.51	Upland Habitat
40490	1.34	Agricultural Land
40490	5.99	Agricultural Land
40521	1.11	Water
40521	28.04	Upland Habitat
40521	89.21	Agricultural Land
40521	6.49	Agricultural Land
40522	0.04	Upland Habitat
40522	0.04	Agricultural Land
40526	15.86	Upland Habitat
40526	21.39	Agricultural Land
40526	24.57	Agricultural Land
40657	0.03	Agricultural Land
40657	0.03	Agricultural Land
40661	126.85	Upland Habitat
40661	2.26	Upland Habitat
40661	4.40	Agricultural Land
40661	0.32	Agricultural Land
40701	17.51	Upland Habitat
40701	4.33	Agricultural Land
40701	0.25	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
40702	20.70	Upland Habitat
40702	1.70	Upland Habitat
40702	1.31	Agricultural Land
40702	4.19	Agricultural Land
40743	13.07	Upland Habitat
40743	7.81	Agricultural Land
40743	5.15	Agricultural Land
40744	0.02	Agricultural Land
40745	0.01	Upland Habitat
40745	0.09	Agricultural Land
40748	0.16	Upland Habitat
40761	0.30	Upland Habitat
40785	3.41	Upland Habitat
40785	0.44	Upland Habitat
40785	12.86	Agricultural Land
40785	3.74	Agricultural Land
40800	14.14	Upland Habitat
40800	5.11	Agricultural Land
40800	0.31	Agricultural Land
40806	0.22	Agricultural Land
40806	0.34	Agricultural Land
40807	0.04	Agricultural Land
40807	0.04	Agricultural Land
40808	0.12	Upland Habitat
40808	0.02	Agricultural Land
40881	0.03	Upland Habitat
40881	0.01	Agricultural Land
40910	0.16	Upland Habitat
40911	0.08	Upland Habitat
40935	1.07	Upland Habitat
40935	0.33	Agricultural Land
40935	0.06	Agricultural Land
40958	18.05	Upland Habitat
40958	16.75	Agricultural Land
40958	6.66	Agricultural Land
40965	0.13	Upland Habitat
40965	0.82	Agricultural Land
40965	1.19	Agricultural Land
41030	33.05	Upland Habitat
41030	5.11	Agricultural Land
41030	0.83	Agricultural Land
41031	17.34	Upland Habitat
41031	2.04	Agricultural Land
41035	0.04	Upland Habitat
41100	0.20	Upland Habitat

Swal2

NAME	ACRES	LAND USE
41113	4.37	Upland Habitat
41113	0.44	Agricultural Land
41114	28.22	Upland Habitat
41114	0.88	Agricultural Land
41114	7.66	Agricultural Land
41115	94.32	Upland Habitat
41115	44.09	Agricultural Land
41115	16.59	Agricultural Land
41143	0.12	Upland Habitat
41143	0.02	Agricultural Land
41145	0.06	Upland Habitat
41145	0.16	Agricultural Land
41158	7.39	Developed Land
41158	2.35	Developed Land
41158	3.04	Upland Habitat
41158	11.88	Agricultural Land
41158	5.68	Agricultural Land
41222	18.86	Upland Habitat
41226	31.86	Upland Habitat
41227	72.41	Upland Habitat
41227	4.10	Agricultural Land
41227	3.75	Agricultural Land
41228	118.59	Upland Habitat
41228	8.92	Agricultural Land
41228	6.32	Agricultural Land
41232	105.27	Upland Habitat
41232	4.86	Upland Habitat
41232	0.22	Upland Habitat
41232	0.16	Agricultural Land
41240	54.43	Upland Habitat
41240	1.11	Upland Habitat
41240	10.45	Agricultural Land
41271	13.63	Upland Habitat
41271	2.06	Agricultural Land
41271	14.29	Agricultural Land
41272	14.95	Upland Habitat
41272	1.91	Agricultural Land
41272	2.58	Agricultural Land
41275	29.94	Upland Habitat
41275	3.24	Upland Habitat
41275	0.07	Agricultural Land
41367	150.00	Upland Habitat
41367	1.33	Upland Habitat
41367	42.16	Agricultural Land
41367	15.37	Agricultural Land

Table F-1 Continued: Section 4 Corridor and Karst Feature Land Use

Swal2

NAME	ACRES	LAND USE
41418	1.90	Upland Habitat
41421	0.17	Upland Habitat
41421	0.07	Agricultural Land
41424	0.22	Water
41424	0.48	Developed Land
41424	352.65	Upland Habitat
41424	1.56	Upland Habitat
41424	97.40	Agricultural Land
41424	261.07	Agricultural Land
41432	13.07	Upland Habitat
41432	1.89	Upland Habitat
41432	0.18	Upland Habitat
41432	9.17	Agricultural Land
41432	5.42	Agricultural Land
41434	18.23	Upland Habitat
41434	0.44	Upland Habitat
41434	3.46	Agricultural Land
41434	1.65	Agricultural Land
41456	0.03	Upland Habitat
41456	0.04	Agricultural Land
41456	0.11	Agricultural Land
41504	22.24	Upland Habitat
41504	2.31	Agricultural Land
41504	0.46	Agricultural Land
41524	22.12	Upland Habitat
41524	1.28	Agricultural Land
41524	0.37	Agricultural Land
41525	1.78	Water
41525	61.91	Upland Habitat
41525	4.72	Upland Habitat
41525	0.22	Upland Habitat
41525	28.38	Agricultural Land
41525	0.89	Agricultural Land
41531	20.64	Upland Habitat
41531	42.42	Agricultural Land
41531	3.07	Agricultural Land

APPENDIX G – Spring Water Chemistry

Figure G-1 has been removed for confidentiality reasons related to karst.

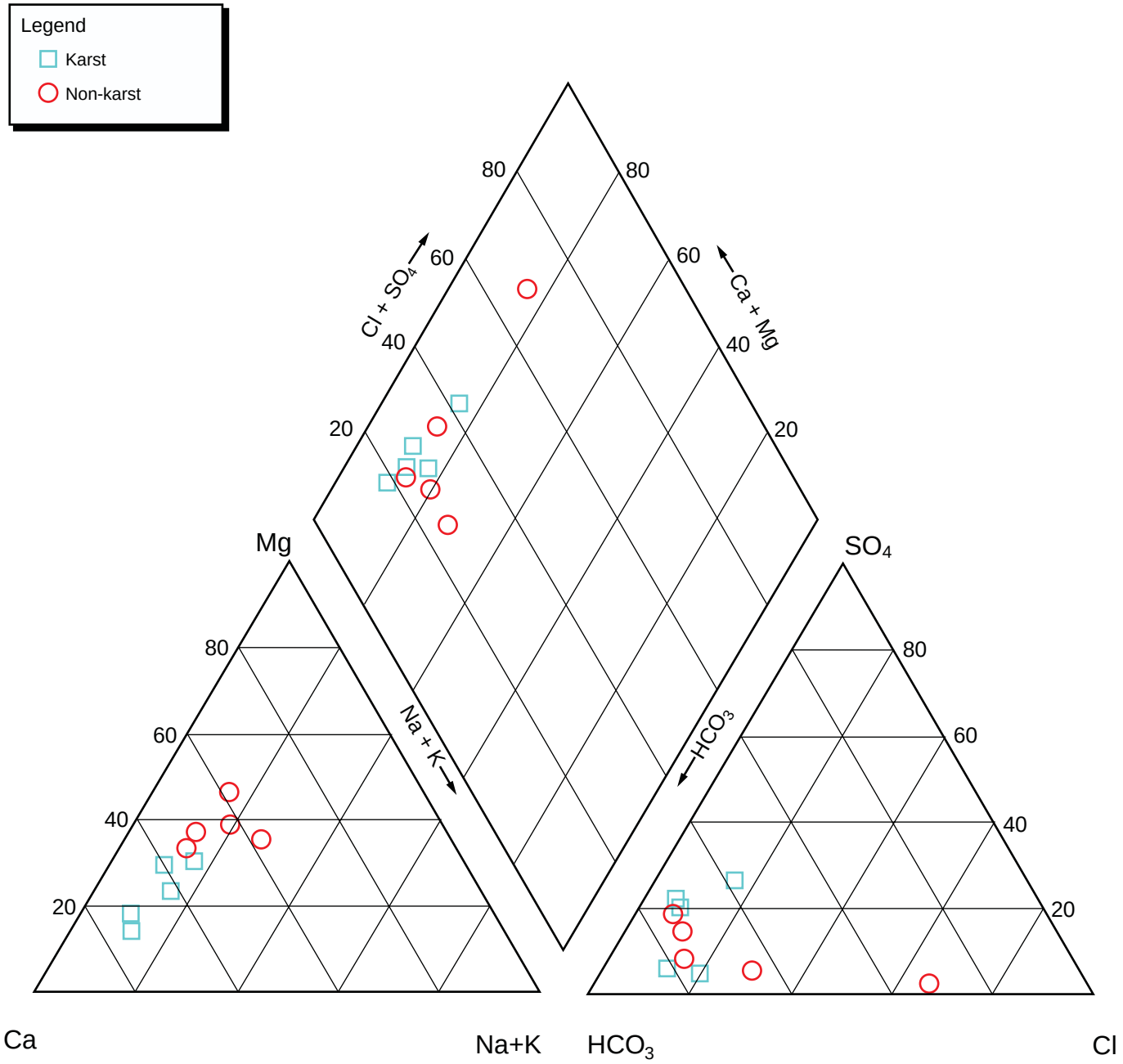

Figure G-2: Trilinear diagram for karst and non-karst springs

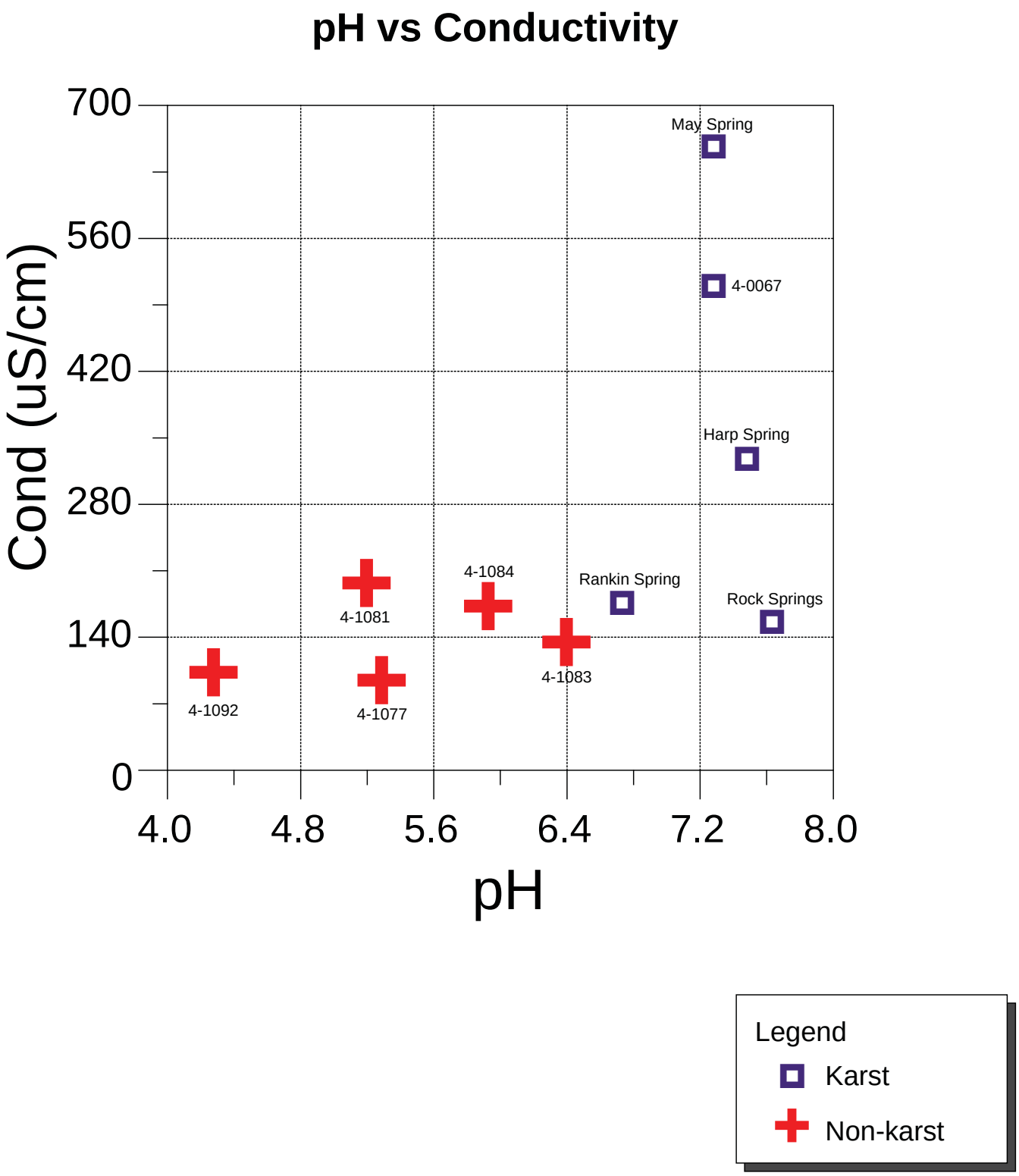

Figure G-3: pH vs conductivity for karst and non-karst springs

Figure G-4 has been removed for confidentiality reasons related to karst.

Figure G-5 has been removed for confidentiality reasons related to karst.

Figure G-6 has been removed for confidentiality reasons related to karst.

Figure G-7 has been removed for confidentiality reasons related to karst.

APPENDIX H – Dye Tracing Summary Figures

Figure H-1 has been removed for confidentiality reasons related to karst.

Figure H-2 has been removed for confidentiality reasons related to karst.

Figure H-3 has been removed for confidentiality reasons related to karst.

Figure H-3B has been removed for confidentiality reasons related to karst.

Figure H-4 has been removed for confidentiality reasons related to karst.

Figure H-5 has been removed for confidentiality reasons related to karst.

Figure H-6 has been removed for confidentiality reasons related to karst.

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Figure H-34B has been removed for confidentiality reasons related to karst.

Figure H-35 has been removed for confidentiality reasons related to karst.

Figure H-35B has been removed for confidentiality reasons related to karst.

Figure H-36 has been removed for confidentiality reasons related to karst.

Figure H-37 has been removed for confidentiality reasons related to karst.

Figure H-38 has been removed for confidentiality reasons related to karst.

Table 7 has been removed for confidentiality reasons related to karst.

APPENDIX I – KARST FEATURE PHOTOGRAPHS

All karst feature photographs have been removed for confidentiality reasons related to karst.

APPENDIX J – KARST FEATURES / DEIS ALTERNATIVES MAPPING AND IMPACT TABLE

Figure J-1 has been removed for confidentiality reasons related to karst.

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40003	Spring	0-1 gpm			X	X	X	X	X	X
40006	Sinkhole	High	X	X	X	X	X	X	X	X
40007	Sinkhole	Medium	X	X	X	X	X	X	X	X
40008	Sinkhole	Low	X	X	X	X	X	X	X	X
40009	Sinkhole	Low	X	X	X	X	X	X	X	X
40010	Sinkhole	Low	X	X	X	X	X	X	X	X
40068	Sinkhole	Medium	X	X	X	X	X	X	X	X
40069	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
40084	Sinkhole	Low			X	X	X	X	X	X
40085	Spring	0-1 gpm			X	X	X	X	X	X
40087	Sinkhole	Medium	X	X						
40092	Sinkhole	Low			X	X	X	X	X	X
40094	Sinkhole	High				X		X		X
40095	Sinkhole	Low	X	X						
40096	Sinkhole	High	X	X						
40097	Sinkhole	Medium			X	X	X	X	X	X
40098	Sinking Stream	High			X	X	X	X	X	X
40099	Sinkhole	Low			X	X	X	X	X	X
40100	Sinkhole	Low			X	X	X	X	X	X
40103	Sinkhole	High			X	X	X	X	X	X
40105	Sinkhole	Low				X				X
40106	Sinkhole	Medium			X	X	X	X	X	X
40107	Sinkhole	Medium				X	X	X		X
40109	Sinkhole	Medium			X	X	X	X	X	X
40110	Sinkhole	Low				X				X
40111	Sinkhole	Medium			X	X	X	X	X	X
40113	Sinkhole	Low			X	X	X	X	X	X
40129	Sinkhole	Low				X				X
40130	Sinkhole	Medium			X	X			X	X
40131	Sinkhole	Medium			X	X			X	X
40132	Sinkhole	Medium			X	X			X	X
40140	Sinkhole	Low				X				X
40142	Sinkhole	Low	X	X						
40164	Spring	0-1 gpm				X		X		X
40168	Sinkhole	High	X	X	X	X	X	X	X	X
40171	Sinkhole	High	X		X		X		X	
40173	Swallet	High	X	X	X	X	X	X	X	X
40182	Sinkhole	Medium	X	X	X	X	X	X	X	X

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40183	Sinkhole	Medium	X	X	X	X	X	X	X	X
40204	Swallet	High	X		X		X		X	
40215	Sinkhole	Medium	X	X	X	X	X	X	X	X
40217	Sinkhole	Medium	X	X	X	X	X	X	X	X
40286	Sinkhole	Medium				X		X		
40293	Sinkhole	Low	X	X	X	X	X	X	X	X
40372	Spring	0-1 gpm	X	X	X	X	X	X	X	X
40381	Sinkhole	High	X	X	X	X	X	X	X	X
40410	Sinkhole	Medium			X	X	X	X		
40411	Sinkhole	Medium	X	X					X	X
40412	Sinkhole	Low	X	X					X	X
40414	Sinkhole	Medium	X	X	X	X	X	X	X	X
40422	Sinkhole	Medium		X						
40423	Sinkhole	Low	X	X						
40428	Spring	2-10 gpm				X		X		X
40429	Spring	0-1 gpm				X		X		X
40430	Swallet	Medium			X	X	X	X	X	X
40432	Sinkhole	Low	X	X						
40433	Sinkhole	High	X	X						
40434	Sinkhole	Medium	X	X						
40435	Sinkhole	Medium	X	X						
40437	Sinkhole	High		X						
40448	Sinkhole	Low	X	X						
40500	Sinkhole	Medium		X						
40509	Spring	2-10 gpm			X	X	X	X		
40514	Sinkhole	Low		X						X
40515	Sinkhole	Low	X	X					X	X
40530	Sinkhole	Low					X	X		
40532	Sinkhole	Medium			X	X			X	X
40533	Sinkhole	High			X	X			X	X
40535	Sinkhole	Low	X	X						
40536	Sinkhole	High	X	X						
40538	Sinkhole	Medium	X	X						
40539	Sinkhole	High	X	X						
40540	Sinkhole	Low		X						
40541	Sinkhole	Low	X	X						
40544	Sinkhole	High		X						
40546	Sinkhole	Medium		X						

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40547	Sinkhole	High	X	X						
40548	Sinkhole	High	X	X						
40549	Sinkhole	High		X						
40550	Sinkhole	High	X	X						
40551	Sinkhole	Low	X	X						
40552	Sinkhole	Medium	X	X						
40553	Sinkhole	Low	X	X						
40554	Sinkhole	Medium	X	X						
40555	Sinkhole	Low	X	X						
40556	Sinkhole	High	X	X						
40557	Sinkhole	High	X	X						
40558	Sinkhole	Low	X	X						
40620	Sinkhole	Low			X	X			X	X
40621	Sinkhole	Medium			X	X			X	X
40622	Sinkhole	Low	X	X	X	X			X	X
40623	Sinkhole	Low	X	X		X				X
40624	Sinkhole	Medium	X	X		X				X
40625	Sinkhole	Low	X	X						
40626	Sinkhole	Low	X	X						
40627	Sinkhole	Low	X	X						
40628	Sinkhole	Low	X	X						
40629	Sinkhole	Low	X	X						
40630	Sinkhole	Medium	X	X						
40631	Sinkhole	Low	X	X	X	X			X	X
40632	Sinkhole	Low			X	X			X	X
40633	Sinkhole	Low			X	X			X	X
40634	Sinkhole	Low	X	X	X	X			X	X
40635	Sinkhole	Medium			X	X			X	X
40640	Sinkhole	Low						X		
40641	Sinkhole	High					X	X		
40642	Sinkhole	High					X	X		
40643	Sinkhole	High					X	X		
40658	Sinkhole	Medium					X	X		
40659	Sinkhole	Medium					X	X		
40708	Sinkhole	Medium					X	X		
40709	Sinkhole	Medium					X	X		
40710	Sinkhole	High					X	X		
40711	Sinkhole	High					X	X		

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40712	Sinkhole	Low					X	X		
40713	Sinkhole	Low						X		
40714	Sinkhole	Low					X	X		
40715	Sinkhole	Low					X	X		
40786	Sinkhole	High	X	X	X	X			X	X
40813	Spring	2-10 gpm	X	X						
40814	Spring	11-100 gpm	X	X						
40908	Spring	0-1 gpm			X	X			X	X
41020	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41027	Sinkhole	Low	X	X	X	X	X	X	X	X
41037	Spring	0-1 gpm		X		X		X		X
41038	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41065	Spring	2-10 gpm	X	X					X	X
41066	Spring	2-10 gpm		X						
41073	Spring	0-1 gpm	X	X					X	X
41099	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41151	Spring	2-10 gpm					X	X		
41152	Spring	0-1 gpm						X		
41188	Spring	0-1 gpm		X		X		X		X
41196	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41200	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41202	Spring	0-1 gpm		X		X		X		X
41215	Spring	2-10 gpm	X	X					X	X
41216	Spring	2-10 gpm	X	X					X	X
41222	Swallet	High	X	X	X	X	X	X	X	X
41238	Sinkhole	High	X	X	X	X	X	X	X	X
41239	Sinkhole	Medium	X	X	X	X	X	X	X	X
41301	Sinkhole	Medium	X	X					X	X
41424	Sinking Stream	High			X	X			X	X
41430	Sinkhole	Low	X	X			X	X		
41432	Sinking Stream	High	X	X	X	X	X	X	X	X
41437	Sinkhole	Medium	X	X	X	X	X	X	X	X
41445	Sinkhole Zone	Medium	X	X						
41455	Sinkhole	High	X	X	X	X	X	X	X	X
41456	Swallet	High	X	X	X	X	X	X	X	X
41457	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41458	Spring	2-10 gpm	X	X	X	X	X	X	X	X
41459	Sinkhole	Low	X	X	X	X	X	X	X	X

Appendix J - Table 1: Karst Feature Impacts by Section 4 Alternative

Feature Number	Feature Type	Infiltration/ Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
41460	Sinkhole	Medium	X	X	X	X	X	X	X	X
41461	Sinkhole	Low	X	X	X	X	X	X	X	X
41462	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
41463	Sinkhole	High	X	X	X	X	X	X	X	X
41464	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X
41465	Sinkhole	Medium	X	X		X		X		X
41466	Sinkhole	Low	X	X	X	X	X	X	X	X
41483	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41512	Spring	0-1 gpm		X		X		X		X
41520	Spring	2-10 gpm			X	X	X	X	X	X
41521	Spring	2-10 gpm	X	X						
41529	Spring	2-10 gpm	X	X						
41530	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41603	Sinkhole	Low	X	X	X	X	X	X	X	X
41604	Sinkhole	Low	X	X	X	X	X	X	X	X
41605	Sinkhole	Medium	X	X	X	X	X	X	X	X
41608	Sinkhole	Low				X		X		X
41614	Sinkhole	Medium	X	X	X	X	X	X	X	X
41700	Sinkhole	High	X	X	X	X	X	X	X	X
41711	Sinkhole	Medium	X	X	X	X	X	X	X	X
41714	Sinkhole	High	X	X	X	X	X	X	X	X
41715	Sinkhole	High	X	X	X	X	X	X	X	X
41744	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41756	Spring	0-1 gpm		X		X		X		X
41757	Spring	0-1 gpm		X		X		X		X
41758	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41759	Spring	0-1 gpm	X	X	X	X	X	X	X	X
41760	Spring	0-1 gpm		X		X		X		X
Total Features Impacted			**107**	**121**	**87**	**106**	**87**	**102**	**93**	**112**

APPENDIX K – SURVEY OF SECTION 4 CAVE FAUNA

Pesi 123.08

Interstate 69 Evansville to Indianapolis Tier 2 Studies: Section 4 Cave Fauna

FINAL REPORT

21 December 2006

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INTERSTATE 69 EVANSVILLE TO INDIANAPOLIS
TIER 2 STUDIES: SECTION 4 CAVE FAUNA

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Abstract

Six sites were sampled for cave invertebrates within and in proximity to Section 4 of the proposed I-69 Evansville to Indianapolis in Greene and Monroe counties:

and

Sites were selected based on hydrologic connections to the corridor, identified through dye tracing studies conducted as a part of this project to address the Memorandum of Understanding (MOU) between the Indiana Department of Transportation (INDOT), Indiana Department of Natural Resources (IDNR), Indiana Department of Environmental Management (IDEM) and US Fish and Wildlife Service (USFWS). Sampling for this study was directed at invertebrates; however, vertebrates were also included when identified from incidental observations. A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families, and 67 genera were found during sampling. Fourteen species with the ecological classification of troglobite or stygobite (obligate subterranean animal) were found:

Species	Location	Listing Status
Sphalloplana weingartneri (Weingartner's cave flatworm)		IDNR Watch List
Pseudocandona jeanneli (Jeannel's groundwater ostracod)		IDNR Endangered
Caecidotea stygia (Northern cave isopod)		
Crangonyx packardi (Packard's groundwater amphipod)		IDNR Watch List
Crangonyx indianensis (Indiana cave amphipod)		IDNR Watch List
Conotyla bollmani (Bollman's cave millipede)		IDNR Watch List
Phanetta subterranea (Subterranean sheet-web spider)		
Porrhomma cavernicola (Cavernicolous sheet-web spider)		
Pseudosinella fonsa (Fountain cave springtail)		IDNR Threatened
Arrhopalites undescribed species (Ashcraft cave springtail)		IDNR Endangered Candidate
Pseudanophthalmus undescribed species (Ray's cave beetle)		IDNR Endangered
Batrisodes krekeleri (Krekeler's cave ant beetle)		IDNR Endangered
Spelobia tenebrarum (Cave dung-fly)		
Sinella alata (Indiana cave springtail)		IDNR Watch List

In addition to the fauna with Listing Status described above, the following two species were found, and although not obligate subterranean animals, are also species of concern:

Species	Location	Listing Status
Pseudosinella collina (Hilly springtail)		IDNR Rare
Myotis sodalis (Indiana bat)		USFWS Endangered

The entire known range of the Ashcraft cave springtail is a single cave in the proposed I-69 project area. The Ray's cave beetle is known only from three caves including one site in the proposed I-69 project area.

Key words – Indiana, cave fauna, troglobite, *Pseudanophthalmus*, *Arrhopalites*

1.0 Introduction

This study is part of the Tier 2 Environmental Impact Statements for the proposed I-69 from Evansville to Indianapolis, Indiana. Six sites identified in the Section 4 Karst Report were selected for cave invertebrate surveys based on their hydrological connections to the proposed I-69 corridor, identified during dye tracing studies for the project. Lewis and Associates LLC was subcontracted by Environmental Solutions and Innovations, Inc. to complete a cave invertebrate inventory for INDOT and FHWA. The six caves included both flowing springs and drier openings, which provided opportunities for sampling.

2.0 Study Area

2.1 Location –

Section 4 of the proposed I-69 corridor (Section 4) begins at US 231 in southeastern Greene County north of SR 58 near the northwest corner of Naval Support Activity Crane. It proceeds northeast into Monroe County and ends at SR 37 near Victor Pike south of Bloomington. The total length of Section 4 in Greene and Monroe counties is approximately 27 miles (Figure 1).

Three sites were selected for study in Greene County: and an unnamed spring designated as These sites were located in the vicinity of the town of Koleen. Three sites were selected for study in Monroe County: and The Monroe County sampling sites were south or southwest of Bloomington. Six additional springs and caves were sampled, each located within or associated with the above sampling sites, and included

and Specific descriptions of the sampling sites and other associated springs and caves within each sampling site are included in the results. Figure 2 and Table 1 provide locations of sampling sites. Appendix C contains photographs of sites. Appendix D contains maps of caves sampled.

2.2 Physiography –

The project area is in the Crawford Upland Section of the Shawnee Hills Natural Region and the Mitchell Plain Section of the Highland Rim Natural Region in southwest Indiana (Homoya et al. 1985). An overview of the caves and karst of the area was presented by Powell (1961). The Crawford Upland Section is characterized by rugged hills with sandstone cliffs and rockhouses, and well-drained acid silt loam soils. The majority of natural communities are upland forest types, although a few sandstone and limestone glades, gravel washes, and barrens are known. To the east, the Mitchell Plain Section is characterized by relatively low relief and marked by sinkholes and extensive cave systems developed in Mississippian age limestone bedrock (Homoya et al. 1985). Upland forest types are common although swamps, flatwoods, and barrens are present. Examples of medium and high gradient streams with rocky bottoms in this area include Indian, Clear, and Popcorn creeks.

2.3 Review of literature –

The first biological survey of caves in the vicinity of the project area was conducted by Blatchley (1897), during a five-week trip through the south-central karst in a horse drawn spring-wagon. Blatchley started at in Crawford County, then continued north through Orange, Lawrence, Monroe, and Owen counties. In Monroe County he visited Mayfield's, , , , and caves.

Since Blatchley's time most of the names have changed due to taxonomic works, collectively the following assemblage of obligate subterranean species was noted: isopod *Caecidotea stygia*, amphipod *Crangonyx gracilis* (=*C. packardi*), crayfish *Cambarus pellucidus* (=*Orconectes inermis*), millipede *Conotyla bollmani*, springtail *Degeeria cavernarum* (either *Sinella cavernarum* or *S. alata*), cave beetle *Anophthalmus tenuis* (=*Pseudanophthalmus* spp.), and fly *Limosina tenebrarum* (=*Spelobia tenebrarum*).

Banta (1907) published a classic account on the fauna of near Bloomington, in Monroe County. Essentially the same obligate subterranean species were found by Banta as Blatchley: isopod *Caecidotea stygia*, amphipod *Crangonyx gracilis* (=*C. packardi*), crayfish *Cambarus pellucidus testii* (=*Orconectes inermis testii*), millipede *Conotyla bollmani*, spider *Phanetta subterranea*, springtail *Sinella cavernarum*, cave beetle *Anophthalmus tenuis* (=*Pseudanophthalmus shilohensis mayfieldensis*), and fly *Limosina tenebrarum* (=*Spelobia tenebrarum*).

Barr (1960) published a monographic treatment of the cave beetles of the genus *Pseudanophthalmus* from the Mitchell Plain in southern Indiana. Included was the description of the new species *P. leonae*, known only from a small cave near Springville, in Lawrence County.

Christiansen (1960) presented a monograph of the collembolan genus *Sinella* and described the troglobite *Sinella alata* from in Monroe County.

In a monograph of cave crayfish of the genus *Orconectes*, Hobbs and Barr (1972) reported the cave crayfish *Orconectes inermis testii* from in Greene County. Fleming (1972) also reported the isopod *Caecidotea stygia* from

In his dissertation on ostracods commensal on crayfish, Hobbs (1973) visited numerous Indiana caves. In the vicinity of the project area, he reported the cave crayfish *Orconectes inermis testii* and the stygophile *Cambarus laevis* from in Monroe County. *Cambarus laevis* was also reported in in Greene County. From the commensal ostracods *Donnaldsoncythere donnaldsonensis*, *Sagittocythere barri*, *Uncinocythere xania* and *Dactylocythere susanae*. *Sagittocythere barri* was also found on crayfish in and *D. donnaldsonensis* in both in Greene County.

Lewis and Rafail (2003) conducted a survey of the life in caves and springs in the in Monroe County, a Bloomington city park a little over a mile west of SR 37 and adjacent to the present study area. This survey included a bioinventory of

and

Ten obligate subterranean species were

discovered in the nature park: northern cave isopod *Caecidotea stygia*, Barr's terrestrial isopod *Miktoniscus barri*, Packard's groundwater amphipod *Crangonyx packardi*, Bollman's cave millipede *Conotyla bollmani*, subterranean sheet-web spider *Phanetta subterranea*, cavernicolous sheet-web spider *Porrhoma cavernicola*, cave springtails *Sinella alata and Tomocerus celsus*, Mayfield cave beetle *Pseudanophthalmus shilohensis mayfieldensis*, and the cave dung beetle *Spelobia tenebrarum*.

In a monograph of the amphipod genus *Crangonyx* Zhang and Holsinger (2003) described the new species *Crangonyx indianensis* from in Greene County, as well as listing *C. packardi* from the same site.

Lewis et al. (2004) prepared a biological inventory of caves of the Hoosier National Forest. In Monroe County, within the Deam Wilderness, there is an isolated band of limestone that occurs just west of the Mt. Carmel Fault Zone. This limestone belt is approximately three miles in length and is not continuous with the other karst found to the west. Only a few caves were known in this area. However, in the seven caves sampled 12 obligate subterranean species were discovered, of which at least three were probably endemic to the area. These include an undescribed species of the cave ground beetle *Pseudanophthalmus*, cave ant beetle *Batriasymmodes*, and cave pseudoscorpion *Apochthonius*, all known only from

Also sampled by Lewis et al. (2004) was the of the Hoosier National Forest, located west of Bedford and appreciably south of the present study area. About 12 square miles of some of the most concentrated karst features in Indiana occur in this region, which lies just to the south of the East Fork of White River in Lawrence County. Many pits, including the deepest open-air free fall pit in the state, caves, springs and uncountable sinkholes exist in the area. Twenty-three species of obligate subterranean species were discovered in the area caves. Noteworthy was the presence of three species of troglobitic sheet-web spiders, including an undescribed species of *Oreonitides*. Most of the known localities of the rare pseudoscorpion *Apochthonius indianensis* are from as well as two of the three known populations of the troglobitic ant beetle *Batrisodes.* Other characteristic species found at that are endemic to the central part of Indiana's south-central karst are the millipede *Conotyla bollmani* and the ground beetle *Pseudanophthalmus stricticollis*.

Unpublished data was solicited from systematic zoologists. A search of the Grinnell College (Grinnell, Iowa) collembolan database by Dr. Kenneth Christiansen yielded a record of the troglobite *Sinella cavernarum* from in Greene County. Barr (personal communication 2006) reported the presence of an undescribed species of the cave beetle *Pseudanophthalmus* from and in Greene County.

3.0 Methods

The following methods of sampling were used during this project:

- Manual collections, which entailed examination of surfaces and turning stones, to find invertebrates that were then collected with a water color brush moistened in alcohol;
- Pitfall traps consisting of four-ounce glass specimen jars filled with 70% isopropyl alcohol as a preservative and baited with Limburger cheese. The jars were placed in mudbanks with the use of a trowel to excavate a small hole. At the time that the pitfall was removed the clay plug was placed back in the hole and the slope smoothed to return the mudbank to its original appearance;
- Berlese extraction, a method that consisted of placing a litter sample into a large funnel, with a light/heat source above that drove the invertebrates into an underlying vial of alcohol;
- Shrimp-baited jars in the springs or deep water habitats of caves, using a single uncooked marine shrimp placed in a jar with a perforated lid, and left typically overnight. Longer trap intervals cause the water in the jar to become anoxic with resulting loss of trap effectiveness;
- Gravel washings, consisting of extracting gravel into a pail, washing it with stream water, stirring the gravel and then quickly pouring the supernatant through a plankton net;
- Plankton tows, pulling a plankton net through a pool, returning the sample to the lab alive;
- Pool dipping/netting, consisting of dipping water from shallow drip pools fed by epikarstic waters, then straining the water through a plankton net for a live sample;
- Karaman-Chappuis extraction, in which a shallow hole is excavated next to a stream or spring, allowed to fill with water, and then water removed and strained through a plankton net to sample for interstitial aquatic fauna. A variation of this technique involves putting a 12-inch section of perforated PVC pipe into the shallow hole, back filling the hole, and putting a shrimp-baited jar in the pipe overnight.

Water sampled from the above aquatic sampling methods was put into jars, removed from the site, placed in a cooler and transported back to the laboratory. The samples were placed in Petri dishes and examined for living fauna under a dissecting microscope. Litter taken from the cave was placed in a Berlese funnel with overhead light/heat extracting the invertebrates into a vial of 40% isopropyl alcohol. Pitfall residues were screened, and then transferred into Petri dishes for sorting of the fauna under a dissecting microscope. Specimens of each taxon were placed in 3 or 4-dram vials of 40% isopropyl alcohol and labeled per cave of origin, state, county, distance to nearest town, date and collector.

Quantitative stream censusing was done using the methodology described in detail by Lewis (2000). In a Surber (square foot) Sampler was placed in the center of riffle areas and the fauna manually

dislodged by gently turning the gravel/stone substrate. Invertebrates taken in the sampler were then placed in a plastic bowl with an underlying millimeter grid for taking measurements. All animals were identified, measured and then released back to the stream alive. In
the shallow water depth was inadequate for using a Surber Sampler, so a standardized square foot quadrat was censused for comparative purposes. All animals were identified, sight estimation of length taken and then left undisturbed in the habitat.

Crayfish censusing was performed by visually locating the animals and removing them from the water by hand or with a net. The crayfish were identified to species, sexed by visual observation of the ventral genitalia, measured with a millimeter rule from the tip of the rostrum to the tip of the tail, and then released back to the stream. Any crayfish that could not be captured were identified and a sight estimate recorded of the length.

This study's sampling was directed at invertebrates; however, vertebrates are also listed in the report when identified from incidental observations. This work was completed under the authority of the appropriate scientific collectors permits (USFWS Endangered Species Permit TE023664-15)

Latitude/longitude locations in degrees/minutes/seconds were taken in with a hand held Garmin® (Olathe, Kansas) model GPSmap 76. Depending on the number of satellites being tapped at any given moment and the proximity to interference from forest canopy or cliffs, the accuracy of this instrument typically is within a diameter of 15-22 feet.

The usual practice of using the metric system for scientific measurements was adhered to in references to animals. Caves in the United States are mapped in feet and this system was maintained. Similarly, museum preparations of specimen labels for vials use the prevailing measurement system of the country in which the sampling was performed. Thus, distances were calculated in miles rather than kilometers.

4.0 Results

4.1 Faunal List Definitions –

In the following list each species is placed within a Linnaean hierarchical classification. For each species there is a scientific name, original author of the species, a descriptive common name and an ecological classification. The ecological classifications adhere to the following system:

Classification/Abbreviation and Definition

- Troglobite (TB) – terrestrial, morphologically adapted and restricted to caves, must feed and reproduce in the cave environment
- Troglophile (TP) – terrestrial, little if any morphological adaptations to caves, not restricted to caves, but can feed and reproduce in the cave environment
- Trogloxene (TX) – terrestrial, not usually morphologically adapted to caves, leaves the cave to either feed and/or reproduce
- Stygobite (SB) – aquatic, morphologically adapted and restricted to caves, must feed and reproduce in the cave environment

- Stygophile (SP) – aquatic, little if any morphological adaptation to caves, not restricted to caves, but can feed and reproduce in the cave environment
- Stygoxene (SX) – aquatic, not morphologically adapted to caves, usually leaves the cave to either feed or reproduce
- Accidental (AC) – fall or wash into caves with no demonstrable affiliation to the habitat
- Parasite/commensal (PS) – lives on or parasitizes a host animal
- Spring dweller (SPR) – spring inhabitant only, not groundwater related

Accompanying each taxon identified to the species level is a S-rank and G-rank, or State rank of rarity and Global rank of rarity, according to the following system:

Global Rank	*Sites*	*Description*
G1	1-5	critically imperiled
G2	6-20	imperiled
G3	21-100	vulnerable
G4	100+	apparently secure
G5		secure

State Rank	*Sites*	*Description*
S1	1-5	critically imperiled
S2	6-10	imperiled
S3	11-20	vulnerable
S4	21+	apparently secure
S5		secure
SE		exotic species

References in this report to listed species came from the Indiana Department of Natural Resources (IDNR), Division of Nature Preserves, Natural Heritage Program of endangered, threatened, rare and extirpated vertebrates and invertebrates of Indiana available at: http://www.in.gov/dnr /naturepr/pdf/vertinve.pdf.

The IDNR Division of Fish and Wildlife maintains a list of species of concern, threatened or endangered available at: http://www.in.gov/dnr/fishwild/endangered /rare.pdf. Vertebrates, mollusks and crustaceans that are listed as endangered in Indiana are protected from taking pursuant to the Nongame and Endangered Species Act of 1973 (IC 14-22-34) and Fish and Wildlife Administrative Rules (312 IAC). No cave invertebrates are presently listed. Species, status, and location are provided in Table 2.

4.2 Faunal List --

4.2.1 Phylum PLATYHELMINTHES –

Class TURBELLARIA –

Order TRICLADIDA –

Family KENKIIDAE –

Sphalloplana weingartneri (Kenk)
Weingartner's cave flatworm

- SB
- Monroe County:

- S4/G3; IDNR Watch List

This species is endemic to southern Indiana, where it has been reported from caves in Clark, Crawford, Harrison, Jefferson, Jennings, Lawrence, Martin, Orange, Ripley and Washington counties (Kenk 1970a; Lewis 1983, 1994, 1996, 1998; Lewis et al. 2004).

Family PLANARIIDAE –

Phagocata gracilis (Haldeman)
Slender spring flatworm

- SP/SX
- Greene County:

  Monroe County:
  Spring, Pic-A-
  ,
- S4/G4

This flatworm is ubiquitous in springs and caves of the eastern U.S. (Kenk 1972). It is also common in cave streams and in some populations the worms are depigmented and nearly white in color. Hyman (1937) described the unpigmented *Phagocata* in Lawrence County, as *Phagocata subterranea*, which Kenk (1970b) synonymized with *Phagocata gracilis*.

4.2.2 Phylum MOLLUSCA –

Class GASTROPODA –

Order BASOMMATOPHORA –

Family PHYSIDAE –

Physa sp.
Aquatic snail

- SPR
- Greene County:

These aquatic snails were found on the undersides of rocks around the outflow of the spring and are not subterranean in nature.

4.2.3 Phylum ARTHROPODA –

Class CRUSTACEA –

Order EUCOPEPODA –

Family CYCLOPIDAE –

Acanthocyclops einslei (Mirabdullayev and Defaye)
Einsle's copepod

- SPR
- Greene County:
- S4/G4

This species is one of the morphs in the *A. robustus-vernalis* group Mirabdullayev and Defaye (2004). Reid (email 2006) reported that *A. einslei* is common in small surface waterbodies.

Acanthocyclops sp.
Copepod

- SPR
- Monroe County:
- S4/G4

This copepod is one of the species of the robustus-vernalis group.

Eucyclops elegans (Herrick)
Elegant copepod

- SPR
- Greene County:
  Monroe County:
- S4/G4

This copepod was taken in shrimp-baited jars in the above localities. In it was taken from the back of the cave in near total darkness. This species is common in surface waters and has been found in much of the U.S. and Canada. Reid and Strayer (1994) pointed out that some species usually considered to be epigean maintain permanent populations in interstitial habitats. Lewis (1998) reported *E. elegans* from (Crawford County) and the at Orangeville (Orange County).

Eucyclops agilis (Koch)
Copepod

- SPR
- Greene County:
- S4/G4

This copepod was taken in a shrimp-baited jar in Lewis (1998) also reported it from the at Orangeville (Orange County).

Macrocyclops albidus (Jurine)
Copepod

- TX
- Greene County:
  Monroe County:
- S4/G4

This copepod was taken from the interstices of stream gravel. This species is not usually associated with groundwater, although Lewis (1998) found it in the at Orangeville (Orange County).

Macrocyclops fuscus (Jurine)
Copepod

- SPR
- Greene County:
- S4/G4

Lewis (1998) found this copepod in the dark zone of (Harrison County), where it was probably introduced with water from the adjacent Blue River.

Microcyclops varicans (G.O.Sars)
Copepod

- SPR
- Monroe County:
- S4/G4

Orthocyclops modestus (Herrick)
Copepod

- SPR
- Monroe County:
- S4/G4

Other groundwater habitats from which this copepod was taken in Indiana were a well in Crawford County and Harrison County (Lewis 1998).

Family CANTHOCAMPTIDAE –

Attheyella nordenskioldii (Lilljeborg)
Nordenskiold's copepod

- TX/SPR
- Monroe County:

- S4/G4

This species has been collected from caves and springs in Crawford, Harrison, Monroe, Orange and Washington counties (Lewis 1998; Lewis et al. 2003, 2004)

Order CLADOCERA –

Family MACROTHRICIDAE –

Ilyocryptus sordidus (Liéven)
Water flea

- Greene County:
- S4/G4

The cladocera of this genus are usually associated with littoral regions where they are found on or near the bottom (Pennak 1978). At it was taken with copepods in a shrimp-baited jar on the bottom of the spring.

Order OSTRACODA –

Family CANDONIDAE –

Candona acuta (Hoff)
Ostracod

- SPR
- Greene County:
- S4/G4

This is an epigean species that is abundant in streams and deltaic areas of lakes (DeLorme email 2006).

Cypria turneri (Hoff)
Ostracod

- SPR
- Greene County:
- S4/G4

This is an epigean species and is abundant in the same habitats as *Candona acuta*.

Pseudocandona jeanneli (Klie)
Jeannel's groundwater ostracod

- SB
- Monroe County:
- S1/G2; IDNR Endangered

This species was described from (Crawford County). Additional populations were found by Lewis (1998) in (Crawford County) and by Lewis et al. (2004) in the Hoosier National Forest at (Lawrence County), (Orange County) and (Monroe County). Formerly considered endemic to the south-central karst of Indiana, additional records were found in (Pulaski County, Kentucky) and (Overton County, Tennessee; Lewis and Lewis unpublished data). Evidence from the new collections suggests that this species is relatively widespread, but poorly known due to its cryptic nature.

Order ISOPODA –

Family ASELLIDAE –

Caecidotea stygia (Packard)
Northern cave isopod

- SB
- Greene County: Monroe County:
- S4/G5

This is one of the most wide ranging subterranean members of the genus, recorded from southwestern Ohio, most of Kentucky, southern Illinois and a small area of eastern Missouri (Lewis and Bowman 1981).

Lirceus fontinalis (Rafinesque)
Bluegrass spring isopod

- SX
- Greene County: Spring, Monroe County: Chic Spring Cave, Spring 179
- S4/G4

Hubricht and Mackin (1949) reported this species from about 45 localities in southern Indiana, Kentucky, southwestern Ohio and northern Tennessee. The isopod is a threshold trogloxene, primarily occurring in springs.

Family ARMADILLIDIDAE –

Cylisticus convexus (DeGeer)
Common convex pillbug

- TX
- Monroe County:
- SE/G5

This pillbug occurs occasionally in cave entrances.

Family LIGIIDAE –

Ligidium elrodi (Packard)
Elrod's terrestrial isopod

- TP/TX
- Greene County: Monroe County:
- S4/G4

These isopods were found on the moist mudbanks of and in the breakdown orifice of Described from (Orange County) by Packard (1873), this species was redescribed by Schultz (1970), who also reported it in caves in Tennessee, Georgia

and Virginia. In Indiana, it is common in caves, especially in or around moist detritus.

Family PORCELLIONIDAE –

Trachelipus rathkei (Brandt)
Rathke's terrestrial isopod

- TX
- Monroe County:
- SE/G5

This is an introduced European species. It is a common threshold trogloxene and was reported from caves in Clark, Crawford, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1995, 1996, 1998; Lewis and Rafail 2002; Lewis et al. 2004).

Order AMPHIPODA –

Family CRANGONYCTIDAE –

Crangonyx forbesi (Hubricht and Mackin)
Forbe's amphipod

- SP/SX
- Greene County:
  Monroe County:
- S4/G4

This amphipod occurs primarily in caves and springs, but has also been recorded from other streams and ponds. It is found from the Ozarks east to Pennsylvania (Zhang and Holsinger 2003).

Crangonyx indianensis (Zhang and Holsinger)
Indiana cave amphipod

- SB
- Greene County:
  Monroe County**:**
- S4/G3; IDNR Watch List

This species has been reported from caves and spring orifices in Clark, Crawford, Decatur, Dubois, Harrison, Jefferson, Lawrence, Martin, Monroe, Orange, Owen and Washington counties (Zhang and Holsinger 2003; Lewis et al. 2004).

Crangonyx packardi (Smith)
Packard's groundwater amphipod

- SB
- Monroe County:
  Monroe County:
- S3-4/G4; IDNR Watch List

This species, first described from a well in Orleans, Orange County, is now known to occur from Indiana west to Kansas (Zhang and Holsinger 2003). *Crangonyx packardi* occurs in drip pools, ephemeral as well as permanent cave streams. Lewis (1998) found it a meter deep in gravel interstices of the Blue River.

Family GAMMARIDAE –

Gammarus minus (Say)
Lesser spring amphipod

- SX/SP
- Greene County:
  Monroe County:
- S4/G5

This species is a common inhabitant of springs in Indiana. In several Indiana populations the amphipods are depigmented and have reduced eyes, similar to populations that occur in West Virginia. Elsewhere, it is known from similar habitats throughout the Appalachians, Interior Low Plateaus and Ozarks (Holsinger 1972).

Order DECAPODA –

Family CAMBARIDAE –

Cambarus laevis (Faxon)
Karst crayfish

- SP

- Greene County:
  Monroe County:

- S4/G4

Simon (2001; Simon and Thoma 2003; Simon et al. 2005) delineated several important morphological differences among the Indiana populations of *C. laevis* and *C. tenebrosus*. Simon et al. (2005) reported that *Cambarus laevis* was widespread in central and southern Indiana, where it was found in brooks, creeks and streams beneath large flat stones.

The cave crayfish *Orconectes inermis inermis* occurs from central Kentucky to Lawrence County, Indiana, where it is replaced by *Orconectes inermis testii* in Monroe and Owen counties. In vicinity of the project area, *Orconectes inermis inermis* was reported from (Lawrence County) and *O. inermis testii* from (Greene County; Hobbs et al. 1977). These reported localities essentially bracket in which *Orconectes inermis inermis* was not found. Closer examination of the record revealed that it is based on an unconfirmed sight record by a caver (Moore 1967). The presence of cave crayfish in Greene County remains a matter of speculation.

Class DIPLOPODA –

Order CHORDEUMATIDA –

Family CONOTYLIDAE –

Conotyla bollmani (McNeill)
Bollman's cave millipede

- TB/TP
- Greene County:
- S3-4/G3-4; IDNR Watch List

Described as *Trichopetalum bollmani* by McNeill (1887) from in Monroe County. Shear (1971), Hoffman and Lewis (1997) and Lewis (2003) summarized the range of this Indiana endemic, which occurs in caves in south-central Indiana in the East Fork of White River drainage (Orange, Lawrence, Monroe, Martin, and Owen counties).

Family TRICHOPETALIDAE –

Trichopetalum uncum (Cook and Collins)
Millipede

- TP
- Greene County:
- S1/G4

A single millipede was found deep in the cave on a bat guano pellet lying on a moist riparian mudbank. Described from an unspecified site in Bloomington, this species is unpigmented and has eyes that are either vestigial or absent. This species has been reported from Oklahoma to South Carolina, south to Georgia and Mississippi (Shear 1972; Shear email 2006)

Order POLYDESMIDA –

Family PARADOXOSOMATIDAE –

Oxidus gracilis (Koch)
Greenhouse millipede

- TX
- Monroe County:

- SE/G5

These millipedes were common on the walls of and were also present on the walls of the springhouse at This species probably originated in Japan, but has spread nearly worldwide in temperate counties and at higher elevations in the tropics. It is found across North America and is present in very high numbers in many parts of the eastern

U.S. (Hoffman 1999). It is frequently present in noxious numbers in caves.

Class ARACHNIDA –

Order ARANEAE –

Family AMAUROBIIDAE –

Coras sp.
Spider

- TX
- Monroe County:

The juvenile specimens collected in this cave are not identifiable to species, but are probably *Coras lamellosis*, a threshold trogloxene that has been taken from caves in Crawford, Martin and Orange counties (Lewis et al. 2004). It is common on bluffs and rock outcrops like the entrance to this cave.

Family DICTYNIDAE –

Cicurina sp.
Funnel-web spider

- TP
- Monroe County:

Juveniles collected in this cave are not identifiable to species, but are likely *Cicurina pallida* (Pallid funnel-web spider). This species has been reported from caves in Clark, Crawford, Harrison, Jennings, Monroe and Orange counties (Lewis 1995, 1996, 1998; Lewis et al. 2004). This species is found from Indiana east to the Atlantic states (Chamberlin and Ivie 1940).

Family LINYPHIIDAE –

Bathyphantes pallidus (Banks)
Pallid sheet-web spider

- TX
- Monroe County:
- S4/G5

This species occurs across the northern half of the United States into Canada. It usually occurs near water or under objects on damp ground, and is a common cave inhabitant (Ivie 1969).

Microneta viaria (Blackwell)
Sheet-web spider

- TX
- Greene County:
- S4/G5

This spider was taken in leaf litter in the entrance of the cave. It is holarctic in distribution and lives in a variety of habitats including forest litter, gardens and quarries.

Phanetta subterranea (Emerton)
Subterranean sheet-web spider

- TB
- Greene County:
  Monroe County:
- S4/G5

This tiny spider is ubiquitous in Indiana caves, where it has been found in essentially every county where there is karst (Lewis 1983, 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004). Originally described from Crawford County, the species was redescribed by Millidge (1984) and reported from a range between Alabama and Pennsylvania, west to Indiana. Peck and Lewis (1978) reported this species from Illinois and Missouri.

Porrhomma cavernicola (Keys)
Cavernicolous sheet-web spider

- TB
- Greene County:
- S2/G4

In this species was taken in the company of the more common *Phanetta*

subterranea. This spider is widespread, but very sporadic in its occurrence in the eastern U.S. In Indiana it was previously reported from caves in Jennings, Lawrence, Monroe and Orange counties (Lewis 1995, 1998; Lewis and Rafail 2002, 2003, Lewis et al. 2004).

Family TETRAGNATHIDAE –

Meta ovalis (Gertsch)
American cave orb weaver

- TP
- Greene County:
- S4/G5

This species is ubiquitous in caves of the eastern U.S. (Marusik and Koponen1992). It has been recorded from essentially every county in Indiana that has caves (Blatchley 1897; Banta 1907; Lewis 1983, 1994, 1995, 1996, 1998, 2001; Lewis and Rafail 2002, 2003; Lewis et al. 2004).

Class COLLEMBOLA –

Family ENTOMOBRYIDAE –

Pseudosinella collina (Wray)
Hilly springtail

- TP
- Monroe County:
- S2/G3-4; IDNR Rare

Reflecting a probable sampling trend where in some instances the cave fauna is better known than that of the surface, this springtail is known only from two surface collections in Indiana, but has been identified from caves in Martin, Monroe, Orange and Washington counties (Lewis 1998, Lewis et al. 2004). This springtail varies from white to blue in color with eyes on a single pair of eye patches. It is reported from Alabama, Tennessee, Illinois, Pennsylvania and Virginia, with numerous cave populations. Further analysis may reveal that this assemblage involves a complex of related species (Christiansen and Bellinger 1998c).

Pseudosinella fonsa (Christiansen)
Fountain cave springtail

- TB
- Greene County:
- S2/G2-3; IDNR threatened

This species is quite rare, usually known from single specimens taken at each locality. In a single specimen was taken from a mudbank along the cave stream, in the dark zone of the cave. Described from a cave in Clark County (Christiansen and Bellinger 1996), Lewis (1998; Lewis et al. 2004) subsequently recorded it from caves in Crawford, Harrison, Lawrence, Orange and Washington counties. It is also known from one cave in southwestern Ohio (Christiansen and Bellinger 1998c).

Sinella alata (Christiansen)
Indiana cave springtail

- TB
- Greene County:
- S4/G3-4; IDNR Watch List

In identifying these specimens Soto (email 2006) reported that the only consistent, unambiguous differences between the material and that from the type-locality in Monroe County was the number of macrochaeta on abdominal segments 2 and 3. There were differences in the shape of the antennal sensila and the setae of the male genital plate. These differences may reflect inaccuracies in the published drawings and the differences in the macrochaetae may also be mistakes by Christiansen and Bellinger (1998c). If on the other hand the Christiansen and Bellinger (1998c) is accurate, the material might be an undescribed

species closely related to *Sinella alata*. Until this can be resolved, this material is being considered as conspecific with that species.

This collembolan is one of the more abundant species in They were taken by Berlese extraction from leaf litter immediately inside the cave entrance and were common under stones in the entrance room. They were taken in small numbers in pitfall traps throughout the cave as well as easily found on riparian mudbanks and around pellets of bat guano. *Sinella alata* is endemic to Indiana, where it occurs in caves in Clark, Crawford, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1983, 1994, 1995, 1998, 2002; Lewis et al. 2004).

Family HYPOGASTRURIDAE –

Ceratophysella succinea (Gisin)
Springtail

- TX
- Greene County:
- S4/G5

The specimens from were intermediate between succinea and engadensis (Soto email 2006), and thus might be interpreted as an undescribed species. As currently understood, the 6 dental setae on the fucula place them in *C. succinea*. This species is a member of the *denticulata* species complex, an assemblage of species that remains taxonomically confused (Christiansen and Bellinger 1998a). As presently understood, this species occurs across the United States and Europe.

Family ISOTOMIDAE –

Desoria trispinata (MacGillivray)
Three-spined springtail

- TX
- Greene County:
  Monroe County:
- S4/G5

This springtail was taken from leaf litter in the entrance of and from pitfall traps in
This is a common nearctic species that is known from numerous collections from caves (Christiansen and Bellinger 1998b). Lewis (1998) reported it from caves in Harrison and Martin counties (Lewis 1998; Lewis et al. 2004).

Family NEELIDAE –

Megalothorax minimus (Willem)
Springtail

- AC
- Greene County
- S4/G5

One specimen of this springtail was taken in the entrance zone of the cave. It is common across North America, where it is occasionally found in caves (Christiansen and Bellinger 1998d).

Family SMINTHURIDAE –

Arrhopalites undescribed species
Ashcraft cave springtail

- TB
- Greene County:
- S1/G1; IDNR Endangered candidate

This is a species new to science known only from As presently known it is endemic to These animals were found on mudbanks where they were typically in the presence of *Sinella* around pellets of bat guano. Many troglobitic species are known in the genus *Arrhopalites*

(Christiansen and Bellinger 1998d), in Indiana including *A. lewisi, A. ater*, *A. carolynae*, and two undescribed species from Lawrence County (Lewis et al. 2004).

This species will be added to the IDNR natural heritage program list of endangered and threatened species after review of this document has been completed.

Family TOMOCERIDAE –

Tomocerus bidentatus (Folsom)
Two-toothed springtail

- TP
- Monroe County:
- S4/G4

This species was taken from pitfall traps in this cave. It is slightly troglomorphic and is known primarily from caves, although a few surface records exist (Christiansen and Bellinger 1998c). It has been reported in Indiana from caves in Crawford, Greene, Harrison, Jennings, Lawrence, Monroe, Orange and Washington counties (Lewis 1995, 1998; Lewis and Rafail 2002, 2003; Lewis et al. 2004).

Tomocerus flavescens (Tullberg)
Golden springtail

- TP
- Greene County:
- S4/G5

Numerous specimens of this springtail were taken from leaf litter in a Berlese sample collected in the entrance zone of

This species has been recorded in caves in Clark, Crawford, Greene, Harrison, Jennings, Martin, Monroe, Orange and Washington counties, Indiana (Lewis, 1994; 1995; 1996; 1998, Lewis and Rafail 2002, 2003, Lewis et al. 2004). It occurs in caves through much of the U.S. and is known from many surface records (Christiansen and Bellinger 1998c).

Class INSECTA –

Order DIPLURA –

Family CAMPODEIDAE –

Tricampa rileyi (Silvestri)
Dipluran

- TP
- Greene County:
- S1/G4

This is a widespread species that had not been previously recorded from Indiana. The range otherwise runs from Ilinois south to Louisiana, and west to California into British Columbia. It has been found in enough caves to consider it a troglophile (Ferguson email 2006). Many of the non-troglobitic diplurans are edaphic and seldom encountered, leading to skewed perceptions as to their rarity.

Order ORTHOPTERA –

Family GRYLLACRIDIDAE –

Ceuthophilus brevipes (Scudder)
Cave cricket

- TX
- Greene County:
  Monroe County:
  Chic Spring Cave
- S4/G4

This species replaces *C. stygius* in the northern part of the Indiana karst and occurs sporadically in other Indiana caves. Hubbell (1936) reported it from seven localities in Indiana, including in Monroe County, as well as 20 states in the eastern U.S and Canada.

Order COLEOPTERA –

Family CARABIDAE –

Pseudanophthalmus undescribed species
Ray's cave beetle

- TB
- Greene County:
- S1/G1; IDNR Endangered

An undescribed species of the troglobite *Pseudanophthalmus* in the *tenuis* group occurs in and caves, Greene County (Barr email 2006). In it was found in small numbers (searching produced samples of 0-4 beetles per sampling trip) on mudbanks. Based on current knowledge, this species is endemic to a small area of Greene County. The full range of this species remains unknown.

To the south, *Pseudanopthalmus shilohensis shilohensis* occurs in Lawrence County caves, hybridizing with *P. s. mayfieldensis* in Monroe County (Barr 1960; Barr email 2006). *Pseudanophthalmus leonae* is known from a single specimen taken in near Springville in Lawrence County (Barr 1960).

Platynus tenuicollis (LeConte)
Slender ground beetle

- TP/TX
- Monroe County:
- S5/G5

This beetle is a common troglophile in the eastern U.S. (Barr, 1964).

Bembidion sp.
Ground beetle

- TX
- Monroe County:
- S4/G4

This is probably *Bembidion texanum*, a common cavernicole in eastern U.S. caves (Barr 1964).

Family LEIODIDAE –

Dissochaetus oblitus (LeConte)
Small carrion beetle

- TX/AC Monroe County:
- S4/G4

One specimen of this tiny beetle was taken from a pitfall trap. This species occurs across the eastern U.S.

Family STAPHYLINIDAE –

Subfamily ALEOCHARINAE –

Aleochara lucifuga (Casey)
Rove beetle

- TP
- Greene County:
  Monroe County:
- S4/G4

This species is known only from caves and animals burrows and has been reported from caves in the Appalachains and Interior Low Plateaus Klimaszewski and Peck (1986). In Indiana, it has been previously recorded from caves in Crawford, Dubois, Harrison, Lawrence, Monroe, Orange and Washington counties (Lewis 1998; Lewis and Rafail 2002, 2003; Lewis et al. 2004). The members of this group of rove beetles have larvae that are ectoparasitoids of the pupae of flies.

Atheta annexa (Casey)
Rove beetle

- TP
- Greene County:
  Monroe County:
- S4/G4

This species is known from Iowa, Illinois and Indiana south to Florida, but most of the records are from Kentucky, Tennessee and Alabama. This beetle is usually collected from organic debris, fungi, raccoon dung, and woodrat nests. It is on the edge of its range in Indiana, where Klimaszewski and Peck (1986) reported it from in Monroe County. Lewis et al. (2004) found it in caves in Dubois, Lawrence, Monroe and Orange counties.

Atheta troglophila (Klimaszewski and Peck)
Rove beetle

- TP
- Greene County:
- S4/G4

This species is known from Iowa to Pennsylvania, south to Florida, west to Arkansas. It is on the edge of its range in Indiana (Klimaszewski and Peck 1986).

Blepharrhymenus illectus (Casey)
Rove beetle

- TX
- Greene County:
- S1/G2-3

This species was previously known from caves in Alabama, Tennessee and Missouri and the type locality in Oregon. This distribution is odd and was speculated to be a collecting artifact (Klimaszewski and Peck 1986). Lewis et al. (2004) reported the first Indiana records from single caves in Lawrence and Orange counties.

Subfamily PSELAPHINAE –

Batrisodes krekeleri (Park)
Krekeler's cave ant beetle

- TB/TP
- Greene County:
- S1/G1; IDNR Endangered

A single female with slightly reduced eyes (Chandler email 2006) was taken under a stone in the entrance room of
This species is being tentatively identified as *B. krekeleri* pending comparison with type material. *Batrisodes krekeleri* was described from a single female specimen taken in in Clark County. Specimens resembling *B. krekeleri* have been collected from caves in Crawford and Lawrence counties (Lewis 1998, Lewis et al. 2004), but specific identification is problematic due to the incomplete nature of the original description.

Subfamily STAPHYLININAE –

Quedius erythrogaster (Mannerheim)
Rove beetle

- TX
- Greene County:
- S4/G5

One specimen of this beetle was taken from a pitfall trap in the entrance room of the cave, where it was associated with a raccoon latrine. This (and the following) species is commonly associated with raccoon dung communities in caves (Lewis 1998, Lewis et al. 2004).

Quedius spelaeus (Horn)
Spelean rove beetle

- TP
- Greene County:
- S4/G5

This species has been found only in subterranean habitats. The subspecies *Quedius spelaeus spelaeus* has been reported almost solely from caves from British Columbia to California, Idaho, Colorado, and in the east from Missouri to Nova Scotia. (Smetana 1971; Mosely et al. 2006). It is usually associated with mammal latrines. In it was found associated with raccoon latrines near the

entrance and came to cheese bait deeper in the cave.

Subfamily OMALIINAE –

Lesteva pallipes (LeConte)
Rove beetle

- TX
- Greene County:

- S4/G5

This beetle is common in cave stream habitats. Lewis (1998, Lewis et al. 2004) reported it from caves in Crawford, Harrison, Lawence, Monroe, Orange and Washington counties.

Order DIPTERA –

Family CHAOBORIDAE –

Undetermined species
Phantom midge

- SX
- Greene County:

This group of phantom midges has larvae that prey on micro-crustaceans (Pennak 1978). The specimens were taken in ceiling drip water collected and processed in a plankton net.

Family HELEOMYZIDAE –

Aecothea specus (Aldrich)
Heleomyzid fly

- TX
- Greene County:
  Monroe County:

- S4/G4

This species occurs on the walls and ceilings of caves. The ecology of heleomyzid flies in an Indiana cave was discussed in some detail by Busacca (1975).

Amoebaleria defessa (Osten Sacken)
Heleomyzid fly

- TX
- Greene County:
  Monroe County:
- S4/G4

This species occurs with *Aecothea specus* in the same wall and ceiling habitat.

Family PHORIDAE –

Megaselia cavernicola (Brues)
Cave hump-backed fly

- TP
- Greene County:
  Monroe County:

- S5/G5

This species is ubiquitous in caves of the eastern U.S. and has also been reported from surface collections (Borgmeier 1965). It probably occurs in nearly every cave in Indiana that is of any length (Lewis 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2003) and comes to baited pitfalls in abundance.

Family PSYCHODIDAE –

Threticus sp.
Moth fly

- TP/TX
- Monroe County:

Psychodid flies are common in caves where they usually occur around streams. The psychodid fauna of American caves is very poorly known and this identification is tentative. No obligate cavernicoles are known to occur in this group in the United States.

Family SCIARIDAE –

Sciara sp.
Dark-winged fungus gnat

- TP
- Greene County:
  Monroe County:

Similar to the situation with psychodids, sciarids are common in caves where they usually occur around streams, feeding on fungi and decaying organic material. They are frequently taken in pitfall traps in Indiana caves. The sciarid fauna of American caves is very poorly known and this identification is tentative. No obligate cavernicoles are known to occur in this group in the United States.

Family SPHAEROCERIDAE

Spelobia tenebrarum (Aldrich)
Cave dung fly

- TB
- Greene County:
  Monroe County:
- S5/G5

This fly is ubiquitous in Indiana caves and comes readily to pitfall traps (Blatchley 1897; Banta 1907; Lewis 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004). It is particularly common on raccoon dung and has been found in essentially every cave in Indiana where baited pitfalls have been placed. The species occurs in caves across the eastern U.S. and is a mildly troglomorphic troglobite (Marshall and Peck 1985).

Order SIPHONAPTERA –

Family LEPTOPSYLLIDAE –

Peromyscopsylla hesperomys (Baker)
Flea

- PS
- Greene County:
- S1/G2

This is a rarely collected ectocommensal on mice (Durden in literature), although it is difficult to know if the rarity is real or an artifact of collecting.

4.2.4 Phylum CHORDATA –

Class OSTEICHTHYES –

Order CYPRINIFORMES –

Family CYPRINIDAE –

Notropis sp.
Shiner

- SPR
- Monroe County:

These fish are common minnows - one was found swimming in the pooled stream in The cave owner reported that a Great blue heron frequents the area outside the cave entrance to feed on the minnows.

Order PERCIFORMES –

Family COTTIDAE –

Cottus carolinae (Gill)
Banded sculpin

- SP/SX
- Greene County:
- S4/G5

This species commonly occurs in caves. It is found from West Virginia south to Georgia, through southern Indiana west to Kansas (Clay 1975).

Class AMPHIBIA –

Order ANURA –

Family RANIDAE –

Rana clamitans (Latreille)
Green frog

- TX
- Greene County:
  Monroe County:
- S5/G5

This species is common throughout Indiana in a variety of habitats (Minton 2001).

Rana palustris (LeConte)
Pickerel frog

- TX
- Greene County:
  Spring
- S4/G5

Minton (2001) reported that in southern Indiana the Pickerel frog was nearly always found near spring streams, often in or near caves. Otherwise, this species occurs across much of the eastern U.S.

Order CAUDATA –

Family PLETHODONTIDAE –

Eurycea lucifuga (Rafinesque)
Cave salamander

- TP
- Greene County:
- S4/G5

Most of the records for the Cave salamander are from springs, spring-fed brooks or caves, but have also been found under stones on dry, open hillsides, under trash in an open field, and in suburban yards (Minton 2001). Compared to the Longtail salamander, the range of the Cave salamander is relatively restricted. In Indiana, it occurs only in the southern half of the state and a more compressed range essentially equal to the karst areas of the Appalachians, Interior Low Plateaus and Ozarks.

Eurycea longicauda (Green)
Longtail salamander

- TX/TP
- Greene County:
- S5/G5

This species is usually associated with rocky streams and is frequently associated with springs (Minton 2001). It was also noted by Minton that the Longtail salamander frequently occurred near the mouths of caves. Its overall range encompasses much of the eastern U.S.

Class MAMMALIA –

Order CHIROPTERA –

Family VESPERTILIONIDAE –

Myotis lucifugus (LeConte)
Little brown bat

- TX
- Greene County:
- S4/G5

The Little brown bat occurs almost exclusively in caves during hibernation, where they may occur singly, in small groups, or clustered in irregular rows. This species of bat does not form large, compact clusters during hibernation. Most Little brown bats seem to inhabit buildings during the summer, with bats found in caves during the summer being almost exclusively males (Mumford and Whitaker 1982).

Myotis sodalis (Miller and Allen)
Indiana bat

- TX
- Greene County:
- S1/G2; USFWS Endangered

This species hibernates in caves in the southern part of Indiana during the winter, and then occurs throughout the state during the summer when it lives in non-cavern habitats. Brack et al (2003, 2005) reported

on the status of the Indiana bat in Indiana, including its tenuous existence in

This species is declining throughout its range (Mumford and Whitaker 1982).

Perimyotis subflavus (Cuvier)
Eastern pipistrelle

- TX
- Greene County:
- S5/G5

The Eastern pipistrelle is a common, permanent inhabitant of southern Indiana. Mumford and Whitaker (1982) reported that almost every cave visited contained at least one bat of this species, although only three caves had 50 or more (one of these was

It was also noted that in small caves the pipistrelle was frequently the only bat species present. These bats always roost singly and usually occur on the walls or overhanging ledges rather than on the ceilings of caves. Pipistrelles occur in caves during all months of the year, although relatively few occur there during the summer months. This species was recently assigned to the genus *Perimyotis* from *Pipistrellus* by Hoofer et al. (2006).

Order RODENTIA –

Family CRICETIDAE –

Peromyscus leucopus (Rafinesque)
White-footed mouse

- TX
- Greene County:
- S5/G5

This species of mouse is one of the most common mammals in Indiana (Mumford and Whitaker 1982). It frequently enters caves and Banta (1907) recorded it at least 1500 feet from the entrance of

in Monroe County. The mice are seldom seen, but their droppings are commonly found in and around pitfall traps, as are the fleas that are their ectoparasites.

Family CASTORIDAE –

Castor canadensis (Kuhl)
Beaver

- TX
- Monroe County:
- S4/G5

In Indiana the beaver is believed to have become extinct by about 1840. The animal was reintroduced in 1935. The beaver has done well and is widely distributed in Indiana (Mumford and Whitaker 1982). Beavers have constructed a lodge in the upper side passage in and the rodents have gnawed numerous sticks scattered about the passage.

Order CARNIVORA –

Family PROCYONIDAE –

Procyon lotor (Linnaeus)
Raccoon

- TX
- Greene County:

  Monroe County:

- S5/G5

Evidence of raccoons in these caves consists of footprints, wall scratch marks and latrines. Raccoon dung is an important source of food and breeding habitat for the invertebrate community in caves (Mosely et al. 2006).

4.3 Sites Sampled --

4.3.1 –

4.3.1.1 Habitat –

The map of prepared in 1980 shows a length of 6074 feet.

is classified by USFWS as a Priority 3 Hibernaculum for *Myotis sodalis.* The Indiana Department of Natural Resources (IDNR) owns the cave entrance. The cave is entered via a hole in sandstone breakdown blocks located about 2/3 of the way up the hillside behind the spring resurgence of the cave stream. The passage enlarges to a walking height room immediately inside the entrance, with a sandstone roof and large blocks of sandstone breakdown on the floor. No aquatic habitat was present in the entrance area at the time of sampling for this project. Several raccoon latrines and a small amount of leaf litter coming in through the small entrance enriched dry terrestrial habitat. is a minor hibernaculum for Indiana bats and the entrance area exhibits significant temperature depression during the winter.

Descending through this entrance room leads to the main passage through which the cave is traversed. The first few hundred feet of passage appear to be a floodwater overflow route in which a small mud-bottomed stream, ponded in areas creating wider pools, creates aquatic habitat. Under base flow conditions the small stream is fed by ceiling drips that collect in small pools, and then enter the stream to flow away from the entrance toward the main stream passage. Under flood conditions, this flow presumably reverses allowing egress of the water from the cave.

The primary aquatic habitat in is the main stream, which is encountered about 400 feet from the entrance. The downstream section is primarily soft, mud-bottom substrate, probably resulting from ponding during flooding. The stream bifurcates at a side passage encountered about 500 feet from the entrance. The stream in the side passage is typically narrow and shallow, flowing over bedrock or through gravels. The stream in the main passage changes character upstream with the mud-bottomed pools becoming interspersed with gravel and breakdown riffle areas. The areas of gravel become more predominant the further upstream one travels.

Approximately 1000 feet from the entrance suds and foam were noted in the cave stream water. This is suggestive of contamination of the stream by a surface source.

The terrestrial habitat of the cave beyond the relatively dry entrance area consists of mudbanks lining the sides of the stream, merging above into the moist bedrock walls of the cave. Localized areas of breakdown occur throughout the cave.

4.3.1.2 Aquatic Community –

The subterranean amphipod *Crangonyx packardi* was common in drip pools near beginning of the stream passage. The troglophilic crayfish *Cambarus laevis* were present starting in residual flood pools where water is first encountered in the cave, and continuing in the main stream. In the main stream the isopod *Caecidotea stygia* was abundant under breakdown blocks in riffles.

Quantitative Surber samples were taken as noted in 3 riffle areas in the main stream passage. Each revealed a community dominated by the isopod *Caecidotea stygia*, with 4 to 5 isopods per sample. The third sample also contained 1 amphipod *Crangonyx forbesi*.

Stream gravel washings completed on 19 August 2006 at the same three sites where

Surber samples were taken revealed *Caecidotea stygia*, *Crangonyx packardi* and 1 cyclopoid copepod *Macrocyclops albidus*.

Three quantitative Surber samples were taken in on 19 August 2006. The first Surber sample was performed mid-stream at the first side passage on the right, about 800 feet from entrance. The habitat was riffle, with stream width 4 feet, sample depth 2 to 4 centimeters, substrate loose gravel on mud/sand. Fauna in this sample:

Caecidotea stygia (mm): 4, 4, 6, 5, and 3

Surber sample #2 was taken mid-stream at the first breakdown room, with habitat consisting of riffle, stream width 2.5 feet, sample depth 4 to 6 centimeters, with a single breakdown slab present, substrate otherwise with loose gravel on bedrock, with sand and mud, sampler placed 3 feet downstream from the upstream end of the riffle. Fauna in this sample:

Caecidotea stygia (mm): 5, 3, 4, and 9

Surber sample #3 was taken mid-stream at second breakdown room. The habitat was a riffle, stream width 7 feet, sample depth 3 to 10 centimeters, loose cobbles, gravel on mud and sand, sampler placed at downstream margin of riffle. Fauna in this sample:

Caecidotea stygia (mm): 8, 10, 9, and 7
Crangonyx forbesi (mm): 14

A bucket placed under a ceiling drip on 2 September 2006 had gathered about 2 liters of water by 4 September and was drained through a plankton net. Phantom midge larvae were present. A high intensity dive light was used to search for crayfish on 2 September 2006 and revealed only the stygophile *Cambarus laevis*.

The stream in the north side passage was investigated on 2 September 2006. The isopod *Caecidotea stygia* was common and the amphipod *Crangonyx indianensis* was found in the gravels. Crayfish were not found.

On 4 September 2006, a crayfish census was conducted from the beginning of the main stream to the passage stricture approximately 2000 feet from the entrance, a census area encompassing about 1600 linear feet. The stream was illuminated with a high intensity dive light. Visibility in the water was about 2 feet. This survey yielded the following fauna observed:

Cottus carolinae (mm): 40 and 75

Eight crayfish *Cambarus laevis* (mm): 82 (male), 75 (male), ca.60 (undetermined) 54 (female), 26 (female), 73 (female), 73 (male), 60 (male).

On 16 September 2006, the bucket that had been left under a drip in the lower level was found full of water and was then drained through a plankton net. No animals were found after examination under a dissecting microscope. It was left in the cave, and then resampled on 30 September 2006. The bucket was removed from the cave at that time. No fauna was appreciated in the sample.

4.3.1.3 Terrestrial Community –

The twilight zone of the cave is characterized by latrines of the raccoon *Procyon lotor*, inhabited by an invertebrate community dominated by the cave dung fly *Spelobia tenebrarum*. Also present was the

rove beetle *Quedius spelaeus*, hump-backed fly *Megaselia cavernicola*, springtail *Sinella alata* and sheet-web spider *Phanetta subterranea*. One ant beetle *Batrisodes* sp. was found under a rock. The cave orb weaver was present on webs suspended from the walls and ceiling. The heleomyzid fly *Aecothea specus* was present on the walls. The cave salamander *Eurycea lucifuga* occurred on walls and under stones in the entrance area.

Berlese extraction of leaf litter taken 19 August 2006 just inside the entrance produced the cave dung fly *Spelobia tenebrarum*, juveniles of the millipede *Conotyla bollmani*, sheet-web spider *Microneta viaria* and numerous collembolans: *Tomocerus flavescens*, *Sinella alata*, *Ceratophysella succinea*, *Desoria trispinata* and *Megalothorax minimus*.

Brack et al. (2003) documented small numbers of the endangered Indiana bat *Myotis sodalis* in 20 (1993), 28 (1995) and 3 (1999). Other bats present were the little brown bat *Myotis lucifugus* (190 in 1993, 170 in 1995, 29 in 1999), Eastern pipistrelles *Perimyotis subflavus* (6 in 1993 and 14 in 1995), and Big brown bats *Eptesicus fuscus* (4 in 1993). Brack et al. (2005) noted that the stream in during a 2005 visit left a watermark 2.3 meters above the base-flow level. This would have inundated most of the areas typically used by all of the hibernating bat species, resulting in their deaths. It was the belief of Brack et al. (2005) that declines in abundance were probably attributable to flooding of the cave.

In the dark zone of the cave the mud-banks were inhabited by springtails *Sinella* sp. and *Arrhopalites* undescribed species, the flies the cave dung fly *Spelobia tenebrarum*, spider *Phanetta subterranea*, and millipede *Conotyla bollmani*. The cave salamander *Eurycea lucifuga* and Longtail salamander *Eurycea longicauda* were present in small numbers of mud-banks. On 12 August 06 one little brown bat *Myotis lucifugus* and a few Eastern pipistrelles *Perimyotis subflavus* were noted. On 19 August 2006, 6 cave salamanders *Eurycea lucifuga* and 1 Longtail salamander *Eurycea longicauda* were noted in the part of the cave traversed along the main stream passage to point about 1500 feet from the entrance. One Eastern pipistrelle *Perimyotis subflavus* and one Indiana bat *Myotis sodalis* were noted. Eight *Myotis* sp. were noted in a breakdown dome about 800 feet from the entrance but dropped into flight before examination could be conducted.

On 19 August 2006, 12 pitfall traps (placed on 12 August in riparian mudbanks between the beginning of the lower level and the intersection of the main stream) were retrieved. Approximately 99% of the fauna present in the pitfalls were the flies *Spelobia tenebrarum*, *Megaselia cavernicola* and *Sciara* sp. A few of the heleomyzid fly *Aecothea specus*, rove beetles *Aleochara lucifuga and Atheta annexa*, millipede *Conotyla bollmani*, one larva of *Quedius spelaeus*, and one carabid beetle *Pseudanophthalmus* undescribed species were present.

On 2 September 2006 the cave was entered to retrieve the pitfall traps. The entrance room in the vicinity of the previous collection site of *Batrisodes* was searched without additional specimens being found. Of the 12 placed, all of them within approximately 4 vertical feet of base level

were destroyed by flooded. Five that had been placed higher remained intact. The pitfalls primarily contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola* and *Sciara* sp. Other species present were springtails *Arrhopalites* undescribed species and *Sinella* sp., cave cricket nymphs *Ceuthophilus brevipes*, a flea (probably from a mouse or raccoon feeding on the bait), heleomyzid fly *Aecothea specus*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, and millipede *Conotyla bollmani*, and *Quedius spelaeus*.

Observations of other fauna on 2 September 2006 included 1 Eastern pipistrelle *Perimyotis subflavus*, 9 Longtail salamanders *Eurycea longicauda,* and 5 Cave salamanders *Eurycea lucifuga*. Two cave beetles *Pseudanophthalmus* undescribed species were collected from riparian mudbanks. Twelve pitfall traps were placed in riparian mudbanks along the north side passage. A bucket was placed under a drip in the lower level to sample for the presence of epikarstic fauna.

On 4 September 2006, the millipede *Trichopetalum uncum* was found deep in the cave on a pellet of bat guano on a riparian mudbank. The collembolans *Sinella* sp. and *Arrhopalites* undescribed species were also regular on the guano pellets. Four of the Ray's cave beetle *Pseudanophthalmus* undescribed species were taken from riparian mudbanks. Several bats were noted flying about the cave, but none were seen other than in flight. Little water was present in the bucket, but it was poured through a plankton net and several phantom midges were found.

On 16 September 2006 the cave was entered and the entrance room again searched for *Batrisodes*. No pselaphids were noted, but the linyphiid spiders *Phanetta subterranea* and *Porrhomma cavernicola* were found under stones. Two Indiana bats *Myotis sodalis* were present and awake in the entrance room. Four pitfalls were placed in the entrance room.

The pitfalls placed in the north side passage were intact and pulled. The pitfalls primarily contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Sciara* sp. Other species present were springtails *Arrhopalites* undescribed species, *Sinella* sp., and two of the rove beetle *Aleochara lucifuga*.

On 30 September 2006 was sampled again. Approximately 400 stones were turned in the entrance room in search of *Batrisodes*, however none were found. The pitfalls were retrieved and contained numerous cave crickets *Ceuthophilus brevipes* and flies *Spelobia* tenebrarum, *Megaselia cavernicola*, *Sciara* sp., collembolans *Tomocerus flavescens*, *Sinella alata*, and 1 each of the staphylinid beetles *Aleochara lucifuga* and *Quedius erythrogaster*.

4.3.1.4 Species –

Obligate subterranean species: 12

Caecidotea stygia
Northern cave isopod

Crangonyx packardi
Packard's groundwater amphipod

Crangonyx indianensis
Indiana cave amphipod

Conotyla bollmani
Bollman's cave millipede

Phanetta subterranea
Subterranean sheet-web spider

Porrhomma cavernicola
Cavernicolous sheet-web spider

Arrhopalites undescribed species
Ashcraft cave springtail
Pseudosinella fonsa
Fountain cave springtail
Sinella alata
Indiana cave springtail
Pseudanopthalmus undescribed species
Ray's cave beetle
Spelobia tenebrarum
Cave dung fly
Batrisodes krekeleri
Krekeler's cave ant beetle

Species of concern: 8
Crangonyx packardi
Packard's groundwater amphipod
G4 IDNR Watch List
Crangonyx indianensis
Indiana cave amphipod
G4 IDNR Watch List
Conotyla bollmani
Bollman's cave millipede
G4 IDNR Watch List
Arrhopalites undescribed species
springtail
G1 IDNR Endangered candidate
Pseudosinella fonsa
Fountain cave springtail
G2-3 IDNR Threatened
Sinella alata Indiana cave springtail
G3-4 IDNR Watch List
Pseudanopthalmus undescribed species
Ray's cave beetle
G1 IDNR Endangered
Myotis sodalis Indiana bat
G2 USFWS Endangered

Vertebrates: 8
Eurycea lucifuga
Cave salamander
Eurycea longicauda
Longtail salamander
Eptesicus fuscus
Big brown bat
Myotis lucifugus
Little brown bat
Myotis sodalis
Indiana bat
Perimyotis subflavus
Eastern pipistrelle
Peromyscus leucopus
White-footed mouse
Procyon lotor
Raccoon

4.3.2 –

4.3.2.1 Habitat –

This is the exit for subterranean waters flowing from The water emerges from a series of unenterable holes among breakdown blocks below the entrance to the cave.

4.3.2.2 Aquatic Community –

The flatworm *Phagocata gracilis*, isopod *Lirceus fontinalis*, and amphipod *Gammarus minus* were present under stones and in aquatic mosses where the water emerges. A Pickerel frog was noted on 19 August 2006. On 30 September 2006 rocks in the emergence area of the spring were pried from the substrate and the cave isopod *Caecidotea stygia* was found.

4.3.2.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.2.4 Species –

Obligate subterranean species: 1
Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 1
Rana palustris Pickerel frog

4.3.3 –

4.3.3.1 Habitat –

This collapsed cave entrance was noticed blowing air while visiting ad had no previous name. It lies approximately 200 feet south and 50 feet west of the Ashcraft entrance. It appeared to be a lower alternate entrance to and was included in the survey. There was a definite drip line and the portion of this cave that could be surveyed is within the twilight zone. On 16 September 2006 a strong air current was blowing out of the cave. A dry streambed leads from the entrance, which is about 3 feet wide by 2 feet high. The cave is floored by breakdown and extends about 25 feet, although the narrow crawl continues to extend and might be enterable by a very small person. A passage in unstable breakdown near the entrance of leads toward the annex cave.

4.3.3.2 Aquatic Community –

This cave appears to be a wet-weather overflow from nearby but was completely dry when examined on 16 and 30 September 2006.

4.3.3.3 Terrestrial Community –

The spider *Phanetta subterranea* was found under a stone. The dung fly *Spelobia tenebrarum* was taken on raccoon dung. Two pitfalls were placed on 16 September 2006 in loose gravel at the limit of entry of the cave. The cave was re-visited on 30 September 2006. A Cave salamander *Eurycea lucifuga* was noted in the twilight zone. One of the pitfalls had been knocked over and emptied, possibly raccoon disturbance, and the other was removed intact. The surviving pitfall contained the cave cricket *Ceuthophilus brevipes*, flies *Megaselia cavernicola*, *Amoebaleria defessa*, and *Spelobia tenebrarum*, and the staphylinid beetle *Lesteva pallipes*.

Two additional pitfalls were placed on 30 September 2006 and retrieved on 8 October 2006. The pitfalls were intact and contained the cave cricket *Ceuthophilus brevipes*, flies *Megaselia cavernicola*, *Amoebaleria defessa*, and *Spelobia tenebrarum*, and the staphylinid beetle *Atheta annexa*. Two pitfalls were again put in the cave on 8 October 2006, which were retrieved on 14 October 2006. These pitfalls contained flies *Megaselia cavernicola*, *Spelobia tenebrarum*, and the staphylinid beetles *Atheta annexa* and *Lesteva pallipes*. The rocks removed from the cave to allow entry were replaced at the last visit to restore the entrance to its original dimensions.

4.3.3.4 Species –

Obligate subterranean species: 2

Phanetta subterranea
Subterranean sheet-web spider

Spelobia tenebrarum
Cave dung fly

Species of concern: 0

Vertebrates: 2

Eurycea lucifug
Cave salamander

Procyon lotor
Raccoon

4.3.4 –

4.3.4.1 Habitat –

The main flow of the spring appears to come from the deepest point in the basin, which is floored with slabs of stone. A concrete standpipe was in the spring to cover a water-inlet pipe used by the owner. The water is

dammed by an adjacent road and forms a wetland around the spring characterized by species such as Burreeds (*Sparganium*), Watercress (*Nasturtium officinale*), and Waterweed (*Elodea*).

4.3.4.2 Aquatic Community –

Hand collections made in the spring on 12 August 2006 produced the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*. A plankton tow produced the copepods *Acanthocyclops einslei* and *Eucyclops agilis*. A shrimp-baited jar was placed in the spring orifice area on 19 August and retrieved on 20 August 2006. It produced the flatworm *Phagocata gracilis*, isopod *Lirceus fontinalis*, ostracods *Candona acuta* and *Cypria turneri*, copepods *Acanthocyclops einslei*, *Eucyclops elegans*, and *Macrocyclops fuscus*, and cladoceran *Ilyocryptus sordidus*.

On 2 September 2006 the spring was visited. The water was murky with significantly reduced visibility. A shrimp-baited jar was placed in the spring. On 3 September 2006 the spring was re-visited and it was found that the line to the baited jar had been cut. Another shrimp-baited jar was placed on the morning 16 September 2006. Due to the previous vandalism of the sampling the jar was pulled that evening and contained the isopod *Lirceus fontinalis*.

The spring was visited on 8 October 2006. At that time the isopod *Lirceus fontinalis*, amphipod *Crangonyx forbesi* and snail *Physa* sp. were found on rocks and aquatic plants.

4.3.4.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.4.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1
Rana clamitans
Green frog

4.3.5 –

4.3.5.1 Habitat –

This spring emerges from the side of the hill and flows over a substrate of bedrock, broken rock and sand. The stream cascades to the nearby creek.

4.3.5.2 Aquatic Community –

The subterranean isopod *Caecidotea stygia*, spring isopod *Lirceus fontinalis*, and spring flatworm *Phagocata gracilis* were present in the area around the spring orifice. A shrimp-baited jar was buried in the substrate near where the water emerges on 19 August 2006, and then retrieved on 20 August 2006. Small numbers of spring isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*, were taken.

On 3 September 2006 the spring was visited and a shrimp-baited jar placed in the upstream orifice. The jar was removed on 4 September 2006 and contained the isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*.

4.3.5.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.5.4 Species –

Obligate subterranean species: 1

Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 0

4.3.6 –

4.3.6.1 Habitat –

The water emerges from breakdown at the base of an alcove with an overhanging shelter cave. The substrate is a mixture of bedrock, stones and sand.

4.3.6.2 Aquatic Community –

The isopod *Lirceus fontinalis* and spring flatworm *Phagocata gracilis* were present in the area around the spring orifice. A shrimp-baited jar was buried in the substrate near where the water emerges on 19 August 2006, and then retrieved on 20 August 2006. Large numbers of the spring flatworm *Phagocata gracilis* essentially covered the surface of the jar. A few of the spring isopod *Lirceus fontinalis* and amphipod *Gammarus minus* were also present. The terrestrial isopod *Ligidium elrodi* was noted in the breakdown orifice of the spring.

On 3 September 2006 the spring was visited and a shrimp-baited jar placed in the upstream orifice. The jar was removed on 4 September 2006 and contained the isopod *Lirceus fontinalis*, amphipod *Gammarus minus*, and the spring flatworm *Phagocata gracilis*.

4.3.6.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.6.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 0

4.3.7 –

4.3.7.1 Habitat –

A hole in the sandstone less than a foot in height (too small to enter by humans), had pronounced air blowing from it on 12 August 2006. The site was visited again on 19 August 2006 and was again blowing.

4.3.7.2 Aquatic Community –

No aquatic habitat exists at this site (
is below it).

4.3.7.3 Terrestrial Community –

A latrine of the raccoon *Procyon lotor* was present in the opening of the blowhole. The site was visited again on 19 August 2006 and a jar with Limburger bait was placed at arm's length into the hole. The jar was pulled on 20 August 2006 and no fauna appreciated. The jar was attached to a stout wire and pushed a total of perhaps 7 feet into the hole.

The site was visited on 3 September 2004 and the baited jar was removed. Several tiny braconid wasps were present – these wasps are parasitic on cave flies, laying their eggs on their larvae.

4.3.7.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1
Procyon lotor
Raccoon

4.3.8 –

4.3.8.1 Habitat –

At base-flow this cave has 1 to 3 feet of water from wall to wall with 1 to 2 feet of airspace. The substrate of the stream is primarily mud/silt, with a small area near the entrance floored with stones. A crawlway about 2 feet above the pool level is present and was mostly filled with beaver den debris. Adjacent to this is a water crawlway that can be entered for only a few feet before it becomes too small for egress. Limited areas of mudbanks are present along both walls. The cave ends in a sump, but examination below the water revealed continuation of the passage.

4.3.8.2 Aquatic Community –

One shiner *Notropis* sp. was noted by snorkeling the cave stream. A Green frog *Rana clamitans* was present on 13 and 19 August 2006. On 2 September 2006 the cave was visited and a shrimp-baited jar placed within a larger bait bucket in the upstream orifice. The jar and bucket were removed on 3 September 2006, the site was snorkeled and no crayfish were visualized in or near the bait. The stygobitic ostracod *Pseudocandona jeanneli* and copepod *Eucyclops elegans* were attracted to the shrimp bait. Inspection of rocks on the bottom of the stream near the cave entrance revealed the cave isopod *Caecidotea stygia*, spring isopod *Lirceus fontinalis*, spring amphipod *Gammarus minus*, and flatworm *Phagocata gracilis*.

A shrimp-baited jar was placed in the cave on 30 September 2006, and then removed on 1 October 2006. The jar contained the isopod *Lirceus fontinalis* and one cyclopoid copepod *Eucyclops elegans*.

4.3.8.3 Terrestrial Community –

Four pitfalls were placed on 13 August 2006 and retrieved on 20 August 2006. These traps were dominated by the hump-backed fly *Megaselia cavernicola*, with sparse cave dung flies *Spelobia tenebrarum*, Dark-winged fungus gnats *Sciara* sp., and heleomyzid flies *Aecothea specus*. The den of the beaver *Castor canadensis* appeared to be intact in the crawlway, but the owners reported that the animal had departed during the floods during the spring of 2006. It was not observed during the fieldwork.

Pitfall traps were pulled and replaced on 3 September 2006. The pitfalls contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Aecothea specus* and one cave cricket *Ceuthophilus brevipes*.

was again visited on 17 September 2006 and the pitfalls were pulled and replaced. The pitfalls contained a Cave salamander *Eurycea lucifuga*, flies *Spelobia tenebrarum* and *Megaselia cavernicola*, 3 cave crickets *Ceuthophilus brevipes*, and 1 ground beetle *Bembidion* sp.

The cave was revisited on 30 September 2006 and the pitfalls were removed. The pitfalls contained flies *Spelobia tenebrarum*, *Megaselia cavernicola*, and *Sciara* sp., 2 ground beetles *Platynus tenuicollis* and 1 terrestrial isopod *Trachelipus rathkei*.

On 14 October 2006 a shrimp-baited jar was placed in which was retrieved on 15 October 2006. The bait attracted several cyclopoid copepods.

4.3.8.4 Species –

Obligate subterranean species: 3

Pseudocandona jeanneli

Jeannel's groundwater ostracod

Caecidotea stygia
Northern cave isopod
Spelobia tenebrarum
Cave dung fly

Species of concern: 1
Pseudocandona jeanneli
Jeannel's groundwater ostracod
G2 IDNR Endangered

Vertebrates: 3
Notropis sp.
Shiner
Rana clamitans
Green frog
Castor canadensis
Beaver

4.3.9 –

4.3.9.1 Habitat –

The entrance to this cave is 11 inches high and allows egress to 31 feet of passage that averages 2 feet wide by 2 feet high. A shallow stream flows the length of the cave. Upon entry, most of the wall area is bedrock, but the left wall has dry, desiccated clay on the wall ledge, the right wall has wet, oozy clay.

4.3.9.2 Aquatic Community –

Present in the stream are the subterranean isopod *Caecidotea stygia*, and amphipods *Crangonyx packardi* and *Gammarus minus* (census data below). A juvenile crayfish was presumptively *Cambarus laevis*.

stream census, 20 August 2006

Sample #1: 10 feet from entrance, habitat: stream width 4 to 7 inches, sample depth 0 to 2 centimeters, substrate mud; fauna:
Gammarus minus (mm): 14 and 6

Sample #2: 15 feet from entrance, habitat: stream width 19 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 4, 5, 4, 4, 3, 5, 6, 8, 3, 3, 7, 4, 7, 5, 5, 5, 3, 3, and 4
Gammarus minus (mm): 5, 3, and 2

Sample #3: 20 feet from entrance, habitat: stream width 19 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 4, 4, 6, 4, 4, and 4
Gammarus minus (mm): 5, 5, 5, and 5
Crangonyx spp. (*packardi*/*forbesi*) (mm): 2, 3, 3, and 3

Sample #4: 25 feet from entrance, habitat: stream width 21 inches, sample depth 0 to 1 centimeter, substrate loose gravel on mud/sand; fauna:
Caecidotea stygia (mm): 5, 6, 4, 4, 4, 2, 5, and 7
Gammarus minus (mm): 5, 4, 5, 5, 5, 4, 4, 4, and 4
Crangonyx spp. (*packardi*/*forbesi*; mm): 2, 2, and 3

On 17 September the cave was visited and in addition to the above species, one Weingartner's cave flatworm *Sphalloplana weingartneri* was found feeding on residual cheese bait on a pitfall jar that had been washed out and fallen into the stream during flooding.

4.3.9.3 Terrestrial Community –

Hand collections on 13 August 2006 included the spiders *Cicurina* sp. and *Coras*

sp. Four pitfalls were placed on 13 August 2006 and retrieved on 20 August 2006. These traps were dominated by the hump-backed fly *Megaselia cavernicola*, cave dung flies *Spelobia tenebrarum*, a few heleomyzid flies *Aecothea specus*. Also present were the rove beetles *Aleochara lucifuga* and *Blepharrhymenus illectus*, one small carrion beetle *Dissochaetus oblitus*, and one each of the spiders *Phanetta subterranea*, *Bathyphantes pallidus*, and *Cicurina* sp.

The cave was visited on 3 September 2006 to retrieve the pitfalls previously placed and another set of pitfalls was placed. The pitfalls contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola,* and *Aecothea specus*. Other species present were cave cricket nymphs *Ceuthophilus brevipes*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, millipede *Oxidus gracilis*, and the troglophilic ground beetle *Platynus tenuicollis*.

was again sampled on 17 September 2006. At that time when the entrance was approached it was noted that two of the pitfall trap lids were lying under the drip line. Upon entry, a third was sticking to the ceiling with other flood debris. All but one of the pitfalls were destroyed. One flooded pitfall contained the flies *Spelobia tenebrarum* and *Megaselia cavernicola*, rove beetle *Atheta annexa*, and 1 terrestrial isopod *Cylisticus convexus*. A new set of pitfalls were placed and baited. These were retrieved on 30 September 2006 and contained the flies *Spelobia tenebrarum*, *Megaselia cavernicola, Threticus* sp., *Sciara* sp., and *Amoebaleria defessa*, rove beetles *Aleochara lucifuga* and *Atheta annexa*, ground beetle *Platynus tenuicollis*

4.3.9.4 Species –

Obligate subterranean species: 4

Sphalloplana weingartneri
Weingartner's cave flatworm

Caecidotea stygia
Northern cave isopod

Phanetta subterranean
Subterranean sheet-web spider

Spelobia tenebrarum
Cave dung fly

Species of concern: 1

Sphalloplana weingartneri
Weingartner's cave flatworm G3
IDNR Watch List

Vertebrates: 0

4.3.10 –

4.3.10.1 Habitat –

This site is a wet weather seep near . No orifice is present. It was examined on 13 August 2006 and 20 August 2006 and damp leaves were present, but no water. On 3 September 2006 the area appeared moister but no water was present. On 17 September 2006 water was oozing from the ground in several spots and with a total flow of less than 1 gallon per minute. Subterranean fauna present in the intermittent stream below the seep is flushed from groundwater during periods of high flow. The site was visited again on 30 September 2006 and the seep was again oozing at about the same rate as the previous visit. On 8 October 2006 water was barely seeping out, and on 14 October flow had stopped and the stream had turned into a series of stagnating pools.

4.3.10.2 Aquatic Community –

On 17 September 2006 the isopods *Caecidotea stygia* and *Lirceus fontinalis*, and amphipod *Crangonyx indianensis* were found. The *Caecidotea* and *Crangonyx* were found by prying rocks out of the substrate and looking on the undersides. On 30 September 2006 the isopod *Caecidotea stygia* was again found in this manner. A plankton net was placed in the flow of the stream and the leaves and substrate were agitated. This sample yielded the isopod *Lirceus fontinalis* and the amphipod *Crangonyx forbesi*.

Another drift sample was taken on 8 October 2006. The seep was barely oozing water at that time. This sample contained *Lirceus fontinalis* and a harpacticoid copepod *Attheyella nordenskioldii*.

4.3.10.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.10.4 Species –

Obligate subterranean species: 2

Caecidotea stygia
Northern cave isopod

Crangonyx indianensis
Indiana cave amphipod

Species of concern: 1

Crangonyx indianensis
Indiana cave amphipod G4
IDNR Watch List

Vertebrates: 0

4.3.11 –

4.3.11.1 Habitat –

The main spring is covered by a block springhouse identified as measuring 7 feet 8 inches square and is 5 feet 8 inches high on the door side. The water emerges from holes near the base of the springhouse, ponds on the floor, and then discharges into a spring run.

The spring stream flows away from the springhouse following the edge of the hill from which it emerges. Perhaps 50 feet downstream is another small spring.
is about an equal distance upstream of the springhouse spring.

4.3.11.2 Aquatic Community –

Hand sampling on 13 August 2006 revealed the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*.

The spring was sampled on 17 September 2006 by placing a plankton net over the main spring orifice and left in place for approximately 8 hours. This sample contained the isopod *Caecidotea stygia* and copepods *Microcyclops varicans* and *Orthocyclops modestus*. Noted on the floor of the springhouse were the isopods *Caecidotea stygia* and *Lirceus fontinalis* and the amphipod *Crangonyx forbesi*.

On 30 September 2006 a Karaman-Chappuis sampling hole was excavated and a piece of perforated PVC pipe placed to retain the soil. A shrimp baited jar was placed in the hole and then retrieved on 1 October 2006. No fauna was found in this jar. A small shred of shrimp was returned to the jar and it was replaced in the hole. Stones in the orifice of the downstream spring were examined and found to contain the isopod *Lirceus fontinalis*, amphipod *Gammarus minus,* and flatworm *Phagocata gracilis*.

A second shrimp baited jar was placed 30 September 2006 in the pooled water in the springhouse immediately below the spring

orifice. This jar was also retrieved on 1 October 2006 and the contents removed. A plankton net was placed to receive the water flowing out of the spring orifice on 1 October 2006 for about an hour; no fauna was appreciated when the sample was examined in the lab.

The jar was returned to the springhouse basin on 1 October 2006 with a shred of shrimp for bait. The jar was drained through a plankton net on 8 October 2006 and contained juvenile cyclopoid copepods, probably *Acanthocyclops*. The jar and the remaining shrimp were returned to the springhouse basin. This was examined on 14 October 2006 for macrofauna and none was noted. A shrimp was placed in the jar and it was returned to the springhouse basin. The jar was removed on 15 October 2006 and contained 4 *Crangonyx forbesi*, 1 *Crangonyx indianensis*, and 2 cyclopoid copepods *Eucyclops elegans* and *Macrocyclops albidus*. A plankton net was hung on the spring orifice on 14 October and then retrieved on 15 October 2006. This sample contained 4 *Crangonyx forbesi*, 1 *Lirceus fontinalis*, cyclopoid *Acanthocyclops* sp., and harpacticoid *Attheyella nordenskioldii*.

The Karaman-Chappuis sampling hole was examined on 8 October 2006 and the jar had been removed and was lying nearby in the stream. It was refilled with water and returned to the sampling hole. On 14 October 2006 the site was re-visited. The PVC sampling well appeared to have been dislodged (as if someone had kicked it) and was leaning to one side in the hole, but the jar within was intact. It was examined and no macrofauna was seen. A shrimp was placed in the jar and it was returned to the sampling site. On 15 October 2006 the water from the jar was run through a plankton net and the sample returned to the lab. The PVC tube was removed and the hole filled with the soil that had been dug out initially. The sample contained 1 isopod *Lirceus fontinalis*, a cyclopoid copepod *Microcyclops varicans,* and was teeming with protozoans.

4.3.11.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.11.4 Species –

Obligate subterranean species: 1
Caecidotea stygia
Northern cave isopod

Species of concern: 0

Vertebrates: 0

4.3.12 –

4.3.12.1 Habitat –

This spring occurs a short distance from emerging from the side of a hill. A small wetland characterized by the presence of bulrush (*Scirpus*) is present. The water from the spring flows toward the spring run from where it then becomes confluent. Water also emerges from the hillside about halfway between .

4.3.12.2 Aquatic Community –

Hand sampling on 13 August 2006 revealed the isopod *Lirceus fontinalis* and amphipod *Crangonyx forbesi*. A Green frog, *Rana clamitans,* was calling from the wetland area.

On 30 September 2006 a Karaman-Chappuis sampling hole was excavated and a piece of

perforated PVC pipe placed to retain the soil. A shrimp baited jar was placed in the hole and then retrieved on 1 October 2006. No fauna was found in this jar. A small shred of shrimp was returned to the jar and it was replaced in the hole. The site was visited on 8 October 2006 and the jar had been removed from the sampling hole and was lying nearby on the bank. It was refilled with water and returned to the sampling hole. Upon returning on 14 October 2006 the jar had again been removed and placed next to the stream. The jar was rebaited and placed back into the sampling well. It was removed intact on 15 October 2006 and contained 11 of the amphipod *Crangonyx forbesi*.

4.3.12.3 Terrestrial Community –

No subterranean habitat exists at this site.

4.3.12.4 Species –

Obligate subterranean species: 0

Species of concern: 0

Vertebrates: 1

Rana clamitans
Green frog

5.0 Discussion

Six sites (Figure 2, Table 1) were sampled for subterranean fauna based on identified hydrological connectivity to the Section 4 Corridor. Sites included:

1) including its resurgence and a crawlway that is probably a floodwater overflow route from (Greene County; sampled 12 August, 19 August, 2 September, 4 September, 16 September, 30 September, 8 October, and 14 October 2006).

2) and and a small associated blowing hole above (Greene County; sampled 12 August, 19 August, 20 August, 3 September, and 4 September 2006).

3) (Greene County; sampled 12 August, 19 August, 2 September, 3 September, 16 September, and 8 October 2006).

4) PicAChic Spring Cave and an associated wet weather seep, (Monroe County; sampled 13 August, 20 August, 3 September, 4 September, 17 September, 30 September, 8 October and 14 October 2006).

5) (Monroe County; sampled 13 August, 19 August, 3 September, 4 September, 17 September, 30 September, 1 October, 14 October, and 15 October 2006).

6) complex, including (Monroe County; sampled 13 August, 17 September, 30 September, 1 October, 8 October, 14 October, and 15 October 2006).

A total of 76 taxa distributed among 4 phyla, 10 classes, 24 orders, 47 families and 67 genera (Table 2) were found in the survey of selected subterranean habitats in Section 4.

Of all species found, 14 were classified as obligate subterranean species:

1) *Sphalloplana weingartneri*
Weingartner's cave flatworm

2) *Pseudocandona jeanneli*
   Jeannel's groundwater ostracod
3) *Caecidotea stygia*
   Northern cave isopod
4) *Crangonyx indianensis*
   Indiana cave amphipod
5) *Crangonyx packardi*
   Packard's groundwater amphipod
6) *Conotyla bollmani*
   Bollman's cave millipede
7) *Phanetta subterranea*
   Subterranean sheet-web spider
8) *Porrhomma cavernicola*
   Cavernicolous sheet-web spider
9) *Pseudosinella fonsa*
   Fountain cave springtail
10) *Arrhopalites* undescribed species
   Ashcraft cave springtail
11) *Pseudanophthalmus* undescribed species
   Ray's cave beetle
12) *Batrisodes krekeleri*
   Krekeler's cave ant beetle
13) *Spelobia tenebrarum*
   Cave dung fly
14) *Sinella alata*
   Indiana cave springtail

Twelve species were classified as species of concern:

1) *Sphalloplana weingartneri*
   Weingartner's cave flatworm
   S3/G4 IDNR Watch List
2) *Pseudocandona jeanneli*
   Jeannel's groundwater ostracod
   S1/G2, IDNR Endangered
3) *Crangonyx indianensis*
   Indiana cave amphipod
   S4/G3, IDNR Watch List
4) *Crangonyx packardi*
   Packard's groundwater amphipod
   S3-4/G4, IDNR Watch List
5) *Conotyla bollmani*
   Bollman's cave millipede
   S3-4/G3-4, IDNR Watch List
6) *Pseudosinella collina*
   Hilly springtail
   S2/G3-4, IDNR Rare
7) *Pseudosinella fonsa*
   Fountain cave springtail
   S2/G2-3, IDNR threatened
8) *Sinella alata*
   Indiana cave springtail
   S4/G3-4, IDNR Watch List
9) *Arrhopalites* undescribed species
   Ashcraft cave springtail
   S1/G1, IDNR endangered candidate
10) *Pseudanophthalmus* undescribed species
   Ray's cave beetle S1/G1, IDNR
   Endangered
11) *Batrisodes krekeleri*
   Krekeler's cave ant beetle
   S1/G1, IDNR Endangered
12) *Myotis sodalis*
   Indiana bat
   S1/G2, USFWS Endangered

The *Arrhopalites* undescribed species is known only from The *Pseudanophthalmus* undescribed species has a slightly larger known range continuing northward to include two other caves within approximately 3 miles.

The following is a list of the top faunal caves in Indiana from cave bioinventories that surveyed over 500 caves (Lewis 1983, 1994, 1995, 1996, 1998, 2005; Lewis and Rafail 2002, 2003; Lewis et al. 2004, Lewis and Lewis 2006). The list is rank-ordered by the number of obligate subterranean species (troglobites and stygobites) identified from the cave. Placed within the context of this list, ranks within the fifth cohort of biologically significant caves:

Cave and obligate subterranean species

- (Harrison County): 19
- Wesley Chapel Gulf/ (Orange County): 18
- (Crawford County): 15
- (Harrison County): 12
- (Orange County): 12
- (Greene County): 11
- (Monroe County): 11
- (Monroe County): 11
- (Orange County): 11
- (Crawford County): 11
- (Harrison County): 11
- (Orange County): 11

6.0 Acknowledgments

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Appendix A
Figures

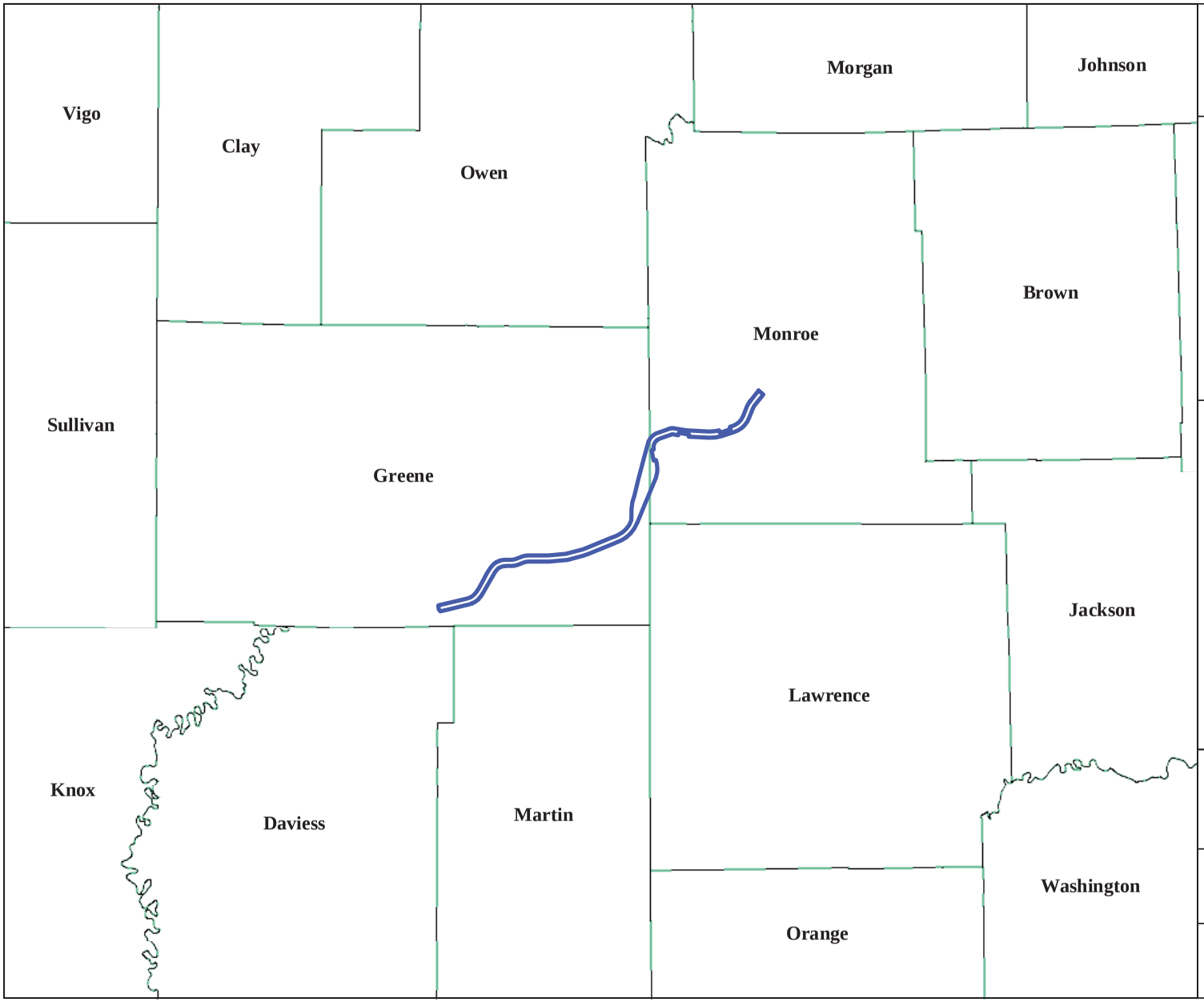
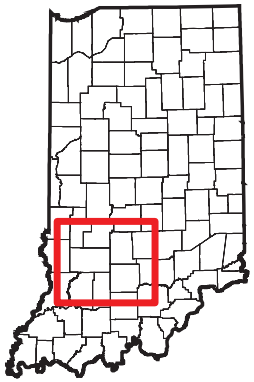


Figure 1. Location of Section 4 of the proposed I-69 corridor in Greene and Monroe counties, Indiana.

Section 4 Corridor

County boundary



N
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Base Map: ESRI Data, and I-69 GIS DAta

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

Project No. 123.08

Figure 2 ("Cave fauna sampling sites on Section 4 of the proposed I-69 corridor in Greene and Monroe counties, Indiana") has been removed for confidentiality reasons related to caves.

Appendix B
Tables

Table 1 ("Locations of cave fauna sampling sites near the proposed I-69, autumn 2006") has been removed for confidentiality reasons related to caves.

Table 2. Cave fauna found during autumn 2006 sampling, including common name, site, ecological class, State/Global rank, and listing status (if any).

Taxon	Common Name	Site	Ecol. Class[1]	S/G Rank[2]	Listing Status (if any)
PHYLUM PLATYHELMINTHES					
CLASS TURBELLARIA					
ORDER TRICLADIDA					
FAMILY KENKIIDAE					
Sphalloplana weingartneri	Weingartner's cave flatworm		SB	S4/G3	IDNR Watch List
FAMILY PLANARIIDAE					
Phagocata gracilis	Slender spring flatworm		SP/SX	S4/G4	
PHYLUM MOLLUSCA					
CLASS GASTROPODA					
ORDER BASOMMATOPHORA					
FAMILY PHYSIDAE					
Physa sp.	Aquatic snail		SPR		
PHYLUM ARTHROPODA					
CLASS CRUSTACEA					
ORDER EUCOPEPODA					
FAMILY CYCLOPIDAE					
Acanthocyclops einslei	Einsle's copepod		SPR	S4/G4	
Acanthocyclops sp.	Copepod		SPR		
Eucyclops elegans	Elegant copepod		SPR	S4/G4	
Eucyclops agilis	Copepod		SPR	S4/G4	

Table 2 continued

Macrocyclops albidus	Copepod	TX	S4/G4	
Macrocyclops fuscus	Copepod	SPR	S4/G4	
Microcyclops varicans	Copepod	SPR	S4/G4	
Orthocyclops modestus	Copepod	SPR	S4/G4	
FAMILY CANTHOCAMPTIDAE				
Attheyella nordenskioldii	Nordenskioldi's copepod	TX/SPR	S4/G4	
ORDER CLADOCERA				
FAMILY MACROTHRICIDAE				
Ilocryptus sordidus	Water flea	SPR	S4/G4	
ORDER OSTRACODA				
FAMILY CANDONIDAE				
Candona acuta	Ostracod	SPR	S4/G4	
Cypria turneri	Ostracod	SPR	S4/G4	
Pseudocandona jeanneli	Jeannel's groundwater ostracod	SB	S1/S2	IDNR Endangered
ORDER ISOPODA				
FAMILY ASELLIDAE				
Caecidotea stygia	Northern cave isopod	SB	S4/G5	
Lirceus fontinalis	Bluegrass spring isopod	SX	S4/G4	

Table 2 continued

FAMILY ARMADILLIDIDAE				
Cylisticus convexus	Common convex pillbug	TX	SE/G5	
FAMILY LIGIIDAE				
Ligidium elrodi	Elrod's terrestrial isopod	TP/TX	S4/G4	
FAMILY PORCELLIONIDAE				
Trachelipus rathkei	Rathke's terrestrial isopod	TX	SE/G5	
ORDER AMPHIPODA				
FAMILY CRANGONYCTIDAE				
Crangonyx forbesi	Forbe's amphipod	SP/SX	S4/G4	
Crangonyx packardi	Packard's groundwater amphipod	SB	S3-4/G4	IDNR Watch List
Crangonyx indianensis	Indiana cave amphipod	SB	S4/G3	IDNR Watch List
FAMILY GAMMARIDAE				
Gammarus minus	Lesser spring amphipod	SX/SP	S4/G5	
ORDER DECAPODA				
FAMILY CAMBARIDAE				
Cambarus laevis	Crayfish	SP	S4/G4	
CLASS DIPLOPODA				
ORDER CHORDEUMATIDA				
FAMILY CONOTYLIDAE				
Conotyla bollmani	Bollman's cave millipede	TB/TP	S3-4/G3-4	IDNR Watch List
FAMILY TRICHOPETALIDAE				
Trichopetalum uncum	Cave millipede	TP/ED	S1/G4	

Table 2 continued

ORDER POLYDESMIDA				
FAMILY PARADOXOSOMATIDAE				
Oxidus gracilis	Greenhouse millipede	TX	SE	
CLASS ARACHNIDA				
ORDER ARANEAE				
FAMILY AMAUROBIIDAE				
Coras sp.	Spider	TX		
FAMILY DICTYNIDAE				
Cicurina sp.	Funnel-web spider	TP		
FAMILY LINYPHIIDAE				
Bathyphantes pallidus	Pallid sheet-web spider	TX	S4/G5	
Phanetta subterranea	Subterranean sheet-web spider	TB	S4/G5	
Porrhomma cavernicola	Cavernicolous sheet-web spider	TB	S2/G4	
Microneta viaria	Sheet-web spider	TX	S4/G5	
FAMILY TETRAGNATHIDAE				
Meta ovalis	American cave orb weaver	TP	S4/G5	
CLASS COLLEMBOLA				
FAMILY ENTOMOBRYIDAE				
Pseudosinella collina	Hilly springtail	TP		IDNR Rare
Pseudosinella fonsa	Fountain cave springtail	TB	S2/G2-3	IDNR Threatened
Sinella alata	Indiana cave springtail	TB	S4/G3-4	IDNR Watch List
FAMILY HYPOGASTRURIDAE				
Ceratophysella succinea	Springtail	TX	S4/G5	
FAMILY ISOTOMIDAE				
Desoria trispinata	Three-spined springtail	TX	S4/G5	
FAMILY NEELIDAE				
Megalothorax minimus	Springtail	TX/AC	S4/G5	
FAMILY SMINTHURIDAE				
Arrhopalites undescribed species	Ashcraft cave springtail	TB	S1/G1	IDNR Endangered Candidate
FAMILY TOMOCERIDAE				
Tomocerus bidentatus	Two-toothed springtail	TP	S4/G4	
Tomocerus flavescens	Golden springtail	TP	S4/G5	

Table 2 continued

CLASS INSECTA				
ORDER DIPLURA				
FAMILY CAMPODEIDAE				
Tricampa rileyi	Dipluran	TP	S1/G4	
ORDER ORTHOPTERA				
FAMILY GRYLLACRIDIDAE				
Ceuthophilus brevipes	Cave cricket	TX	S4/G4	
ORDER COLEOPTERA				
FAMILY CARABIDAE				
Bembidion sp.	Ground beetle	TX		
Platnus tenuicollis	Ground beetle	TP/TX	S4/G4	
Pseudanophthalmus undescribed species	Ray's cave beetle	TB	S1/G1	IDNR Endangered
FAMILY STAPHYLINIDAE				
Subfamily Aleocharinae				
Aleochara lucifuga	Rove beetle	TP	S4/G4	
Atheta troglophila	Rove beetle	TP	S4/G4	
Atheta annexa	Rove beetle	TP	S4/G4	
Blepharrhymenus illectus	Rove beetle	TX/TP	S1/G2-3	
Subfamily Pselaphinae				
Batrisodes krekeleri	Krekeler's cave ant beetle	TB	S1/G1	IDNR Endagnered
Subfamily Staphylininae				
Quedius erythrogaster	Rove beetle	TX	S4/G5	
Quedius spelaeus	Spelean rove beetle	TP	S4/G5	
Subfamily Omaliinae				
Lesteva pallipes	Rove beetle	TX	S4/G5	
ORDER DIPTERA				
FAMILY CHAOBORIDAE				
Unidentified species (larvae)	Phantom midge	SX		

Table 2 continued

FAMILY HELEOMYZIDAE			
Amoebaleria defessa	Heleomyzid fly	TX	S4/G4
Aecothea specus	Heleomyzid fly	TX	S4/G4
FAMILY PHORIDAE			
Megaselia cavernicola	Hump-backed fly	TP	S5/G5
FAMILY PSYCHODIDAE			
Threticus sp.	Moth fly	TP/TX	
FAMILY SCIARIDAE			
Sciara sp.	Dark-winged fungus gnat	TP/TX	
FAMILY SPHAEROCERIDAE			
Spelobia tenebrarum	Cave dung-fly	TB	S5/G5
ORDER SIPHONAPTERA			
FAMILY LEPTOPSYLLIDAE			
Peromyscopsylla hespermys	Mouse flea	PS	S1/G2
PHYLUM CHORDATA			
CLASS OSTEICHTHYES			
ORDER CYPRINIFORMES			
FAMILY CYPRINIDAE			
Notropis sp.	Shiner	TX/AC	
ORDER PERCIFORMES			
FAMILY COTTIDAE			
Cottus carolinae	Banded sculpin	SP/SX	S4/G5
CLASS AMPHIBIA			

Table 2 continued

ORDER ANURA					
FAMILY RANIDAE					
Rana clamitans	Green frog		TX	S4/G5	
Rana palustris	Pickerel frog	Spring	TX	S4/G5	
ORDER CAUDATA					
FAMILY PLETHODONTIDAE					
Eurycea lucifuga	Cave salamander		TP	S4/G5	
Eurycea longicauda longicauda	Longtail salamander		TX/TP	S5/G5	
CLASS MAMMALIA					
ORDER CHIROPTERA					
FAMILY VESPERTILIONIDAE					
Myotis lucifugus	Little brown bat		TX	S4/G5	
Myotis sodalis	Indiana bat		TX	S1/G2-3	USFWS Endangered
Perimyotis subflavus	Eastern pipistrelle		TX	S5/G5	
ORDER RODENTIA					
FAMILY CRICETIDAE					
Peromyscus leucopus	White-footed mouse		TX	S5/G5	
FAMILY CASTORIDAE					
Castor canadensis	Beaver		TX	S4/G5	
ORDER CARNIVORA					
FAMILY PROCYONIDAE					
Procyon lotor	Raccoon		TX	S5/G5	

1 Ecological Class = (TB) Troglobite, (TP) Troglophile, (TX) Trogloxene, (SB) Stygobite, (SP) Stygophile, (SX) Stygoxene, (AC) Accidental, (PS) Parasite/commensal, (SPR) Spring dweller

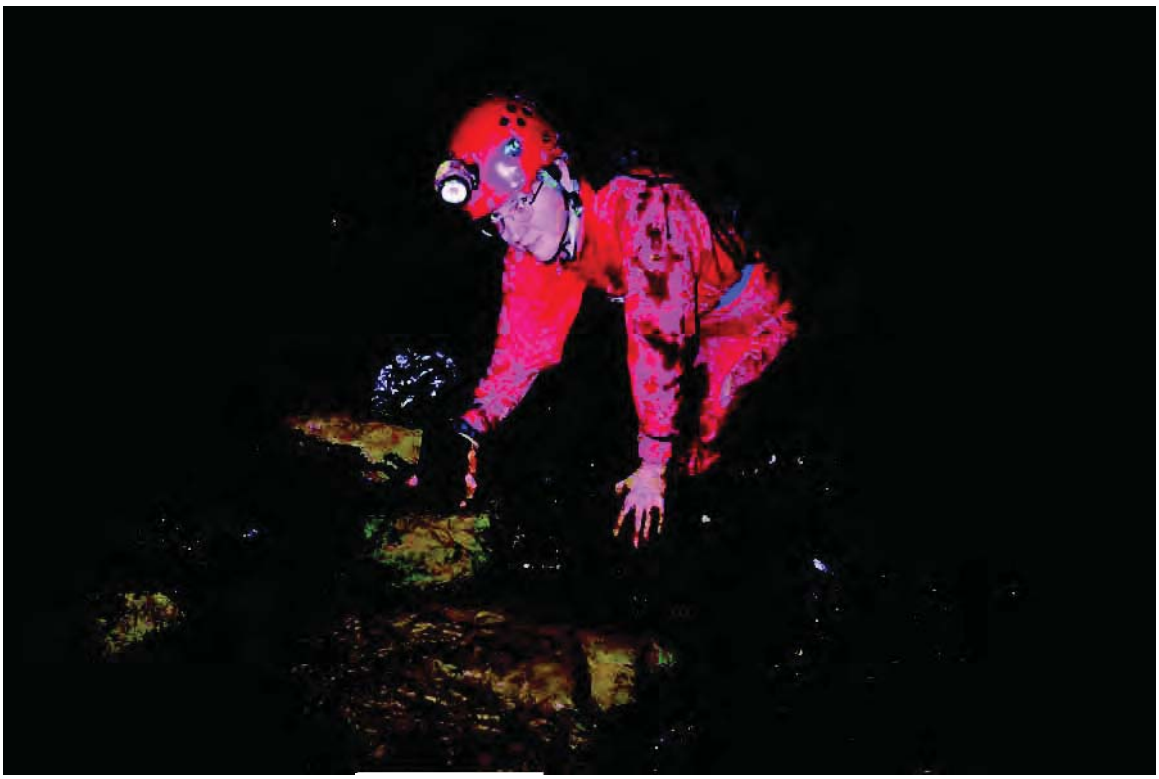
2 State/Global Rank = (S1/G1) critically imperiled, (S2/G2) imperiled, (S3/G3) vulnerable, (S4/G4) apparently secure, (S5/G5) secure, (SE) exotic species

Appendix C
Photographs

Entrance to (Greene County).

Placing a four-ounce pitfall trap jar in a typical mudbank habitat in (Greene County). This is typical habitat for the Ashcraft cave springtail (*Arrhopalites* undescribed species).

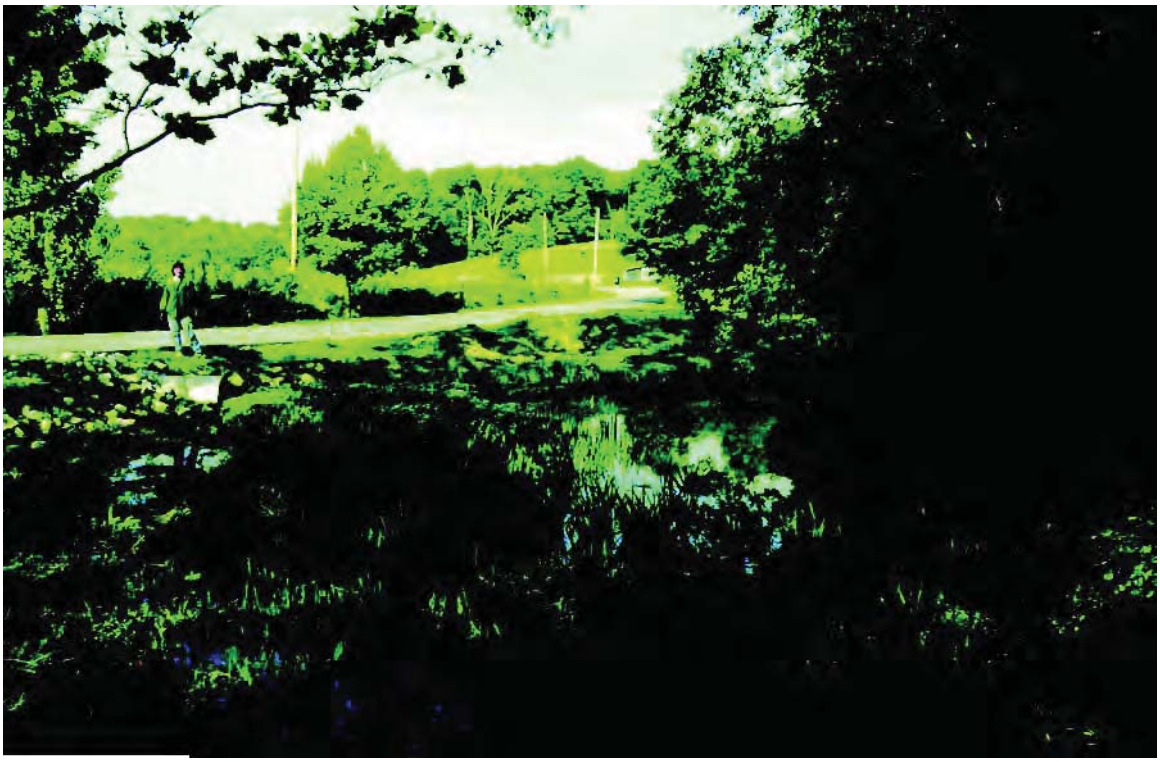
Deep mud floor in the downstream end of the stream passage in (Greene County). This is the habitat in which the Ray's cave beetle (*Pseudanophthalmus* undescribed species) was most frequently found.



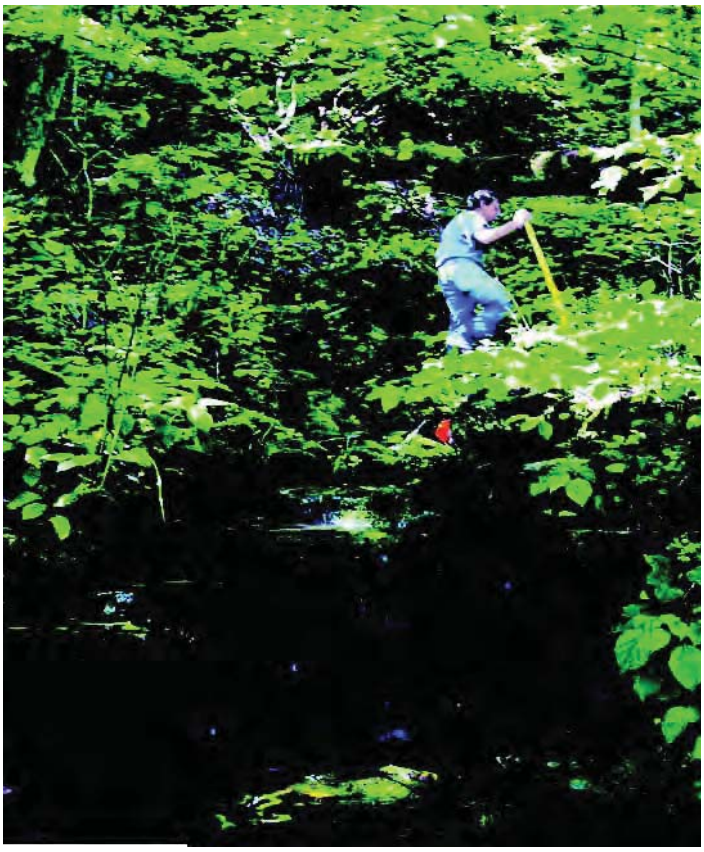
Breakdown riffle habitat in (Greene County).

Examining crayfish *Cambarus laevis* in stream passage of (Greene County).

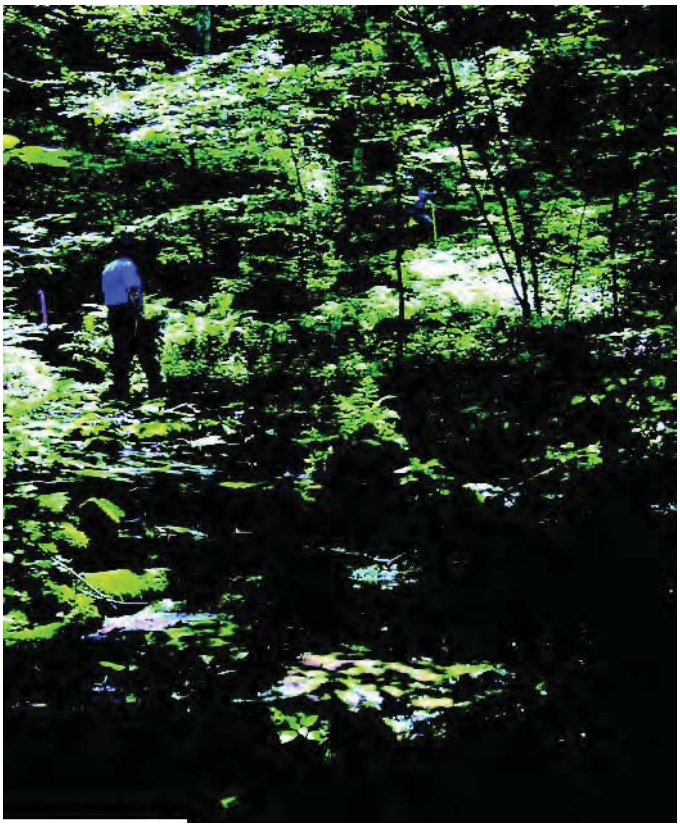
Entrance to (Greene County), a 20 foot long cave adjacent to



(Greene County) has been impounded by the adjacent county road.



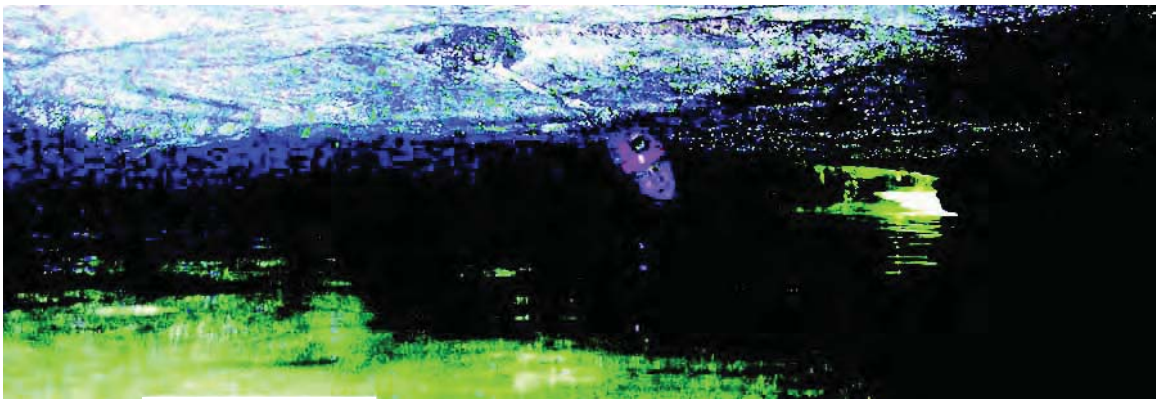
(Greene County).



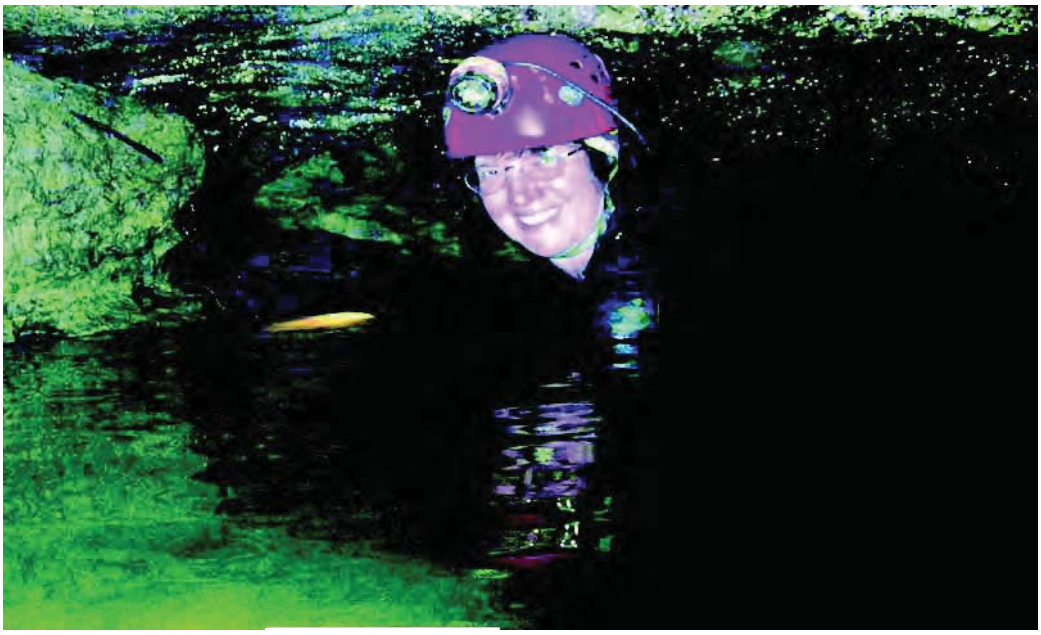
(Greene County).

Shrimp-baited jar taken from with numerous spring flatworms *Phagocata gracilis*.

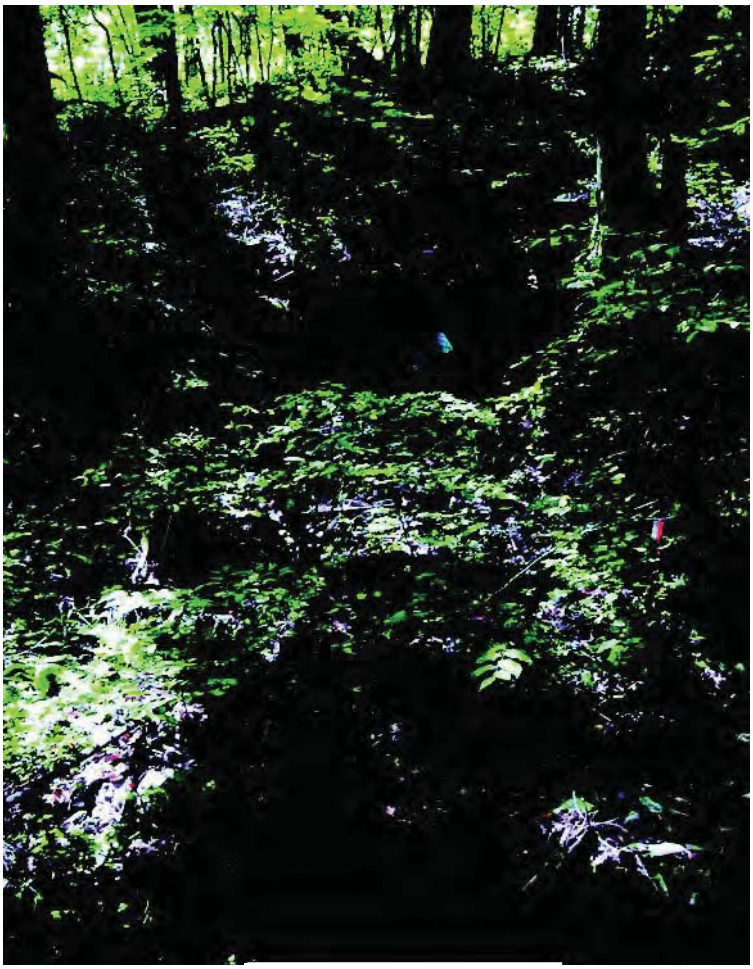
Entrance to (Monroe County) is under a rock outcrop. The cave is only enterable during base flow conditions.



Passage in looking toward entrance.

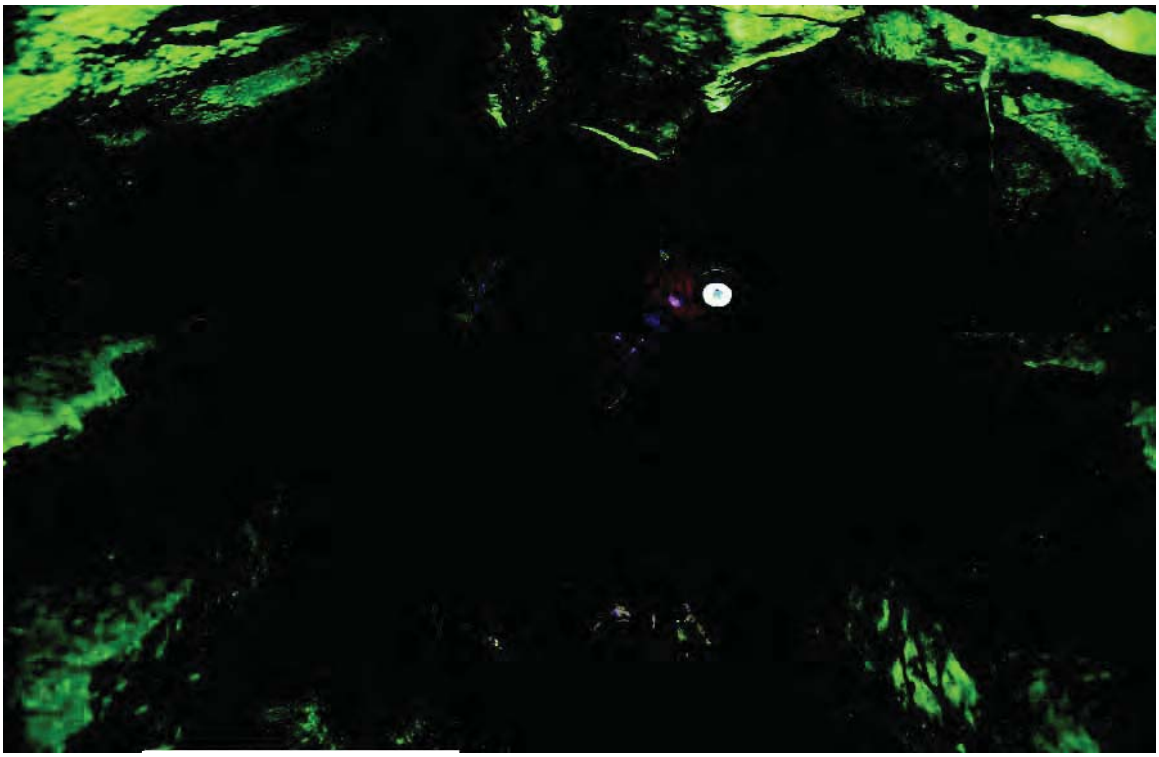


Mudbank at back of at point where the passage siphons.



Entrance alcove at (Monroe County).

The entrance to (Monroe County) is 11 inches high at the center.

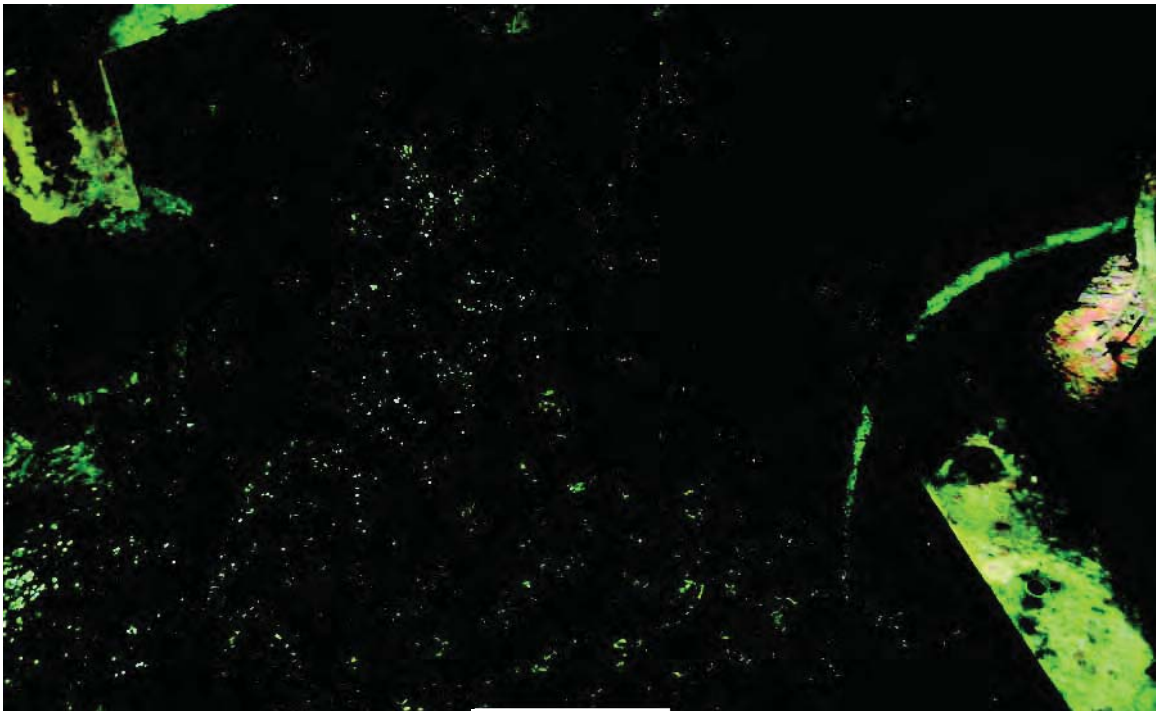


Passage in (Monroe County).

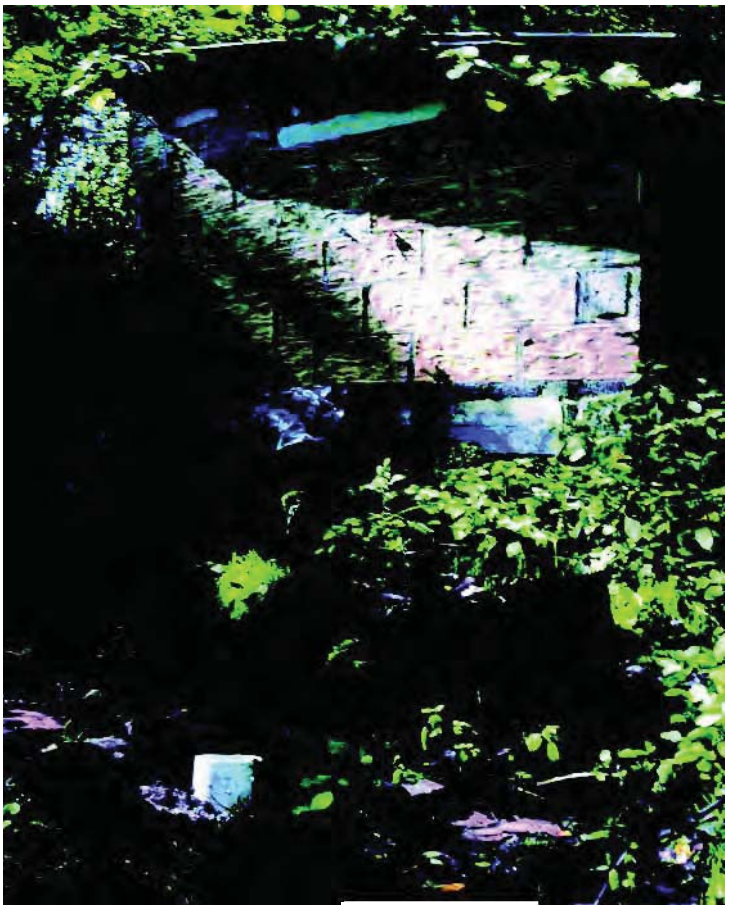
Seepage area at near (Monroe County).

near (Monroe County).

Spring house at (Monroe County).



Spring orifice inside springhouse at with shrimp-baited jar lying on floor of spring basin (obscured by ripples).



Exterior of springhouse at Water drains from the spring basin from the pipe at the base of the building, falls into a catchment basin, then flows into a spring run. White plastic pipe in the foreground is a Karaman-Chappuis shallow sampling well.

is part of a complex of springs emerging at Photo shows the use of a post-hole digger to excavate a shallow Karaman-Chappuis sampling well in the substrate adjacent to the spring run.

Appendix D
Cave Maps

Appendix D: (Cave Maps) has been removed for confidentiality reasons related to caves.

APPENDIX L – WATER WELL LOCATIONS IN THE SECTION 4 CORRIDOR

Figure L-1 has been removed for confidentiality reasons related to karst.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213513	ABOUT 2MI SW OF CLEAR CREEK IN, ON VICTOR RD. 2ND HOUSE ON L AFTER PASSING DILLMAN RD.	Jul 14, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM E. BORUFF	RR5, BLGTON IN	
Driller	FREDERICK SCOTT	RR4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 48.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	RED CLAY
4.0	29.0	STONE GRAY LS HARD
29.0	33.0	STONE BLUE LS HARD
33.0	42.0	STONE GRAY LS HARD
42.0	55.0	STONE WH LS SOFT
55.0	68.0	STONE GRAY LS SOFT
68.0	81.0	STONE GRAY LS HARD
81.0	93.0	STONE BLUE LS EX HARD
93.0	105.0	STONE GRAY SOAPSTONE SOFT

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213517		Mar 31, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLEO RADER	RR#5	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	75.0	WH LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213674	SOUTH EAST CORNER ROCKPORT RD & THAT ROAD. 2ND HOUSE SOUTH.	Sep 02, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY DAVIS	223 SO. MAPLE	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP & HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 71.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	26.5	DIRT
26.5	125.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213693	CORNER OF ROCKPORT ROAD & THAT ROAD ABOUT 3.5 SOUTH OF BLOOMINGTON	Jul 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIVER LINTHICOM	1416 WEST KIRKWOOD AVE.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	41.0	TOP SOIL & CLAY
41.0	120.0	MEDIUM WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213698	ON THAT ROAD ON NORTH SIDE 1 BLOCK EAST OF ROCKPORT RD.	Aug 12, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	29.0	TOP SOIL
2.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213719	CORNER OF THAT RD & ROCKPORT RD THEN SOUTH OF THAT RD 0.4 MILE	Jun 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEITH HILLENBURG		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	50.0	WHITE SOFT LIMESTONE
50.0	65.0	BLUE HARD LIMESTONE
65.0	85.0	BROWN MEDIUM HARD LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213744	CORNER OF THAT RD AND ROCKPORT RD SOUTH BLOOMINGTON, IN. THEN SOUTH OFF THAT RD 0.5 MILE	Jul 10, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	75.0	MEDIUM HARD WHITE LIMESTONE
75.0	85.0	HARD BLUE LIMESTONE
85.0	95.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
221993	W OF BLOOMINGTON 2 MI	May 13, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOGAN HOWARD	BLOOMINGTON, IN	
Driller	PAUL SHUTE	1420 W 14TH ST, BLOOMINGTON	
Operator	OREN LAKE	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 600.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W

Section: of Section 31 **Topo map:** BLOOMINGTON

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	14.0	RED CLAY
14.0	74.0	HARD BLUE STONE
74.0	99.0	MED LITE STONE
99.0	110.0	HARD STONE

Comments WELL 1 OF 2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
227746	GO E OF DOANS, IN ON HWY. 45/56E ABOUT 2.5MI TO GO RD 625E (NEXT TOKENTUCKEY RIDGE CHURCH) TURN N ON CR625E. GO 2.5MI CR MAKES 90*TURN, 2ND HOUSE ON L	Jan 28, 1993

Owner-Contractor	Name	Address	Telephone
Owner	ANDY STINSON	R.R. 3 BOX 466A BLOOMFIELD, IND	
Driller	MUMMA BROS. DRILLING INC.	R.R. 1 BOX 85 LYONS. IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 103.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 103.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 14 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	13.0	CLAY
13.0	23.0	SOFT SH
23.0	35.0	BREAK OF LIME DAR SH
35.0	40.0	LS & SH
40.0	66.0	YEL SANDROCK
66.0	68.0	CLAY SEAM
68.0	73.0	SAND ROCK
73.0	76.0	BR SANDY LIME
76.0	88.0	LS CRACK WATER, ODOR

88.0	91.0	CLAY
91.0	95.0	LS
95.0	100.0	BLUE SH RED ROCK
100.0	106.0	SANDY SH BLUE SH
106.0	110.0	REDROCK
110.0	130.0	SANDROCK , SANDY SH BREAKS
130.0	165.0	DARK SH
165.0	170.0	SANDROCK SANDY WH
170.0	176.0	LS
176.0	177.0	BROKEN CRACK WATER
177.0	185.0	LS CRACKS WATER

Comments 2GRS. HARDNESS /PH 8 IRON/NONE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231909	3140 W THAT RD	Jun 11, 1982

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FIDELLA SWANGO	4031 WOODLY N DR, BLOOMINGTON, IN	
Driller	FRED SMITH		
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	45.0	LS
45.0	105.0	LS & SH
105.0	170.0	LS

Comments ADD'L CONSTRUCTION INFO ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231943	SW. OF BLOOMINGTON,TAKE SR#375 TO ROCKPORT RD., TURN S.W ON ROCKPORT TO DUVALL RD. TURN GOTO GRAVE YARD 1ST. DRIVE PAST GRAVE YARD	May 29, 1991

Owner-Contractor	Name	Address	Telephone
Owner	BURLAN STONE	5156 W. DUVALL RD. BLOOMINGTON,IN.	(812) 344-8163
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:** Submersible
	Depth: 105.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 49.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 28.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	10.0	GRAY LS FINE
10.0	12.0	BLUE LS CRS
12.0	18.0	GRAY LS CRS
18.0	26.0	BUFF LS FINE
26.0	38.0	GRAY LS CRS
38.0	40.0	YEL SHALE

40.0	55.0	GRAY LS CRS
55.0	56.0	WHITE SHALE
56.0	59.0	GRAY LS CRS
59.0	61.0	BLUE SHALE
61.0	78.0	BLUE LS CRS
78.0	89.0	GRAY LS CRS
89.0	90.0	WHITE SHALE
90.0	98.0	BLUE LS CRS
98.0	105.0	GRAY LS FINE

Comments SEE MAP ;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231953	S. OF BLOOMINGTON,TAKE 37S TO THAT RD. , E. OF 3RD. DRIVEWAY TO N. , WELL OFF MAIN RD. , NEW BRICK HOUSE	Aug 16, 1990

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BARRY ELKINS	2010 W. THAT RD. BLGTON,IN.	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED & CURT SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 55.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PCX	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	9.0	YEL SHALE
9.0	14.0	GRAY LS MD CHIP
14.0	18.0	BLUE LS LARGE CHIP
18.0	22.0	GRAY LS MD CHIP
22.0	25.0	BLUE LS LARGE CHIP
25.0	38.0	GRAY LS FINE CHIP
38.0	55.0	BLUE LS FINE CHIP
55.0	63.0	BLUE SOAPSTONE LARGE CHIPS

63.0	77.0	BUFF LS FINE CHIPS
77.0	103.0	GRAY LS LARGE CHIPS
103.0	109.0	YEL LS MD CHIPS
109.0	128.0	GRAY LS MD CHIPS
128.0	138.0	LS LARGE CHIPS
138.0	145.0	GRAY LS LARGE CHIPS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231983	S.W. OF BLOOMINGTON, TAKE SR#37 TO ROCKPORT RD., R. STAY ON ROCKPORT RD,TIL LODGE RD.,L. GO NEXT TO LAST HOUSE ON R. # ON MAILBOX 7150	May 15, 1989

Owner-Contractor	Name	Address	Telephone
Owner	DAVID STULTZ	7150 S. LODGE RD. BLOOMINGTON,IN.	(812) 825-9100
Driller	FRED SCOTT'S WELL DRILLING	236 W. COWDEN RD. ELLETTSVILLE,IN.	(999) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 5.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR-PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	3.0	BR CLAY
3.0	4.0	YEL CLAY
4.0	20.0	GRAY LS HARD
20.0	26.0	BLUE LS HARD
26.0	31.0	GRAY LS HARD
31.0	35.0	BLUE LS HARD

35.0	48.0	GRAY LS HARD
48.0	60.0	BUFF LS HARD
60.0	75.0	GRAY LS HARD
75.0	82.0	BLUE LS HARD
82.0	118.0	GRAY LS HARD
118.0	125.0	BLUE LS HARD

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
257650	APPROX. 3.5 MI. N. OF JCT. #45 & #58 NEAR OWENSBURG,IN. TURN W. ON CR#300S. GO 1 MI. 1ST. DRIVE ON L.	Feb 28, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VAN ROBERSTON	R.R. #3 BOX 302 BLOOMFIELD,IN.	
Driller	MUMMA BROS. DRILLING,INC.	R.R.#1 BOX #85 LYONS,IN.	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 345.0	**Pump setting depth:** 320.0	**Water quality:**
Casing	**Length:** 166.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 18.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 200.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 130.0 to 163.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 9 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 28.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	21.0	LS
21.0	28.0	CLAY
28.0	38.0	SANDROCK,CLAY SEAMS
38.0	61.0	YEL SANDROCK
61.0	76.0	LS
76.0	84.0	BLUE SHALE
84.0	91.0	GREEN SANDROCK

91.0	100.0	GREENISH RED ROCK
100.0	144.0	SANDROCK
144.0	160.0	DARK SHALE
160.0	165.0	SANDY SHALE
165.0	235.0	SANDROCK
235.0	239.0	LS
239.0	243.0	GREEN SHALE
243.0	310.0	LS BROKEN
310.0	345.0	SANDY LS WATER

Comments PH7,HAR 20,IRON 1.0 PPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
274817	LEAVING SOLSBURG 1ST RD TO R OFF OF HWY 43, GO 1 MI OUT OF SOLSBERRY, TURN R ONTO WASHBOARD RD, STAY STRAIGHT FOR 3.5 MI HOUSE ON R WELL IN FRONT YARD	Aug 17, 1995

Owner-Contractor	Name	Address	Telephone
Owner	JEFF ADAMS	RR1 BOX 370A, SOLSBERRY, IN	(812) 825-9283
Driller	PHILLIP'S WELL DRILLING	RR12 BOX 624, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 220.0	**Pump setting depth:** 200.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 6.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOP SOIL
1.0	2.0	BLANK
2.0	17.0	CLAY
17.0	28.0	SS
28.0	56.0	LS
56.0	62.0	SHELL
62.0	220.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
278105	SW OF BLOOMINGTON TAKE SR 37 S TO ROCKPORT RD TURN SW GO TO DUALL RD TURN W GO 1.5 MI DRIVEWAY AT BOTTOM OF HILL HSE BACK OFF MAIN RD TOP OF HILL	Jul 22, 1994

Owner-Contractor	Name	Address	Telephone
Owner	STEVE CAIN	5950 W CUVALL RD, BLOOMINGTON, IN	(812) 334-4087
Driller	FRED SCOTTS WELL DRLG	6236 W COWDEN RD, ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 165.0	**Pump setting depth:** 150.0	**Water quality:** CLEAR
Casing	**Length:** 33.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 94.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 32.0 to 0.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	11.0	RED CLAY
11.0	35.0	GRAY LS CRS
35.0	39.0	BLUE LS CRS
39.0	60.0	GRAY LS FINE
60.0	62.0	BLUE SH
62.0	86.0	GRAY LS CRS

86.0	88.0	BLUE SH
88.0	92.0	BLUE LS FINE
92.0	96.0	GRAY LS FINE
96.0	124.0	BUFF LS EX FINE
124.0	143.0	GRAY LS CRS
143.0	146.0	BLUE SH
146.0	150.0	BLUE LS CRS
150.0	151.0	YEL SH
151.0	159.0	GRAY LS FINE
159.0	160.0	BLUE SH
160.0	165.0	GRAY LS FINE

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295360	FROM 37N TAKE ROCKPORT RD E GO APPROX 8 MI TO TRANWAY RD TURN LEFT GO 1.5 MI PLACE IS ON LF	May 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEVIN H. WRIGLEY	4198 W TRAMWAY RD., BLOOMINGTON, IN	
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 27.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 27.0
Installation Method: PUMP **Number of bags used:** 1.25

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	145.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295361	SR37 TO ROCKPORT RD GO 5 MI TO TRANWAY TURN L ONTO TRAMWAY GO .5 MI ON L	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.0 gpm for 60.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 37.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY
22.0	65.0	LS
65.0	73.0	SHELL
73.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295362	SR37 TO ROCKPORT RD GO 5 MI TO TRAMWAY TURN LEFT ON TO TRAMWAY GO .5 MI ON LEFT	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 2.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	24.0	CLAY
24.0	68.0	LS
68.0	75.0	SHELL
75.0	140.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295365	W OF STANFORD, ON HWY45 GO .25 MI DRIVEWAY ON N SD OF HWY	Apr 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ALOHA GINSENG FARM	9840 W ST HWY45, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 83.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	CLAY RED
15.0	22.0	SUB CLAY
22.0	25.0	SOFT SANDROCK
25.0	35.0	REDROCK
35.0	50.0	GREEN SANDY SHALE
50.0	53.0	SANDROCK
53.0	60.0	GREEN SHALE & BLUE SHALE

60.0	80.0	DK SHALE & LIME BKS
80.0	83.0	SANDY DK SHALE
83.0	90.0	DK SHALE
90.0	100.0	LS
100.0	103.0	BLUE SHALE
103.0	110.0	SANDROCK
110.0	123.0	DK SHALE & BLUE SHALE
123.0	132.0	LS
132.0	134.0	BLUE SAHLE
134.0	215.0	LS
215.0	240.0	LS CRACKS WATER

Comments SEE MAP; CHEM ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295367	FOLLOW BREEDEN RD S OF HWY45 2 MI TO PRIVATE DRIVE ON W SD OF RD	Jun 30, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP LONG	7625 S BREEDEN RD., BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 31.0 to 0.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	18.0	RED CLAY
18.0	68.0	LS
68.0	75.0	BLUE SHALE
75.0	100.0	LS
100.0	125.0	LS & CRACKS WATER

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309951	37/OLD 37 INTERSECTION GO ON OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 215.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 28.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
11.0	165.0	LIME STONE
166.0	175.0	LIME STONE
176.0	191.0	LIME STONE
192.0	215.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309952	37/OLD 37 INTERSECTION GO UP OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRARIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:**	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: YOM BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 28, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	75.0	LIME STONE
75.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309953	37/OLD 37 INTERSECTION - GO TO OLD 37 TO TOP OF HILL OR E	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ELEM BENT **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 25, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309959	OFF 37 TO OLD 37 INTERSECTION - TAKE OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 310.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
3.0	6.0	BUST LIMESTONE
7.0	29.0	HARD LIMESTONE
30.0	33.0	LIME STONE
34.0	82.0	HARD LIMESTONE
83.0	175.0	SOFT LIMESTONE
176.0	310.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
322971	8897 W THACKER RD, W 45 TO BREEDEN RD S ON BREEDEN TO THACKER .5 MI ON S	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CAMERON DECKARD	8897 W THACKER RD, BLOOMINGTON, IN	(812) 825-3530
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	
Company	CAMERON DECKARD		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 300.0	**Pump setting depth:** 280.0	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .025

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 32.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	22.0	RED CLAY
22.0	140.0	GRAY SH
140.0	221.0	LS
221.0	245.0	GRAY SH
245.0	300.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324080	45 R TO 580 - GO 5 MI	Oct 01, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE NEHRT	550 BRIDE DALYON RD BLOOMINGTON	
Driller	PHILLIPS WELL DRLG	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	JAY PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 80.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 9.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 80.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	CLAY
25.0	50.0	BLUE MUCK
75.0	100.0	SANDSTONE
100.0	125.0	LS
503.0	75.0	SHELLY SANDSTONE

Comments (? LOC)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324084	TAKE 45 TO BREEDEN RD GO 4 MI TO THOACKER RD GO 1.5 MI UNTIL YOU SEE A BIG RED BARN ON LT, THIS IS HIS HOME SITE	Jun 02, 1998

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY CLARK	3811 E ANDERSON RD., BLOOMINGTON, IN	(812) 331-8464
Driller	PHILLIPS WELL DRLNG	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 42.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 42.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	10.0	RED CLAY
10.0	24.0	BUSTED LS
24.0	27.0	RED CLAY
27.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
338841		Jul 23, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB BARTHOLOMEW	PO BOX 702 CLEAR CREEK IN	(812) 824-7841
Driller	PHILLIPS WELL DRLG & PUMP SVC	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	
Company	DISTRICTIVE HOMES		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 280.0	**Pump setting depth:** 260.0	**Water quality:** GOOD
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 2

Well Capacity Test

Type of test: Bailing **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL
7.0	40.0	SANDSTONE
40.0	66.0	LS
66.0	83.0	SANDSTONE
83.0	149.0	SHALE
149.0	280.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
339114	N SD OF STONE MILL & E OF RR VIADOCK	Nov 20, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL J. BUNCH	7665 S. VICTOR PIKE, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRLNG INC.	R1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.5 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 28.0 to 0.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	35.0	LS
35.0	36.0	SEAM WATER
36.0	50.0	LS
50.0	77.0	LS & SH BKS
77.0	105.0	GREY SANDROCK

Comments SEE MAP; PETROLIUM ODOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
349513	GO OFF SR54 AT THE HOBBIESVILLE TURNOFF GO DOWN RD TO "Y" HANG L GO ABOUT 1.5 MI UP GRAVEL RD YOU'LL SEE AN IRON GATE TURN L	Nov 10, 1999

Owner-Contractor	Name	Address	Telephone
Owner	BOB HILL	PO BXO 230, OOLITIC, IN	(000) 279-5904
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 320.0	**Pump setting depth:** 300.0	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 5.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 1 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	TOPSOIL
4.0	8.0	CLAY
8.0	16.0	SH LS
16.0	32.0	MUD SEAM
32.0	39.0	BUSTED LS
39.0	55.0	SH
55.0	60.0	SS

60.0	102.0	SH
102.0	244.0	SS
244.0	320.0	LS

Comments SEE MAP; HWY54 TO 1375E, R ON 1320E, APPROX .75 MI

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
349665	TAKE 54 W TO HOBBIESVILLE RD; TURN R; GO ABOUT 2.5 MI; ON L; 2ND HOUSE TO L PAST MYERS DRYWALL	Oct 18, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BRAD STURGEON	9960 W ROCKEAST RD BLOOMINGTON, IN	(812) 825-2034
Driller	PHILLIPS WELL DRILLING&PUMP	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Other
	Depth: 170.0	**Pump setting depth:**	**Water quality:** CLEAR/GOOD
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 3.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	11.0	CLAY
11.0	21.0	SS
21.0	27.0	BUSTED LS
27.0	58.0	SH
58.0	170.0	SOLID LS

Comments SEE MAP;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
352175	S OF KOLEEN, 1/2 TO COUNTY ROAD TO LT, GO .5 MILE	Apr 26, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID MONTGOMERY	PO BOX 50, KOLEEN, IN	
Driller	MUMMA BROS. DRLNG INC.	RR1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 53.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 140.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 53.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY & ROCKS
17.0	20.0	LS
20.0	30.0	SH
30.0	31.0	LS
31.0	44.0	SH & LIME BKS
44.0	48.0	SANDY SH
48.0	70.0	SANDROCK
70.0	83.0	BRN LS
83.0	100.0	GREY LS, HD
100.0	108.0	GREY SH & REDROCK

108.0	118.0	SANDROCK
118.0	130.0	DK SANDY SH
130.0	142.0	DK GREY SH
142.0	148.0	SANDROCK
148.0	179.0	REDROCK & DK SH
179.0	185.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
370693	W OF CAMP OLIVET FOUNDATION, ON W SD OF HWY54	May 16, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE BONNEY	OWENSBURG, IN	
Driller	MUMMA BROS. DRILLING INC.	RR1 BOX 84, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 370.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 150.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 220.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:** 220

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 174.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 150.0 to 0.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	18.0	YEL SANDROCK & CLAY SEAMS
18.0	28.0	BRN CLAY
28.0	35.0	SOFT SH
35.0	40.0	GREY SANDY SH
40.0	46.0	SANDROCK & LIME BKS
46.0	53.0	YELLOW SANDROCK
53.0	60.0	BROWN SANDROCK
60.0	80.0	BRKN SANDY SH
80.0	147.0	DK SH & LIME BKS

147.0	149.0	SANDY SH
149.0	160.0	LS
160.0	168.0	DK SH
168.0	173.0	BLUE SH SOFT
173.0	185.0	LS & SH BKS
185.0	240.0	LS
240.0	260.0	SANDY LS
260.0	275.0	LS CRACKS
275.0	295.0	LS
295.0	305.0	LS CRACKS
305.0	355.0	LS
355.0	370.0	BRKN LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383065	HWY 45 TO STANFORD, LEFT ON BREEDEN RD, 4 MI TO 1ST CROSS RD, GO RT, 2ND FARM ON LEFT;	Aug 10, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MICHAEL WAMPLER/CJ STURGEON	9501 ROCK EAST RD B'TON IN	(812) 825-5804
Driller	PHILLIPS WELL DRLG&PUMP SVC IN	RR 12 BOX 444 BEDFORD, INDIANA	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 56.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 4 IN

Well Capacity Test

Type of test: Air **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 27.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 50.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	RED CLAY
7.0	51.0	BUSTED ROCK
51.0	80.0	LIMESTONE

Comments SEE MAP;30-72W; PLAT 2;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
391301	ST RD 45 WEST TO COUNT ROAD BREADEN ROAD GO 5 MILE TO WEST CRAVES ROAD GO 1 MILE TO RIGHT BOX 8785	Nov 26, 2004

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF NEW	8785 WEST GRAVES ROAD	(812) 336-7537
Driller	J AND K WATER WELL SERVICE	1369 STATE ROAD 158 WILLIAMS IN	
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 112.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 5.0 gpm for 300.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 20.0 ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 5.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	SAND
5.0	10.0	SABD ABD PEA GRAVEL
10.0	15.0	SAND AND MUD
15.0	20.0	CLAY
20.0	25.0	LIMESTONE
25.0	30.0	LIMESTONE
30.0	35.0	BUSTED LIMESTONE
35.0	40.0	LIMESTONE
40.0	112.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
404946	SR54 - GO TO HOBBIEVILLE RD - GO THRU HOBBIEVILLE- CONTINUE ON - GO AROUND SHARP CURVE - PASS DECKARD HOME SALES - TO NEW CONSTRUCTION ON R! FENCED IN	Nov 19, 2005

Owner-Contractor	Name	Address	Telephone
Owner	JOE BYERS	RR1 SPRINGVILLE, IN	(812) 855-4307
Driller	PHILLIPS WELL DRILLING	RR3 BOX 55-A OWENSBURG, IN	(812) 863-4843
Operator	DEXTER SWARTZENTRUBER	License: 302	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth:	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 40.0	**Material:** STEEL	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 2

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	11.0	CLAY
11.0	14.0	BROKEN LIMESTONE
14.0	30.0	LIMESTONE
30.0	32.0	BROKEN LIMESTONE
32.0	85.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
407312	SOUTH WEST OF BLOOKINGTON ON 45 THRU STANFORD. LEFT OR SOUTH ON BREEDEN RD APP 1 MIL ACROSS CREEK (DRIVEWAY) ON RIGHT. REPLACES EXIST WELL AT OLD BARN	Apr 04, 2006

Owner-Contractor	Name	Address	Telephone
Owner	LISA SWOAPE	7625 S BREEDEN RD BLOOMINGTON, IN	
Driller	MADER WELL DRILLING	9262 OWEN PARK RD SPENCER, IN	(765) 795-3343
Operator	STEVE MADER	License: 541	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 95.0	**Pump setting depth:** 65.0	**Water quality:** CLEAR
Casing	**Length:** 41.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bail / Pump **Test rate:** 40.0 gpm for 0.5 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 15.0 ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: W-O-B **Depth:** from to
Installation Method: POUR **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 6.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	6.0	BROKEN LIMESTONE
6.0	15.0	LS
15.0	16.0	SOFTER
16.0	38.0	MD & SOFTER LS
38.0	75.0	HD GRAY LIMESTONE
75.0	85.0	GRAY LIMESTONE
85.0	88.0	HD DARKER GRAY LS
88.0	95.0	BROKEN LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40745		May 09, 1946

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	A PADGETT		
Driller	WAGGONER BROTHERS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 67.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 530.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	OVERBURDEN
15.0	31.0	SOFT RED SS
31.0	33.0	LS
33.0	43.0	BLUISH GRAY SANDY SHALE
43.0	45.0	HARD YELL SS, WATER
45.0	67.0	YELL SS, WATER

Comments WELL E-1, DATA FROM USGS BULL 11 AND WWRS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410928	37 - VICTOR PIKE - GO DOWN ABOUT 2.5 MILES TO 30 MILL ON R - WELL IS LOCATED BY BACK LOT	Jul 16, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3D STONE, INC/WHALEY INVESTMEN	4810 SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 55A OWENSBURG, IN	(812) 863-4843
Operator	TAMMY HOLLAND/REX MARTIN	License: null	

Construction Details

Well	**Use:** Industry	**Drilling method:**	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 24.0 ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 40.0 to 0.0
Installation Method: TREMMIE **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	135.0	LIMESTONE
135.0	136.0	SANDY SHALE
136.0	137.0	LIMESTONE
137.0	140.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410932	VICTOR PIKE - 3 D STONE INC. MILL ON VICTOR PIKE OFF OF HWY 37	Jul 10, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3 D STONE INC/WHALEY INVESTMEN	4810 WEST SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	HACKER PLUMBING & DRILLING	2687 S OLD DECKER RD VINCENNES, IN	(812) 882-8053
Operator	TIM HACKER	License: 152	
Company	PHILLIPS WELL DRILLING	R # 3 BOX 55A OWENSVILLE, IN	(812) 863-4844

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 340.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: BENTONITE **Depth:** from 0 to 340
Installation Method: TREMMIE **Number of bags used:** 10.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	110.0	LIMESTONE W/MUD SEAMS
110.0	170.0	LIMESTONE W/SANDY SHALE SHALE
170.0	340.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
52692	GO N OF JUNCTION HWY 45 & 48 GO N ON 45 .75 MI TO 1ST CROSS ROAD TURN W ENTERENCE AS STEEL GATES, PRIVATE DR .5 MI THRU CLASSIFIED FOREST	Oct 26, 1993

Owner-Contractor	Name	Address	Telephone
Owner	WENDELL LEEDY	R 3 BOX 29C OWENSBURG, IN	
Driller	MUMMA DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 365.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 100.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 280.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 100.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of Section 17 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	CLAY & SANDROCK
15.0	22.0	BREAK OF COAL & SH
22.0	34.0	SANDROCK & CLAY SEAMS
34.0	43.0	SOFT SH
43.0	55.0	SANDROCK (HARD)
55.0	61.0	BLUE SH
61.0	64.0	YEL SANDROCK

64.0	69.0	LS & SEAMS
69.0	95.0	DARK SH
95.0	134.0	SANDROCK
134.0	137.0	SH
137.0	155.0	LS
155.0	170.0	BLUE SH, REDROCK, GREEN SH
170.0	200.0	SANDY SH & SANDY LIME
200.0	212.0	DARK SH
212.0	225.0	SANDROCK & SANDY SH
225.0	245.0	DARK SH
245.0	255.0	SANDROCK & SHEAL BKS
255.0	260.0	SANDROCK
260.0	267.0	DARK SH
267.0	275.0	SANDROCK
275.0	298.0	LS
298.0	304.0	BLUE SH
304.0	365.0	LS CRACKS (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52702	GO S OF HWY 45 & 54 UCT ON 54S TO CR 1250E GO S TO CHURCH TURN R ON GRAV RD GO 200 YRDS TURN R GO TO TEE GO LEFT DEAD END	Aug 06, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM RICHARD	OWENSBURG, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 60.0 to 35.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	30.0	SANDROCK & SEAMS
30.0	55.0	SANDROCK
55.0	62.0	SANDY SH
62.0	78.0	DARK SH
78.0	85.0	YEL SANDROCK
85.0	95.0	DARK SH & SANDY SH
95.0	100.0	SANDROCK (WATER)
100.0	120.0	DARK SH
120.0	127.0	SANDROCK (WATER)
127.0	140.0	DARK SH & SANDROCK
140.0	145.0	LS

Comments 28 HARDNESS 7.0 PH28 HARDNESS 7.0 PH 3PPM IRON

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52704	GO 200 FT S OF HWY JCT 54 & 45 EXIT HWY 54 ONTO CR 50S (DEAD END) GO E .75 MI ONTO PRIVATE DR THRU WOODS	Jun 28, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOE JAMES	R 4 BOX 416 BLOOMFIELD, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2398
Operator	DAVID RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 285.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 82.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 200.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 80.0 to 20.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of Section 26 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	SANDROCK & SEAMS
15.0	20.0	SOFT SH
20.0	32.0	SANDY SH
32.0	68.0	DARK SH
68.0	69.0	LS
69.0	78.0	DARK SH

78.0	81.0	SANDROCK
81.0	100.0	DARK SH & SANDROCK BREAKS
100.0	102.0	GREEN SH
102.0	240.0	LS
240.0	273.0	LIMECRACKS
273.0	285.0	LIMECRACK (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213513	ABOUT 2MI SW OF CLEAR CREEK IN, ON VICTOR RD. 2ND HOUSE ON L AFTER PASSING DILLMAN RD.	Jul 14, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM E. BORUFF	RR5, BLGTON IN	
Driller	FREDERICK SCOTT	RR4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 48.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	RED CLAY
4.0	29.0	STONE GRAY LS HARD
29.0	33.0	STONE BLUE LS HARD
33.0	42.0	STONE GRAY LS HARD
42.0	55.0	STONE WH LS SOFT
55.0	68.0	STONE GRAY LS SOFT
68.0	81.0	STONE GRAY LS HARD
81.0	93.0	STONE BLUE LS EX HARD
93.0	105.0	STONE GRAY SOAPSTONE SOFT

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213517		Mar 31, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLEO RADER	RR#5	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	75.0	WH LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213674	SOUTH EAST CORNER ROCKPORT RD & THAT ROAD. 2ND HOUSE SOUTH.	Sep 02, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY DAVIS	223 SO. MAPLE	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP & HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 71.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	26.5	DIRT
26.5	125.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213693	CORNER OF ROCKPORT ROAD & THAT ROAD ABOUT 3.5 SOUTH OF BLOOMINGTON	Jul 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIVER LINTHICOM	1416 WEST KIRKWOOD AVE.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	41.0	TOP SOIL & CLAY
41.0	120.0	MEDIUM WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213698	ON THAT ROAD ON NORTH SIDE 1 BLOCK EAST OF ROCKPORT RD.	Aug 12, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	29.0	TOP SOIL
2.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213719	CORNER OF THAT RD & ROCKPORT RD THEN SOUTH OF THAT RD 0.4 MILE	Jun 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEITH HILLENBURG		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	50.0	WHITE SOFT LIMESTONE
50.0	65.0	BLUE HARD LIMESTONE
65.0	85.0	BROWN MEDIUM HARD LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213744	CORNER OF THAT RD AND ROCKPORT RD SOUTH BLOOMINGTON, IN. THEN SOUTH OFF THAT RD 0.5 MILE	Jul 10, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	75.0	MEDIUM HARD WHITE LIMESTONE
75.0	85.0	HARD BLUE LIMESTONE
85.0	95.0	MEDIUM HARD WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
221993	W OF BLOOMINGTON 2 MI	May 13, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOGAN HOWARD	BLOOMINGTON, IN	
Driller	PAUL SHUTE	1420 W 14TH ST, BLOOMINGTON	
Operator	OREN LAKE	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 600.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W

Section: of Section 31 **Topo map:** BLOOMINGTON

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	14.0	RED CLAY
14.0	74.0	HARD BLUE STONE
74.0	99.0	MED LITE STONE
99.0	110.0	HARD STONE

Comments WELL 1 OF 2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
227746	GO E OF DOANS, IN ON HWY. 45/56E ABOUT 2.5MI TO GO RD 625E (NEXT TOKENTUCKEY RIDGE CHURCH) TURN N ON CR625E. GO 2.5MI CR MAKES 90*TURN, 2ND HOUSE ON L	Jan 28, 1993

Owner-Contractor	Name	Address	Telephone
Owner	ANDY STINSON	R.R. 3 BOX 466A BLOOMFIELD, IND	
Driller	MUMMA BROS. DRILLING INC.	R.R. 1 BOX 85 LYONS. IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 103.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 103.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 14 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	13.0	CLAY
13.0	23.0	SOFT SH
23.0	35.0	BREAK OF LIME DAR SH
35.0	40.0	LS & SH
40.0	66.0	YEL SANDROCK
66.0	68.0	CLAY SEAM
68.0	73.0	SAND ROCK
73.0	76.0	BR SANDY LIME
76.0	88.0	LS CRACK WATER, ODOR

88.0	91.0	CLAY
91.0	95.0	LS
95.0	100.0	BLUE SH RED ROCK
100.0	106.0	SANDY SH BLUE SH
106.0	110.0	REDROCK
110.0	130.0	SANDROCK , SANDY SH BREAKS
130.0	165.0	DARK SH
165.0	170.0	SANDROCK SANDY WH
170.0	176.0	LS
176.0	177.0	BROKEN CRACK WATER
177.0	185.0	LS CRACKS WATER

Comments 2GRS. HARDNESS /PH 8 IRON/NONE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231909	3140 W THAT RD	Jun 11, 1982

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FIDELLA SWANGO	4031 WOODLY N DR, BLOOMINGTON, IN	
Driller	FRED SMITH		
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: **on:**

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**

Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	45.0	LS
45.0	105.0	LS & SH
105.0	170.0	LS

Comments ADD'L CONSTRUCTION INFO ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231943	SW. OF BLOOMINGTON,TAKE SR#375 TO ROCKPORT RD., TURN S.W ON ROCKPORT TO DUVALL RD. TURN GOTO GRAVE YARD 1ST. DRIVE PAST GRAVE YARD	May 29, 1991

Owner-Contractor	Name	Address	Telephone
Owner	BURLAN STONE	5156 W. DUVALL RD. BLOOMINGTON,IN.	(812) 344-8163
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:** Submersible
	Depth: 105.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 49.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 28.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	10.0	GRAY LS FINE
10.0	12.0	BLUE LS CRS
12.0	18.0	GRAY LS CRS
18.0	26.0	BUFF LS FINE
26.0	38.0	GRAY LS CRS
38.0	40.0	YEL SHALE

40.0	55.0	GRAY LS CRS
55.0	56.0	WHITE SHALE
56.0	59.0	GRAY LS CRS
59.0	61.0	BLUE SHALE
61.0	78.0	BLUE LS CRS
78.0	89.0	GRAY LS CRS
89.0	90.0	WHITE SHALE
90.0	98.0	BLUE LS CRS
98.0	105.0	GRAY LS FINE

Comments SEE MAP ;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
231953	S. OF BLOOMINGTON,TAKE 37S TO THAT RD. , E. OF 3RD. DRIVEWAY TO N. , WELL OFF MAIN RD. , NEW BRICK HOUSE	Aug 16, 1990

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BARRY ELKINS	2010 W. THAT RD. BLGTON,IN.	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD. ELLETTSVILLE,IN.	(000) 876-1055
Operator	FRED & CURT SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 55.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PCX	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	9.0	YEL SHALE
9.0	14.0	GRAY LS MD CHIP
14.0	18.0	BLUE LS LARGE CHIP
18.0	22.0	GRAY LS MD CHIP
22.0	25.0	BLUE LS LARGE CHIP
25.0	38.0	GRAY LS FINE CHIP
38.0	55.0	BLUE LS FINE CHIP
55.0	63.0	BLUE SOAPSTONE LARGE CHIPS

63.0	77.0	BUFF LS FINE CHIPS
77.0	103.0	GRAY LS LARGE CHIPS
103.0	109.0	YEL LS MD CHIPS
109.0	128.0	GRAY LS MD CHIPS
128.0	138.0	LS LARGE CHIPS
138.0	145.0	GRAY LS LARGE CHIPS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
231983	S.W. OF BLOOMINGTON, TAKE SR#37 TO ROCKPORT RD., R. STAY ON ROCKPORT RD,TIL LODGE RD.,L. GO NEXT TO LAST HOUSE ON R. # ON MAILBOX 7150	May 15, 1989

Owner-Contractor	Name	Address	Telephone
Owner	DAVID STULTZ	7150 S. LODGE RD. BLOOMINGTON,IN.	(812) 825-9100
Driller	FRED SCOTT'S WELL DRILLING	236 W. COWDEN RD. ELLETTSVILLE,IN.	(999) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 5.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 25.0
Installation Method: AIR-PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	3.0	BR CLAY
3.0	4.0	YEL CLAY
4.0	20.0	GRAY LS HARD
20.0	26.0	BLUE LS HARD
26.0	31.0	GRAY LS HARD
31.0	35.0	BLUE LS HARD

35.0	48.0	GRAY LS HARD
48.0	60.0	BUFF LS HARD
60.0	75.0	GRAY LS HARD
75.0	82.0	BLUE LS HARD
82.0	118.0	GRAY LS HARD
118.0	125.0	BLUE LS HARD

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
257650	APPROX. 3.5 MI. N. OF JCT. #45 & #58 NEAR OWENSBURG,IN. TURN W. ON CR#300S. GO 1 MI. 1ST. DRIVE ON L.	Feb 28, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VAN ROBERSTON	R.R. #3 BOX 302 BLOOMFIELD,IN.	
Driller	MUMMA BROS. DRILLING,INC.	R.R.#1 BOX #85 LYONS,IN.	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 345.0	**Pump setting depth:** 320.0	**Water quality:**
Casing	**Length:** 166.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 18.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 200.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 130.0 to 163.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 9 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 28.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	21.0	LS
21.0	28.0	CLAY
28.0	38.0	SANDROCK,CLAY SEAMS
38.0	61.0	YEL SANDROCK
61.0	76.0	LS
76.0	84.0	BLUE SHALE
84.0	91.0	GREEN SANDROCK

91.0	100.0	GREENISH RED ROCK
100.0	144.0	SANDROCK
144.0	160.0	DARK SHALE
160.0	165.0	SANDY SHALE
165.0	235.0	SANDROCK
235.0	239.0	LS
239.0	243.0	GREEN SHALE
243.0	310.0	LS BROKEN
310.0	345.0	SANDY LS WATER

Comments PH7,HAR 20,IRON 1.0 PPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
274817	LEAVING SOLSBURG 1ST RD TO R OFF OF HWY 43, GO 1 MI OUT OF SOLSBERRY, TURN R ONTO WASHBOARD RD, STAY STRAIGHT FOR 3.5 MI HOUSE ON R WELL IN FRONT YARD	Aug 17, 1995

Owner-Contractor	Name	Address	Telephone
Owner	JEFF ADAMS	RR1 BOX 370A, SOLSBERRY, IN	(812) 825-9283
Driller	PHILLIP'S WELL DRILLING	RR12 BOX 624, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 220.0	**Pump setting depth:** 200.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 6.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOP SOIL
1.0	2.0	BLANK
2.0	17.0	CLAY
17.0	28.0	SS
28.0	56.0	LS
56.0	62.0	SHELL
62.0	220.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
278105	SW OF BLOOMINGTON TAKE SR 37 S TO ROCKPORT RD TURN SW GO TO DUALL RD TURN W GO 1.5 MI DRIVEWAY AT BOTTOM OF HILL HSE BACK OFF MAIN RD TOP OF HILL	Jul 22, 1994

Owner-Contractor	Name	Address	Telephone
Owner	STEVE CAIN	5950 W CUVALL RD, BLOOMINGTON, IN	(812) 334-4087
Driller	FRED SCOTTS WELL DRLG	6236 W COWDEN RD, ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 165.0	**Pump setting depth:** 150.0	**Water quality:** CLEAR
Casing	**Length:** 33.0	**Material:** STEEL	**Diameter:** 6.63
Screen	**Length:** 120.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 94.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 32.0 to 0.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	11.0	RED CLAY
11.0	35.0	GRAY LS CRS
35.0	39.0	BLUE LS CRS
39.0	60.0	GRAY LS FINE
60.0	62.0	BLUE SH
62.0	86.0	GRAY LS CRS

86.0	88.0	BLUE SH
88.0	92.0	BLUE LS FINE
92.0	96.0	GRAY LS FINE
96.0	124.0	BUFF LS EX FINE
124.0	143.0	GRAY LS CRS
143.0	146.0	BLUE SH
146.0	150.0	BLUE LS CRS
150.0	151.0	YEL SH
151.0	159.0	GRAY LS FINE
159.0	160.0	BLUE SH
160.0	165.0	GRAY LS FINE

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295360	FROM 37N TAKE ROCKPORT RD E GO APPROX 8 MI TO TRANWAY RD TURN LEFT GO 1.5 MI PLACE IS ON LF	May 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KEVIN H. WRIGLEY	4198 W TRAMWAY RD., BLOOMINGTON, IN	
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 145.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 27.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 27.0
Installation Method: PUMP **Number of bags used:** 1.25

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	145.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295361	SR37 TO ROCKPORT RD GO 5 MI TO TRANWAY TURN L ONTO TRAMWAY GO .5 MI ON L	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	JUNIOR PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.0 gpm for 60.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 37.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY
22.0	65.0	LS
65.0	73.0	SHELL
73.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295362	SR37 TO ROCKPORT RD GO 5 MI TO TRAMWAY TURN LEFT ON TO TRAMWAY GO .5 MI ON LEFT	May 01, 1996

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BETH SCROGGINS	3903 E BETHEL LANE, BLOOMINGTON, IN	(812) 331-8555
Driller	PHILLIPS WELL DRILLING	RR12 BOX 444, BEDFORD, IN	(812) 279-4843

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 135.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 2.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	24.0	CLAY
24.0	68.0	LS
68.0	75.0	SHELL
75.0	140.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295365	W OF STANFORD, ON HWY45 GO .25 MI DRIVEWAY ON N SD OF HWY	Apr 09, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ALOHA GINSENG FARM	9840 W ST HWY45, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 83.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	CLAY RED
15.0	22.0	SUB CLAY
22.0	25.0	SOFT SANDROCK
25.0	35.0	REDROCK
35.0	50.0	GREEN SANDY SHALE
50.0	53.0	SANDROCK
53.0	60.0	GREEN SHALE & BLUE SHALE

60.0	80.0	DK SHALE & LIME BKS
80.0	83.0	SANDY DK SHALE
83.0	90.0	DK SHALE
90.0	100.0	LS
100.0	103.0	BLUE SHALE
103.0	110.0	SANDROCK
110.0	123.0	DK SHALE & BLUE SHALE
123.0	132.0	LS
132.0	134.0	BLUE SAHLE
134.0	215.0	LS
215.0	240.0	LS CRACKS WATER

Comments SEE MAP; CHEM ON LOG

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
295367	FOLLOW BREEDEN RD S OF HWY45 2 MI TO PRIVATE DRIVE ON W SD OF RD	Jun 30, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP LONG	7625 S BREEDEN RD., BLOOMINGTON, IN	
Driller	MUMMA BROS. DRILLING INC.	R1 BOX 85, LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 31.0 to 0.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	18.0	RED CLAY
18.0	68.0	LS
68.0	75.0	BLUE SHALE
75.0	100.0	LS
100.0	125.0	LS & CRACKS WATER

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309951	37/OLD 37 INTERSECTION GO ON OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 215.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 28.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
11.0	165.0	LIME STONE
166.0	175.0	LIME STONE
176.0	191.0	LIME STONE
192.0	215.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309952	37/OLD 37 INTERSECTION GO UP OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRARIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:**	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: YOM BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 28, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	75.0	LIME STONE
75.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309953	37/OLD 37 INTERSECTION - GO TO OLD 37 TO TOP OF HILL OR E	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 2 BOX 444 BED, IN	(812) 279-4843
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 125.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ELEM BENT **Depth:** from 0.0 to 25.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 25, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	LIME STONE
25.0	50.0	LIME STONE
50.0	100.0	LIME STONE
100.0	125.0	LIME STONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
309959	OFF 37 TO OLD 37 INTERSECTION - TAKE OLD 37 TO TOP OF HILL ON R	Jun 01, 1997

Owner-Contractor	Name	Address	Telephone
Owner	PRAIRIE GROUP	PO BOX 41193 INDIANAPOLIS, IN	
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 310.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: WYO BEN **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CALLED OFFIC **on:** Apr 24, 2008
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
3.0	6.0	BUST LIMESTONE
7.0	29.0	HARD LIMESTONE
30.0	33.0	LIME STONE
34.0	82.0	HARD LIMESTONE
83.0	175.0	SOFT LIMESTONE
176.0	310.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
322971	8897 W THACKER RD, W 45 TO BREEDEN RD S ON BREEDEN TO THACKER .5 MI ON S	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CAMERON DECKARD	8897 W THACKER RD, BLOOMINGTON, IN	(812) 825-3530
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	
Company	CAMERON DECKARD		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 300.0	**Pump setting depth:** 280.0	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .025

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 32.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	22.0	RED CLAY
22.0	140.0	GRAY SH
140.0	221.0	LS
221.0	245.0	GRAY SH
245.0	300.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324080	45 R TO 580 - GO 5 MI	Oct 01, 1997

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE NEHRT	550 BRIDE DALYON RD BLOOMINGTON	
Driller	PHILLIPS WELL DRLG	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	JAY PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 80.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 9.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 3.0 to 80.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	25.0	CLAY
25.0	50.0	BLUE MUCK
75.0	100.0	SANDSTONE
100.0	125.0	LS
503.0	75.0	SHELLY SANDSTONE

Comments (? LOC)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
324084	TAKE 45 TO BREEDEN RD GO 4 MI TO THOACKER RD GO 1.5 MI UNTIL YOU SEE A BIG RED BARN ON LT, THIS IS HIS HOME SITE	Jun 02, 1998

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY CLARK	3811 E ANDERSON RD., BLOOMINGTON, IN	(812) 331-8464
Driller	PHILLIPS WELL DRLNG	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	BRYAN PHILLIPS	License: 1463	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 140.0	**Pump setting depth:** 120.0	**Water quality:** CLEAR
Casing	**Length:** 42.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 42.0
Installation Method: PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	1.0	TOPSOIL
1.0	10.0	RED CLAY
10.0	24.0	BUSTED LS
24.0	27.0	RED CLAY
27.0	140.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
338841		Jul 23, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB BARTHOLOMEW	PO BOX 702 CLEAR CREEK IN	(812) 824-7841
Driller	PHILLIPS WELL DRLG & PUMP SVC	RR 12 BOX 444 BEDFORD IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	
Company	DISTRICTIVE HOMES		

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 280.0	**Pump setting depth:** 260.0	**Water quality:** GOOD
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 2

Well Capacity Test

Type of test: Bailing **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 25.0
Installation Method: PUMP IN **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL
7.0	40.0	SANDSTONE
40.0	66.0	LS
66.0	83.0	SANDSTONE
83.0	149.0	SHALE
149.0	280.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
339114	N SD OF STONE MILL & E OF RR VIADOCK	Nov 20, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL J. BUNCH	7665 S. VICTOR PIKE, BLOOMINGTON, IN	
Driller	MUMMA BROS. DRLNG INC.	R1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 28.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 1.5 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 28.0 to 0.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	35.0	LS
35.0	36.0	SEAM WATER
36.0	50.0	LS
50.0	77.0	LS & SH BKS
77.0	105.0	GREY SANDROCK

Comments SEE MAP; PETROLIUM ODOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
349513	GO OFF SR54 AT THE HOBBIESVILLE TURNOFF GO DOWN RD TO "Y" HANG L GO ABOUT 1.5 MI UP GRAVEL RD YOU'LL SEE AN IRON GATE TURN L	Nov 10, 1999

Owner-Contractor	Name	Address	Telephone
Owner	BOB HILL	PO BXO 230, OOLITIC, IN	(000) 279-5904
Driller	PHILLIPS WELL DRLNG & PUMP SVC	RR12 BOX 444, BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 320.0	**Pump setting depth:** 300.0	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 5.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of Section 1 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	TOPSOIL
4.0	8.0	CLAY
8.0	16.0	SH LS
16.0	32.0	MUD SEAM
32.0	39.0	BUSTED LS
39.0	55.0	SH
55.0	60.0	SS

60.0	102.0	SH
102.0	244.0	SS
244.0	320.0	LS

Comments SEE MAP; HWY54 TO 1375E, R ON 1320E, APPROX .75 MI

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
349665	TAKE 54 W TO HOBBIESVILLE RD; TURN R; GO ABOUT 2.5 MI; ON L; 2ND HOUSE TO L PAST MYERS DRYWALL	Oct 18, 1999

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BRAD STURGEON	9960 W ROCKEAST RD BLOOMINGTON, IN	(812) 825-2034
Driller	PHILLIPS WELL DRILLING&PUMP	RR 12 BOX 444 BEDFORD, IN	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Other
	Depth: 170.0	**Pump setting depth:**	**Water quality:** CLEAR/GOOD
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 4.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 0.0 to 60.0
Installation Method: PUMP **Number of bags used:** 3.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	11.0	CLAY
11.0	21.0	SS
21.0	27.0	BUSTED LS
27.0	58.0	SH
58.0	170.0	SOLID LS

Comments SEE MAP;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
352175	S OF KOLEEN, 1/2 TO COUNTY ROAD TO LT, GO .5 MILE	Apr 26, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID MONTGOMERY	PO BOX 50, KOLEEN, IN	
Driller	MUMMA BROS. DRLNG INC.	RR1 BOX 85, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 53.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 140.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 53.0 to 0.0
Installation Method: PUMP **Number of bags used:** 4.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY & ROCKS
17.0	20.0	LS
20.0	30.0	SH
30.0	31.0	LS
31.0	44.0	SH & LIME BKS
44.0	48.0	SANDY SH
48.0	70.0	SANDROCK
70.0	83.0	BRN LS
83.0	100.0	GREY LS, HD
100.0	108.0	GREY SH & REDROCK

108.0	118.0	SANDROCK
118.0	130.0	DK SANDY SH
130.0	142.0	DK GREY SH
142.0	148.0	SANDROCK
148.0	179.0	REDROCK & DK SH
179.0	185.0	LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
370693	W OF CAMP OLIVET FOUNDATION, ON W SD OF HWY54	May 16, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE BONNEY	OWENSBURG, IN	
Driller	MUMMA BROS. DRILLING INC.	RR1 BOX 84, LYONS, IN	(812) 659-2280
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 370.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 150.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 220.0	**Material:** PVC LINER	**Diameter:** 4.5 **Slot size:** 220

Well Capacity Test

Type of test: Air **Test rate:** 50.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 174.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 150.0 to 0.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	18.0	YEL SANDROCK & CLAY SEAMS
18.0	28.0	BRN CLAY
28.0	35.0	SOFT SH
35.0	40.0	GREY SANDY SH
40.0	46.0	SANDROCK & LIME BKS
46.0	53.0	YELLOW SANDROCK
53.0	60.0	BROWN SANDROCK
60.0	80.0	BRKN SANDY SH
80.0	147.0	DK SH & LIME BKS

147.0	149.0	SANDY SH
149.0	160.0	LS
160.0	168.0	DK SH
168.0	173.0	BLUE SH SOFT
173.0	185.0	LS & SH BKS
185.0	240.0	LS
240.0	260.0	SANDY LS
260.0	275.0	LS CRACKS
275.0	295.0	LS
295.0	305.0	LS CRACKS
305.0	355.0	LS
355.0	370.0	BRKN LS

Comments SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383065	HWY 45 TO STANFORD, LEFT ON BREEDEN RD, 4 MI TO 1ST CROSS RD, GO RT, 2ND FARM ON LEFT;	Aug 10, 2001

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MICHAEL WAMPLER/CJ STURGEON	9501 ROCK EAST RD B'TON IN	(812) 825-5804
Driller	PHILLIPS WELL DRLG&PUMP SVC IN	RR 12 BOX 444 BEDFORD, INDIANA	(812) 279-4843
Operator	LLOYD PHILLIPS	License: 208	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 56.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:** 40.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 4 IN

Well Capacity Test

Type of test: Air **Test rate:** 8.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 27.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENT **Depth:** from 0.0 to 50.0
Installation Method: PUMP **Number of bags used:** 6.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	RED CLAY
7.0	51.0	BUSTED ROCK
51.0	80.0	LIMESTONE

Comments SEE MAP;30-72W; PLAT 2;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
391301	ST RD 45 WEST TO COUNT ROAD BREADEN ROAD GO 5 MILE TO WEST CRAVES ROAD GO 1 MILE TO RIGHT BOX 8785	Nov 26, 2004

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF NEW	8785 WEST GRAVES ROAD	(812) 336-7537
Driller	J AND K WATER WELL SERVICE	1369 STATE ROAD 158 WILLIAMS IN	
Operator	JAY A PHILLIPS	License: 1464	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 112.0	**Pump setting depth:** 90.0	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 5.0 gpm for 300.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 20.0 ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENTONITE **Depth:** from 5.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	5.0	SAND
5.0	10.0	SABD ABD PEA GRAVEL
10.0	15.0	SAND AND MUD
15.0	20.0	CLAY
20.0	25.0	LIMESTONE
25.0	30.0	LIMESTONE
30.0	35.0	BUSTED LIMESTONE
35.0	40.0	LIMESTONE
40.0	112.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
404946	SR54 - GO TO HOBBIEVILLE RD - GO THRU HOBBIEVILLE- CONTINUE ON - GO AROUND SHARP CURVE - PASS DECKARD HOME SALES - TO NEW CONSTRUCTION ON R! FENCED IN	Nov 19, 2005

Owner-Contractor	Name	Address	Telephone
Owner	JOE BYERS	RR1 SPRINGVILLE, IN	(812) 855-4307
Driller	PHILLIPS WELL DRILLING	RR3 BOX 55-A OWENSBURG, IN	(812) 863-4843
Operator	DEXTER SWARTZENTRUBER	License: 302	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth:	**Pump setting depth:**	**Water quality:** GOOD
Casing	**Length:** 40.0	**Material:** STEEL	**Diameter:** 6.0
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** 2

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENSEAL **Depth:** from 0.0 to 40.0
Installation Method: PUMPED IN **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	11.0	CLAY
11.0	14.0	BROKEN LIMESTONE
14.0	30.0	LIMESTONE
30.0	32.0	BROKEN LIMESTONE
32.0	85.0	LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
407312	SOUTH WEST OF BLOOKINGTON ON 45 THRU STANFORD. LEFT OR SOUTH ON BREEDEN RD APP 1 MIL ACROSS CREEK (DRIVEWAY) ON RIGHT. REPLACES EXIST WELL AT OLD BARN	Apr 04, 2006

Owner-Contractor	Name	Address	Telephone
Owner	LISA SWOAPE	7625 S BREEDEN RD BLOOMINGTON, IN	
Driller	MADER WELL DRILLING	9262 OWEN PARK RD SPENCER, IN	(765) 795-3343
Operator	STEVE MADER	License: 541	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:** Submersible
	Depth: 95.0	**Pump setting depth:** 65.0	**Water quality:** CLEAR
Casing	**Length:** 41.0	**Material:** PVC	**Diameter:** 10.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Bail / Pump **Test rate:** 40.0 gpm for 0.5 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 15.0 ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: W-O-B **Depth:** from to
Installation Method: POUR **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** 6.0 **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	2.0	CLAY
2.0	6.0	BROKEN LIMESTONE
6.0	15.0	LS
15.0	16.0	SOFTER
16.0	38.0	MD & SOFTER LS
38.0	75.0	HD GRAY LIMESTONE
75.0	85.0	GRAY LIMESTONE
85.0	88.0	HD DARKER GRAY LS
88.0	95.0	BROKEN LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40745		May 09, 1946

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	A PADGETT		
Driller	WAGGONER BROTHERS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 67.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 530.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	15.0	OVERBURDEN
15.0	31.0	SOFT RED SS
31.0	33.0	LS
33.0	43.0	BLUISH GRAY SANDY SHALE
43.0	45.0	HARD YELL SS, WATER
45.0	67.0	YELL SS, WATER

Comments WELL E-1, DATA FROM USGS BULL 11 AND WWRS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410928	37 - VICTOR PIKE - GO DOWN ABOUT 2.5 MILES TO 30 MILL ON R - WELL IS LOCATED BY BACK LOT	Jul 16, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3D STONE, INC/WHALEY INVESTMEN	4810 SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	PHILLIPS WELL DRILLING	RR 12 BOX 55A OWENSBURG, IN	(812) 863-4843
Operator	TAMMY HOLLAND/REX MARTIN	License: null	

Construction Details

Well	**Use:** Industry	**Drilling method:**	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 24.0 ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BENONITE **Depth:** from 40.0 to 0.0
Installation Method: TREMMIE **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	135.0	LIMESTONE
135.0	136.0	SANDY SHALE
136.0	137.0	LIMESTONE
137.0	140.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
410932	VICTOR PIKE - 3 D STONE INC. MILL ON VICTOR PIKE OFF OF HWY 37	Jul 10, 2007

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	3 D STONE INC/WHALEY INVESTMEN	4810 WEST SR 45 BLOOMINGTON, IN	(812) 825-3766
Driller	HACKER PLUMBING & DRILLING	2687 S OLD DECKER RD VINCENNES, IN	(812) 882-8053
Operator	TIM HACKER	License: 152	
Company	PHILLIPS WELL DRILLING	R # 3 BOX 55A OWENSVILLE, IN	(812) 863-4844

Construction Details

Well	**Use:** Industry	**Drilling method:** Rotary	**Pump type:**
	Depth: 340.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: BENTONITE **Depth:** from 0 to 340
Installation Method: TREMMIE **Number of bags used:** 10.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	110.0	LIMESTONE W/MUD SEAMS
110.0	170.0	LIMESTONE W/SANDY SHALE SHALE
170.0	340.0	SANDY SHALE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
52692	GO N OF JUNCTION HWY 45 & 48 GO N ON 45 .75 MI TO 1ST CROSS ROAD TURN W ENTERENCE AS STEEL GATES, PRIVATE DR .5 MI THRU CLASSIFIED FOREST	Oct 26, 1993

Owner-Contractor	Name	Address	Telephone
Owner	WENDELL LEEDY	R 3 BOX 29C OWENSBURG, IN	
Driller	MUMMA DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2212
Operator	DAVID/RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 365.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 100.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 280.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 5.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 100.0 to 50.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of Section 17 **Topo map:** KOLEEN
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	CLAY & SANDROCK
15.0	22.0	BREAK OF COAL & SH
22.0	34.0	SANDROCK & CLAY SEAMS
34.0	43.0	SOFT SH
43.0	55.0	SANDROCK (HARD)
55.0	61.0	BLUE SH
61.0	64.0	YEL SANDROCK

64.0	69.0	LS & SEAMS
69.0	95.0	DARK SH
95.0	134.0	SANDROCK
134.0	137.0	SH
137.0	155.0	LS
155.0	170.0	BLUE SH, REDROCK, GREEN SH
170.0	200.0	SANDY SH & SANDY LIME
200.0	212.0	DARK SH
212.0	225.0	SANDROCK & SANDY SH
225.0	245.0	DARK SH
245.0	255.0	SANDROCK & SHEAL BKS
255.0	260.0	SANDROCK
260.0	267.0	DARK SH
267.0	275.0	SANDROCK
275.0	298.0	LS
298.0	304.0	BLUE SH
304.0	365.0	LS CRACKS (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52702	GO S OF HWY 45 & 54 UCT ON 54S TO CR 1250E GO S TO CHURCH TURN R ON GRAV RD GO 200 YRDS TURN R GO TO TEE GO LEFT DEAD END	Aug 06, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM RICHARD	OWENSBURG, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	
Operator	DAVID MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 100.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 60.0 to 35.0
Installation Method: PUMP **Number of bags used:** 1.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	4.0	CLAY
4.0	30.0	SANDROCK & SEAMS
30.0	55.0	SANDROCK
55.0	62.0	SANDY SH
62.0	78.0	DARK SH
78.0	85.0	YEL SANDROCK
85.0	95.0	DARK SH & SANDY SH
95.0	100.0	SANDROCK (WATER)
100.0	120.0	DARK SH
120.0	127.0	SANDROCK (WATER)
127.0	140.0	DARK SH & SANDROCK
140.0	145.0	LS

Comments 28 HARDNESS 7.0 PH28 HARDNESS 7.0 PH 3PPM IRON

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
52704	GO 200 FT S OF HWY JCT 54 & 45 EXIT HWY 54 ONTO CR 50S (DEAD END) GO E .75 MI ONTO PRIVATE DR THRU WOODS	Jun 28, 1993

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOE JAMES	R 4 BOX 416 BLOOMFIELD, IN	
Driller	MUMMA BROS DRILLING	R 1 BOX 85 LYONS, IN	(812) 659-2398
Operator	DAVID RICHARD MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 285.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 82.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 200.0	**Material:** PVC	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 80.0 to 20.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of Section 26 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: **UTM Northing:**

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	15.0	SANDROCK & SEAMS
15.0	20.0	SOFT SH
20.0	32.0	SANDY SH
32.0	68.0	DARK SH
68.0	69.0	LS
69.0	78.0	DARK SH

78.0	81.0	SANDROCK
81.0	100.0	DARK SH & SANDROCK BREAKS
100.0	102.0	GREEN SH
102.0	240.0	LS
240.0	273.0	LIMECRACKS
273.0	285.0	LIMECRACK (WATER)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
20401	E OF HOBBIEVILLE, GO ABOUT 3.25MI, GO TO BOTTOM OF HILL AND STAY L TO ROCK E RD THEN ABOUT 1.25MI FROM BOTTOM OF HILL, LOT ON N SIDE OF RD	Oct 17, 1990

Owner-Contractor	Name	Address	Telephone
Owner	MIKE WAMPLER	10024 W ROCK EAST RD BLOOMINGTON IN	(812) 825-2076
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	CURT AND FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 30.0	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 125.0 ft. **Static water level:** 38.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 5.0 to 30.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the SE of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 28, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1250.0 **Ft N of SL:** 500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**
UTM Easting: 527150.0 **UTM Northing:** 4317565.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELLOW CLAY
8.0	13.0	YELLOW SANDSTONE EX SOFT
13.0	20.0	YELLOW GUMMY SHALE
20.0	27.0	BLUE SHALE EX SOFT
27.0	39.0	GRAY LIMESTONE LARGE CHIPS
39.0	50.0	BLUE LIMESTONE MED CHIPS

50.0	76.0	GRAY LIMESTONE MED CHIPS
76.0	80.0	WHITE SHALE
80.0	95.0	BLUE LIMESTONE LARGE CHIPS
95.0	96.0	YELLOW SHALE
96.0	109.0	GRAY LIMESTONE FINE CHIPS
109.0	125.0	BLUE LIMESTONE FINE CHIPS

Comments LINER SET TO 100', WELL #1, SKETCH MAP, MC 632

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
20402	E OF HOBBIEVILLE GO E ABOUT 3.5MI, GO TO BOTTOM OF HILL AND STAY L, ROCK EAST RD ABOUT 1.5MI FROM BOTTOM OF HILL, HOUSE ON N SIDE OF RD	Oct 05, 1990

Owner-Contractor	Name	Address	Telephone
Owner	MIKE WAMPLER	10024 W ROCK EAST RD BLOOMINGTON IN	(812) 825-2076
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	CURT AND FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 31.5	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 42.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 6.0 to 31.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NE of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 28, 1992
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 527285.0 **UTM Northing:** 4317850.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLAY
5.0	21.0	BROWNISH RED SANDSTONE EX SOFT
21.0	26.0	YELLOW MUCKY SHALE
26.0	29.0	OPEN SEAM
29.0	39.0	GRAY LIMESTONE LARGE CHIP
39.0	46.0	BLUE LIMESTONE MED CHIPS

46.0	70.0	GRAY LIMESTONE MED CHIPS
70.0	80.0	BLUE LIMESTONE MED CHIPS
80.0	87.0	DEEP BLUE LIMESTONE LRG CHIPS
87.0	105.0	GRAY LIMESTONE LRG CHIPS

Comments VERIFIED BY OWNER, WELL #2, SKETCH MAP, MC 655

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
20404	S OF STANFORD, TAKE SR 45W TO BREEDEN RD TURN S PAST T. PHILLIPS RD, HOUSE ON R (W) SIDE OF RD	Jun 26, 1991

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RONALD PORTER	7211 S BREEDEN RD BLOOMINGTON IN	(812) 825-9307
Driller	FRED SCOTT'S WELL DRILLING	6236 W COWDEN RD ELLETSVILLE IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 26.0	**Material:** STEEL	**Diameter:** 6.6
Screen	**Length:** 80.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 60.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 105.0 ft. **Static water level:** 5.25 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 26.0
Installation Method: AIR PUMP **Number of bags used:** 2.5

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the NE of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: JS **on:** Jul 27, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2125.0 **Ft S of NL:** 2225.0
Ground elevation: 695.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 528115.0 **UTM Northing:** 4324760.0

Well Log

Top	Bottom	Formation
0.0	2.0	TOPSOIL
2.0	7.0	YELLOW CLAY
7.0	52.0	GRAY LIMESTONE COARSE
52.0	57.0	BLUE LIMESTONE FINE
57.0	67.0	GRAY LIMESTONE FINE
67.0	85.0	YELLOWISH LIMESTONE FINE
85.0	105.0	GRAY LIMESTONE COARSE

Comments VERIFIED BY MAILBOX, SKETCH MAP, MC 688

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213403		

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUFUS FLEEMER		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 60.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 35.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1800.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 537946.0 **UTM Northing:** 4327746.0

Well Log

Top	Bottom	Formation
0.0	18.0	RED CLAY
18.0	60.0	WH LS

Comments RELATIVE VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213408	4 MI S BLOMINGTON ON SR37 TO DILLMAN RD&TURN R GOTO T RD&THIS PLACE IS ON NE SIDE OR 1ST HOUSE ON R AFTER YOU TURN R ON T RD.	May 12, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EARL KIRK		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 31.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SE of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 680.0 **Aquifer elevation:**
UTM Easting: 538163.0 **UTM Northing:** 4327099.0

Well Log

Top	Bottom	Formation
0.0	30.0	RED CLAY
30.0	110.0	WH LS

Comments MC 680;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213412	S BLOOMINGTON IN, ON SR37, 4 MI.	Aug 23, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARSHALL MAY	RR#4	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 75.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 10.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1600.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 614.0 **Aquifer elevation:**
UTM Easting: 539627.0 **UTM Northing:** 4327386.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOPSOIL
6.0	50.0	HARD LS
50.0	65.0	LAYERS LS & SHALE

Comments MC 614; OWNER & SIGN VERIFIED 60' W OF RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213413	NEAR CLEAR CREEK ABOUT 3MI SW ON BOWLIN RD.	Oct 16, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FLOYD MEADOWS	RR4	
Driller	PAUL SCOTT	SUGAR LANE 3615	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the SW of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1700.0 **Ft E of WL:** 2200.0 **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 666.0 **Aquifer elevation:**
UTM Easting: 537567.0 **UTM Northing:** 4327546.0

Well Log

Top	Bottom	Formation
1.0	14.0	CLAY
14.0	36.0	STONE BUFF LIME SOFT
36.0	45.0	STONE GRAY LIME HARD
45.0	52.0	STONE WH LIME HARD
52.0	78.0	STONE WH LIME SOFT
78.0	90.0	STONE BLUE LIME HARD
90.0	94.0	STONE GRAY LIME HARD
94.0	110.0	STONE BLUE SHALE SOFT
110.0	137.0	STONE GRAY LIME HARD
137.0	150.0	STONE BLUE SOAPSTONE SOFT

Comments MC 665; VERIFIED BY NEIGHBOR;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213417		May 08, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARSHALL MAY	RR#4, BLOOMINGTON	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 25, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 608.0 **Aquifer elevation:**
UTM Easting: 539590.0 **UTM Northing:** 4327343.0

Well Log

Top	Bottom	Formation
0.0	12.0	DIRT
12.0	30.0	BLUE HARD LS
30.0	75.0	BLUE SHALE

Comments MC 608; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213418	ON BOWLING LANE 1.05 MI SW, CLEAR CEEK IN.	May 11, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS. VEACH	RR#5, BLGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 37.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NE of the SW of Section 30 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 700.0 **Aquifer elevation:**
UTM Easting: 537312.0 **UTM Northing:** 4327754.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	50.0	MD HARD GREY LS
50.0	106.0	WH MD HARD LS
106.0	125.0	VERH HARD WH LS

Comments DRY VERIFIED; MAILBOX LOCATION;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213422	NEAR OLD DILLMAN SCHOOL, N ABOUT 500' ON OLD SMITH FARM. L SIDE, 1ST HOUSE, N OF NEW RET.	Dec 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES SMITH	RR#4, BLOOMINGTON	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.13 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 645.0 **Aquifer elevation:**
UTM Easting: 539456.0 **UTM Northing:** 4327142.0

Well Log

Top	Bottom	Formation
0.0	24.5	RED CLAY
24.5	100.0	HARD WH LIME

Comments DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213492	S EDGE CLEAR CREEK IN.	Oct 17, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #4	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 42.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1500.0
Ground elevation: 660.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539490.0 **UTM Northing:** 4328099.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	100.0	HARD LS
100.0	125.0	BLUE SHALE

Comments MC 650; OWNER VERIFIED ABOUT 50 YDS NW OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213497	S EDGE CLEAR CREEK IN.	Sep 26, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #1	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1650.0
Ground elevation: 665.0 **Depth to bedrock:** 36.0 **Bedrock elevation:** 629.0 **Aquifer elevation:**
UTM Easting: 539514.0 **UTM Northing:** 4328057.0

Well Log

Top	Bottom	Formation
0.0	36.0	TOPSOIL & LAYERS LS
36.0	100.0	HARD LS
100.0	135.0	SHALE

Comments MC 629; OWNER VERIFIED 25' W OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213498	ON SIGO RD, WAS CALLED DILMAN RD.	Oct 25, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEE LUCAS	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NE of the NE of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 25, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 680.0 **Depth to bedrock:** 49.0 **Bedrock elevation:** 631.0 **Aquifer elevation:**
UTM Easting: 539888.0 **UTM Northing:** 4326952.0

Well Log

Top	Bottom	Formation
0.0	49.0	BLANK
49.0	79.0	BLUE LS
79.0	115.0	BLUE SHALE

Comments MC; OWNER VERIFIED; DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213503	OLD PUBLIC SERVICE SUB STATION 4.5 MI S BLOOMINGTON IN, OFF SR37 ABOUT .125 MI.	Apr 06, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROY CRAIG	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 63.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 7.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 32 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 655.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 648.0 **Aquifer elevation:**
UTM Easting: 539404.0 **UTM Northing:** 4326466.0

Well Log

Top	Bottom	Formation
0.0	7.0	LS FILL
7.0	63.0	WH MD HARD LS

Comments MC 650; DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213507	S EDGE CLEAR CREEK IN.	Oct 08, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #3	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1850.0
Ground elevation: 675.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 667.0 **Aquifer elevation:**
UTM Easting: 539496.0 **UTM Northing:** 4327996.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOPSOIL
8.0	100.0	WH LS
100.0	145.0	BLUE SHALE

Comments MC 667; OWNER VERIFIED ABOUT 60 YDS SW OF HOUSE; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213508	1ST HOUSE INDIAN HILL STONE MILL ON VICTOR RD.	Feb 03, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	C.T. HAGERS	RR#4	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 650.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 635.0 **Aquifer elevation:**
UTM Easting: 537322.0 **UTM Northing:** 4325621.0

Well Log

Top	Bottom	Formation
0.0	15.0	DIRT
15.0	50.0	HARD LS
50.0	100.0	BLUE SHALE

Comments MC 635; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213512	S EDGE CLEAR CREEK IN.	Oct 02, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MAY #2	5800 S RODGERS ST	
Driller	GEORGE SNAPP	BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the NE of Section 29 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 670.0 **Depth to bedrock:** 19.0 **Bedrock elevation:** 651.0 **Aquifer elevation:**
UTM Easting: 539514.0 **UTM Northing:** 4328032.0

Well Log

Top	Bottom	Formation
0.0	19.0	TOPSOIL & LAYERS LS
19.0	100.0	HARD DARK LS

Comments

MC 651; OWNER VERIFIED ON W SIDE OF FENCE LINE ABOUT 40 YDS. SW OF HOUSE; DRY WELL;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213518	ON VICTOR PIKE 0.25 MILE S OF DILLMAN ROAD TEE.	Nov 28, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WILLIAM BOWFF	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 41.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 81.0 ft. **Bailer Drawdown** 29.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: SJ **on:** Jun 01, 1975
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2600.0 **Ft S of NL:** 900.0
Ground elevation: 680.0 **Depth to bedrock:** 79.0 **Bedrock elevation:** 601.0 **Aquifer elevation:**
UTM Easting: 537674.0 **UTM Northing:** 4326725.0

Well Log

Top	Bottom	Formation
0.0	79.0	RED CLAY W/ LAYERS LIMESTONE
79.0	115.0	HARD WHITE LIMESTONE

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213644	ABOUT 2MI W CLEAR CREEK ON THAT RD JUST BACK OF POND OFF ROCKPORT RD. ABOUT 2MI W OF CLEAR CR ON THAT RD JUST BACK OF POND OFF ROCKPORT RD.	Apr 28, 1964

Owner-Contractor	Name	Address	Telephone
Owner	EUGENE STANFIERS #1	RR5, BLOOMINGTON	
Driller	PAUL SCOTT	3615 SUGAR ACRES, BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 28.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2200.0 **Ft E of WL:** 1300.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 766.0 **Aquifer elevation:**
UTM Easting: 537265.0 **UTM Northing:** 4329242.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	14.0	RED CLAY
14.0	16.0	GRAY LS SOFT
16.0	20.0	GRAY LS HARD
20.0	25.0	BLUE LS EX HARD
25.0	28.0	GRAY LS SOFTER
28.0	35.0	GRAY LS HARD

35.0	39.0	BUFF LS SOFT
39.0	46.0	GRAY LS HARD
46.0	50.0	GRAY LS SOFTER
50.0	60.0	GRAY LS EX HARD
60.0	65.0	LIGHT BLUE LS EX HARD
65.0	75.0	LIGHT GRAY LS HARD
75.0	84.0	WH LS SOFT
84.0	102.0	GRAY LS HARD
102.0	117.0	DARK GRAY LS SOFTER
117.0	125.0	WH LS SOFT
125.0	137.0	LIGHT GRAY LS HARD
137.0	146.0	LIGHT GRAY LS SOFTER
146.0	161.0	LIGHT GRAY LS HARD
161.0	165.0	LIGHT GRAY LS SOFTER

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213645	ON THAT ROAD WEST OF RODGERS ST. ABOUT 2 BLOCKS ON NORTH SIDE ROAD	Nov 25, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VIRGIL FENDER	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 23.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0
Ground elevation: 680.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 675.0 **Aquifer elevation:**
UTM Easting: 539477.0 **UTM Northing:** 4329374.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL CLAY
5.0	80.0	VERY HARD LIMESTONE

Comments MC 675; OWNER VERIFIED; JUST NORTH OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213649	STONISFER LANE	May 15, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LAUGHLIN		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 85.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 687.0 **Aquifer elevation:**
UTM Easting: 536913.0 **UTM Northing:** 4328628.0

Well Log

Top	Bottom	Formation
0.0	13.0	TOP SOIL & LAYERS LIMESTONE
13.0	25.0	BROWN LIMESTONE (MED. HARD)
25.0	85.0	WHITE LIMESTONE (MED. HARD)

Comments NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213650	CLEAR CREEK	Oct 07, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JIM AKERS	CLEAR CREEK	
Driller	FRED SMITH	RR#1, HELTONVILLE IN	
Operator	FRED SMITH-TOM SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1400.0
Ground elevation: 660.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 539838.0 **UTM Northing:** 4329701.0

Well Log

Top	Bottom	Formation
0.0	5.0	SOIL
5.0	40.0	LS
40.0	100.0	BLUE SHALE

Comments MC 655; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213654	1ST DRIVE AST ROCKPORT ROAD ON SO. SIDE OF THAT ROAD THEN 0.25 MILE SOUTH.	May 17, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EUGENE STONSIFER #2	R5 BLOOMINGTON, IN.	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 36.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 68.0 ft. **Bailer Drawdown** 47.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1500.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 34.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537294.0 **UTM Northing:** 4329047.0

Well Log

Top	Bottom	Formation
0.0	34.0	DIRT & LAYERS OF STONE
34.0	56.0	BROWN LIMESTONE (MED HARD)
56.0	105.0	WHITE LIMESTONE (MED HARD)
105.0	120.0	BLUE LIMESTONE (MED HARD)

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213655	ON THAT ROAD 1 BNLOCK WEST RODGERS ST. ON SO. SIDE ROAD	Oct 23, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST KIEFFABER #1	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2050.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 665.0 **Aquifer elevation:**
UTM Easting: 539531.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL CLAY
5.0	70.0	LIMESTONE W/ LAYERS SHALE

Comments MC 665; OWNER VERIFIED; 10 FT EAST OF HOUSE THAT'S PAINTED GREEN.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213658	CORNER OF FULERTON PIKE & ROCKPORT ROAD ON EAST SIDE OF ROAD	Sep 18, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RODNEY VANPELT		
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.5 gpm for hrs.
Drawdown: ft. **Static water level:** 51.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 250.0
Ground elevation: 770.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 537827.0 **UTM Northing:** 4330099.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOP SOIL
10.0	140.0	MEDIUM HARD WHITE LIMESTONE

Comments MC 760; NEIGHBOR VERIFIED; EAST OF HOUSE; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213659	NEAR CORNNER OF ROCKPORT ROAD AND THAT ROAD. IN STONSIFER ADDITION	Jul 16, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEVE RUSH	RR#5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 300.0 **Ft S of NL:**
Ground elevation: 720.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 711.0 **Aquifer elevation:**
UTM Easting: 536980.0 **UTM Northing:** 4328615.0

Well Log

Top	Bottom	Formation
0.0	9.0	TOP SOIL & LAYERS LIMESTONE
9.0	95.0	WHITE LIME MEDIUM HARD

Comments MC 711; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213660		Nov 05, 1980

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KIEFFABER	689 W. THAT	
Driller	GEORGE SNAPP	4625 S. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 665.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 539525.0 **UTM Northing:** 4329360.0

Well Log

Top	Bottom	Formation
0.0	5.0	TOP SOIL
5.0	65.0	BLUE LIMESTONE
65.0	75.0	BLUE SHALE

Comments VERIFIED BY OWNER WELL #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213663	ON ROCKPORT RD	Sep 30, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT VAUGHT	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 730.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 724.0 **Aquifer elevation:**
UTM Easting: 537986.0 **UTM Northing:** 4330160.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	80.0	BUFF LIMESTONE
80.0	110.0	BLUE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213664	NEAR CORNER OF ROCKPORT ROAD & THAT ROAD, IN STANSIFER ADDITION. WEST CLEAR CREEK, IN. 4 MILES SOUTH WEST OF BLOOMINGTON, IN	Jul 29, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PAUL PAGE	RR 5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.5	**Material:**	**Diameter:** 4.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1150.0 **Ft E of WL:** 350.0 **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 753.0 **Aquifer elevation:**
UTM Easting: 537024.0 **UTM Northing:** 4328914.0

Well Log

Top	Bottom	Formation
0.0	17.0	DIRT & LAYERS LIMESTONE
17.0	130.0	WHITE LIMESTONE

Comments MC 753; WELL DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213665	CLEAR CREEK, IN	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK JAMES	CLEAR CREEK	
Driller	GEORGE SNAPP	R5 BNOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 10.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 28, 1977
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 647.0 **Aquifer elevation:**
UTM Easting: 539684.0 **UTM Northing:** 4329330.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL
8.0	95.0	HARD BLUE LIMESTONE

Comments POST OFFICE VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213668	N THAT ROAD 2 MILES WEST OF CLEAR CREEK, IN. ON NORTH SIDE ROAD	Oct 09, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DEWEY WOODS	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 55.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the NE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2550.0
Ground elevation: 770.0 **Depth to bedrock:** 50.0 **Bedrock elevation:** 720.0 **Aquifer elevation:**
UTM Easting: 537904.0 **UTM Northing:** 4329392.0

Well Log

Top	Bottom	Formation
0.0	52.0	RED CLAY OPENINGS &LIMESTONE
50.0	100.0	SLIGHT BLUE LIMESTONE HARD
100.0	120.0	WHITE LIMESTONE

Comments MC 720; OWNER VERIFIED; 75 FT NORTH OF THAT RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213669	RIGHT OFF BY PASS #37 WEST BETWEEN THAT ROAD & VACTOR PIKE.	Jan 15, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE RICE	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 107.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SE of the SE of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 775.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 538382.0 **UTM Northing:** 4328598.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	20.0	LIMESTONE
20.0	23.0	CREVIS
23.0	107.0	MEDIUM HARD LIMESTONE WHITE

Comments MC 768; OWNER VERIFIED / 50 FT WEST OF HOUSE.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213670	GO S FROM BLOOMINGTON IN, ON RODGERS ST TO CLEAR CREEK IN, TURN W ON THAT RD. 6TH HOUSE ON S SIDE OF RD.	Nov 10, 1980

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST M. KIEFFSBER	689 W THAT RD	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 659.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539867.0 **UTM Northing:** 4329329.0

Well Log

Top	Bottom	Formation
0.0	9.0	RED CLAY
9.0	90.0	WH LS
90.0	125.0	BLUE SHALE

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213673	LOCATED 200' N OF INTERSECTION OF ROCKPORT RD & THAT RD.	Apr 06, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LOUIS BAILEY		
Driller	ALBERT LENTZ	SMITHVILLE IN	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: US **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2800.0 **Ft E of WL:** 900.0 **Ft S of NL:**
Ground elevation: 783.0 **Depth to bedrock:** 39.0 **Bedrock elevation:** 744.0 **Aquifer elevation:**
UTM Easting: 537150.0 **UTM Northing:** 4329425.0

Well Log

Top	Bottom	Formation

Comments MC; WATER BEGIN COMING IN ABOUT 120' FILLED UP AROUND ABOUT 5 MPM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213675	CLEAR CREEK, IN	Oct 01, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KIEFFABER	CLEAR CREEK, IN	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 35.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 15.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1850.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 648.0 **Aquifer elevation:**
UTM Easting: 539562.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOP SOIL
7.0	35.0	LIMESTONE

Comments MC 648; OWNER VERIFIED; 25 FT SE OF YELLOW HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213678	NE CORNER ROCKPORT RD & THAT RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RICHARD VANPELT		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	HASKLE GROGAN&JIM HAYES	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2750.0 **Ft E of WL:** 1150.0 **Ft S of NL:**
Ground elevation: 785.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 537650.0 **UTM Northing:** 4329435.0

Well Log

Top	Bottom	Formation
0.0	75.0	EXISTING WELL
75.0	130.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213679		Jun 18, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE SNAPP	4625 SO. STANISFER LANE BLOOMINGTON, IN	
Driller	GEORGE SNAPP	4625 SO. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 124.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 15.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 669.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 537365.0 **UTM Northing:** 4328920.0

Well Log

Top	Bottom	Formation
0.0	12.0	RED CLAY
12.0	75.0	BROWN LIMESTONE
75.0	120.0	WHITE LIMESTONE

Comments OWNER VERIFIED; WELL IS 10' WEST OF SW CORNER OF HOUSE (BURIED)

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213680	GO WEST FROM CLEAR CREEK, IN. ON THAT ROAD TO 1ST ROAD TO LEFT THEN 3RD HOUSE ON LEFT.	Sep 11, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 40.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 6.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** 25.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3300.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 650.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 644.0 **Aquifer elevation:**
UTM Easting: 539139.0 **UTM Northing:** 4328845.0

Well Log

Top	Bottom	Formation
0.0	6.0	DIRT
6.0	40.0	WHITE LIMESTONE

Comments IN FLAT GROUND AT NE COR OF PROPERTY; #3

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213683	ON FULLERTON PIKE	Apr 21, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BUTCHER	R5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Jul 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2200.0 **Ft S of NL:** 100.0
Ground elevation: 775.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 537559.0 **UTM Northing:** 4330161.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	100.0	WHITE LIME
100.0	130.0	BLUE LIME

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213684	STANISFER LANE	Apr 13, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TERRY WHITE	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 350.0 **Ft E of WL:** 1350.0 **Ft S of NL:**
Ground elevation: 755.0 **Depth to bedrock:** 39.0 **Bedrock elevation:** 716.0 **Aquifer elevation:**
UTM Easting: 537291.0 **UTM Northing:** 4328669.0

Well Log

Top	Bottom	Formation
0.0	34.0	TOP SOIL W/ LAYERS LIMESTONE
34.0	115.0	WHITE MEDIUM HARD LIMESTONE

Comments MC 716; DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213685	FROM BLOOMINGTON SOUTH ROGERS STREET TOE THAT ROAD. 0.25 TO VICTOR PIKE ROAD. 1ST HOUSE ON LEFT	Oct 05, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD ROBERTSON		
Driller	FRED SMITH	8565 O. S. ROAD 37 SOUTH	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 25.0 ft. **Bailer Drawdown** 175.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1900.0 **Ft E of WL:** 2200.0 **Ft S of NL:**
Ground elevation: 679.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 673.0 **Aquifer elevation:**
UTM Easting: 539189.0 **UTM Northing:** 4329137.0

Well Log

Top	Bottom	Formation
0.0	6.0	SOIL
6.0	90.0	LIMESTONE
90.0	200.0	SHALE

Comments MC 673; NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213688	S. OF BLOOMINGTON TAKE 4LANE 37 S. TO ROCKPORT RD. GO LFT GO TO BOTTOM OF 1ST LITTLE HILL HOUSE ON LFT AT BOTTOM OF HILL	Oct 22, 1987

Owner-Contractor	Name	Address	Telephone
Owner	WILLIAM L WHEELER	4060 S. ROCKPORT RD., BLOOMINGTON, IN	
Driller	FRED SCOTTS DRILLING	6236 W COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 3.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 38.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JLL **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2550.0 **Ft S of NL:** 450.0
Ground elevation: 770.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 761.0 **Aquifer elevation:**
UTM Easting: 537650.0 **UTM Northing:** 4330050.0

Well Log

Top	Bottom	Formation
0.0	5.0	YEL CLAY
5.0	9.0	RED CLAY
9.0	13.0	GRAY LS HARD
13.0	15.0	YEL SH SOFT
15.0	30.0	GRAY LS H.
30.0	36.0	BLUE LS H.
36.0	52.0	GRAY LS H.
52.0	76.0	BUFF LS H.

76.0	84.0	BLUE LS H.
84.0	106.0	GRAY LS H.
106.0	120.0	WHITE LS H.
120.0	132.0	GRAY LS H.
132.0	145.0	DARK GRAY LS H.

Comments MAILBOX VERIFIED WELL OFF SW CORNER OF HOUSE VISABLE FROM RD., WELL 1550' NE OF HWY 37 ON N. SIDE ROCKPORT RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213689	CORNER OF THAT ROAD & ROCKPORT WEST CLEAR CREEK, IN. 2 MILES (NEST HOUSE WEST OF TRAILER.	Oct 11, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES WRIGHT	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 16.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1300.0 **Ft E of WL:** 400.0 **Ft S of NL:**
Ground elevation: 765.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 750.0 **Aquifer elevation:**
UTM Easting: 536994.0 **UTM Northing:** 4328975.0

Well Log

Top	Bottom	Formation
0.0	16.0	TOP SOIL & LAYERS LIMESTONE
16.0	50.0	BLUE HARD LIMESTONE
50.0	85.0	MEDIUM SOFT LIMESTONE WHITE
85.0	115.0	GREY MEDIUM WHITE LIMESTONE
115.0	125.0	BLUE LIMSTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213690	0.25 MILE SOUTH EAST OF CLEAR CREEK, IN. ON CHURCH LANE	Jun 07, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BILL STUCKEY	RR #5	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** 5.0 ft. **Bailer Drawdown** 31.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 450.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 684.0 **Aquifer elevation:**
UTM Easting: 539096.0 **UTM Northing:** 4328704.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	17.0	SOFT WHITE LIMESTONE
17.0	60.0	MEDIUM HARD WHITE LIMESTONE
60.0	70.0	SHALE BLUE
70.0	80.0	HARD WHITE LIMESTONE
80.0	90.0	HARD BLUE LIMESTONE

Comments MC 684; NEIGHBOR VARIFIED; SULFUR WATER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213694	SOUTH OF THAT ROAD	Sep 19, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ANCEL BLACK	RR#5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 55.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Feb 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 700.0 **Ft E of WL:** 1400.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 739.0 **Aquifer elevation:**
UTM Easting: 537292.0 **UTM Northing:** 4328797.0

Well Log

Top	Bottom	Formation
0.0	21.0	DIRT & LAYERS LIMESTONE
21.0	65.0	HARD BLUE LIMESTONE
65.0	70.0	MEDIUM WHITE LIMESTONE
70.0	95.0	MEDIUM BROWN LIMESTONE
95.0	105.0	MEDIUM WHITE LIMESTONE
105.0	115.0	HARD WHITE LIMESTONE
115.0	117.0	MEDIUM WHITE LIMESTONE
117.0	140.0	HARD WHITE LIMESTONE

Comments DRILLER VERIFIED; DRY HOLE; WATER AT 117

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213695	0.5 MI S/W CLEAR CREEK, IN. WELL 36' FROM S EAST CORNER OF OWNERS HOUSE.	Aug 25, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	W. M. ACUFF		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 6.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: NO **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 400.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 538992.0 **UTM Northing:** 4328687.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLLAY
17.0	70.0	LIMESTONE
70.0	80.0	SAND & GRAVEL

Comments MC 690;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213699	1ST DR E ROCKPORT RD ON S SIDE OF THAT RD THEN .5 MI S.	Jul 07, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE SNAPP	RR#5, BLOOMINGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 53.0 ft. **Bailer Drawdown** 56.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 1600.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537359.0 **UTM Northing:** 4328894.0

Well Log

Top	Bottom	Formation
0.0	24.0	DIRT & LAYERS LS
24.0	27.0	3' COAL
27.0	73.0	BR CLAY LS
73.0	95.0	WH LS
95.0	125.0	BLANK

Comments MC 735; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213700	GO WEST FROM CLEAR CREEK ON THAT ROAD TO 1ST ROAD TO THE LEFT; THE 3RD HOUSE ON LEFT.	Aug 25, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 690.0 **Aquifer elevation:**
UTM Easting: 539029.0 **UTM Northing:** 4328796.0

Well Log

Top	Bottom	Formation
0.0	5.0	DIRT
5.0	90.0	LIME BLUE CAST
90.0	140.0	BLUE SHALE

Comments DRY HOLE; IN BACK OF LITTLE BLOCK HOUSE.; #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213703	ON THAT RD, WEST OF CLEAR CREEK 0.25 MILE EAST OF ROCKPORT RD. ON NORTH SIDE OF THAT RD. (RT ON THAT RD, 1ST HOUSE ON LEFT.)	Jul 10, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOM LANGLEY		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 105.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 8.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 41.0 ft. **Bailer Drawdown** 48.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2500.0
Ground elevation: 760.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 753.0 **Aquifer elevation:**
UTM Easting: 537416.0 **UTM Northing:** 4329424.0

Well Log

Top	Bottom	Formation
0.0	7.0	RED CLAY
7.0	105.0	MEDIUM HARD WHITE LIMESTONE

Comments DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213705	GO WEST FROM CLEAR CREEK, IN. ON THAT ROAD TO 1ST ROAD TO LEFT THEN THE 3RD HOUSE ON LEFT.	Sep 04, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD RUSH	RR #5	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 538987.0 **UTM Northing:** 4328802.0

Well Log

Top	Bottom	Formation
0.0	40.0	CREVI CE OF DIRT LIMESTONE
40.0	100.0	BLUE LIMESTONE

Comments DRY HOLE; #2IN FRONT OF NEW HOUSE, BETWEEN TWO TREES, AT ROAD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213708	SOUT OF SR45 ON ROGERS RD. TO ROCK PORT RD. & SOUTHWEST TO THAT RD. NORTH OF THAT RD APPROX 1000 FT. WEST SIDE OF RD.	Apr 21, 1965

Owner-Contractor	Name	Address	Telephone
Owner	PAUL COHOON	750 S, WALKER BLOOMINGTON	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	LEON ENGLISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 132.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 125.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1000.0 **Ft S of NL:** 2400.0
Ground elevation: 760.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 738.0 **Aquifer elevation:**
UTM Easting: 537209.0 **UTM Northing:** 4329462.0

Well Log

Top	Bottom	Formation
0.0	22.0	CLAY YELLOW
22.0	132.0	LIMESTONE

Comments MC; MAILBOX VERIFIED; WELL IN FRONT OF HOUSE APPROX. 25 FT.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213709	STANSIFER ADDITION AT CORNER THAT ROAD & ROCKPORT ROAD SO. BLOOMINGTON, IN	Sep 19, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ARTHUR MELTON	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 5.5 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 738.0 **Aquifer elevation:**
UTM Easting: 536920.0 **UTM Northing:** 4328878.0

Well Log

Top	Bottom	Formation
0.0	22.0	RED CLAY W/ LAYERS LIMESTONE
22.0	120.0	LIMESTONE

Comments MC 738; WELL DRILLER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213710	.5 MI W CLEAR CREEK, 2ND ON THAT RD THEN 1ST RD TO L .5 MI, ON E SIDE RD.	Apr 25, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LESTER SEGO	RR#5	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.2 gpm for hrs.
Drawdown: ft. **Static water level:** 56.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SE of the SW of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 600.0 **Ft E of WL:** 1500.0 **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 10.5 **Bedrock elevation:** 695.0 **Aquifer elevation:**
UTM Easting: 538986.0 **UTM Northing:** 4328735.0

Well Log

Top	Bottom	Formation
0.0	10.5	RED CLAY
10.5	105.0	WH LS
105.0	130.0	BLUE SHALE

Comments DRY HOLE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213713	3MI W OF CLEAR CREEK. 3RD HOUSE N OF THAT RD & ROCKPORT RD, ON L GOING N.	Aug 12, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CONNIE DAVIS	RR#4, BLOOMINGTON	
Driller	FREDERICK SCOTT	RR#4, BLOOMINGTON IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 20.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 5.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1200.0 **Ft S of NL:** 2250.0
Ground elevation: 785.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 769.0 **Aquifer elevation:**
UTM Easting: 537234.0 **UTM Northing:** 4329492.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	12.0	RED CLAY
12.0	16.0	YEL CLAY
16.0	26.0	STONE GRAY LS HARD
26.0	30.0	STONE LIGHT GRAY LS SOFTER
30.0	37.0	STONE LIGHT BLUE LS HARD
37.0	45.0	STONE DARK BLUE LS HARD
45.0	50.0	STONE LIGHT GRAY LS EX HARD
50.0	63.0	STONE LIGHT BR LS EX HARD
63.0	67.0	STONE GRAY LS HARD
67.0	71.0	STONE GRAY LS EX HARD

71.0	89.0	STONE BUFF LS SOFT
89.0	92.0	STONE BUFF LS HARD
92.0	104.0	STONE GRAY LS HARD
104.0	122.0	STONE GRAY LS EX HARD
122.0	140.0	STONE LIGHT GRAY LS HARD

Comments MC 769; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213714		May 23, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ARTHUR MELTON	RR5, BOX 21 I, BLOOMINGTON	
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 16.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 100.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 750.0 **Aquifer elevation:**
UTM Easting: 536920.0 **UTM Northing:** 4328878.0

Well Log

Top	Bottom	Formation
0.0	10.0	TOPSOIL
10.0	67.0	MD HARD GREY LS
67.0	75.0	MD HARD BR LS
75.0	130.0	MD HARD WH LS

Comments FC #3 "OLD"; WATER AT 92' & 115' 130 GAL BASIN

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213718	3 MILES SOUTH BLOOMINGTON ON ROCKPORT ROAD	Apr 23, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH JOHNSON	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 77.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2450.0 **Ft S of NL:** 1000.0
Ground elevation: 800.0 **Depth to bedrock:** 76.0 **Bedrock elevation:** 724.0 **Aquifer elevation:**
UTM Easting: 537625.0 **UTM Northing:** 4329875.0

Well Log

Top	Bottom	Formation
0.0	60.0	LAYERS STONE & CLAY
60.0	76.0	CAVE OR OPENING
76.0	120.0	BROWN LIMESTONE

Comments MC 724; OWNER VERIFIED; JUST SOUTH OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213723	BLOOMINGTON 1 MILE SOUTH ON ROGERS RD. TO ROCKPORT RD. 3 MILE SOUTH ON ROCKPORT RD ON EAST SIDE OF RD 500 FT NORTH OF THAT RD.	Sep 08, 1964

Owner-Contractor	Name	Address	Telephone
Owner	STIGALL	R8 BOX 249 BLOOMINGTON	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	ED RYBAK JR	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 75.0 ft. **Bailer Drawdown** 164.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2000.0
Ground elevation: 790.0 **Depth to bedrock:** 27.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 537399.0 **UTM Northing:** 4329577.0

Well Log

Top	Bottom	Formation
0.0	3.0	TOPSOIL
3.0	12.0	RED CLAY
12.0	27.0	CLAY W/ BROKEN LIME
27.0	170.0	LIMESTONE

Comments MC 763; NEIGHBOR VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213724	CLEAR CREEK, IN. ON THAT ROAD. FARM ON RIGHT GOING WEST FROM CLEAR CREEK	Feb 24, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PAUL HAYES	CLEAR CREEK	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 4.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2400.0
Ground elevation: 665.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 658.0 **Aquifer elevation:**
UTM Easting: 539684.0 **UTM Northing:** 4329397.0

Well Log

Top	Bottom	Formation
0.0	7.0	DIRT & LAYERS LIMESTONE
7.0	58.0	HARD WHITE LIMESTONE
58.0	80.0	BLUE SHALE

Comments NEIGHBOR VERIFIED; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213728	2 MILES SO. BLOOMINGTON, IN. ON ROCKPORT RD TO FULLERTON PIKE THEN TURN WEST & 3RD HOUSE ON SO. SIDE RD	Nov 24, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GLEN LANGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CES **on:** Jul 01, 1966
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2600.0 **Ft S of NL:** 100.0
Ground elevation: 740.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 725.0 **Aquifer elevation:**
UTM Easting: 537694.0 **UTM Northing:** 4330161.0

Well Log

Top	Bottom	Formation
0.0	16.0	RED CLAY
16.0	30.0	WHITE SOFT LIMESTONE
30.0	95.0	WHITE MEDIUM HARD LIMESTONE
95.0	100.0	BLUE LIMESTONE HARD

Comments MC 725

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213729	ON THAT ROAD WEST OF ROGERS STREET AT CLEAR CREEK, IN. ABOUT 0.25 MILE WEST ON SO. SIDE OF ROAD	Jul 10, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ERNEST M, KIEFFABER	689 WEST THAT ROAD	
Driller	GEORGE SNAPP	4625 S. STANISFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NE of Section 20 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 658.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 650.0 **Aquifer elevation:**
UTM Easting: 539556.0 **UTM Northing:** 4329337.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL RED CLAY
8.0	80.0	HARD WHITE LIMESTONE

Comments VERIFIED BY MAILBOX

Record of Water Well

Indiana Department of Natural Resources

Reference Number
213733

Driving directions to well
ABOUT 2 ILES WEST CLEAR CREEK ON THAT ROAD. LAST HOUSE ON RIGHT BEFORE COMING TO ROCKPORT RD.

Date completed
Nov 05, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES GOAD	R5 BLOOMINGTON, IN	
Driller	FREDERICK SCOTT	R4 BLOOMINGTON, IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 8N **Range:** 1W
Section: SE of the SW of the NW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1300.0 **Ft S of NL:** 2500.0
Ground elevation: 780.0 **Depth to bedrock:** 23.0 **Bedrock elevation:** 757.0 **Aquifer elevation:**
UTM Easting: 537282.0 **UTM Northing:** 4329425.0

Well Log

Top	Bottom	Formation
0.0	12.0	YELLOW LCAY
12.0	23.0	RED CLAY
23.0	38.0	STONE GRAY LIMESTONE HARD
38.0	40.0	STONE BLUE SHALE SOFT
40.0	44.0	STONE DARK GRAY LS HARD
44.0	50.0	STONE GRAY LS HARD
50.0	71.0	STONE GRAY LS EXTRA HARD
71.0	98.0	STONE BUFF LS SOFT
98.0	117.0	STONE GRAY LS HARD
117.0	126.0	STONE WHITE OR GRAY LS HARD
126.0	150.0	STONE GRAY LS HARD

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213734	SOUTH OF TAHT ROAD WEST OF CLEAR CREEK, IN. ABOUT 2 MILES	Oct 07, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	THOMAS DECKARD		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1200.0 **Ft E of WL:** 1300.0 **Ft S of NL:**
Ground elevation: 765.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 757.0 **Aquifer elevation:**
UTM Easting: 537275.0 **UTM Northing:** 4328960.0

Well Log

Top	Bottom	Formation
0.0	8.0	DIRT
8.0	45.0	MEDIUM HARD WHITE LIMESTONE
45.0	62.0	HARD BLUE LIMESTONE
62.0	85.0	MEDIUM WHITE LIMESTONE
85.0	99.0	MEDIUM HARD BROWN
99.0	117.0	MEDIUM BLUE LIMESTONE
117.0	125.0	HARD WHITE LIMESTONE

Comments DRILLER VERIFIED; DRY HOLE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213738	SOUTH END OF STONSIFER LANE	May 07, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOHNSON	BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** 41.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 400.0 **Ft S of NL:**
Ground elevation: 730.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 722.0 **Aquifer elevation:**
UTM Easting: 537005.0 **UTM Northing:** 4328627.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL & LAYERS LIMESTONE
8.0	45.0	BROWN LIMESTONE (MED HARD)
45.0	95.0	WHITE LIMESTONE (MED HARD)

Comments MC 722; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213739	GO S BLOOMINGTON ON RODGERS ST TO ROCKPORT RD THEN S ON ROCKPORT RD TO THAT RD TURN R 1 BLK TO SHARPCURVE.WELL IS ON L SIDE OF RD.	Aug 30, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GERALD FLYNN		
Driller	GEORGE SNAPP	RR#4, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 34.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2100.0 **Ft E of WL:** 0.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 33.0 **Bedrock elevation:** 747.0 **Aquifer elevation:**
UTM Easting: 536891.0 **UTM Northing:** 4329201.0

Well Log

Top	Bottom	Formation
0.0	33.0	RED CLAY & LAYERS LS
33.0	90.0	WH MD HARD LS
90.0	120.0	BR MD HARD LS
120.0	165.0	WH LS

Comments OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213743	1ST DRIVE EAST OF ROCKPORT ROAD ON SOUT SIDE OF THAT ROAD THEN 2ND HOUSE ON EAST SIDE OF DRIVE	Aug 26, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT CRACROFT		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 61.0 ft. **Bailer Drawdown** 41.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1800.0 **Ft E of WL:** 1600.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 736.0 **Aquifer elevation:**
UTM Easting: 537360.0 **UTM Northing:** 4329114.0

Well Log

Top	Bottom	Formation
0.0	24.0	TOP SOIL & LAYERS LIMESTONE
24.0	37.0	SOFT WHITE LIMESTONE
37.0	45.0	SOFT BROWN LIMESTONE
45.0	95.0	SOFT WHITE LIMESTONE
95.0	105.0	SOFT BROWN LIMESTONE
105.0	110.0	SOFT YELLOW LIMESTONE
110.0	120.0	HARD WHITE LIMESTONE

Comments MEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213748	SO OF THAT ROAD WEST OF CLEAR CREEK, IN. 2 MILES	May 03, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK SUMMERS		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 54.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: SW of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1400.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 760.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 537427.0 **UTM Northing:** 4328991.0

Well Log

Top	Bottom	Formation
0.0	15.0	TOP SOIL
15.0	35.0	WHITE LIMESTONE MEDIUM
35.0	55.0	VERY HARD BLUE LIMESTONE
55.0	90.0	MEDIUM HARD WHITE LIMESTONE
90.0	95.0	MEDIUM BROWN LIMESTONE
95.0	120.0	MEDIUM BLUE LIMESTONE
120.0	130.0	MEDIUM WHITE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213749	ON SOUTH SIDE OF THAT ROAD 1.75 MILES WEST OF CLEAR CREEK, IN	Nov 10, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ENOS DYER		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 69.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2550.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 18.5 **Bedrock elevation:** 762.0 **Aquifer elevation:**
UTM Easting: 537233.0 **UTM Northing:** 4329352.0

Well Log

Top	Bottom	Formation
0.0	18.5	DIRT & RED CLAY
18.5	125.0	WHITE LIMESTONE

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213753	WELL IS APPROXIMATELY 5 MILES SOUTHWEST OF BLOOMINGTON ON ROCKPORT RD. WELL IS ON WEST SIDE OF RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WOODROW HUESTON	R5 ROCKPORT RD BLOOMINGTON, IN	
Driller	ALBERT LENTZ		

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2400.0 **Ft E of WL:** 600.0 **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 35.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 537062.0 **UTM Northing:** 4329298.0

Well Log

Top	Bottom	Formation
0.0	35.0	SOIL & UNCONSOLIDATED
35.0	150.0	LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213754	CORNER OF THAT ROAD & ROCKPORT RD. WEST CLEAR CREEK, IN. TRAILER WEST OF HOUSE	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES LANGLEY		
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 24.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the SW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1100.0 **Ft E of WL:** 800.0 **Ft S of NL:**
Ground elevation: 740.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 728.0 **Aquifer elevation:**
UTM Easting: 537122.0 **UTM Northing:** 4328913.0

Well Log

Top	Bottom	Formation
0.0	12.0	TOP SOIL
12.0	40.0	HARD WHITE LIMESTONE
40.0	70.0	MEDIUM HARD WHITE LIMESTONE
70.0	85.0	MEDIUM HARD BROWN LIMESTONE
85.0	110.0	HARD WHITE LIMESTONE

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
213758	ABOUT 1.54 MILES WEST CLEAR CREEK, 1ST PIKE ROAD TO LEFT & 1ST HOUSE ON LEFT ON THE PIKE ROAD.	Oct 22, 1964

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	REX DECKARD	R5 BLOOMINGTON	
Driller	FREDERICK SCOTT	R4 BLOOMINGTON, IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NE of the NE of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 750.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 742.0 **Aquifer elevation:**
UTM Easting: 537586.0 **UTM Northing:** 4329259.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELLOW CLAY
8.0	12.0	STONE BLUE FLINT EXTRA HARD
12.0	18.0	STONE BUFF LS HARD
18.0	39.0	STONE GRAY LS SOFT
39.0	47.0	STONE BUFF LS HARD
47.0	61.0	STONE BROWNISH LS EXTRA HARD
61.0	65.0	STONE BROWNISH LS SOFTER
65.0	70.0	STONE GRAY LS HARD
70.0	76.0	STONE GRAY LS EXTRA HARD
76.0	82.0	STONE WHITE LS HARD
82.0	93.0	STONE WHITE LS SOFT
93.0	100.0	STONE WHITE LS HARD

Comments OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
213759	S OF SR45 IN BLOOMINGTON ON ROGERS STREET TO ROCKPORT ROAD. SW ON ROCKPORT RD TO THAT ROAD. W ON THAT ROAD TO 1ST ROAD S. S ON EAST SIDE OF RD	Feb 19, 1966

Owner-Contractor	Name	Address	Telephone
Owner	JEWELL EVANS	1631 SOUTH OLIVER BLOOMINGTON, IN	
Driller	WILLARD ENGLISH & SON	R1 CLAYTON, IN	
Operator	LEON ENGLISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 180.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.5
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.5 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 170.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the NW of the SW of Section 19 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: CAS **on:** Jul 01, 1966
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 4400.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 765.0 **Aquifer elevation:**
UTM Easting: 536904.0 **UTM Northing:** 4329341.0

Well Log

Top	Bottom	Formation
0.0	14.0	CLAY YELLOW
14.0	30.0	BROKEN LIMESTONE
30.0	180.0	LIME STONE

Comments MC 76?

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217441	3 MI NE OF HABBIEVILLE IN ON E BANK OF INDIAN CREEK	Sep 17, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFIELD IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 69.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 4.0 hrs.
Drawdown: ft. **Static water level:** 6.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NE of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: REB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1100.0
Ground elevation: 660.0 **Depth to bedrock:** 27.0 **Bedrock elevation:** 633.0 **Aquifer elevation:**
UTM Easting: 528309.0 **UTM Northing:** 4318731.0

Well Log

Top	Bottom	Formation
0.0	27.0	ORIGINAL WELL
27.0	67.0	GREY LS W/OCCSNL 1' LYERWHLS
67.0	69.0	SOFT SANDROCK MUD PELT H20

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217446	2 1/2 MI NE OF HOBBIEVILLE IN ON INDIAN CREEK RD	Jun 06, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFILED IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 35.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.7	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NE of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: PB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2450.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1400.0
Ground elevation: 650.0 **Depth to bedrock:** **Bedrock elevation:** 640.0 **Aquifer elevation:**
UTM Easting: 528169.0 **UTM Northing:** 4318633.0

Well Log

Top	Bottom	Formation
0.0	9.5	SOIL & SAND
9.5	10.5	FRACTURED LS
10.5	26.5	LS GREY & BLUE
26.5	27.0	SH GREY
27.0	32.0	GREY LS
32.0	35.0	CAVE OF FAULTE

Comments SLAUTING ROCK ON BOTTOM COULD NOT GO DEEPER:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217451	FROM BLGTN ON SR 45 S OF MONROE & GREEN COUNTY LINE TURN S GO 4 M TO ROCK E RD TURN R 3/4 OF W MI	Aug 28, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLIE STURGEN		
Driller	SMITH WELL DRILLING	8565 OLD ST RD 38 S	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the NW of Section 30 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1650.0 **Ft S of NL:** 450.0
Ground elevation: 685.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 655.0 **Aquifer elevation:**
UTM Easting: 528048.0 **UTM Northing:** 4318970.0

Well Log

Top	Bottom	Formation
0.0	30.0	SOIL & BOLTERS
30.0	115.0	LS

Comments MC 655: OWNER VERIFIED 50' SW OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217506	S OF STANFORD GO TO BREEDEN RD TURN & GO TO ROCK EAST RD TURN RIGHT, THEN GO TO 1ST DRIVEWAY TURN GO TO TOP OF HILL	May 17, 1990

Owner-Contractor	Name	Address	Telephone
Owner	YEAGER	4154 DANIEL ST., BLGTON., IN	(812) 336-8240
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:** Submersible
	Depth: 225.0	**Pump setting depth:** 215.0	**Water quality:** CLEAR
Casing	**Length:** 73.5	**Material:** STEEL	**Diameter:** 6.625
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .040

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 225.0 ft. **Static water level:** 85.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 82.0 to 73.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JL **on:** Jul 28, 1993
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 450.0 **Ft S of NL:** 1850.0
Ground elevation: 790.0 **Depth to bedrock:** 3.0 **Bedrock elevation:** 787.0 **Aquifer elevation:**
UTM Easting: 529080.0 **UTM Northing:** 4320050.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	19.0	YEL SS
19.0	30.0	BLUE SHALE EX SOFT
30.0	56.0	BLUE SHALE SOLID
56.0	64.0	YEL SS HARD
64.0	66.0	GRAY LS HARD
66.0	70.0	OPEN HOLE

70.0	84.0	GRAY LS HARD
84.0	85.0	BLUE SHALE SOFTER
85.0	115.0	GRAY LS HARD
115.0	127.0	GREEN LS HARD
127.0	146.0	GRAY LS HARD
146.0	148.0	DARK GRAY LS
148.0	160.0	GRAY LS HARD
160.0	183.0	BUFF LS
183.0	185.0	BLUE SHALE SOFTER
185.0	205.0	CREAM LS SOFTER
205.0	215.0	GRAY LS HARD
215.0	225.0	LIGHT YEL LS

Comments MC787; VERIFIED BY NEIGHBOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217511	GO TO STANFORD .25 MI TURN L AND GO 4.5 MI TO CLYDE WEBSTER FARM; O NLEE PHILLIPS RD	Sep 15, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLYDE WEBSTER	R6,BLOOMINGTON, IN	
Driller	EADS & DECKARD	R9, BLOOMINGTON	
Operator	EADS & DECKARD	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the SW of the SE of Section 20 **Topo map:** STANFORD

Grant Number:

Field located by: JRP **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2000.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 825.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 787.0 **Aquifer elevation:**

UTM Easting: 529920.0 **UTM Northing:** 4319453.0

Well Log

Top	Bottom	Formation
0.0	38.0	CLAY & SH
38.0	152.0	LS

Comments MC 782; OWNER VER; 30' NE OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217516	UNION CHURCH NEAR STANFORD	Aug 08, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	UNION CHURCH	STANDORD	
Driller	FRED SMITH	HELTONVILLE IN RR #1	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 45.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 17.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2550.0 **Ft S of NL:** 1950.0
Ground elevation: 790.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 773.0 **Aquifer elevation:**
UTM Easting: 529725.0 **UTM Northing:** 4320078.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY
17.0	45.0	LS

Comments MC 773: NEIGHBOR & SIGN VARIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217521	ON THE ROCK EAST RD 2 MI SW KIRKSVILLE, IN	Jun 06, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH FILLDEN	RR9, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** 23.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NE of Section 20 **Topo map:** STANFORD
Grant Number:
Field located by: JRP **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 800.0
Ground elevation: 705.0 **Depth to bedrock:** 19.0 **Bedrock elevation:** 686.0 **Aquifer elevation:**
UTM Easting: 529938.0 **UTM Northing:** 4320430.0

Well Log

Top	Bottom	Formation
0.0	19.0	RED CLAY & LAYERS OF LS
19.0	80.0	WHITE VERY HARD LS

Comments MC 686; NEIGHBOR & MAILBOX VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217526	ABOUT 5 MI S OF STANFORD IN ON ROCK E RD	Dec 22, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLUADIE WEVER	R 9 BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR 4 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 16.0 ft. **Bailer Drawdown** 59.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NE of the NE of the SE of Section 19 **Topo map:** STANFORD

Grant Number:

Field located by: RC **on:** Jul 12, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 100.0 **Ft N of SL:** 2400.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 690.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 684.0 **Aquifer elevation:**

UTM Easting: 528868.0 **UTM Northing:** 4319813.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOP SOIL & YEL CLAY
6.0	24.0	STONE WH LS HARD
24.0	65.0	STONE WH LS EX HARD
65.0	75.0	STONE GRAY LS HARD

Comments MC 684: BY NEIGHBOR & MAILBOX:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217531	ABOUT 3 MI S OF STANSFORD ON BREEDEN RD BETWEEN CRUM RD & CARTER RD ON LEFT.	Aug 03, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GLEN CROHN	BREEDEN RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 84.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 10.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 164.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NE of Section 18 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2175.0
Ground elevation: 868.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 853.0 **Aquifer elevation:**
UTM Easting: 528906.0 **UTM Northing:** 4321625.0

Well Log

Top	Bottom	Formation
0.0	15.0	YEL CLAY
15.0	82.0	BLUE SH EX SOFT
82.0	105.0	STONE GRAY LS HARD
105.0	118.0	STONE BLUE LS EX HARD
118.0	130.0	STONE YELLOWISH LS HARD
130.0	162.0	STONE GRAY LS HARD
162.0	163.0	STONE BLUE SH SOFTER
163.0	189.0	STONE GRAY LS EX HARD
189.0	201.0	STONE DARK GRAY LS, HARD

201.0	202.0	STONE BLUE SH SOFTER
202.0	212.0	STONE GRAY LS EX HARD
212.0	213.0	STONE BLUE GREEN SH SOFTER
213.0	220.0	STONE DARK GRAY LS HARD
220.0	221.0	STONE GRAY SH SOFTER
221.0	237.0	STONE YELLOWISH LS HARD
237.0	251.0	STONE GRAY LS HARD
251.0	252.0	STONE WH SH SOFTER
252.0	265.0	STONE DARK GRAY LS HARD

Comments MC 853: VERIFIED BY OWNER - WELL BEHIND HOUSE 25':

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217536	ABOUT 3 1/2 MI S OF STANFORD TAKE ST 45 S TO BREEDEN RD TURN & GO TO CRUM RD TURN E GO TO 1ST HOUSE ON RIGHT.	May 11, 1983

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ED CROHN	S CRUM RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 25.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 189.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 300.0 **Ft S of NL:** 1500.0
Ground elevation: 860.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 845.0 **Aquifer elevation:**
UTM Easting: 529025.0 **UTM Northing:** 4321780.0

Well Log

Top	Bottom	Formation
0.0	15.0	YEL CLAY
15.0	17.0	YEL SS HARD
17.0	18.0	HOLE
18.0	19.0	YEL SS HARD
19.0	25.0	STONE BLUE LS HARD
25.0	27.0	BLUE SH SOFTER
27.0	38.0	BLUE SH HARD
38.0	44.0	RED SH HARD
44.0	101.0	BLUE SH HARD

101.0	117.0	STONE GRAY LS HARD
117.0	119.0	BLUE SH SOFT
119.0	127.0	STONE GRAY LS HARD
127.0	129.0	STONE WH SH SOFTER
129.0	136.0	STONE YEL LS HARD
136.0	137.0	BLUE SH HARD
137.0	141.0	STONE GRAY LS HARD
141.0	142.0	YEL SH SOFTER
142.0	154.0	STONEGRAY LS EX HARD
154.0	164.0	STOEN CREAM LS EX HARD
164.0	165.0	STONE WH SH SOFTER
165.0	178.0	STONE GRAY LS EX HARD
178.0	188.0	STONE DARK GRAY LS HARD
188.0	189.0	BLUE SH SOFTER
189.0	215.0	STONE GRAY LS HARD
215.0	216.0	STONE YEL SH SOFTER
216.0	236.0	STONE DARK GRAY LS HARD
236.0	238.0	STONE BLUE SHALE SOFTER
238.0	254.0	STONE GRAY LS HARD
254.0	255.0	STONE WH SH SOFTER
255.0	265.0	STONE DARK GRAY LS HARD

Comments MC 845: WELL LOCATED ON S SIDE OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217541	ABOUT 3 1/2 MI S OF STANFORD TAKE S HWY 45 TO BREEDEN RD GO TO CRUM RD TURN 1ST HOUSE ON LEFT APP 0.3 MI E OF BREEDEN RD ON N SIDE OF CRUM RD	Sep 10, 1980

Owner-Contractor	Name	Address	Telephone
Owner	DONALD CONDER	8888 W CRUM RD BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 166.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1100.0 **Ft S of NL:** 1250.0
Ground elevation: 870.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 858.0 **Aquifer elevation:**
UTM Easting: 529270.0 **UTM Northing:** 4321850.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	20.0	YEL SS HARD
20.0	27.0	RED CLAY
27.0	29.0	YELSH EX SOFT
29.0	56.0	BLUE SH EX SOFT
56.0	75.0	STONE GRAY SS HARD
75.0	80.0	STONE BLUE SOAPSTONE HARD
80.0	84.0	STONE GRAY SS HARD
84.0	102.0	STONE BLUE SH HARD

102.0	110.0	STONE GRAY LS HARD
110.0	125.0	STONE GRAY LS EX HARD
125.0	139.0	STONE YELLOWISH LS HARD
139.0	140.0	STONE WH SH SOFT
140.0	146.0	STONE LT BLUE LS EX HARD
146.0	172.0	STONE GRAY LS EX HARD
172.0	173.0	STONE BLUE SH SOFT
173.0	180.0	STONE GRAY LS EX HARD
180.0	203.0	STONE DARK GRAY LS HARD
203.0	204.0	STONE BLUE SH SOFT
204.0	212.0	STNE BROWNISH LS HARD
212.0	213.0	STONE BLUE SH SOFT
213.0	229.0	STONE GRAY LS HARD
229.0	230.0	STONE BLUE SH SOFT
230.0	245.0	STONE GRAY LS HARD

Comments MC 858: WELL IS BURIED LOCATED NE OF HOUSE BY OLD SHED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217546	ABOUT 5 MI S OF STANFORD LAKE BREEDEN RD TO CRUM RD TURN LEFT 1ST HOUSE ON RIGHT.	May 26, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LARRY CONDER	RR 9 BLOOMINGTON IN	
Driller	FRED SCOTT	RR 13 BOX 452 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 210.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 101.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 9.0 gpm for hrs.
Drawdown: ft. **Static water level:** 130.0 ft. **Bailer Drawdown** 200.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: FRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2500.0 **Ft S of NL:** 2400.0
Ground elevation: 840.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 832.0 **Aquifer elevation:**
UTM Easting: 529697.0 **UTM Northing:** 4321569.0

Well Log

Top	Bottom	Formation
0.0	8.0	YEL CLAY
8.0	25.0	STONE BR SS SOFT
25.0	60.0	STONE BLUE SH EX SOFT
60.0	70.0	STONE BR SS HARD
70.0	76.0	STONE GRAY SH EX SOFT
76.0	86.0	STONE WH SS EX HARD
86.0	88.0	MUE HOLE
88.0	92.0	STONE BR SS EX HARD
92.0	101.0	STONE GREY SH HARD
101.0	108.0	STONE GRAY LS EX HARD
108.0	126.0	STONE YELLOWISH LS EX HARD

126.0	132.0	STONE GRAY SL EX HARD
132.0	140.0	STONE BLUE LS EX HARD
140.0	170.0	STONE DARK YEL LS EX HARD
170.0	210.0	STONE YEL LS HARD

Comments MC 832: OWNER VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
217551	1/2 MI SW OF STANFORD & 3 1/2 MI S ON BREEDEN RD 3/4 MI E ON CRUM RD.	Jul 24, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MR THOMAS R STONE	RR 9 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 146.0	**Material:**	**Diameter:** 6.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.5 hrs.

Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 230.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the NE of Section 17 **Topo map:** STANFORD

Grant Number:

Field located by: JRD **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 500.0

Ground elevation: 860.0 **Depth to bedrock:** 98.0 **Bedrock elevation:** 762.0 **Aquifer elevation:**

UTM Easting: 529875.0 **UTM Northing:** 4322114.0

Well Log

Top	Bottom	Formation
0.0	98.0	CLAY & SOFT SH & SANDROCK
98.0	140.0	LIME & CLAY SEAMS & MUD
140.0	215.0	LIME
215.0	245.0	LIME & BREAKS WATER

Comments MC 762: NEIGHBOR & MAILBOX VARIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number
217556

Driving directions to well
S OF STANDFORD LAKE BREEDEN RD OFF HWYT 45 JUST S OF STANDFORD GO TO CRUM RD TURN L 1ST NEW HOUSE ON RIGHT

Date completed
Apr 02, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TED JOHNSON	RR 9 BLOMINGTON IN	
Driller	FRED SCOTT	R1 ELLETTSVILLE IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 98.0	**Material:**	**Diameter:** 6.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 185.0 ft. **Bailer Drawdown** 215.0 ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NE of Section 17 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 840.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 819.0 **Aquifer elevation:**
UTM Easting: 530086.0 **UTM Northing:** 4321746.0

Well Log

Top	Bottom	Formation
0.0	16.0	YEL CLAY
16.0	21.0	RED CLAY
21.0	33.0	STONE BR SS HARD
33.0	78.0	STONE BLUJE SH EX SOFT
78.0	84.0	STONE YEL SS HARD
84.0	95.0	STONE BLUE SH EX SOFT
95.0	117.0	STONE ST GREY LS EX HARD
117.0	145.0	STONE YELLOWISH LS HARD
145.0	168.0	STONE GRAY LS EX HARD
168.0	178.0	STONE CREAM LS HARD
178.0	203.0	STONE GRAY LS HARD
203.0	245.0	STONE YELLOWISH LS HARD

Comments
MC 819: OWNER VERIFIED 10' S OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
217566	S OF STANFORD TURN OFF 45S AT BREEDEN RD GO TO YOU COME TO ROCK EAST RD, TURN LEFT GO TO 3RD DRIVEWAY ON LEFT, HAS A BOARD FENCE AROUND IT	Oct 09, 1989

Owner-Contractor	Name	Address	Telephone
Owner	ROBERT HARLOW	7898 ROCK EAST RD., BLOOMINGTON, IN	(812) 825-5834
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: 298	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 31.0	**Material:** STEEL	**Diameter:** 6.625
Screen	**Length:** 20.0	**Material:** PVC	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 185.0 ft. **Static water level:** 78.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIROPLUG **Depth:** from 0.0 to 31.0
Installation Method: AIR PUMP **Number of bags used:** 3.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the SW of Section 16 **Topo map:** STANFORD
Grant Number:
Field located by: LW **on:** Jun 15, 1990
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 150.0 **Ft E of WL:** 150.0 **Ft S of NL:**
Ground elevation: 748.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 741.0 **Aquifer elevation:**
UTM Easting: 530595.0 **UTM Northing:** 4320660.0

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY HARDPAN
7.0	13.0	GRAY LS HARD
13.0	28.0	BLUE SHALE SOFT
28.0	42.0	GRAY LS HARD
42.0	45.0	BLUE SHALE SOFT
45.0	51.0	BLUE LS HARD
51.0	62.0	GRAY LS HARD

62.0	68.0	SMALL OPEN SEAM
68.0	89.0	GRAY LS HARD
89.0	91.0	BLUE SHALE SOFT
91.0	106.0	BLUE LS HARD
106.0	118.0	GRAY LS HARD
118.0	146.0	GRAY LS SEAMY
146.0	161.0	BLUE LS EX HARD
161.0	162.0	WHITE LS SOFT
162.0	185.0	GRAY LS HARD

Comments MC741; VERIFIED BY NEIGHBOR/FATHER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222643	ON ROCKPORT SOUTH BLOOMINGTON, IN ABOUT 5 MILES ON WEST SIDE ROAD	Jun 15, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOM LONGLEY	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BOX 86 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	
Company	TOM LONGLEY	R5 BLOOMINGTON, IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 850.0 **Ft N of SL:** 300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 652.0 **Aquifer elevation:**
UTM Easting: 536632.0 **UTM Northing:** 4328683.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOP SOIL & LAYERS LIMESTONE
28.0	65.0	HARD LIMESTONE

Comments MC 652; OWNER VERIFIED; 15 FT EAST OF HOUSE; MC; SULPHUR WATER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222644	IN STANFORD, IN	Oct 14, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LLOYD HAWKINS	STANFORD, IN	
Driller	FRED SCOTT	R4 BLOOMINGTON, IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SW of the NW of Section 32 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 950.0 **Ft S of NL:** 1400.0
Ground elevation: 790.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 782.0 **Aquifer elevation:**
UTM Easting: 529149.0 **UTM Northing:** 4326617.0

Well Log

Top	Bottom	Formation
0.0	6.0	YELLOW CLAY
6.0	8.0	RED CLAY
8.0	20.0	STONE GREY LIMESTONE HARD
20.0	25.0	STONE GRAY SHALE SOFT
25.0	33.0	STONE GRAY LIMESTONE HARD
33.0	46.0	STONE WHITE LIMESTONE HARD
46.0	52.0	STONE BLUE LIMESTONE HARD
52.0	67.0	STONE GRAY LS EXTRA HARD
67.0	88.0	STONE BROWN LS EXTRA HARD
88.0	112.0	STONE GRAY LS EXTRA HARD
112.0	125.0	STONE WHITE LS EXTRA HARD
125.0	128.0	STONE GRAY LS EXTRA HARD
128.0	135.0	STONE GRAY LIMESTONE HARD

Comments MC 782; OWNER VERIFIED; 5 FT EAST OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222648	SO. OF BLOOMINGTON, IN ON ROCKPORT ROAD 4 MILES ON EAST SIDE OF ROAD	May 22, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLARENCE BRUMMETT	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 13.5 ft. **Bailer Drawdown** 67.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 450.0 **Ft N of SL:** 50.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 536747.0 **UTM Northing:** 4328621.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	HARD WHITE LIMESTONE

Comments MC 660; WELL DRILLER VERIFIED; 50 FT EAST OF RD; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222649	8 MILES SOUTH WEST OF BLOOMINGTON, IN. ON ROCKPORT ROAD TWO SOUTH UNION CHURCH WEST 1.75 MILES	Jan 04, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TODD	R9 BLOOMINGTON, IN	
Driller	PAUL SCOTT	R4 BLOOMINGTON, IN	
Operator	PAUL SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 114.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 46.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 76.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the NW of the NE of Section 34 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: MT **on:** Jul 13, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 900.0

Ground elevation: 840.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 828.0 **Aquifer elevation:**

UTM Easting: 533115.0 **UTM Northing:** 4326754.0

Well Log

Top	Bottom	Formation
0.0	12.0	DIRT
12.0	65.0	BUFF LIME HARD
65.0	80.0	YELLOW LIME XTRA HARD
80.0	114.0	BUFF LIME SOFT

Comments MC 825; HOLE AT 42 FT WITH MUD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222654	1MI W OF THE S UNION CHURCH ON DUNALL RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WINFRED SMITH	RR#5	
Driller	ALBERT LENTZ	BOX 83, SMITHVILLE IN	
Operator	BUYRIC ERA 22W	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 94.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:** Bailing	**Test rate:** gpm for hrs.	**BailTest rate:** 14.0 gpm for hrs.
	Drawdown: ft.	**Static water level:** 110.0 ft.	**Bailer Drawdown** 110.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: NE of the NE of the SE of Section 34 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 24, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 250.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 760.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: 533601.0 **UTM Northing:** 4326186.0

Well Log

Top	Bottom	Formation

Comments MC; OWNER VERIFIED W OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222659	KOONTZ RD	Jun 18, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JIM MARTIN	BLOOMINGTON RR5	
Driller	GEORGE SNAPP	RR5, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 300.0 **Ft N of SL:** 150.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 759.0 **Aquifer elevation:**
UTM Easting: 533587.0 **UTM Northing:** 4325454.0

Well Log

Top	Bottom	Formation
0.0	11.0	R CLAY & LAYERS LS
11.0	17.0	WH LS
71.0	75.0	LAYERS SHALE
75.0	90.0	WH LS

Comments MC 759; NEIGHBOR & MAILBOX VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222663	SOUTH UNION SCHOOL	Jun 06, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROGER MAY		

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 70.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SE of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 705.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 535262.0 **UTM Northing:** 4327248.0

Well Log

Top	Bottom	Formation

Comments MC 690; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222664	ABOUT 8MI S OF BLGTON,TAKE SR456 TO HARMONYRD,TURN L GOTO KOONTZRD, TURN L THEN TO DEVAUL RD,TURN L. 1ST HOUSE ON L.	Jun 28, 1974

Owner-Contractor	Name	Address	Telephone
Owner	BOYD JONES #1	RR#9, BLGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 252B, ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 195.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 195.0 ft. **Static water level:** 133.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3000.0 **Ft N of SL:** 400.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 840.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 835.0 **Aquifer elevation:**
UTM Easting: 532764.0 **UTM Northing:** 4325548.0

Well Log

Top	Bottom	Formation
0.0	5.0	RED CLAY
5.0	6.0	STONE BR SS HARD
6.0	11.0	YEL SHALE EX SOFT
11.0	30.0	STONE GRAY LS EX HARD
30.0	36.0	STONE WH LS EX HARD
36.0	52.0	STONE CREAM LS HARD
52.0	60.0	STONE WH LS EX HARD
60.0	63.0	STONE CREAM LS EX HARD
63.0	77.0	STONE WH LS EX HARD

77.0	82.0	STONE CREAM LS HARD
82.0	89.0	STONE GRAY LS HARD
89.0	91.0	STONE DARK GRAY LS HARD
91.0	95.0	STONE GRAY LS HARD
95.0	97.0	STONE DARK GRAY LS HARD
97.0	116.0	STONE GRAY LS HARD
116.0	118.0	STONE DARK GRAY LS HARD
118.0	158.0	STONE GRAY LS HARD
158.0	160.0	STONE YEL LS HARD
160.0	161.0	STONE WH SHALE SOFT
161.0	170.0	STONE GRAY LS HARD
170.0	195.0	STONE GRAY LS SOFT

Comments MC 835; OWNER VERIFIED 25' NE OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222668	ABOUT 6MI SW OF BLGTON ATINTSEC OF LEONARDSPRINGSRD&MAYRD. THE WELL IS ABOUT 145'N OF MAYRD&ABOUT 280'W OF LEONARDSPRINGS RD,NEXTDOOROLDSUNIONSCHOOL	Oct 21, 1966

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OLLIE M. BOWFF	RR#9, BOX 343, BLOOMINGTON IN	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	ALBERT LENTZ	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 47.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 1.0 gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: 50.0 ft. **Static water level:** 50.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 200.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 47.0 **Bedrock elevation:** 613.0 **Aquifer elevation:**
UTM Easting: 535225.0 **UTM Northing:** 4327028.0

Well Log

Top	Bottom	Formation

Comments MC; NEIGHBOR DIRECTIONS ON WELL LOG & MAILBOX; CLAY 47' TO BOTTOM;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222669	E OF STANFORD, TAKE KIRKVILLE RD TO HARMONY RD, TURN R GO KOONTZ RD TURN L GO DUVALL RD, TURN L, 1ST HOUSE ON L.	Nov 12, 1970

Owner-Contractor	Name	Address	Telephone
Owner	MARVIN SPARKS	RR9, BLOOMINGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 452, BLOOMINGTON IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 24.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 110.0 ft. **Bailer Drawdown** 150.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2900.0 **Ft N of SL:** 700.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 840.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 833.0 **Aquifer elevation:**
UTM Easting: 532813.0 **UTM Northing:** 4325658.0

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	7.0	RED CLAY
7.0	9.0	STONE GRAY LS HARD
9.0	16.0	STONE GRAY LS EX HARD
16.0	19.0	STONE LIGHT BLUE LS EX HARD
19.0	31.0	STONE GRAY LS HARD
31.0	56.0	STONE GRAY LS EX HARD
56.0	70.0	STONE BUFF LS EX HARD

70.0	98.0	STONE CREAM LS EX EX HARD
98.0	107.0	STONE GRAY LS EX EX HARD
107.0	139.0	STONE YEL LS EX EX HARD
139.0	144.0	STONE GRAY LS EX EX HARD
144.0	170.0	STONE LIGHT BR LS HARD

Comments MC 833; BROTHER VERIFIED 30' NW OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222678	ABOUT 10MI SW BLGTON ON MAY RD.	Oct 24, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WILLIAM KOONTZ	RR9, BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR4, BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 85.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the SW of Section 26 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 200.0 **Ft E of WL:** 950.0 **Ft S of NL:**
Ground elevation: 800.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 784.0 **Aquifer elevation:**
UTM Easting: 533982.0 **UTM Northing:** 4327062.0

Well Log

Top	Bottom	Formation
0.0	14.0	YEL CLAY
14.0	16.0	RED CLAY
16.0	23.0	STONE GRAY LS AHRD
23.0	24.0	YEL CLAY
24.0	29.0	STONE GRAY LS HARD
29.0	33.0	MUD
33.0	47.0	STONE GRAY LS HARD
47.0	48.0	STONE MUD
48.0	54.0	STONE BLUE LS HARD
54.0	63.0	STONE GRAY LS HARD
63.0	67.0	STONE BR LS HARD

67.0	70.0	STONE MUD
70.0	79.0	STONE GRAY LS HARD
79.0	81.0	MUD
81.0	99.0	STONE GRAY LS EX HARD
99.0	120.0	STONE GRAY LS HARD

Comments MC 784; OWNER VERIFIED 75' N OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222679	TAKE SR45 OUT OF BLGTON 5 MI TO HARMONY RD, TURN L ON HARMONY RD F GOTO KOONTZRD L ON 1ST RD. 3RD HOUSE ON L SIDE OF RD.	Mar 03, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOYD JANER #2		
Driller	FRED SMITH	R13, BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SE of the SW of Section 34 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 3700.0 **Ft N of SL:** 1050.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 795.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 774.0 **Aquifer elevation:**
UTM Easting: 532564.0 **UTM Northing:** 4325762.0

Well Log

Top	Bottom	Formation
0.0	21.0	SOIL
21.0	150.0	LS

Comments MC 774; OWNER VERIFIED 10' W OF FARMHOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222684	E OF STANFORD ABOUT 2.5 MILES, LAKE KIRKSVILLE RD TO HARMONY RD TURN R GO TO KOONTZ RD TURN & GO TO 2ND DRIVE ON L & TURN, HOUSE IS BACK OF MAIN ROAD	Oct 13, 1978

Owner-Contractor	Name	Address	Telephone
Owner	JAMES SHULTZ	R9 BLGTON, IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 12.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 161.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the SW of Section 34 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1020.0 **Ft E of WL:** 280.0 **Ft S of NL:**
Ground elevation: 880.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 875.0 **Aquifer elevation:**
UTM Easting: 532133.0 **UTM Northing:** 4325765.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLALY
5.0	8.0	YELLOW SHALE SOFT
8.0	10.0	STONE YEL SANDSTONE SOFT
10.0	15.0	STONE YEL SANDSTONE HARD
15.0	21.0	STONE BLUE SHALE
21.0	29.0	STONE YEL SANDSTONE HARD
29.0	87.0	STONE BLUE SOAPSTONE SOFTER
87.0	115.0	STONE GRAY LIMESTONE HARD
115.0	127.0	STONE DARK GRAY LS HARD

127.0	154.0	STONE GRAY LS EX. HARD
154.0	166.0	STONE GRAY LIMESTONE HARD
166.0	175.0	STONE GRAY LS EX. HARD
175.0	180.0	STONE DARK GRAY LS HARD
180.0	195.0	STONE GRAY LS EX. HARD
195.0	196.0	STONE BLUE GRN SHALE SOFTER
196.0	222.0	STONE GRAY LIMESTONE HARD
222.0	232.0	STONE DARK GRAY LS HARD
232.0	245.0	STONE GRAY LIMESTONE HARD

Comments MC 875; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number
222689

Driving directions to well
ABOUT 6MI S OF BLOOMINGTON, TAKE ROCKPORT RD TO TRAMWAY RD, PASS & IT 1ST HOUSE ON L.

Date completed
Jul 15, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	L.D. HONEYCUTT	RR5, BLOOMINGTON IN	
Driller	FRED SCOTT'S WELL DRLG	RR1, BOX 252B, ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 205.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test
Type of test: Air **Test rate:** gpm for 30.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 205.0 ft. **Static water level:** 25.0 ft. **Bailer Drawdown** ft.

Grouting Information
Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment
Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative
County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the SE of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 300.0 **Ft N of SL:** 950.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 675.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 535197.0 **UTM Northing:** 4325694.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	28.0	GRAY LS HARD
28.0	55.0	BUFF LS HARD
55.0	80.0	GRAY LS HARD
80.0	90.0	BLUE LS HARD
90.0	118.0	GRAY LS HARD
118.0	136.0	WH LS HARD
136.0	165.0	GRAY LS HARD
165.0	170.0	BLUE LS HARD
170.0	174.0	GRAY LS HARD
174.0	205.0	BLUE SOAPSTONE HARD

Comments MC 669; DIRECTIONS & MAILBOX VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222694	NE OF STANFORD IN, ON MAY RD, AROUND 4MI FROM STANDFORD.	Sep 15, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LUTHER HILLENBURG	R#9, BLGTON IN	
Driller	FRED SCOTT'S WELL DRLG	R#4, BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 67.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 55.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the NW of the NW of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 100.0
Ground elevation: 780.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 769.0 **Aquifer elevation:**
UTM Easting: 533792.0 **UTM Northing:** 4326972.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	11.0	RED CLAY
11.0	20.0	STONE GRAY LS HARD
20.0	49.0	STONE GRAY LS EX HARD
49.0	51.0	MUD HOLE
51.0	60.0	STONE BUFF LS HARD
60.0	64.0	MUD HOLE
64.0	75.0	STONE BUFF LS HARD
75.0	80.0	STONE LIGHT BLUE SHALE SOFT
80.0	100.0	STONE GRAY LS HARD
100.0	110.0	STONE GRAY LS EX HARD

Comments MC 770; VERIFIED BY NEIGHBOR;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222699		Oct 12, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS HARRIS ROBINSON		
Driller	GEORGE SNAPP	BLOOMINGTON, INDIANA, R#4	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** 32.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the NW of Section 35 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 2500.0
Ground elevation: 695.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 533955.0 **UTM Northing:** 4326252.0

Well Log

Top	Bottom	Formation
0.0	38.0	DIRT LAYER LS & DIRT
38.0	50.0	LS DARK
50.0	100.0	LS WHITE

Comments MC 657; NEIGHBORS (KIDS) VERIFIED; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222704	DRILLED ON TRANEWAY RD .5WAY BETWEEN ROCKPORT RD & VICTOR PK.	May 24, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LARRY BLACKERBY	101 S. CARRY PK	
Driller	GEORGE SNAPP	RR#5, BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 9.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 28.0 ft. **Bailer Drawdown** 107.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the SE of the NE of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 950.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0
Ground elevation: 690.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 683.0 **Aquifer elevation:**
UTM Easting: 536613.0 **UTM Northing:** 4326238.0

Well Log

Top	Bottom	Formation
0.0	7.0	TOPSOIL & LAYERS OF LS
7.0	55.0	WH LS SOFT
55.0	65.0	BLUE LS SOFT
65.0	105.0	WH LS
105.0	140.0	BLUE LS HARD & ABRASIVE

Comments MC 683; OWNER VERIFIED JUST N OF HOUSE;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222709	GO S FROM BLOOMINGTON ON IND #37 4 LANE TO VICTOR PIKE, TO TRAMWAY RD, GO W ON TRAMWAY ABOUT 1 MI. TRAILER ACROSS CREEK ON SIDE HILL	Jun 28, 1980

Owner-Contractor	Name	Address	Telephone
Owner	KENNY LONG	4371 W. TRAMWAY RD	(000) 824-8956
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.58 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 106.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the SE of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2450.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 670.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 662.0 **Aquifer elevation:**
UTM Easting: 536260.0 **UTM Northing:** 4325633.0

Well Log

Top	Bottom	Formation
0.0	8.0	TOP SOIL & LAYER LIMESTONE
8.0	0.45	WHITE LIMESTONE
45.0	95.0	GREY LIMESTONE
95.0	135.0	BLUE LIMESTONE

Comments

MC 662; LOCATION CORRECT - OWNER NOT HOME; WELL 30 FT SW OF SW CORNER OF TRAILER.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222714	ABOUT 8 MILES SOUTH BLOOMINGTON, ON ROCKPORT RD, BY SHAWNEE QUARRY	Jul 01, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	INDEPENDENT STONE CO.	SOUTH HWY 50 & 37 PO BOX 142 BEDFORD, IN	
Driller	FRED SCOTT	R13 BOX 452 BLOOMINGTON, IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 120.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SW of the NW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 700.0 **Ft S of NL:** 2050.0
Ground elevation: 740.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 735.0 **Aquifer elevation:**
UTM Easting: 535516.0 **UTM Northing:** 4326369.0

Well Log

Top	Bottom	Formation
0.0	5.0	YELLOW CLAY
5.0	12.0	STONE GRAY LIMESTONE HARD
12.0	30.0	STONE DARK GRAY LS EX. HARD
30.0	45.0	STONE CREAM LIMESTONE HARD
45.0	88.0	STONE BUFF LIMESTONE BUFF
88.0	112.0	STONE GRAY LIMESTONE HARD
112.0	125.0	STONE WHITE LS EXTRA HARD

Comments MC 735; OWNER VERIFIED; ON TOP OF HILL ABOUT 200 FT EAST OF RD.

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222719	5 MI. SOUTH BLOOMINGTON, IN ON ROCKPORT RD JUST AFTER GO BETWEEN TWO QUARRIES HOLES.	Sep 01, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KENNETH A. EADS		
Driller	GEORGE SNAPP	4625 SO STONSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 53.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SW of the NW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 450.0 **Ft S of NL:** 1800.0
Ground elevation: 715.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 704.0 **Aquifer elevation:**
UTM Easting: 535437.0 **UTM Northing:** 4326455.0

Well Log

Top	Bottom	Formation
0.0	11.0	TOP SOIL & LAYERS STONE
11.0	135.0	WHITE LIME MEDIUM HARD

Comments MC 704; VERIFIED BY MAILBOX; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222724	GO SOUT ON SR37 TO ROCKPORT RD TURN ON ROCKPORT TO TRAMWAY RD THEN GO TO S CURVE ON TRAMWAY RD. WELL ON LEFT OF CURVE, ALONG DRIVE NEAR RD	Oct 27, 1981

Owner-Contractor	Name	Address	Telephone
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 95.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.11 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1575.0 **Ft E of WL:** 1625.0 **Ft S of NL:**
Ground elevation: 638.0 **Depth to bedrock:** 13.0 **Bedrock elevation:** 625.0 **Aquifer elevation:**
UTM Easting: 535790.0 **UTM Northing:** 4325860.0

Well Log

Top	Bottom	Formation
0.0	13.0	TOP SOIL
13.0	80.0	WHITE LIME
80.0	95.0	SHALE

Comments MC 625; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222727	W CLEAR CREEK ON CLEAR CREEK RD 2800' N OF SL 100' W OF EL	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEROY ROTHROCK		
Driller	SNAPPS		

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 0.5 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the NE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 536860.0 **UTM Northing:** 4329493.0

Well Log

Top	Bottom	Formation
0.0	8.0	SURFACE
8.0	130.0	LS

Comments

COLLECTED BY DGJ 6/20/57 USGS; OWNER NOT AT HOME MAY BE CORRECT LOCATION U-S 9/63

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222729	LAKE ROCKPORT RD OFF 4 LANE #37 SOUT TO TRAMWAY RD THEN GO TO S CURVE ON TRAMWAY RD. WELL ON LEFT SIDE OF CURVE.	Oct 23, 1981

Owner-Contractor	Name	Address	Telephone
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.083 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	75.0	WHITE LIMESTONE

Comments MC 630; VERIFIED BY OWNER; WELL IS 10' N OF N SIDE OF TRAILER UNDER SHED.; #3

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222732	7MI S OF BLGTON IN, ON ROCKPORT RD.	

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	E.L. WINTER	BLOOMINGTON RR#5	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	ALBERT LENTZ, BUYRIC ERIE M	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 160.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 45.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:** Pumping	**Test rate:** 36.0 gpm for 1.0 hrs.	**BailTest rate:** gpm for hrs.
	Drawdown: ft.	**Static water level:** ft.	**Bailer Drawdown** 100.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SW of the NW of the SE of Section 25 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: MT **on:** Jul 12, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2200.0 **Ft N of SL:** 1700.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 760.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**

UTM Easting: 536226.0 **UTM Northing:** 4327538.0

Well Log

Top	Bottom	Formation
0.0	160.0	BLANK

Comments MC; OWNER VERIFIED;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222734	TAKE ROCKPORT RD OFF 4 LANE 37 SO TO TRAMWAY RD GO TO S CURVE. WELL ON LEFT OF CURVE.	Oct 19, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 11.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.46 gpm for hrs.
Drawdown: ft. **Static water level:** 13.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	WHITE LIMESTONE
80.0	90.0	BLUE LIMESTONE
90.0	130.0	BLUE SHALE

Comments MC 630; VERIFIED BY OWNER; WELL IS 15 FT NORTH OF NORTH SIDE OF TRAILER; #2

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222737	THAT ROAD 2 MI. WEST OF CLEAR CREEK	Jul 15, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	EDWARD L. CRUM	8 MI	
Driller	ALBERT LENTZ	SMITHVILLE, IN	
Operator	ALBERT LENTZ	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 1.5 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 80.0 ft. **Static water level:** 80.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the NE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: U-S **on:** Sep 01, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 0.0 **Ft N of SL:** 2500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 536877.0 **UTM Northing:** 4329340.0

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY
20.0	140.0	LIMESTONE

Comments 22 ' CASING

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222739	TAKE ROCKPORT RD OFF 4 LANE 37 TO TRAMWAY RD THEN GO TO S CURVE. WELL ON NORTH SIDE OR LEFT SIDE OF RD.	Oct 15, 1981

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRED WELLMAN	5183 FAIRFAX RD	
Driller	GEORGE SNAPP	4625 SO. STANSIFER LANE BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.16 gpm for hrs.
Drawdown: ft. **Static water level:** 14.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SW of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: LH **on:** May 19, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1675.0 **Ft E of WL:** 1550.0 **Ft S of NL:**
Ground elevation: 640.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 630.0 **Aquifer elevation:**
UTM Easting: 535755.0 **UTM Northing:** 4325905.0

Well Log

Top	Bottom	Formation
0.0	10.0	RED CLAY
10.0	80.0	WHITE LIMESTONE
80.0	90.0	BLUE LIMESTONE
90.0	145.0	BLUE SHALE

Comments MC 630; VERIFIED BY OWNER; WELL IS 5' NORTH OF NORTH SIDE OF TRAILER; #1

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222742		Mar 28, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ASSOCIATE BLDRS. C. ROTHROCK	ST. RD. 45 AT LEONARD SPR. RD	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 25.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NE of the SE of the NE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 27, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1350.0
Ground elevation: 785.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 760.0 **Aquifer elevation:**
UTM Easting: 536848.0 **UTM Northing:** 4329779.0

Well Log

Top	Bottom	Formation
0.0	25.0	YELLOW DIRT
25.0	127.0	GREY LIMESTONE
127.0	132.0	BUFF COLOR LIMESTONE
132.0	140.0	GREY LIMESTONE

Comments

MC 60; OWNER VERIFIED / JUST WEST OF HOUSE; COULDN'T LOCATE, NEE SPECIFIC DISTANCE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
222744	SW OF BLOOMINGTON ST. RD. 37 S. TO ROCKPORT RD. TURN RIGHT GO TO TRAMWAY RD. GO LEFT GO TO 2ND TRAILER ON LEFT	Sep 17, 1985

Owner-Contractor	Name	Address	Telephone
Owner	DON AXSOM	TRAMWAY RD., BLOOMINGTON, IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 164.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 55.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 11.6 ft. **Bailer Drawdown** 164.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the NE of the SW of Section 36 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: LH **on:** May 19, 1989

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** 1650.0 **Ft E of WL:** 2350.0 **Ft S of NL:**

Ground elevation: 634.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 620.0 **Aquifer elevation:**

UTM Easting: 536010.0 **UTM Northing:** 4325895.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	14.0	RED CLAY
14.0	17.0	YEL SH
17.0	23.0	GRAY LS
23.0	27.0	BLUE LS
27.0	40.0	GRAY LS
40.0	52.0	BLUE LS

52.0	62.0	BLUE LS
62.0	89.0	GRAY LS
89.0	100.0	DARK GRAY LS
100.0	121.0	GRAY LS
121.0	138.0	WHITE LS
138.0	154.0	GRAY LS
154.0	164.0	DARK GRAY LS

Comments MC 620: WELL 25' N. OF NW SIDE OF HOUSE: SEE MAP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222747	ON WEST SIDE ROCKPORT ROAD JUST AFTER YOU PAS THAT ROAD SOUTH BLOOMINGTON, IN ABOUT 4 MILES	Dec 24, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 8.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:**	**Test rate:** gpm for hrs.	**BailTest rate:** 4.0 gpm for hrs.
	Drawdown: ft.	**Static water level:** 35.0 ft.	**Bailer Drawdown** 35.0 ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 475.0 **Ft N of SL:** 500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 700.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 693.0 **Aquifer elevation:**

UTM Easting: 536742.0 **UTM Northing:** 4328755.0

Well Log

Top	Bottom	Formation
0.0	7.0	RED CLAY
7.0	40.0	WHITE MEDIUM HARD LIMESTONE
40.0	75.0	HARD WHITE LIMESTONE

Comments MC 693; OWNER VERIFED / 15 FT WEST OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222752	4 MILES SOUTH BLOOMINGTON, IN ON ROCKPORT RD 0.25 MILE SOUTH OF THAT ROAD ON WEST SIDE OF ROCKPORT ROAD.	Apr 22, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER #2	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.83 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** 400.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 700.0 **Depth to bedrock:** 4.0 **Bedrock elevation:** 696.0 **Aquifer elevation:**
UTM Easting: 536729.0 **UTM Northing:** 4328743.0

Well Log

Top	Bottom	Formation
0.0	4.0	TOP RED CLAY
4.0	115.0	HARD WHITE LIMESTONE
115.0	132.0	SOFT GREY LIMESTONE
132.0	140.0	HARD BLUE LIMESTONE

Comments MC 695; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222753	0.25 MILE SOUTH OF STANFORD; 1ST HOUSE N AFTER BRIDGE	Oct 08, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BYRON BOWMAN	R5 BLOOMINGTON	
Driller	EADS & DECKARD	R9 BLOOMINGTON	
Operator	EADS & DECKARD	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 15.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W

Section: SE of the SE of the NE of Section 31 **Topo map:** STANFORD

Grant Number:

Field located by: RC **on:** Jul 17, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2500.0

Ground elevation: 722.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 710.0 **Aquifer elevation:**

UTM Easting: 528698.0 **UTM Northing:** 4326319.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	100.0	LIMESTONE

Comments MC 710; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222757	4 MILES SOUTH BLOOMINGTON, IN. ON ROCKPORT ROAD 0.25 MILE SOUTH OF THAT ROAD ON WEST SIDE OF ROCKPORT ROAD.	May 15, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SANTA PARKER #1	R5 BLOOMINGTON, IN	
Driller	GEORGE SNAPP	R5 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 3.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 26.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: NW of the SE of the SE of Section 24 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 900.0 **Ft N of SL:** 1100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 690.0 **Depth to bedrock:** 2.0 **Bedrock elevation:** 688.0 **Aquifer elevation:**
UTM Easting: 536602.0 **UTM Northing:** 4328945.0

Well Log

Top	Bottom	Formation
0.0	2.0	TOP SOIL
2.0	45.0	SOFT GREY LIMESTONE
45.0	70.0	HARD WHITE LIMESTONE

Comments MC 685; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
222758	ON BURCH ROAD SO. OF STANFORD, IN.	Nov 16, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	OTTIS HENDERSON	R5 BLOOMINGTON	
Driller	GEORGE SNAPP	R4 BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 41.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 34.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 8N **Range:** 2W
Section: SE of the SE of the SE of Section 31 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** 200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 741.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 720.0 **Aquifer elevation:**
UTM Easting: 528793.0 **UTM Northing:** 4325550.0

Well Log

Top	Bottom	Formation
0.0	21.0	TOP SOIL
21.0	39.0	LAYERS OF RED CLAY & LS
39.0	75.0	HARD WHITE LIMESTONE

Comments MC 720; OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223845	W OF BLOOMINGTON ON SR 45 TO STANFORD LEFT ON BURCH RD 3/4 MI TO EVANS RD 3/4 MI ON RIGHT 4TH HOUSE FROM CORNER.	Apr 30, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TIM CAMPBELL	R9 EVANS RD	
Driller	FRED SMITH	RR #13 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 186.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 105.0 ft. **Bailer Drawdown** 76.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2250.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 150.0
Ground elevation: 830.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 820.0 **Aquifer elevation:**
UTM Easting: 529778.0 **UTM Northing:** 4325385.0

Well Log

Top	Bottom	Formation
0.0	10.0	SOIL
10.0	30.0	LS WITH HOLES
30.0	186.0	LS

Comments MC 820: NEIGHBOR & MAILBOX VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223850	S OF STANFORD, TURN ON BURCH RD AT STANFORD, GO TO EVANS RD TURN LEFT THEN GO TO 2ND HOUSE ON RIGHT	Aug 22, 1988

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVID SPEARS	8801 W. EVANS RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 25.0	**Material:**	**Diameter:** 6.625
Screen	**Length:** 160.0	**Material:**	**Diameter:** 4.0 **Slot size:** .32

Well Capacity Test

Type of test: Air / Pump **Test rate:** 20.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 165.0 ft. **Static water level:** 40.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NE of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: LH **on:** May 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 50.0
Ground elevation: 755.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 745.0 **Aquifer elevation:**
UTM Easting: 529350.0 **UTM Northing:** 4325425.0

Well Log

Top	Bottom	Formation
0.0	4.0	YEL CLAY
4.0	10.0	RED CLAY
10.0	40.0	GRAY LS HARD
40.0	44.0	BLUE LS HARD
44.0	83.0	GRAY LS HARD
83.0	87.0	LIGHT BLUE LS EX HARD
87.0	120.0	GRAY LS EX HARD
120.0	130.0	BLUE LS EX HARD

130.0	141.0	GRAY LS HARD
141.0	155.0	YEL LS HARD
155.0	158.0	BLUE SHALE SOFT
158.0	165.0	GRAY LS HARD

Comments MC745; VERIFIED BY OWNER; WELL IS 30' NE OF NE CORNER OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223855	S OF STANFORD, TURN ON BURCH RD AT STANFORD. GO TO EVANS RD TURN LEFT THEN GO TO 3RD HOUSE ON RIGHT	Aug 16, 1988

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RITA STULTZ	8701 W EVANS RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 32.0	**Material:**	**Diameter:** 6.625
Screen	**Length:** 175.0	**Material:**	**Diameter:** 4.0 **Slot size:** .032

Well Capacity Test

Type of test: Air / Pump **Test rate:** 8.0 gpm for 2.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 185.0 ft. **Static water level:** 75.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: LH **on:** May 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2250.0 **Ft S of NL:** 50.0
Ground elevation: 794.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 788.0 **Aquifer elevation:**
UTM Easting: 529530.0 **UTM Northing:** 4325420.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	14.0	YEL SS SOFT
14.0	22.0	YEL SHALE EX SOFT
22.0	28.0	BLUE SHALE EX SOFT
28.0	74.0	GRAY LS HARD
74.0	76.0	BLUE SHALE
76.0	102.0	GRAY LS HARD
102.0	106.0	YEL LS SOFT

106.0	120.0	GRAY LS HARD
120.0	124.0	BROWN SS SOFT
124.0	137.0	LIGHT BLUE LS EX HARD
137.0	141.0	YEL LS HARD
141.0	164.0	GRAY LS HARD
164.0	167.0	BLUE SHALE SOFT
167.0	172.0	GRAY LS HARD
172.0	180.0	BLUE SHALE SOFT
180.0	185.0	BLUE LS HARD

Comments MC788; VERIFIED BY OWNER; WELL IS 20' NE OF NE CORNER OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223860	GO S OF STANFORD, IN ON CR, TO EVANS RD, TURN L GO 1.25 MI GO S .1 MI LOT TO R FROM CURVE EAST	Aug 13, 1987

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MIKE COMBS	STANFORD, IN	
Driller	MUMMA BROS DRILLING INC	RR1, BOX 85, LYONS, IN	
Operator	DAVID MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth:	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 100.0	**Material:**	**Diameter:** 6.0
Screen	**Length:** 160.0	**Material:**	**Diameter:** 4.5 **Slot size:**

Well Capacity Test

Type of test: Bailing **Test rate:** 30.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SE of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 250.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 883.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 868.0 **Aquifer elevation:**
UTM Easting: 530420.0 **UTM Northing:** 4324900.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	15.0	SANDROCK & CLAY SEAMS
15.0	19.0	SOFT SH
19.0	35.0	BR SANDROCK
35.0	36.0	CLAY SEAM
36.0	42.0	BR SANDROCK
42.0	45.0	MUD GRAY
50.0	55.0	CLAY & SOFT SH
55.0	57.0	YEL SANDROCK
57.0	67.0	LS BR
67.0	69.0	CLAY SEAM

69.0	72.0	SOFT GRAY SH
72.0	76.0	CLAY & MUD
76.0	88.0	SANDROCK BR
88.0	91.0	CLAY
91.0	155.0	LS WHITE
155.0	158.0	SEAM
158.0	161.0	LS
161.0	162.0	SEAM
162.0	180.0	LS BR SANDY
180.0	250.0	LS WATER AT 226

Comments MC 868; NO CONTACT MADE WELL LOCATED AT NW CORNER OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223865	SE OF STANFORD	Aug 30, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHARLES EVANS	RR #9 BLOOMINGTON	
Driller	ALBERT MARTINDALE	RR #4 BLOOMFIELD IN	

Construction Details

Well	**Use:**	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 95.0	**Material:**	**Diameter:** 5.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for hrs.
Drawdown: ft. **Static water level:** 140.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: **on:** Apr 18, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1900.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 900.0
Ground elevation: 874.0 **Depth to bedrock:** 95.0 **Bedrock elevation:** 779.0 **Aquifer elevation:**
UTM Easting: 529890.0 **UTM Northing:** 4325183.0

Well Log

Top	Bottom	Formation
0.0	95.0	MUD
95.0	200.0	LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223869	.5 MI S OF VICTOR STONE OOLITIC STONE CO	Sep 08, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOMAS DECKARD		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 182.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SW of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1300.0 **Ft E of WL:** 700.0 **Ft S of NL:**
Ground elevation: 805.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 535518.0 **UTM Northing:** 4322641.0

Well Log

Top	Bottom	Formation
0.0	215.0	ORIGINAL WELL
215.0	240.0	BROWNISH COLOR LS
240.0	250.0	BLUE LS

Comments MC; MAILBOX VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223870	ABOUT 7 MI SW OF BLOOMINGTON LAKE 45 HWY TO HARMONY RD TURN LEFT THEN GO EVANS RD TURN RIGHT 2ND HOUSE ON LEFT.	Jul 20, 1981

Owner-Contractor	Name	Address	Telephone
Owner	CHUCK MC QUARRY	EVANS RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6236 W COWDEN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 145.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.7	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 15.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 145.0 ft. **Static water level:** 85.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NE of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1500.0
Ground elevation: 800.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 788.0 **Aquifer elevation:**
UTM Easting: 531590.0 **UTM Northing:** 4324955.0

Well Log

Top	Bottom	Formation
0.0	9.0	YEL CLAY
9.0	12.0	RED CLAY
12.0	18.0	STONE YEL SS HARD
18.0	29.0	RED CLAY
29.0	31.0	HOLE
31.0	42.0	STONE GRAY LS EX HARD
42.0	50.0	STONE DARK GRAY LS EX HARD
50.0	70.0	STONE GRAY LS EX HARD
70.0	98.0	STONE LT GREY LS EX HARD

98.0	101.0	STONE BLUE LS EX HARD
101.0	126.0	STONE GRAY LS HARD
126.0	134.0	STONE DARK GRAY LS HARD
134.0	145.0	STONE GRAY LS HARD

Comments MC 788: NOTE CONTACT MADE WITH OWNER WEL LOCATED N OF HOUSE WELL NO LONGER USED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223874	BLOOMINGTON IN ON VICTOR PIKE JUST N VICTOR QUARRY	Aug 21, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CECIL HENDRICKS	RR 5 BLOOMINGTON IN	
Driller	GEORGE H SNAPP	RR 5 BOX 86 BLOOMINGTON IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NE of Section 12 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1650.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 50.0
Ground elevation: 600.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 594.0 **Aquifer elevation:**
UTM Easting: 536413.0 **UTM Northing:** 4323820.0

Well Log

Top	Bottom	Formation
0.0	6.0	TOP SOIL
6.0	100.0	LS

Comments MC 594: NEIGHBOR VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223875	W ON BLOOMFIELD RD 7 MI TO HARMONY RD TO MT LION & TURN R ON MT QION RD 1/4 MI.	Oct 21, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES G GOBLE	R #5 BOX 374 A	
Driller	PAUL SHUTE	1420 W 14TH ST BLOOMINGTON IN	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 263.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 173.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SE of the SE of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 700.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 960.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 531900.0 **UTM Northing:** 4324105.0

Well Log

Top	Bottom	Formation

Comments NEIGHBOR & MAILBOX VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223879	65' 2ND RD AT DRIVE WAY ENTRANCE DUE W OFF OF VICTOR PIKE.	May 11, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	PHILLIP TEAGUE	7860 S VICTOR PIKE	
Driller	FRED L SMITH	S HWY 37 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 210.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 140.0 ft. **Bailer Drawdown** 140.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1950.0 **Ft N of SL:** 1275.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 815.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 797.0 **Aquifer elevation:**
UTM Easting: 534750.0 **UTM Northing:** 4322638.0

Well Log

Top	Bottom	Formation
0.0	18.0	SOIL
18.0	28.0	LS & HOLES
28.0	210.0	LS

Comments MC 797: VERIFIED BY NEIGHBOR: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223880	ABOUT 2 1/4 MI SE OF STANFORD THAKE BURCH RD TO EVANS RD TURN LEFT & GO TO 1ST HOUSE ON LEFT.	Oct 31, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GEORGE EAST	512 GRAHAM DR BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX 252B ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 265.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 265.0 ft. **Static water level:** 142.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NW of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1150.0 **Ft S of NL:** 1250.0
Ground elevation: 895.0 **Depth to bedrock:** 24.0 **Bedrock elevation:** 871.0 **Aquifer elevation:**
UTM Easting: 530829.0 **UTM Northing:** 4325072.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	15.0	BLUE SH SOFT
15.0	18.0	YEL SH SOFT
18.0	24.0	BLUE SH SOFT
24.0	30.0	STONE BR SS HARD
30.0	39.0	BLUE SH SOFT
39.0	65.0	SOTNE BLUE SOAPSTONE HARD
65.0	68.0	STONE YEL SS HARD
68.0	140.0	STONE BLUE SOAPSTONE HARD

140.0	142.0	STONE GRAY LS HARD
142.0	168.0	STONE BLUE SOAPSTONE HARD
168.0	180.0	STONE GRAY LS HARD
180.0	197.0	STONE CREAM LS HARD
197.0	200.0	STONE BLUE SH SOFTER
200.0	218.0	STONE GRAY LS HARD
218.0	226.0	STONE BLUE LS EX HARD
226.0	240.0	STONE GRAY LS HARD
240.0	265.0	STONE YELLOWISH LS HARD

Comments MC 871: NEIGHBOR VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223884	ON VICTOR PIKE ABOUT 3 BLOCKS FROM ROCKPROT BELOW VICTOR OOLITIES STONE CO	May 01, 1975

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STEPHEN LOCKWOOD	BLOOMINGTON IN RR5	
Driller	GEORGE SNAPP	BLOOMINGTON IN RR5	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 180.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 130.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 805.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 789.0 **Aquifer elevation:**
UTM Easting: 534811.0 **UTM Northing:** 4322620.0

Well Log

Top	Bottom	Formation
0.0	16.0	TOPSOIL
16.0	180.0	HARD LS

Comments MC 789: OWNER VARIFIED/ 10' E OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223885	S OF STANDFORD ABOUT 3 1/2 MI TAKE KIRKSVILLE RD TO HARMONY RD TURN R GO EVANS RD TURN R THEN 3RD HOUSE ON LEFT.	Nov 10, 1978

Owner-Contractor	Name	Address	Telephone
Owner	SARAH CABANAW	RR 9 BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	6238 W COWDERN RD ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 205.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 205.0 ft. **Static water level:** 97.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SE of the NW of Section 4 **Topo map:** STANFORD
Grant Number:
Field located by: RJS **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2500.0 **Ft S of NL:** 1400.0
Ground elevation: 835.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 828.0 **Aquifer elevation:**
UTM Easting: 531248.0 **UTM Northing:** 4325022.0

Well Log

Top	Bottom	Formation
0.0	7.0	YEL CLAY
7.0	15.0	STONE YELLOWISH LS HARD
15.0	27.0	STONE YEL SS HARD
27.0	55.0	STONE BLUE SOAPSTONE SOFTER
55.0	64.0	STONE GRAY LS HARD
64.0	70.0	STONE BLUE LS HARD
70.0	105.0	STONE GRAY LS EX HARD
105.0	106.0	STONE BLUE SH SOFTER
106.0	112.0	STONE DARK GRAY LS EX HARD

112.0	135.0	STONE GRAY LS EX HARD
135.0	137.0	STONE BLUE SH SOFT
137.0	152.0	STONE CREAM LS HARD
157.0	162.0	STONE DARK GRAY LS EX HARD
162.0	165.0	STONE GRAY LS HARD
165.0	180.0	STONE GRAY LS EX HARD
180.0	187.0	STONE CREAM LS HARD
187.0	205.0	STONE YELLOWISH LS HARD

Comments MC 828: VERIFIED BY OWNER:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223889	BLGTN IN ON SR37, OLD #37 TURN S TO KETCHEM RD, R 1ST RD TO VICTOR PIKE, S TO RCKPRT RD 3 BLKS BACK ON VICTOR PIKE FROM ROCKPORT	Nov 12, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LEWIS MAY SON	RR 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	RR 5 BOX 86 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 165.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 11.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 135.0 ft. **Bailer Drawdown** 30.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the SE of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2300.0 **Ft N of SL:** 1250.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 825.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 816.0 **Aquifer elevation:**
UTM Easting: 534616.0 **UTM Northing:** 4322620.0

Well Log

Top	Bottom	Formation
0.0	9.0	RED CLAY
9.0	100.0	WH LS
100.0	165.0	LAYERS LS & SOFT MATERIAL

Comments MC 816: OWNER VERIFIED / JUST W OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223894	SEE MAP	Apr 15, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MASTER BUILT HOMES		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	SNAPP & GROGAN	License: null	

Construction Details

Well	**Use:**	**Drilling method:**	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 12.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the SW of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: US **on:** Sep 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 900.0 **Ft S of NL:**
Ground elevation: 860.0 **Depth to bedrock:** 12.5 **Bedrock elevation:** 847.5 **Aquifer elevation:**
UTM Easting: 534006.0 **UTM Northing:** 4322574.0

Well Log

Top	Bottom	Formation
0.0	12.5	DIRT YEL
12.5	200.0	LS GRAY HARD

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223895	E OF STANFORD, TAKE KIRKSVILLE RD TO KOONTZ RD TURN LEFT ABOUT 1.5 MI TRAILER ON RIGHT	May 08, 1985

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JEFF SELF	6005 W. KOONTZ RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 10.5	**Material:**	**Diameter:** 6.25
Screen	**Length:** 110.0	**Material:**	**Diameter:** 4.0 **Slot size:** .40

Well Capacity Test

Type of test: **Test rate:** 20.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 115.0 ft. **Static water level:** 61.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NE of the NE of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JA **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1150.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 50.0
Ground elevation: 765.0 **Depth to bedrock:** 2.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 533350.0 **UTM Northing:** 4325375.0

Well Log

Top	Bottom	Formation
0.0	2.0	RED CLAY
2.0	7.0	GRAY LS H
6.0	10.0	BLUE SHALE S
10.0	26.0	GRAY LS H
26.0	30.0	BLUE SHALE S
30.0	38.0	GRAY LS H
38.0	40.0	BLUE SHALE S
40.0	62.0	GRAY LS EX. H
62.0	75.0	GRAY LS H

75.0	76.0	WHITE SHALE S
76.0	84.0	GRAY LS H
84.0	85.0	YEL SHALE S
85.0	105.0	WHITE LS H
105.0	115.0	GRAY LS H

Comments NEIGHBOR & MAILBOX VERIFIED; PITLESS ADAPTER VISIBLE W. SIDE OF TRAILER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223899	S ON ROCKPORT RD 8 MI FROM BLOOMINGTON, IN	Jul 20, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WESLEY BAXTER	RR13, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 45.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 13.0	**Material:**	**Diameter:** 5.625
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 12.0 ft. **Bailer Drawdown** 25.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the SW of the NW of Section 11 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1150.0 **Ft S of NL:** 1750.0
Ground elevation: 685.0 **Depth to bedrock:** 11.0 **Bedrock elevation:** 674.0 **Aquifer elevation:**
UTM Easting: 534088.0 **UTM Northing:** 4323299.0

Well Log

Top	Bottom	Formation
0.0	11.0	TOPSOIL & LAYERS LS
11.0	45.0	HARD LS

Comments MC 674; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223900	1/2 WAY DOWN KOONTZ RD BETWEEN HARMONY RD & ROCKPORT RD ON THE S SIDE OF THE RD LOCATED APROX 600' OFF THE RD COURSE RD AT BELOW ADDRESS	Aug 18, 1977

Owner-Contractor	Name	Address	Telephone
Owner	MICHAEL R MC KENNA	6123 W KOONTZ BLOOMINGTON IN	
Driller	FRED SMITH L WATER-WELL DRLG	RR 13 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 125.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 122.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 65.0 ft. **Bailer Drawdown** 65.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the NE of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 700.0
Ground elevation: 750.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 740.0 **Aquifer elevation:**
UTM Easting: 533260.0 **UTM Northing:** 4325204.0

Well Log

Top	Bottom	Formation
0.0	10.0	SOIL
10.0	90.0	LS
90.0	125.0	SH TO SOFT TO STAND UP

Comments MC 740: NEIGHBOR & MAILBOX VERIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223904	ABOUT 2 MI W OF KIRKSVILLE ON MT ZOIN RD	Dec 29, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WAYNE MC CONNELL	RR 9 BLGTON IN	
Driller	FRED SCOTT	RR 4 BLGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 250.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 176.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 150.0 ft. **Bailer Drawdown** 200.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: SW of the SW of the NE of Section 9 **Topo map:** STANFORD

Grant Number:

Field located by: JRD **on:** Jul 21, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2150.0

Ground elevation: 900.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 892.0 **Aquifer elevation:**

UTM Easting: 531383.0 **UTM Northing:** 4323214.0

Well Log

Top	Bottom	Formation
0.0	8.0	YEL CLAY
8.0	20.0	STONE BR SS SOFT
20.0	23.0	STONE BR SS EX HARD
23.0	35.0	STONE BR SS SOFT
35.0	38.0	STONE BLUE SH SOFT
38.0	40.0	STONE BR SS SOFT
40.0	42.0	STONE BR SS EX HARD
42.0	52.0	STONE BR SS HARD
52.0	60.0	STONE BR SS HARD
60.0	82.0	STONE BLUE SH SOFT

82.0	85.0	STONE BR SS HARD
85.0	109.0	STONE GRAY SH SOFT
109.0	115.0	STONE GRAY LS HARD
115.0	120.0	STONE GRAY LS EX HARD
120.0	132.0	STONE BR LS EX HARD
132.0	139.0	STONE BR LS EX HARD
139.0	165.0	STONE WH LS HARD
165.0	175.0	YEL MUD HOLE
175.0	210.0	STONE YELLOWISH BR LS EX HARD
210.0	236.0	STONE YEL LS HARD
236.0	250.0	STONE YEL LS EX HARD

Comments MC 892: OWNER VERIFIED ABOUT 50' E OF THE HOUSE THAT THEY RENT OUT ON MT ZION RD:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223905	S OF BLOOMINGTON ABOUT 8 M TAKE 45 W TO HARMONY RD TURN TO LEFT THEN TO KOONTZ RD TURN LEFT THEN TO DEVALL RD TURN R 1ST HOUSE TRAILER ON RIGHT	May 12, 1973

Owner-Contractor	Name	Address	Telephone
Owner	ROBERT KINDER	RR 9 BLGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX 252B ELLETSVILLIE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 135.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 45.0 gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** 135.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NE of the NW of Section 3 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2800.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 700.0
Ground elevation: 755.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 735.0 **Aquifer elevation:**
UTM Easting: 532870.0 **UTM Northing:** 4325236.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	20.0	RED CLAY
20.0	32.0	STONE GRAY LS HARD
32.0	36.0	SEAM W/SOME HYEL CLAY
36.0	48.0	STONE GRAY LS HARD
48.0	57.0	STONE BLUE LS HARD
57.0	62.0	STONE YELLOWISH LS HARD
62.0	90.0	STONE GRAY LS HARD
90.0	112.0	STONE WH LS EX HARD
112.0	135.0	STONE DARK GRAY LS HARD

Comments MC 735: OWNER VERIFIED / 50' W OF RD: N OF HOUSE: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223909	S W OF KIRKSVILLE IN	Jun 30, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLARENCE RATLIFF	RR #5	
Driller	GEORGE SNAPP	BLOOMINGTON IN RR #4	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.18 gpm for hrs.
Drawdown: ft. **Static water level:** 135.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SE of the NW of Section 9 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 12, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 2700.0 **Ft E of WL:** 2500.0 **Ft S of NL:**
Ground elevation: 900.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 860.0 **Aquifer elevation:**
UTM Easting: 531319.0 **UTM Northing:** 4323098.0

Well Log

Top	Bottom	Formation
0.0	20.0	BR DIRT
20.0	40.0	BLUE MUCK W/GRAV MIXED
40.0	42.0	HARD LS
42.0	80.0	BLUE MUCK W/GRAV MIXED
80.0	123.0	BR LS
123.0	126.0	BLUE MUCK W/GRAV MIXED
126.0	200.0	HARD WH LS

Comments MC 860: OWNER VERIFIED: DRY WELL:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223910	SEE MAP	Jul 22, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	FRANK PING	RR5	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 65.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 63.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 0.42 gpm for hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 45.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 24, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 700.0 **Ft S of NL:** 200.0
Ground elevation: 855.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 841.0 **Aquifer elevation:**
UTM Easting: 532334.0 **UTM Northing:** 4325394.0

Well Log

Top	Bottom	Formation
0.0	14.0	CLAY
14.0	65.0	LS & FULL CANES

Comments MC 841; SEE MAP; BUILDING VER; 15' S OF HSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
223914	S OF STANFORD, SR45 S TO BREEDEN RD TURN LEFT GO TO 2ND RD WHICH IS GRAVES RD, TURN LEFT. 3RD DRIVE ON LEFT. NEW HOUSE UP ON HILL	Oct 16, 1985

Owner-Contractor	Name	Address	Telephone
Owner	DONNA DWYER	8920 W GRAVES RD., BLGTON., IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 175.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 84.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 12.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 175.0 ft. **Static water level:** 77.5 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SW of the NW of Section 8 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 21, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 400.0 **Ft S of NL:** 2100.0
Ground elevation: 770.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 765.0 **Aquifer elevation:**
UTM Easting: 529050.0 **UTM Northing:** 4323170.0

Well Log

Top	Bottom	Formation
0.0	5.0	YEL CLAY
5.0	6.0	YEL SHALE
6.0	16.0	YEL SS
16.0	17.0	BLUE SHALE
17.0	28.0	GRAY LS
28.0	32.0	BLUE LS
32.0	56.0	GRAY LS
56.0	65.0	DARK GRAY LS

65.0	71.0	GRAY LS
71.0	82.0	OPEN CAVE
82.0	105.0	GRAY LS
105.0	113.0	BROWNISH LS
113.0	130.0	GRAY LS
130.0	146.0	WHITE LS
146.0	162.0	GRAY LS
162.0	170.0	YELLOWISH LS
170.0	175.0	DARK BLUE LS

Comments MC765; WELL LOCATED ON N SIDE OF HOUSE; VERIFIED BY OWNER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223915	ON RD BETWEEN KIRKSVILLE & SR 45 1.5 MI FROM KIRKSVILLE	Aug 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SLOAN		
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	HASKLE GROGAN	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 80.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 31.0 ft. **Bailer Drawdown** 40.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1975
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 200.0 **Ft S of NL:** 1450.0
Ground elevation: 920.0 **Depth to bedrock:** 26.0 **Bedrock elevation:** 894.0 **Aquifer elevation:**
UTM Easting: 532193.0 **UTM Northing:** 4325006.0

Well Log

Top	Bottom	Formation
0.0	26.0	CLAY RED
26.0	80.0	SH BLUE

Comments MC 894; WELL WAS DEEPENED 6 OVER 200' BY SNAPP

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223919	FM SE OF BLOOMINGTON IN ON SR 45 OF 3 MI ON BREEDER RD	Sep 16, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WARD HARP	STANFORD IN	
Driller	PARRISH & SONS WELL DRILLING	RR #3 SPENCER IN	
Operator	ROBERT PARRISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 56.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 18.0 ft. **Bailer Drawdown** 35.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the SW of the NE of Section 7 **Topo map:** STANFORD
Grant Number:
Field located by: RC **on:** Jul 13, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2400.0
Ground elevation: 690.0 **Depth to bedrock:** 21.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 528373.0 **UTM Northing:** 4323166.0

Well Log

Top	Bottom	Formation
0.0	21.0	RED CLAY SOFT
21.0	55.0	LS HARD
55.0	56.0	BLUE SH HARD

Comments MC 669: OWNER VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223920	ON RD BETWEEN KIRKSVILLE & SR 45 1.5 MI FROM KIRKSVILLE; ORDERED BY ORGERS BUILDING SUPPLY	Nov 14, 1961

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SLOAN	RR9	
Driller	GEORGE SNAPP	RR4, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 26.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** 175.0 ft. **Bailer Drawdown** 167.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the SW of the NW of Section 3 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 21, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 200.0 **Ft S of NL:** 1450.0
Ground elevation: 920.0 **Depth to bedrock:** 26.0 **Bedrock elevation:** 894.0 **Aquifer elevation:**
UTM Easting: 532164.0 **UTM Northing:** 4324995.0

Well Log

Top	Bottom	Formation
0.0	80.0	ORIGINAL WELL
80.0	105.0	SH & CREVIS
105.0	245.0	SLIGHTLY YEL LS

Comments MC 894; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223924	1/2 MI S STANFORD	May 12, 1960

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	T R STONE	STNAFORD	
Driller	ALBERT MARTINDALE	RR #4 BLOOMINGTON	
Operator	ALBERT MARTINDALE	License: null	

Construction Details

Well	**Use:**	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 75.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 68.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 30.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NE of the NE of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: PB **on:** Aug 08, 1962
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1050.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 850.0
Ground elevation: 725.0 **Depth to bedrock:** 68.0 **Bedrock elevation:** 657.0 **Aquifer elevation:**
UTM Easting: 528543.0 **UTM Northing:** 4325185.0

Well Log

Top	Bottom	Formation

Comments NEIGHBOR VERIFIED: 68' OF CASING REST LS:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223925	ABOUT 1 1/2 MI N O F KICKSVILLE ON ROCKPORT RD	Sep 09, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR #5 BEGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX ELLETTSVILLE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 57.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRD **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 645.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 615.0 **Aquifer elevation:**

UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	8.0	RED CLAY
8.0	30.0	RED CLAY & FLINTSTONE
30.0	31.0	STONE GRAY LS HARD
31.0	33.0	RED CLAY
33.0	34.0	STONE GRAY LS HARD
34.0	37.0	YEL SH EX SOFT
37.0	46.0	STONE GRAY LS HARD
46.0	48.0	STONE BLUE LS HARD
48.0	57.0	STONE GRAY LS HARD
57.0	77.0	STONE BUFF LS HARD

77.0	82.0	STONE DARK GRAY LS HARD
82.0	90.0	STONE WH GRAY LS HARD

Comments MC 615: OWNER VERIFIED/ 50' E OF RD: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223929	ABOUT 2 MI S STANFORD LAKE SR 45 TO BREEDEN RD AFTER ENTERING BREEDEN RD 2ND HOUSE ON R ON TOP OF A HILL IT HAT ABOUT 1/4 MI OF PRIVATE DRIVE.	May 07, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	STARNES	R9 BLOOMINGTON IN	
Driller	FREDERICK SCOTT	RR 4 BLOOMINGTON IN	
Operator	FREDERICK SCOTT	License: null	

Construction Details

Well	**Use:** Stock	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 129.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 95.0 ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NW of Section 6 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 750.0 **Ft S of NL:** 550.0
Ground elevation: 810.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 804.0 **Aquifer elevation:**
UTM Easting: 527713.0 **UTM Northing:** 4325310.0

Well Log

Top	Bottom	Formation
0.0	6.0	YEL CLAY
6.0	15.0	STONE BR SS SOFT
15.0	45.5	STONE GRAY SH SOFT
45.5	52.0	STONE BR SS HARD
52.0	75.0	STONE GRAY SH SOFT
75.0	92.0	STONE GRAY LS HARD
92.0	97.0	STONE GRAY LS SOFTER
97.0	121.0	STONE BUFF LS HARD
121.0	129.0	YEL CLAY WATER & GRAV
129.0	154.0	STONE BUFF LS HARD

154.0	163.0	STONE GRAY LS EX HARD
163.0	178.0	STONE WH LS HARD
178.0	185.0	STONE GRAY LS EX HARD

Comments MC 804: NEIFHBOR VARIFIED: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223930	6 MI S BLOOMINGTON ON ROCK PORT RD	Oct 22, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR5, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 88.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.5 gpm for hrs.
Drawdown: ft. **Static water level:** 7.0 ft. **Bailer Drawdown** 75.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 645.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	38.0	ORIGINAL WELL
38.0	88.0	MED HARD WHITE LS

Comments OWNER VER; 50' E OF RD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223934	1 1/2 MI S OF STANFORD	May 24, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	KARL ENGLISH	RR #9	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 220.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 102.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 0.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SE of the NW of the SW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1750.0 **Ft E of WL:** 650.0 **Ft S of NL:**
Ground elevation: 845.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 825.0 **Aquifer elevation:**
UTM Easting: 529087.0 **UTM Northing:** 4324397.0

Well Log

Top	Bottom	Formation
0.0	20.0	SOIL
20.0	100.0	BLUE SH
100.0	220.0	LS HARD

Comments MC 825: OWNER VERIFIED / 50' W OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223935	ABOUT 1 1/2 MI N OF KICKSVILLE ON ROCKPORT RD	Sep 09, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SPEARS	RR #5 BEGTON IN	
Driller	FRED SCOTTS WELL DRILLING	RR 1 BOX ELLETTSVILE IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.5	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** gpm for hrs. **BailTest rate:** 25.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 57.0 ft. **Bailer Drawdown** 90.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W

Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK

Grant Number:

Field located by: JRH **on:** Jul 26, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 2500.0 **Ft N of SL:** 2300.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 645.0 **Depth to bedrock:** 30.0 **Bedrock elevation:** 615.0 **Aquifer elevation:**

UTM Easting: 534538.0 **UTM Northing:** 4324553.0

Well Log

Top	Bottom	Formation
0.0	8.0	RED CLAY
8.0	30.0	RED CLAY & FLINTSTONE
30.0	31.0	STONE GRAY LS HARD
31.0	33.0	RED CLAY
33.0	34.0	STONE GRAY LS HARD
34.0	37.0	YEL SH EX SOFT
37.0	46.0	STONE GRAY LS HARD
46.0	48.0	STONE BLUE LS HARD
48.0	57.0	STONE GRAY LS HARD
57.0	77.0	STONE BUFF LS HARD

77.0	82.0	STONE DARK GRAY LS HARD
82.0	90.0	STONE WH LS HARD

Comments MC 615: OWNER VERIFIED / 50' E OF RD: MC:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223939	2 MI E OF STANDFORD	Sep 30, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RALPH BRIDGES	6999 BURCH RD BLOOMINGTON IN	
Driller	MUMMA DRILLING IN	RR #2 BOX 131 SUNNYSIDE RD WASHINGTON IN	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 83.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 12.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NW of the NW of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 600.0 **Ft S of NL:** 1100.0
Ground elevation: 780.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 768.0 **Aquifer elevation:**
UTM Easting: 529018.0 **UTM Northing:** 4325140.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	75.0	LIME & MUD
75.0	85.0	LIME
85.0	90.0	SOFT SH
90.0	140.0	LIME
140.0	142.0	SH
142.0	190.0	LIME

Comments MC 768: OWNER VERIFIED / 15' S OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223940	8.5 MI S OF BLOOMINGTON, IN ON ROCKPORT RD	Jul 31, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	HAROLD SIMS	RR5, BLOOMINGTON, IN	
Driller	PARRISH WELL DRILLING	RR3, SPENCER, IN	
Operator	ROBERT PARRISH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 109.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 14.0 ft. **Bailer Drawdown** 93.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the SE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2500.0 **Ft N of SL:** 2450.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 655.0 **Depth to bedrock:** 14.0 **Bedrock elevation:** 641.0 **Aquifer elevation:**
UTM Easting: 534550.0 **UTM Northing:** 4324602.0

Well Log

Top	Bottom	Formation
0.0	14.0	BR CLAY
14.0	48.0	BUFF LS
48.0	94.0	WHITE LS
94.0	104.0	GRAY STONE
104.0	109.0	WHITE LS

Comments MC 641; OWNER VER; 60' E OF RD

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223944	ABOUT 2 MI SE OF STANDFORD ON EVANS RD	Apr 24, 1971

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DON LANE	RR 9 BLOOMINGTON IN	
Driller	FRED SCOTT	RR 13 BOX 452 BLOOMINGTON IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 160.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** 85.0 ft. **Bailer Drawdown** 160.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NW of the NE of Section 5 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 200.0
Ground elevation: 880.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 868.0 **Aquifer elevation:**
UTM Easting: 530047.0 **UTM Northing:** 4325406.0

Well Log

Top	Bottom	Formation
0.0	12.0	YEL CLAY
12.0	25.0	STONE BR SS SOFT
25.0	38.0	STONE BLUE SH SOFT
38.0	52.0	STONE GRAY LS EX HARD
52.0	118.0	STONE CREAM LS EX HARD
118.0	124.0	STONE GRAY LS HARD
124.0	138.0	STONE GRAY LS EX HARD
138.0	148.0	STONE CREAM LS EX HARD
148.0	160.0	STONE YELLWISH LS EX HARD

Comments MC 868: OWNER VERIFIED / 5' S OF HOUSE:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223945	ON KOONTZ RD ABOUT 1 BLOCK E OF ROCK PAST RD 7M S BLOOMINGTON IN	Jun 16, 1978

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MARK A MAHRENHOLTZ	5221 W KOONTZ RD	
Driller	GEORGE SNAPP	4625 S STANSIFER LANE BLGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 36.0	**Material:**	**Diameter:**
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 50.0 ft. **Bailer Drawdown** 55.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NW of the NW of the NE of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: PES **on:** Jul 02, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2375.0 **Ft S of NL:** 150.0
Ground elevation: 760.0 **Depth to bedrock:** 34.0 **Bedrock elevation:** 726.0 **Aquifer elevation:**
UTM Easting: 534590.0 **UTM Northing:** 4325376.0

Well Log

Top	Bottom	Formation
0.0	34.0	TOP SOIL
34.0	110.0	LS

Comments MC 726: VERIFIED BY NEIGHBOR & MAILBOX:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223950	TAKE ROCKPORT RD OFF HWY 378 GO TILL YOU PASS KOONTZ RD GO TO NUDEST CAMP AND THEN 1ST DRIVE ON RIGHT	Aug 25, 1987

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MATT JOHNSON	7330 ROCKPORT RD., BLOOMINGTON, IN	
Driller	FRED SCOTT'S WELL DRILLING	6236 W. COWDEN RD., ELLETTSVILLE, IN	(000) 876-1055

Construction Details

Well	**Use:** Home	**Drilling method:** Other	**Pump type:**
	Depth: 245.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Pumping **Test rate:** 0.9 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 245.0 ft. **Static water level:** 100.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the NE of the SW of Section 2 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JA **on:** Nov 10, 1988
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1600.0 **Ft E of WL:** 1700.0 **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**
UTM Easting: 534200.0 **UTM Northing:** 4324375.0

Well Log

Top	Bottom	Formation
0.0	3.0	YEL CLAY
3.0	28.0	RED CLAY
28.0	29.0	SHALE YEL
29.0	32.0	GRAY LS
32.0	38.0	BLUE SHALE
38.0	48.0	BLUE LS
48.0	56.0	GRAY LS
56.0	58.0	BLUE SHALE
58.0	126.0	GRAY LS

126.0	155.0	BUFF LS
155.0	175.0	BLUE LS
175.0	195.0	GRAY LS
195.0	201.0	BLUE LS
201.0	226.0	GRAY LS
226.0	230.0	BLUE LS
230.0	239.0	GRAY LS
239.0	245.0	BLUE SOAPSTONE

Comments MC632; SEE MAP; VERIFIED BY MAILBOX

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223955	ON LODGE RD ABOUT .5 WAY BETWEEN ROCK PORT & VICTOR PIKE ON N SIDE ABOUT 5 MI SE BLOOMINGTON, IN	Aug 08, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CRANDELL	RR5, BLOOMINGTON, IN	
Driller	GEORGE SNAPP	RR5, BOX 86, BLOOMINGTON, IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 28.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 73.0 ft. **Bailer Drawdown** 60.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: SW of the SE of the NW of Section 1 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 26, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1550.0 **Ft S of NL:** 2200.0
Ground elevation: 710.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 682.0 **Aquifer elevation:**
UTM Easting: 535716.0 **UTM Northing:** 4324713.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOPSOIL & LAYERS LS
28.0	140.0	VARIOUS COLOR LS

Comments MC 682; NEIGHBOR VER

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223960	VICTOR RD BLOOMINGTON IN NEAR QUARRY FOR DRINKING WATER SW OF BLOOMINGTON	Nov 30, 1959

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BLOOM LIME ST CO	BLOOMINGTON IN VICTOR RD	
Driller	ALBERT LENTZ	SMITHVILLE IN	
Operator	BUYRIC ERIE	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:**	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 18.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 2W
Section: NE of the NE of the SE of Section 1 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: MT **on:** Jul 14, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 400.0 **Ft N of SL:** 2200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 710.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 692.0 **Aquifer elevation:**
UTM Easting: 536800.0 **UTM Northing:** 4324520.0

Well Log

Top	Bottom	Formation
0.0	18.0	BLANK
18.0		LS

Comments EMPLOYEE VERIFIED:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
223980	ON VICTOR PIKE S BLOOMINGTON IN LSAT HOUSE ON RIGHT	Nov 24, 1976

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT BAKER	RR 5 BLOOMINGTON IN	
Driller	GEORGE H SNAPP	BLOOMINGTON IN RR5 BOX 86	
Operator	GEORGE H SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 7.5	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 40.0 ft. **Bailer Drawdown** 160.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: MONROE **Township:** 7N **Range:** 1W
Section: NW of the NW of the NW of Section 6 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: JRD **on:** Jul 25, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 0.0 **Ft S of NL:** 550.0
Ground elevation: 675.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 669.0 **Aquifer elevation:**
UTM Easting: 536930.0 **UTM Northing:** 4325159.0

Well Log

Top	Bottom	Formation
0.0	6.0	RED CLAY
6.0	130.0	HARD WH LS
130.0	200.0	MED HARD LS

Comments MC 669:WATER BETWEEN 50 - 55:

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
30683	ABOUT .50 MI OF SR 45 ON SOLSBERRY RD ON RT SIDE	Sep 25, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GARY COVEY	R R 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	R R 5 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 50.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 22.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 15.0 gpm for hrs.
Drawdown: ft. **Static water level:** 20.0 ft. **Bailer Drawdown** 20.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: NW of the SW of the NE of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1700.0
Ground elevation: 750.0 **Depth to bedrock:** 22.0 **Bedrock elevation:** 728.0 **Aquifer elevation:**
UTM Easting: 526798.0 **UTM Northing:** 4326558.0

Well Log

Top	Bottom	Formation
0.0	22.0	TOP SOIL & SHALE
22.0	32.0	SHALE
32.0	50.0	HARD WHITE LS

Comments NEIGHBOR VERIFIED, 20' N OF NW CORNER; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
30684	ABOUT .50 MI OFF SR 45 ON SOLSBERRY RD ON RT SIDE	Nov 14, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAY FOWLER	R R 5 BLOOMINGTON IN	
Driller	GEORGE SNAPP	R R 5 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 100.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 14.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.0 gpm for hrs.
Drawdown: ft. **Static water level:** 35.0 ft. **Bailer Drawdown** 63.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 8N **Range:** 3W
Section: NE of the SW of the NE of Section 36 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 20, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1850.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1950.0
Ground elevation: 780.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 770.0 **Aquifer elevation:**
UTM Easting: 526881.0 **UTM Northing:** 4326476.0

Well Log

Top	Bottom	Formation
0.0	10.0	YELL SANDY SOIL
10.0	45.0	SS
45.0	75.0	HARD GRAY LS
75.0	100.0	SS

Comments OWNER VERIFIED, 25' N OF NW CORNER; MV

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34733	NE CORNER OF SW .25 OF SW .25 OF SEC 1, RUNNING S, 78 RD NW 47 RODS TO BLOOMINGTON & BLOOMFIELD RD 45, 10.2 MI SW HWY 45 OF BLOOMINGTON IN DR-WAY	Apr 18, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RUSSELL WAYNE WORKMAN	R 1 SOLSBERRY IN	
Driller	HAROLD JACKSON		
Operator	HAROLD JACKSON	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 140.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:**	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: 40.0 ft. **Static water level:** ft. **Bailer Drawdown** 100.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NE of the SW of the SW of Section 1 **Topo map:** STANFORD
Grant Number:
Field located by: RJS **on:** Jan 28, 1964
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1000.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 885.0 **Depth to bedrock:** 7.0 **Bedrock elevation:** 878.0 **Aquifer elevation:**
UTM Easting: 526250.0 **UTM Northing:** 4324125.0

Well Log

Top	Bottom	Formation
0.0	7.0	CLAY
7.0	100.0	BRN SS
100.0	125.0	RED SHALE
125.0	140.0	SANDY LIME YELL

Comments MC 885

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34738	AOBUT 5 MI S OF STANFORD, TAKE BREEDEN RD OFF HWY 45 TO CARTER RD, TURN GO ABOUT 1.5 MI, A LOG HOUSE ON LF	Apr 19, 1979

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JADE BUTCHER	8119 W RATLIFF RD BLOOMINGTON IN	
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 305.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 43.6	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 7.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: 305.0 ft. **Static water level:** 112.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NW of the SE of the SE of Section 13 **Topo map:** STANFORD
Grant Number:
Field located by: PES **on:** Jul 03, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 700.0 **Ft N of SL:** 1250.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 8.0 **Bedrock elevation:** 772.0 **Aquifer elevation:**
UTM Easting: 527289.0 **UTM Northing:** 4321068.0

Well Log

Top	Bottom	Formation
0.0	8.0	YELL CLAY
8.0	45.0	S YELL SS HARD
45.0	52.0	S BLUE SOAPSTONE HARD
52.0	65.0	S YELL SS HARD
65.0	70.0	S BLUE SPST HARD
70.0	75.0	S GRAY SS HARD
75.0	77.0	S BLUE SHALE SOFTER
77.0	85.0	S YELL SS HARD

85.0	145.0	S BLUE SPST HARD
145.0	147.0	S GRAY LS HARD
147.0	148.0	S BLUE SHALE SOFTER
148.0	165.0	S GRAY LS HARD
165.0	166.0	S BLUE SHALE SOFTER
166.0	175.0	S GRAY LS HARD
175.0	195.0	S GRAY LS EX HARD
195.0	196.0	S BLUE GREEN SHALE SOFTER
196.0	209.5	S GRAY LS EX HARD
209.5	210.0	S BLUE SHALE SOFTER
210.0	218.0	S DK GRAY LS HARD
218.0	219.0	S BLUE SHALE SOFTER
219.0	235.0	S GRAY LS HARD
235.0	249.0	S DK GRAY LS HARD
249.0	250.0	S BLUE SHALE SOFTER
250.0	272.0	S GRAY LS EX HARD
272.0	285.0	S BLUE LS HARD
285.0	305.0	S GRAY LS EX HARD

Comments VERIFIED BY OWNER, WELL WAS WITCHED; FC-MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34754	NE OF LITTLE CINCINNATI ABOUT 3 MI, TAKE HWY 45 TO 1ST RD TO LF, TURN GO 1.5 MI, NEW HOUSE ON LF	Oct 11, 1973

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GARRY HESHELMAN		
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 51.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 70.0 ft. **Bailer Drawdown** 170.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SW of the NW of the SW of Section 24 **Topo map:** STANFORD
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 1650.0 **Ft E of WL:** 250.0 **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 689.0 **Aquifer elevation:**
UTM Easting: 526010.0 **UTM Northing:** 4319561.0

Well Log

Top	Bottom	Formation
0.0	6.0	YELL CLAY
6.0	8.0	STONE YELL SS HARD
8.0	29.0	S YELL SHALE EX SOFT
29.0	47.0	S BLUE SHALE EX SOFT
47.0	55.0	S YELL SS HARD
55.0	78.0	S GRAY LS HARD
78.0	88.0	S BLUE LS HARD
88.0	105.0	S GRAY LS HARD
105.0	132.0	S WHITE LS HARD
132.0	150.0	S GRAY LS HARD
150.0	170.0	S YELL LS HARD

Comments OWNER VERIFIED, 40' NE OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34755	2 MI NE OF HOBBIEVILLE IN, ON INDIAN CREEK RD	Jun 02, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H B TURNER	BLOOMFIELD IN	
Driller	HOWELL DRILLING CO	SWITZ CITY IN	
Operator	S L HOWELL	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 64.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 33.6	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for 2.0 hrs.

Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W

Section: SE of the NE of the SE of Section 25 **Topo map:** STANFORD

Grant Number:

Field located by: RLB **on:** Aug 08, 1962

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 300.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 630.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 624.0 **Aquifer elevation:**

UTM Easting: 527425.0 **UTM Northing:** 4317875.0

Well Log

Top	Bottom	Formation
0.0	6.0	SAND
6.0	33.0	FRACTURED LS & SS
33.0	35.0	LS & GRAY, BLUE
35.0	37.0	LIME SHALE
37.0	64.0	GRAY LS

Comments

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34756	ABOUT 2 MI E & N OF HOBBYVILLE, 1 MI N OF 190S ON E SIDE OF 1375E	Jan 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JERRY SIRUCEK	R R 5 BOX 342 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 42.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 10.0 gpm for hrs.
Drawdown: ft. **Static water level:** 8.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SW of the SE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: **on:**
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1350.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 635.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 625.0 **Aquifer elevation:**
UTM Easting: 527107.0 **UTM Northing:** 4317495.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	30.0	LIME
30.0	38.0	LIME & MUDDY SAND
38.0	60.0	LIME
60.0	61.0	DK GRAY SHALE
61.0	72.0	LIME
72.0	100.0	LIME & DOMITE
100.0	130.0	LIME & DIRTY SEAMS

Comments OWNER VERIFIED, 25' N OF HOUSE; PH 8, IRON .1, HARDNESS 10 GRAINS; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34768	HOBBYVILLE IN, E .25 MI	Jun 11, 1968

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	GENE NORRIS	R R 1 SPRINGVILLE IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 261.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 245.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the NW of the SE of Section 35 **Topo map:** OWENSBURG
Grant Number:
Field located by: PW **on:** Aug 19, 1971
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** 1500.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 780.0 **Depth to bedrock:** 17.0 **Bedrock elevation:** 763.0 **Aquifer elevation:**
UTM Easting: 525335.0 **UTM Northing:** 4316325.0

Well Log

Top	Bottom	Formation
0.0	17.0	CLAY
17.0	26.0	LIME
26.0	57.0	GREEN SHALE & RED ROCK
57.0	67.0	SANDROCK
67.0	90.0	GREEN, GRAY SHALE & BRK OF LIM
90.0	137.0	DK GRAY SHALE & BRK OF LIME
137.0	150.0	SANDROCK
150.0	160.0	BRK OF LIME & SOFT SHALE
160.0	261.0	LIME, WATER

Comments VERIFIED BY NEIGHBOR; PH 7.7, IRON .2, HARDNESS 11 GRAINS; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34769	NEAR BLK TOP RD, E OF HOBBIESVILLE	Nov 04, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CARL L & MAYME B MITCHELL	R R 1 SPRINGVILLE IN	
Driller	FRED SMITH	R R 1 HELTONVILLE IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 130.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 51.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 1.5 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 52.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SW of the SW of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: PW **on:** Aug 19, 1971
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 500.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 660.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 642.0 **Aquifer elevation:**
UTM Easting: 526250.0 **UTM Northing:** 4315930.0

Well Log

Top	Bottom	Formation
0.0	18.0	SOIL
18.0	49.0	BLK SHALE
49.0	130.0	LS HARD, WATER

Comments VERIFIED BY OWNER; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
34770	ROCKPORT RD TO KIRKSVILLE THEN 1ST RD W OF KIRKSVILLE AND GO WITHIN 1 MI OF SR 54	Oct 08, 1974

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RICHARD DECKARD	R R 1 SPRINGVILLE IN	
Driller	GEORGE SNAPP	R R 5 BOX 86 BLOOMINGTON IN	
Operator	GEORGE SNAPP	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 150.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 29.0	**Material:**	**Diameter:** 5.63
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 5.0 gpm for hrs.
Drawdown: ft. **Static water level:** 60.0 ft. **Bailer Drawdown** 80.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: NE of the SW of the SW of Section 36 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 800.0 **Ft E of WL:** 1100.0 **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 28.0 **Bedrock elevation:** 652.0 **Aquifer elevation:**
UTM Easting: 526232.0 **UTM Northing:** 4316081.0

Well Log

Top	Bottom	Formation
0.0	28.0	TOP SOIL
28.0	40.0	SHALE
40.0	150.0	LS

Comments OWNER VERIFIED, 25' W OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
383062		May 15, 2003

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BOB STURGIS	BLOOMINGTON, IN	
Driller	MUMMA BROS	RR1 BOX 85 LYONS, IN	(812) 659-2280
Operator	DAVE MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 155.0	**Pump setting depth:** 0.0	**Water quality:** CLEAR
Casing	**Length:** 40.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:** 120.0	**Material:** PVC LINER	**Diameter:** 4.0 **Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 10.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: 155.0 ft. **Static water level:** 41.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: BNSL **Depth:** from 0.0 to 40.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from 0 to 0
Installation Method: **Number of bags used:** 0.0

Administrative

County: MONROE **Township:** 8N **Range:** 1W
Section: NW of the SE of the NW of Section 31 **Topo map:** CLEAR CREEK
Grant Number:
Field located by: DRILLER **on:** Oct 29, 2004
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1750.0 **Ft S of NL:** 2075.0
Ground elevation: 670.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 664.0 **Aquifer elevation:**
UTM Easting: 537451.0 **UTM Northing:** 4326349.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	58.0	LIMESTONE
58.0	63.0	DARK SHALE
63.0	80.0	LIMESTONE
80.0	88.0	SANDY SHALE AND QURTZ
88.0	117.0	GREY LIMESTONE
117.0	120.0	DARK SHALE
120.0	155.0	GREY SANDY SHALE

Comments MC 664; SEE MAP; DATUM NAD27, SOURCE GPS;

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40740	.50 MI W OF KOLEEN AND 4 MI E OF MINERAL ON THE MINERAL & KOLEEN RD	Aug 05, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	ROBERT SLADCIK	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the SW of the NE of Section 10 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1700.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1900.0
Ground elevation: 535.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 497.0 **Aquifer elevation:**
UTM Easting: 514078.0 **UTM Northing:** 4313409.0

Well Log

Top	Bottom	Formation
0.0	38.0	MUD
38.0	70.0	SANDROCK

Comments MC; OWNER VERIFIED, 20' S OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40741	1 MI W OF KOLEEN	Aug 13, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WINFRED BAKER	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 110.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 100.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 75.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NE of the NW of Section 10 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2450.0 **Ft S of NL:** 550.0
Ground elevation: 525.0 **Depth to bedrock:** 65.0 **Bedrock elevation:** 460.0 **Aquifer elevation:**
UTM Easting: 513783.0 **UTM Northing:** 4313840.0

Well Log

Top	Bottom	Formation
0.0	65.0	CLAY & MUD
65.0	98.0	SOFT & GREEN SHALE, REDROCK
98.0	104.0	LIME
104.0	106.0	GREEN SHALE
106.0	110.0	LIME, WATER

Comments MC, NEIGHBOR VERIFIED, PH 8.5, IRON .5, HARDNESS 2 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40742	IN COLEEN IN	Oct 09, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	TOMMY PITCHER	COLEEN IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 115.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 15.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 70.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the SW of the NW of Section 11 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 850.0 **Ft S of NL:** 1600.0
Ground elevation: 565.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 553.0 **Aquifer elevation:**
UTM Easting: 514894.0 **UTM Northing:** 4313516.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	12.0	SANDROCK & SEAMS
12.0	39.0	SANDROCK
39.0	43.0	BRK LIME LOOSE
43.0	63.0	LIME
63.0	88.0	RED ROCK, GREEN & GRAY SHALE
88.0	115.0	SANDROCK, WATER

Comments MC; OWNER VERIFIED, 15' NE OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40743		Apr 21, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	LESTER FLYNN	KOLEEN IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 55.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 33.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test	**Type of test:**	**Test rate:** gpm for hrs.	**BailTest rate:** 45.0 gpm for 0.5 hrs.
	Drawdown: ft.	**Static water level:** ft.	**Bailer Drawdown** ft.

Grouting Information	**Material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Well Abandonment	**Sealing material:**	**Depth:** from to
	Installation Method:	**Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: NW of the SW of the NW of Section 11 **Topo map:** KOLEEN

Grant Number:

Field located by: JRD **on:** Jul 18, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** **Ft E of WL:** 100.0 **Ft S of NL:** 1800.0

Ground elevation: 525.0 **Depth to bedrock:** 32.0 **Bedrock elevation:** 493.0 **Aquifer elevation:**

UTM Easting: 514659.0 **UTM Northing:** 4313467.0

Well Log

Top	Bottom	Formation
0.0	32.0	CLAY & MUD
32.0	55.0	SANDROCK, WATER

Comments OWNER VERIFIED, NE OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40744	ABOUT 1.5 MI S OF KOLEEN, 1ST DR ON LF AFTER CROSSING BRIDGE	Jul 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DON COMBS	217 CARLISLE TERR MANHATTAN KS	
Driller	FRED SCOTTS WELL DRILLING	R R 1 BOX 252B ELLETTSVILLE IN 47429	(000) 876-1055
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 170.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 148.5	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 30.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** 145.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: SW of the NE of the SW of Section 11 **Topo map:** KOLEEN

Grant Number:

Field located by: JRD **on:** Jul 18, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: **Ft N of SL:** 1400.0 **Ft E of WL:** 1800.0 **Ft S of NL:**

Ground elevation: 650.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 632.0 **Aquifer elevation:**

UTM Easting: 515207.0 **UTM Northing:** 4312812.0

Well Log

Top	Bottom	Formation
0.0	14.0	YELL CLAY
14.0	18.0	RED CLAY
18.0	27.0	STONE YELL SS SOFT
27.0	36.0	S BRN SS SOFT
36.0	62.0	S YELL SS SOFT
62.0	69.0	S REDDISH SS SOFT
69.0	75.0	S BRN SS SOFT

75.0	132.0	S YELL SS SOFT
132.0	144.0	S YELL SEAM WITH MUD
144.0	170.0	S YELL SS SOFT

Comments MC, NEIGHBOR VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40746	3 MI E OF KOLEEN	Nov 08, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WALTER SMITH	R R 3 BLOOMFIELD IN 47424	
Driller	MUMMA DRILLING INC	R R 2 BOX 131 SUNNYSIDE RD WASHINGTON IN 47501	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 85.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 70.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 30.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SE of the SW of the NE of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: PES **on:** Jul 31, 1980
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1350.0 **Ft N of SL:** 3200.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 550.0 **Depth to bedrock:** 25.0 **Bedrock elevation:** 525.0 **Aquifer elevation:**
UTM Easting: 517400.0 **UTM Northing:** 4313350.0

Well Log

Top	Bottom	Formation
0.0	25.0	CLAY
25.0	55.0	SANDROCK
55.0	56.0	BRK SANDROCK, WATER BAD, IRON
56.0	66.0	SANDROCK
66.0	67.0	SANDROCK, WATER BAD, IRON
67.0	72.0	SANDY SHALE
72.0	85.0	WATER

Comments MC 525, VERIFIED BY NEIGHBOR

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40747	1 MI E OF KOLEEN IN	Apr 26, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	MRS. CHAS CUMMINGS	KOLEEN IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	DEAN & NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 71.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test **Type of test:** **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 2.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information **Material:** **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment **Sealing material:** **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SW of the SE of the NW of Section 12 **Topo map:** KOLEEN
Grant Number:
Field located by: U **on:** Mar 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1700.0 **Ft S of NL:** 2300.0
Ground elevation: 540.0 **Depth to bedrock:** 38.0 **Bedrock elevation:** 502.0 **Aquifer elevation:**
UTM Easting: 516525.0 **UTM Northing:** 4313250.0

Well Log

Top	Bottom	Formation
0.0	38.0	CLAY MUD
38.0	42.0	SANDROCK, WATER
42.0	50.0	GREEN SHALE
50.0	52.0	SANDROCK
52.0	68.0	SANDY SHALE, BRK SANDROCK
68.0	71.0	BRN LIME

Comments PH 7.5 NON ACID SIDE, IRON LESS THAN .5 PPM, HARDNESS 7 GRAINS; MC 502

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40749	E OF KOLEEN ABOUT 3 MI	Apr 23, 1962

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RAYMOND BAKER	KOLEEN IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	NORMAN & DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 94.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 38.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: SE of the NE of the NE of Section 13 **Topo map:** KOLEEN
Grant Number:
Field located by: U **on:** Mar 01, 1963
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 500.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1000.0
Ground elevation: 560.0 **Depth to bedrock:** 42.0 **Bedrock elevation:** 518.0 **Aquifer elevation:**
UTM Easting: 517650.0 **UTM Northing:** 4312075.0

Well Log

Top	Bottom	Formation
0.0	42.0	CLAY MUD
42.0	45.0	SANDROCK
45.0	67.0	GREEN SHALE, BRK SANDROCK SOFT
67.0	94.0	SANDROCK, WATER

Comments PH 7.5 NON ACID, IRON LESS THAN .5 PPM, HARDNESS 7 GRAINS; MC 548

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40750	2.5 MI S OF KOLEEN	Apr 19, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BURTON H CALKINS	3742 W MONTROSE AVE CHICAGO IL	
Driller	MUMMA BROS DRILLING CO	LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 70.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 47.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 60.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 25.0 ft. **Bailer Drawdown** 50.0 ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W

Section: NE of the SE of the SE of Section 15 **Topo map:** KOLEEN

Grant Number:

Field located by: MT **on:** Jul 06, 1967

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 400.0 **Ft N of SL:** 1200.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 565.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 555.0 **Aquifer elevation:**

UTM Easting: 514495.0 **UTM Northing:** 4311163.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	47.0	SANDROCK, MUD SEAMS, SOFT SHAL
47.0	70.0	YELL SANDROCK, WATER

Comments OWNER VERIFIED, PH 7.7, IRON .2 PPM, HARDNESS 9 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40751	2.25 MI N OF DOANS	Jul 16, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CHEMMA WERNER	R R 3 BOX 220 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 240.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 104.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 6.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NW of the NE of the SE of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 2550.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 720.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 708.0 **Aquifer elevation:**
UTM Easting: 512745.0 **UTM Northing:** 4311564.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	25.0	SANDROCK
25.0	35.0	COAL & FIRECLAY
35.0	100.0	BLUE SHALE & SANDROCK
100.0	101.0	LIME
101.0	102.0	GREEN SHALE
102.0	106.0	SANDROCK
106.0	107.0	GREEN SHALE
107.0	123.0	LIME

123.0	140.0	RED ROCK
140.0	175.0	DK GRAY SHALE
175.0	180.0	LIME
180.0	182.0	DK GRAY SHALE
182.0	215.0	SANDROCK
215.0	240.0	SHALE

Comments MC, NEIGHBOR & MAILBOX VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40752	W OF OWENSBURG, ON TAYLOR RIDGE RD, THERE IS NO RD MARKING FOR THE RD, 475E ?	May 24, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	WM CUTSHALL	5527 BROADWAY INDPLS IN	
Driller	FRED SCOTT	R 1 ELLETTSVILLE IN	
Operator	FRED SCOTT	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 220.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 23.5	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 220.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NW of the NE of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 18, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1400.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 250.0
Ground elevation: 695.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 683.0 **Aquifer elevation:**
UTM Easting: 512599.0 **UTM Northing:** 4312330.0

Well Log

Top	Bottom	Formation
0.0	12.0	YELL CLAY
12.0	19.0	STONE YELL SS HARD
19.0	27.0	S BRN SS HARD, COAL
27.0	30.0	S YELL SS HARD
30.0	155.0	S BLUE SHALE HARD
155.0	170.0	S GRAY LS HARD
170.0	177.0	S BLUE SHALE HARD
177.0	207.0	S GRAY LS HARD
207.0	209.0	S BLUE SHALE HARD
209.0	220.0	S GRAY LS HARD

Comments MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40758	E OF HOBBYVILLE 2 MI ON SR 54	Jul 17, 1969

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DAVE ROLLINS	400 PERRACE DR #19 BLOOMINGTON IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 90.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 27.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the SE of Section 2 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1150.0 **Ft N of SL:** 900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 620.0 **Depth to bedrock:** 16.0 **Bedrock elevation:** 604.0 **Aquifer elevation:**
UTM Easting: 525525.0 **UTM Northing:** 4314379.0

Well Log

Top	Bottom	Formation
0.0	16.0	CLAY
16.0	22.0	LIME & SOFT SHALE
22.0	70.0	LIME
70.0	90.0	BRK IN LIME, WATER

Comments MC; OWNER VERIFIED, 25' N OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40759	ABOUT 1.5 MI E OF JCT 54 & 45	Oct 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JAMES ROY BOX	R R 1 SPRINGVILLE IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 126.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 39.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 55.0 gpm for 1.0 hrs.

Drawdown: ft. **Static water level:** 45.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to

Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to

Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W

Section: NE of the SE of the SE of Section 2 **Topo map:** OWENSBURG

Grant Number:

Field located by: JRD **on:** Aug 01, 1978

Courthouse location by: **on:**

Location accepted w/o verification by: **on:**

Subdivision name: **Lot number:**

Ft W of EL: 300.0 **Ft N of SL:** 800.0 **Ft E of WL:** **Ft S of NL:**

Ground elevation: 635.0 **Depth to bedrock:** 36.0 **Bedrock elevation:** 599.0 **Aquifer elevation:**

UTM Easting: 525782.0 **UTM Northing:** 4314340.0

Well Log

Top	Bottom	Formation
0.0	36.0	CLAY
36.0	85.0	LIME
85.0	95.0	LIME, BRKS, WATER
95.0	115.0	LIME, BRKS, WATER
115.0	126.0	LIME

Comments OWNER VERIFIED, 25' W OF HOUSE; MC; PH 7.8, IRON .5, HARDNESS 22 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40760	APPROX 3.5 MI N OF JCT 45 & 58 ON SR 45 NEAR OWENSBURG IN., .50 MI W ON CR, SPRINGHILL FARMS	Nov 22, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JACK TAYLOR		
Driller	S & M DRILLING INC	R R 1 MONTGOMERY & BOX 67 LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 325.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 96.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 20.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the SE of the SW of Section 4 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2650.0 **Ft N of SL:** 100.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 735.0 **Depth to bedrock:** 9.0 **Bedrock elevation:** 726.0 **Aquifer elevation:**
UTM Easting: 521869.0 **UTM Northing:** 4314098.0

Well Log

Top	Bottom	Formation
0.0	9.0	CLAY
9.0	35.0	SANDROCK, BRN
35.0	55.0	LS, ULTRA HARD
55.0	59.0	SOFT SHALE & MUD SEAM, GRAY
59.0	75.0	GREEN SHALE & REDROCK
75.0	84.0	BRN SANDROCK
84.0	94.0	GRAY SHALE & SANDY SHALE
94.0	124.0	SANDROCK, WATER
124.0	145.0	DK SHALE

145.0	187.0	SANDROCK
187.0	197.0	LS
197.0	204.0	SANDROCK & SANDY SHALE
204.0	212.0	LIME & GREEN SHALE, LITE
212.0	299.0	LS
299.0	325.0	LS & CRACK, WATER

Comments MC, NEIGHBOR & SIGN VERIFIED, PH 8.0, HARDNESS 11, IRON LOW

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40761	3 MI E OF KOLEEN	Nov 09, 1977

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	RONNIE CRAIG	R R 3 BLOOMFIELD IN 47424	
Driller	MUMMA DRILLING INC	R R 2 BOX 131 SUNNYSIDE RD WASHINGTON IN 47501	
Operator	NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Other	**Drilling method:** Rotary	**Pump type:**
	Depth: 190.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 40.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SW of the SW of the NW of Section 7 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 250.0 **Ft S of NL:** 2500.0
Ground elevation: 565.0 **Depth to bedrock:** 40.0 **Bedrock elevation:** 525.0 **Aquifer elevation:**
UTM Easting: 517913.0 **UTM Northing:** 4313237.0

Well Log

Top	Bottom	Formation
0.0	25.0	CLAY
25.0	40.0	MUD SEAMS
40.0	50.0	SANDROCK
50.0	80.0	SHALE
80.0	98.0	SANDY SHALE
98.0	130.0	LIME
130.0	132.0	SHALE
132.0	165.0	LIME
165.0	166.0	SHALE
166.0	190.0	LIME

Comments MC, NEIGHBOR & MAILBOX VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40762	2.5 MI S OF JCT 45 & 54, ABOUT 1.5 MI W, CLIFTY MEMORIAL ASSOC., AT EDGE OF WOODS 100' W OF CK, HOUSE JUST E OF CREEK, HILL BEHIND CHURCH	Aug 06, 1965

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	CLIFTY MEMORIAL ASSOCATION		
Driller	MUMMA BROS DRILLING CO	LYONS IN	
Operator	DEAN K MUMMA	License: null	

Construction Details

Well	**Use:** Public Supply	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 8.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** 138.0 ft. **Bailer Drawdown** 190.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the NE of the NE of Section 8 **Topo map:** KOLEEN
Grant Number:
Field located by: MT **on:** Jul 06, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 1200.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 100.0
Ground elevation: 635.0 **Depth to bedrock:** 15.0 **Bedrock elevation:** 620.0 **Aquifer elevation:**
UTM Easting: 520684.0 **UTM Northing:** 4313993.0

Well Log

Top	Bottom	Formation
0.0	8.0	CLAY
8.0	15.0	MUD
15.0	35.0	SANDROCK, BAD WATER
35.0	58.0	BLUE SHALE
58.0	90.0	GRAY SANDROCK
90.0	140.0	LIME, BRK, WATER
140.0	200.0	LIME, WATER

Comments VERIFIED BY NEIGHBOR, PH 7.8, IRON .1, HARDNESS 13 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40763	FROM BLOOMINGTON COME W OUT ON 54 TO 45 PAST FIRE TOWER TO 3RD STONE RD, WRIGHT RD, TURN LF 6TH HOUSE ON LF	Mar 01, 1977

Owner-Contractor	Name	Address	Telephone
Owner	AUDREY BENNETT	R R 1 SPRINGVILLE IN	
Driller	PHILLIPS WELL DRILLING	R 1 BOX 305 SPRINGVILLE IN	
Operator	JUNIOR PHILLIPS	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 157.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 30.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter:** **Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 107.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the SE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 800.0 **Ft N of SL:** 1000.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 695.0 **Depth to bedrock:** **Bedrock elevation:** **Aquifer elevation:**
UTM Easting: 524025.0 **UTM Northing:** 4312780.0

Well Log

Top	Bottom	Formation

Comments FATHER VERIFIED, 25' N OF HOUSE; MC

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40764	5 MI N OF OWENSBURG, 3 MI W OF BETHEL CHRISTIAN CHURCH, WRIGHT RD	May 20, 1967

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	VINCE JACKSON	SPRINGVILLE IN	
Driller	LOUIE O SMITH	R 1 BEDFORD IN	
Operator	LOUIE O SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 120.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 21.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for 1.0 hrs.
Drawdown: ft. **Static water level:** 90.0 ft. **Bailer Drawdown** 115.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SW of the SE of Section 10 **Topo map:** OWENSBURG
Grant Number:
Field located by: JRD **on:** Aug 01, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2050.0 **Ft N of SL:** 700.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 680.0 **Depth to bedrock:** 10.0 **Bedrock elevation:** 670.0 **Aquifer elevation:**
UTM Easting: 523650.0 **UTM Northing:** 4312709.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	68.0	SS
68.0	75.0	BLUE SS
75.0	125.0	HARD SS

Comments MC; OWNER VERIFIED, 15' W OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40765	1.25 MI S OF VILLAGE HOBBIEVILLE IN	Apr 10, 1963

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	SAMUEL F LYNN	R R 1 SPRINGVILLE IN	
Driller	HAROLD JACKSON		
Operator	HAROLD JACKSON	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 162.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 35.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 2.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** 110.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SE of the NW of the NW of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: RJS **on:** Jan 29, 1964
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** 4100.0 **Ft E of WL:** 1200.0 **Ft S of NL:**
Ground elevation: 825.0 **Depth to bedrock:** 5.0 **Bedrock elevation:** 820.0 **Aquifer elevation:**
UTM Easting: 524635.0 **UTM Northing:** 4313725.0

Well Log

Top	Bottom	Formation
0.0	5.0	CLAY
5.0	110.0	BRN SS
110.0	135.0	RED SHALE
135.0	162.0	BLUE LS

Comments MC 820

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40766	1.5 MI S OF HOBBYVILLE BY THE BETHEL CHRISTAIN CHURCH	Sep 30, 1964

Owner-Contractor	Name	Address	Telephone
Owner	GUY KEISTER	PLAINFIELD IN	
Driller	MUMMA BROS DRILLING CO	LYONS & WASHINGTON IN	
Operator	DEAN & NORMAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Cable Tool	**Pump type:**
	Depth: 260.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 79.0	**Material:**	**Diameter:** 7.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 4.0 gpm for 1.5 hrs.
Drawdown: ft. **Static water level:** 195.0 ft. **Bailer Drawdown** 260.0 ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: SW of the NW of the SE of Section 11 **Topo map:** OWENSBURG
Grant Number:
Field located by: MT **on:** Jul 06, 1967
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2300.0 **Ft N of SL:** 1900.0 **Ft E of WL:** **Ft S of NL:**
Ground elevation: 770.0 **Depth to bedrock:** 6.0 **Bedrock elevation:** 764.0 **Aquifer elevation:**
UTM Easting: 525158.0 **UTM Northing:** 4313120.0

Well Log

Top	Bottom	Formation
0.0	6.0	CLAY
6.0	39.0	SANDROCK & MUD SEAMS
39.0	52.0	LIME
52.0	57.0	MUD SEAMS
57.0	79.0	SOFT SHALE
79.0	90.0	SANDROCK, SANDY SHALE
90.0	100.0	GREEN SHALE
100.0	106.0	RED ROCK
106.0	130.0	SANDROCK, SANDY SHALE
130.0	190.0	BLUE SHALE

190.0	215.0	LIME
215.0	220.0	LIME & SHALE, WATER
220.0	260.0	LIME

Comments OWNER VERIFIED, PH 7.8, IRON .1 PPM, HARDNESS 6 GRAINS

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40772	3 MI N OF BLOOMINGTON & CRANE GATE ON HWY 45 & .25 MI W, APPROX .4 MI W OF SR 45 ON S SIDE OF 425 S, WRIGHT RD, BACK A LANE	Feb 11, 1972

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	JOSEPH JACOB	R R 3 BLOOMFIELD IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 455.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 71.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 3.0 gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NE of the SW of the NW of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: BER **on:** Feb 16, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1300.0 **Ft S of NL:** 1600.0
Ground elevation: 850.0 **Depth to bedrock:** 12.0 **Bedrock elevation:** 838.0 **Aquifer elevation:**
UTM Easting: 521432.0 **UTM Northing:** 4311963.0

Well Log

Top	Bottom	Formation
0.0	12.0	CLAY
12.0	20.0	SANDROCK & CLAY SEAMS
20.0	46.0	SOFT SHALE
46.0	53.0	LIME
53.0	62.0	SOFT SHALE
62.0	67.0	COAL & FIRECLAY
67.0	73.0	SANDY SHALE
73.0	80.0	SOFT SHALE & SANDROCK
80.0	85.0	YELL SANDROCK
85.0	95.0	BRN LIME & BRN SANDROCK

95.0	98.0	GRAY LIME
98.0	113.0	SOFT GRAY SHALE
113.0	120.0	GRAY LIME
120.0	125.0	SANDY SHALE
125.0	132.0	LIME & SHALE
132.0	165.0	YELL SANDROCK
165.0	183.0	LIME
183.0	186.0	GREEN SHALE
186.0	195.0	SANDROCK
195.0	197.0	GREEN SHALE
197.0	218.0	SANDROCK, DEAD OIL
218.0	223.0	LIME
223.0	228.0	GRAY SHALE
228.0	235.0	SANDY SHALE
235.0	260.0	SANDROCK & SANDY LIME, DEADOIL
260.0	275.0	SANDY SHALE
275.0	318.0	SANDROCK
318.0	331.0	LIME
331.0	335.0	GREEN SHALE
335.0	425.0	LIME
425.0	431.0	GRAY SHALE LT
431.0	455.0	LIME

Comments MC838, OWNER VERIFIED

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40773	4 MI E OF COLLEEN	Feb 23, 1970

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DR H ADRIAN REHNER	OWENSBURG IN	
Driller	MUMMA DRILLING INC	WASHINGTON & LYONS IN	
Operator	DEAN MUMMA	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 200.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 20.0	**Material:**	**Diameter:** 6.63
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** gpm for hrs. **BailTest rate:** 7.0 gpm for hrs.
Drawdown: ft. **Static water level:** 120.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SW of the NE of Section 18 **Topo map:** KOLEEN
Grant Number:
Field located by: JRD **on:** Jul 19, 1978
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 2000.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 1750.0
Ground elevation: 635.0 **Depth to bedrock:** 18.0 **Bedrock elevation:** 617.0 **Aquifer elevation:**
UTM Easting: 518793.0 **UTM Northing:** 4311883.0

Well Log

Top	Bottom	Formation
0.0	10.0	CLAY
10.0	18.0	CLAY & SANDROCK
18.0	38.0	SANDROCK
38.0	61.0	LS
61.0	80.0	RED ROCK & GREEN SHALE
80.0	95.0	GRAY & YELL SANDROCK
95.0	150.0	GRAY SANDROCK & SHALE
150.0	195.0	SANDROCK, WATER
195.0	200.0	LIME

Comments MC; OWNER VERIFIED, 20' SE OF GARAGE-BARN

Record of Water Well

Indiana Department of Natural Resources

Reference Number	Driving directions to well	Date completed
40921	45 W TO STANFORD TURN LF ON BREEDEN RD GO 4 MI TO ROCK EAST RD TURN RT GO 1.5 MI ON RT, AT CO LINE JUST W OF HEBRON CH	May 11, 1984

Owner-Contractor	Name	Address	Telephone
Owner	DAN STURGEON	R R 1 SPRINGVILLE IN	
Driller	FRED SMITH	8565 S OLD SR 37 BLOOMINGTON IN	
Company	WILLIAM WAMPLER	S KETCHAM RD	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:**
	Depth: 73.0	**Pump setting depth:**	**Water quality:** CLEAR
Casing	**Length:** 37.0	**Material:**	**Diameter:** 6.25
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: **Test rate:** 1.0 gpm for 12.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 64.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 7N **Range:** 3W
Section: SE of the SE of the NE of Section 25 **Topo map:** STANFORD
Grant Number:
Field located by: BEB **on:** Feb 22, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: 100.0 **Ft N of SL:** **Ft E of WL:** **Ft S of NL:** 2350.0
Ground elevation: 680.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 660.0 **Aquifer elevation:**
UTM Easting: 527492.0 **UTM Northing:** 4318350.0

Well Log

Top	Bottom	Formation
0.0	20.0	SOIL
20.0	34.0	LS, WITH HOLES
34.0	77.0	LS

Comments MC 660; WELL SE OF HOUSE

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40944	4.3 MI S OF 54 ON 45, TURN W ON 425S WRIGHT RD, THEN .4 MI ON LF	Jun 17, 1986

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	DONALD L HENSLEY	RR3 BOX 316C BLOOMFIELD IN 47424	
Driller	FRED SMITH WELL DRILLING	8565 S SR 37 BLOOMINGTON IN	
Operator	FRED SMITH	License: null	

Construction Details

Well	**Use:** Home	**Drilling method:**	**Pump type:**
	Depth: 477.0	**Pump setting depth:**	**Water quality:** CLOUDY
Casing	**Length:** 40.0	**Material:**	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:** 60

Well Capacity Test

Type of test: **Test rate:** 3.0 gpm for 1.0 hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** 360.0 ft. **Bailer Drawdown** ft.

Grouting Information

Material: **Depth:** from to
Installation Method: **Number of bags used:**

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 3W
Section: NW of the SE of the NW of Section 16 **Topo map:** KOLEEN
Grant Number:
Field located by: BEB **on:** Feb 16, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 1600.0 **Ft S of NL:** 1550.0
Ground elevation: 862.0 **Depth to bedrock:** 32.0 **Bedrock elevation:** 830.0 **Aquifer elevation:**
UTM Easting: 521541.0 **UTM Northing:** 4311975.0

Well Log

Top	Bottom	Formation
0.0	32.0	SOIL
32.0	51.0	SS
51.0	75.0	SHALE
75.0	140.0	SS
140.0	175.0	SHALE
175.0	190.0	LS
190.0	331.0	SHALE
331.0	345.0	LS
345.0	477.0	LS

Comments OWNER VERIFIED; MC 830; WELL HAS LINER WITH SHALE TRAP 80' FROM BOTTOM

Record of Water Well

Indiana Department of Natural Resources

Reference Number	**Driving directions to well**	**Date completed**
40945	N AT KENTUCKY RIDGE BAPTIST CHURCH ALONG HWY 45, GO 2.75 MI N ON CR 875, HOME ON HILLSIDE ON E SIDE OF RD	May 20, 1989

Owner-Contractor	**Name**	**Address**	**Telephone**
Owner	BERT CALKINS	RR 3 BOX 448 BLOOMFIELD IN	
Driller	MUMMA BROS DRILLING INC	RR1 BOX 85 LYONS IN	
Operator	DAVE MUMMA	License: 401	

Construction Details

Well	**Use:** Home	**Drilling method:** Rotary	**Pump type:** Submersible
	Depth: 185.0	**Pump setting depth:**	**Water quality:**
Casing	**Length:** 60.0	**Material:** PVC	**Diameter:** 6.0
Screen	**Length:**	**Material:**	**Diameter: Slot size:**

Well Capacity Test

Type of test: Air **Test rate:** 30.0 gpm for hrs. **BailTest rate:** gpm for hrs.
Drawdown: ft. **Static water level:** ft. **Bailer Drawdown** ft.

Grouting Information

Material: ENVIRO **Depth:** from 60.0 to 25.0
Installation Method: PUMP **Number of bags used:** 2.0

Well Abandonment

Sealing material: **Depth:** from to
Installation Method: **Number of bags used:**

Administrative

County: GREENE **Township:** 6N **Range:** 4W
Section: NE of the NE of the NW of Section 23 **Topo map:** KOLEEN
Grant Number:
Field located by: JP **on:** May 23, 1989
Courthouse location by: **on:**
Location accepted w/o verification by: **on:**
Subdivision name: **Lot number:**
Ft W of EL: **Ft N of SL:** **Ft E of WL:** 2400.0 **Ft S of NL:** 600.0
Ground elevation: 575.0 **Depth to bedrock:** 20.0 **Bedrock elevation:** 555.0 **Aquifer elevation:**
UTM Easting: 515340.0 **UTM Northing:** 4310585.0

Well Log

Top	Bottom	Formation
0.0	20.0	CLAY & ROCKS
20.0	30.0	SOFT SHALE & LIME BKS
30.0	42.0	SOFT SHALE
42.0	46.0	REDROCK & GREEN SHALE
46.0	50.0	SANDROCK & SHALE
50.0	80.0	BRN SANDROCK
80.0	102.0	LS
102.0	115.0	GREEN SHALE & REDROCK

115.0	120.0	SANDROCK
120.0	123.0	SHALE
123.0	128.0	GREEN SANDROCK
128.0	165.0	GRAY SHALE & DARK SHALE
165.0	180.0	SANDROCK, WATER
180.0	182.0	SHALE
182.0	185.0	LS

Comments MC 555

APPENDIX M – INDIANA BAT WINTER HIBERNACULA SURVEY

Reconnaissance of Caves in West-Central Indiana, As Part of Tier-2 Environmental Impact Investigations Of Winter Hibernacula of the Indiana Bat (*Myotis sodalis*) For the Proposed Interstate-69 Transportation Corridor

Final Report
To Bernardin, Lochmueller and Associates, Inc.
August 22, 2005

From the
Indiana Geological Survey
Bloomington, Indiana

Principal Investigators:
Samuel Frushour and Denver Harper

Reconnaissance of Caves in West-Central Indiana, as Part of Tier-2 Environmental Impact Investigations of Winter Hibernacula of the Indiana Bat (*Myotis sodalis*) for the Proposed Interstate-69 Transportation Corridor

By **Denver Harper and Samuel Frushour, Indiana Geological Survey**

Introduction

The Indiana bat (*Myotis sodalis*) is an endangered species. As part of Tier-2 environmental impact investigations being conducted in association with the proposed Interstate-69 transportation corridor through southwestern Indiana, it was necessary to determine if any caves within 5 miles of the proposed corridor (including parts of Monroe, Greene, and Lawrence Counties) are winter hibernacula for this species. Thorough biological assessments were needed to avoid or mitigate any negative impacts of the proposed highway on the endangered species.

In summer 2004, the Indiana Geological Survey (IGS) was contracted by Bernardin, Lochmueller and Associates, Inc. (BLA) and the Indiana Department of Transportation (INDOT) to perform a reconnaissance of all known caves within the study area. The purpose of the investigation was to identify and visit caves that represented potential winter hibernacula for the Indiana bat and make recommendations regarding independent, more detailed investigations that were to be conducted later by teams of biologists.

Method

The reconnaissance began with the compilation of a database of known cave locations by Samuel Frushour (IGS). The locations were derived from various publications and from oral and unpublished reports and maps made by cave explorers over a period of decades. While a few of the locations had been derived from global positioning system (GPS) surveys, most were obtained from points plotted on 1:24,000-scale topographic quadrangle maps of the United States Geological Survey and were in the Public Land Survey System (Township, Range, and Section). The accuracy of such locations varied widely; in some cases, footage information was available, but where footage information was not available, the point was located to the center of the smallest quarter-section given.

The location information was converted from the Public Land Survey System into Universal Transverse Mercator (UTM) coordinates. Geographic information system (GIS) software was then used to convert the database into ESRI ArcGIS shapefile format and to eliminate those caves that were more than 5 miles from either side of the proposed transportation corridor. The resulting shapefile, which includes 330 points, is named "CAVES_I69_IGS" (Table 1 and Figure 1) and accompanies this report on CD-ROM. A Microsoft Excel spreadsheet derived from the shapefile's database is included in Appendix 1, and metadata for the shapefile are included in Appendix 2.

Based on knowledge of Frushour and other cave explorers with considerable Indiana experience, 96 of the caves were eliminated from consideration as winter hibernacula for the Indiana bat because they were too small, too warm in winter, too wet, or subject to flooding. Eight other records from the original database were eliminated because they were recognized as duplicate entries appearing under different cave names. Five caves could not be visited because access to the property was not granted by landowners.

Table 1. Summary of CAVES_I69_IGS Original database that was used to guide the search		
Total number of records	330	
Duplicate records	8	
Caves deemed "not worth visiting"	96	Indicated by a value of "NV" ("not visited") in the field named "Visited" and a value of "1" ("not a habitat") in the field named "Bat_Potent."
Access to property denied	5	Indicated by a value of "NV" ("not visited") in the field named "Visited" and a value of "0" (status unknown) in the field named "Bat_Potent."
Caves searched for, but not found	14	Indicated by a value of "NF" ("not found") in the field named "Visited."
Caves that were visited	207	Indicated by a value of "Y" ("yes") in the field named "Visited."

Figure 1 has been removed for confidentiality reasons related to caves.

Figure 1. Map showing final status of the search for caves in the original database (CAVES_I69_IGS). Some caves were not visited because they were known to be unsuitable as winter hibernacula, access to the property was denied, or searches were unsuccessful because of poor location data.

Beginning on July 20, 2004, field investigations were undertaken to visit each of the caves. The investigators used the locations contained in CAVES_I69_IGS to guide their search, as waypoints in GPS instruments. Fourteen of the caves were never found in the field. In most cases, failure to locate those caves can be attributed to bad location data. In addition to 207 caves from the original database, 41 caves were visited that were not part of the original database; these include newly discovered caves, as well as previously known caves that did not happen to be included in the original database. Also, two abandoned railroad tunnels were visited and evaluated as possible winter hibernacula.

When each cave was visited in the field, investigators determined accurate locations by using Garmin 76CS GPS instruments, photographed the caves, and made notes regarding the potential suitability of the cave as a winter hibernaculum for the Indiana bat. The evaluations for suitability as hibernacula were subjective and based upon observations by Samuel Frushour and Drew Packman (IGS) of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors. Such factors are discussed in detail in Kurta and Kennedy (2002). Five values

of potential suitability as winter hibernacula appear in the field named "Bat_Potent" in CAVES_I69_IGS: (1) "Status unknown," (2) "Not a habitat," (3) "Possible but unlikely," (4) "Possible," and (5) "Definitely a habitat."

During each visit to a cave, field investigators recorded measurements and observations on paper records referred to as "Cave and Karst Feature Reports." Selected data for visited caves were later compiled in a Microsoft Excel spreadsheet, which was subsequently converted into shapefile format. The shapefile, which is named "CAVES_I69_GPS_IGS," accompanies this report (Table 2 and Figure 2). A Microsoft Excel spreadsheet derived from the shapefile's database is included in Appendix 1, and metadata for the shapefile are included in Appendix 2. At the suggestion of personnel of the U.S. Fish and Wildlife Service, the subjective categorization of caves as potential winter hibernacula was increased from five to six values: (1) "Not a habitat," (2) "Unlikely," (3) "Weak Possible," (4) "Medium Possible," (5) "Strong Possible," and (6) "Definitely a habitat."

Table 2. Summary of CAVES_I69_GPS_IGS
Database of caves that were visited

Total number of caves that were visited		250		
New caves (not included in CAVES_I69_IGS)		41		
Railroad tunnels (not included in CAVES_I69_IGS)		2		
Evaluation of caves as potential habitat			Netted 2004	Recommended for netting 2005
	Not habitat	113	0	0
	Unlikely	61	14	3
	Weak possible	25	16	6
	Medium possible	29	21	8
	Strong possible	11	8	3
	Definite habitat	11	0	0

Figure 2 has been removed for confidentiality reasons related to caves.

Figure 2. Map showing evaluation of visited caves (CAVES_I69_GPS_IGS) as possible winter hibernacula.

During field visits, investigators also took photographs of cave openings. Selected images are included on the CD-ROM that accompanies this report.

Results

In August 2004, personnel of the IGS, in consultation with personnel of BLA and the U.S. Fish and Wildlife Service, used the evaluations contained in CAVES_I69_GPS_IGS to recommend 59 caves for intensive investigations as winter hibernacula. In CAVES_I69_GPS_IGS, these caves are indicated by a value of "Y" ("yes") in the field named "Net." Biological teams subsequently conducted mist-netting at the entrances to the recommended caves in autumn 2004 and entered and explored selected caves in winter 2004-2005. (Note that an additional cave—Cave—was also netted, but it was later determined that the cave is outside the 5-mile buffer, and so it does not appear in the database.)

In August 2005, an additional 20 caves were recommended for investigations in autumn and winter 2005. In CAVES_I69_GPS_IGS, these caves are indicated by a value of "R" ("recommended") in the field named "Net."

The results of the biological investigations will be reported separately by the responsible agencies.

Reference

Allen Kurta and Jim Kennedy (eds.), 2002, The Indiana Bat—Biology and Management of an Endangered Species: Bat Conservation International, Austin, Texas, 253 p.

Appendix 1

Spreadsheets Extracted from Shapefiles

This spreadsheet has been removed for confidentiality reasons related to caves

CAVES_I69_IGS

Explanation of fields and coded values:

UTMX83 and UTMY83: Location according to the original database. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

NOTES2004: Explanation of why a cave was not found or not visited, or identification of a cave that was re-named or identified as a duplicate of another record.

VISITED:

NF = Not found, even though an attempt was made to find the cave.

NV = Not visited, either because access to the property was denied (Bat_Potent = 0) or because the cave was deemed not worthy of visiting (Bat_Potent = 1).

Y = Yes, the cave was visited by field investigators of IGS.

BAT_POTENT:

0 = Status unknown.
1 = Not a habitat.
2 = Unlikely habitat.
3 = Possible habitat.
4 = Definitely a habitat.

CAVES_I69_GPS_IGS

Explanation of fields and coded values:

CAVE_NAME: Name of the cave. The designation of "New Cave" indicates that the cave was not included in the original database.

DATE_VISIT: The date on which the cave was visited by field investigators of IGS.

FLAG_ID: The unique identification number assigned to the cave by IGS field investigators. The alphanumeric identification consists of the date visited (MM/DD/YYYY), followed by the initials of the individual who completed the "Cave and Karst Feature Report" (SF, Samuel Frushour; DP, Drew Packman; DH, Denver Harper), followed by a number indicating the sequence in which the cave was visited on that day.

UTMX83 and UTMY83: Location obtained in the field by field investigators of IGS using GPS instruments. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

PARK_X and PARK_Y: Location of parking area that was used by IGS field investigators. These locations may not necessarily provide the best access to the cave. Coordinates are in Universal Transverse Mercator (UTM), Zone 16, NAD83.

ENT_SIZE_F: Entrance dimensions of the cave (in feet).

AIRFLOW: Qualitative estimate of airflow

IND_BAT_HAB: Subjective evaluation by Samuel Frushour or Drew Packman of the likelihood that the cave serves as a winter hibernaculum for *Myotis sodalis*. Values include: "No," "Unlikely," "Weak Possible," "Medium Possible," "Strong Possible," and "Definite."

NET: A value of "Y" indicates that the cave was investigated by biological teams (mist netting and possibly cave exploration) in autumn and winter, 2004-2005). A value of "R" indicates that the cave was recommended for intensive biological investigation in autumn and winter, 2005-2006.

HAB_NOTE: Notes regarding suitability of the cave as a winter hibernaculum.

Appendix 2

Metadata for Shapefiles

Metadata for CAVES_I69_IGS

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Indiana Geological Survey (IGS)
      Originator: Samuel Frushour (Data collection)
      Originator: Denver Harper (Data collection and GIS compiler)
      Originator: Drew Packman (Data collection)
      Originator: Chris Dintaman (Data collection and GIS compiler)
      Originator: Chris Walls (Data collection)
      Originator: Chris Parks (Data collection)
      Publication_Date: 20050804
      Title:
        CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Environmental Impact Investigation for a Proposed
        Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile)
      Geospatial_Data_Presentation_Form: Vector digital data
      Publication_Information:
        Publication_Place: Bloomington, Indiana
        Publisher: Indiana Geological Survey
      Other_Citation_Details:
        The Microsoft Excel database from which this shapefile was derived was compiled by Samuel Frushour of the Indiana Geological Survey. This shapefile was produced in association with another shapefile named "CAVES_I69_GPS_IGS."
  Description:
    Abstract:

        CAVES_I69_IGS is a point shapefile that shows the distribution of caves in southwestern Indiana that are located within 5 miles of a transportation corridor associated with a proposed extension of Interstate 69 from Indianapolis to Evansville, Indiana. The locations of the caves are derived from a database that was compiled by Samuel Frushour (Indiana Geological Survey). The accuracy of these locations varies greatly because the data were collected over a period of decades from various sources, including oral and unpublished written reports, as well as published material.

        As part of the Tier-2 environmental impact investigation of the proposed corridor, as many of the caves as possible were visited by personnel of the Indiana Geological Survey. The investigators used the locations contained in this shapefile to guide their search, as waypoints in GPS instruments. When the investigators found a cave, they collected more accurate locational data by using the GPS instruments. Those more accurate coordinates were used to create an associated shapefile named "CAVES_I69_GPS_IGS."

    Purpose:
        The purpose of this shapefile was to assist researchers in locating caves within a 5-mile buffer around a proposed extension of Interstate 69 through southwestern Indiana as part of a Tier-2 environmental impact investigation.
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 1959
        Ending_Date: 20050804
    Currentness_Reference: Publication date
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: None planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -86.8621

East_Bounding_Coordinate: -86.5000
North_Bounding_Coordinate: 39.2617
South_Bounding_Coordinate: 38.9058
Keywords:
Theme:
Theme_Keyword_Thesaurus: Metadata Service Keyword Thesaurus
Theme_Keyword: geoscientificInformation
Theme:
Theme_Keyword_Thesaurus: IGS Metadata Keyword Thesaurus
Theme_Keyword: Indiana Geological Survey (IGS)
Theme_Keyword: cave
Theme_Keyword: caves
Theme_Keyword: karst
Theme_Keyword: Interstate 69 (I69)
Theme_Keyword: Indiana bat
Theme_Keyword: Myotis sodalis
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Indiana
Place_Keyword: Greene County
Place_Keyword: Lawrence County
Place_Keyword: Monroe County
Access_Constraints:
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Use_Constraints:
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These data are intended for use only at the published scale or smaller and are for reference purposes only. They are not to be construed as a legal document or survey instrument. A detailed on-the-ground survey and historical analysis of a single site may differ from these data.

CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:

Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Native_Data_Set_Environment: ESRI ArcGIS version 9.1 shapefile format, approximately 65 Kb

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The locations of the caves are derived from a database that was compiled by Samuel Frushour (Indiana Geological Survey) from various publications and from oral and unpublished reports and maps by various cave explorers over a period of decades. While a few of the locations were derived from GPS surveys, most were obtained from points plotted on 1:24,000-scale USGS topographic quadrangle maps. The coordinates estimated from those points were compiled into a database and converted from the Public Land Survey System into UTM coordinates using Geographix software.

Evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) are highly subjective and based upon observations by Samuel Frushour and Drew Packman of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors.
Logical_Consistency_Report:
Subjective evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) were made by either of two different field investigators (Samuel Frushour and Drew Packman).
Completeness_Report:
This shapefile includes all cave locations contained in the database provided by Samuel Frushour that are situated within 5 miles of the transportation corridor for the proposed extension of Interstate 69.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Most of the locations were obtained from hand-plotted points on 1:24,000-scale USGS topographic quadrangle maps. Geographix software was then used to convert the locational data from the Public Land Survey System to UTM coordinates. In some cases footage information was available, and this was used in the conversion. Where footage information was not available, the point was located to the center of the smallest quarter-section given. A few of the locations were derived from GPS surveys.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: Not a factor in the production of this shapefile.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Indiana Geological Survey
Publication_Date: Unpublished material
Title: None
Geospatial_Data_Presentation_Form: Tabular digital data
Publication_Information:
Publication_Place: Bloomington, Indiana
Publisher: Indiana Geological Survey
Type_of_Source_Media: Tabular digital data

Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1959
Ending_Date: 20040611
Source_Currentness_Reference: 20040611
Source_Citation_Abbreviation: DRAFTI69CavesJuneil2004.xls
Source_Contribution: Cave locations
Process_Step:
Process_Description:
A Microsoft Excel spreadsheet named "DRAFTI69CavesJuneil2004.xls" was obtained from Samuel Frushour, Indiana Geological Survey. This spreadsheet contained records for 378 caves. Although the spreadsheet contained locational information in the Public Land Survey System (Township, Range, and Section), the coordinate information had previously been processed using Geographix software, so that the spreadsheet also contained coordinate information in Universal Transverse Mercator (UTM) Zone 16, NAD27.

The spreadsheet was opened and saved as a TXT file, which was then added to an ESRI ArcView project. The "Add Event Theme" and "Convert to Shapefile" functions were then used to create a shapefile. ESRI ArcToolbox was then used to convert the shapefile from NAD27 to NAD83.

Except for the field giving the names of the caves, all the fields in the shapefile were deleted, new fields were added, and the shapefile was saved as "Caves_I69_IGS."
Source_Used_Citation_Abbreviation: PDRAFTI69CavesJuneil2004.xls
Process_Date: 20040701
Source_Produced_Citation_Abbreviation: CAVES_I69_IGS.SHP
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Process_Step:
Process_Description:
This metadata file was pre-parsed and parsed using CNS (Chew and Spit, v. 2.6.1) and MP (Metadata Parser, v. 2.7.1) software written by Peter N. Schweitzer (U.S. Geological Survey). The errors generated by MP were all addressed and corrected, except that no values were assigned to "Abscissa_Resolution" and "Ordinate_Resolution."
Process_Date: 20050805
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper

Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Point
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
Point_and_Vector_Object_Count: 330

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 16
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -87.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: Row and column
Coordinate_Representation:
Abscissa_Resolution:
Ordinate_Resolution:
Planar_Distance_Units: Meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: GRS 80
Semi-major_Axis: 6378137.0000000
Denominator_of_Flattening_Ratio: 298.26

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: CAVES_I69_IGS.DBF
Entity_Type_Definition: Shapefile Attribute Table
Entity_Type_Definition_Source: None
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry
Attribute_Definition_Source: ESRI software generated

Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features
Attribute:
Attribute_Label: Cave_name
Attribute_Definition: Name of the cave
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Utmx83
Attribute_Definition: X-coordinate (UTM Zone 16, NAD83) of the feature, as derived from a database compiled by Samuel Frushour of the Indiana Geological Survey
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 514179.64
Range_Domain_Maximum: 543138.89
Attribute:
Attribute_Label: Utmy83
Attribute_Definition: Y-coordinate (UTM Zone 16, NAD83) of the feature, as derived from a database compiled by Samuel Frushour of the Indiana Geological Survey
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 4306437.76
Range_Domain_Maximum: 4345823.52
Attribute:
Attribute_Label: Notes2004
Attribute_Definition:
Miscellaneous notes regarding reasons why a cave was not visited or not found.
Also, notes regarding caves that were renamed or had multiple names.
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Unrepresentable_Domain: Character Field
Attribute:
Attribute_Label: Visited
Attribute_Definition: Has the cave been visited by field researchers?
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: NF
Enumerated_Domain_Value_Definition: Not found. At attempt was made to find the cave in the field, but the attempt was unsuccessful.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: NV
Enumerated_Domain_Value_Definition:
Not visited. There are two possible reasons why a cave was not visited --

1. The cave might not have been visited because access to the property was denied by the landowner (this is indicated by a value of "0" in the field named "Bat_Potent").

2. The cave was not considered to be worth visiting for evaluation as a potential bat hibernaculum, as determined by Samuel Frushour, based upon his knowledge of the feature (this is indicated by a value of "1" in the field named "Bat_Potent").
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey

Enumerated_Domain:
Enumerated_Domain_Value: Y
Enumerated_Domain_Value_Definition:
Yes. The cave has been visited by field investigators of the Indiana Geological Survey. More detailed information that was recorded during the visit can be obtained from the shapefile named "CAVES_I69_GPS_IGS.SHP."
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Attribute:
Attribute_Label: Bat_potent
Attribute_Definition:
Subjective evaluation of field investigators regarding the suitability of the cave as possible winter hibernaculum for the Indiana bat (Myotis sodalis).
Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 0
Enumerated_Domain_Value_Definition:
Unknown status. The cave has not been visited by field researchers of the Indiana Geological Survey, and there is no preexisting information that disqualifies the feature as a possible winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition:
No. The cave is definitely not suitable as a winter hibernaculum for the Indiana bat (Myotis sodalis). This evaluation may be based on either (1) field observations by researchers of the Indiana Geological Survey, or (2) prior knowledge by Samuel Frushour of the Indiana Geological Survey.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 2
Enumerated_Domain_Value_Definition:
Possible but unlikely. Based on field observations by researchers of the Indiana Geological Survey, it is unlikely that the cave serves as a winter hibernaculum for the Indiana bat (Myotis sodalis), but the possibly cannot be entirely ruled out.
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 3
Enumerated_Domain_Value_Definition:
Possible. Based on field observations by researchers of the Indiana Geological Survey, the cave may serve as a winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey
Enumerated_Domain:
Enumerated_Domain_Value: 4
Enumerated_Domain_Value_Definition:
Definite. The cave is known to serve as a winter hibernaculum for the Indiana bat (Myotis sodalis).
Enumerated_Domain_Value_Definition_Source: Indiana Geological Survey

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Publication Sales

Contact_Position: Publication Sales Coordinator
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Resource_Description: Downloadable data

Distribution_Liability:
CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_IGS: Caves in Southwestern Indiana that Were Included in a Tier-2 Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

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Metadata_Reference_Information:
Metadata_Date: 20050804
Metadata_Review_Date: 20050805
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address

Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Metadata_Standard_Name: FGDC CSDGM
Metadata_Standard_Version: FGDC-STD-001-1998

Metadata for CAVES_I69_GPS_IGS

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Indiana Geological Survey (IGS)
      Originator: Samuel Frushour (Data collection)
      Originator: Denver Harper (Data collection and GIS compiler)
      Originator: Drew Packman (Data collection)
      Originator: Chris Dintaman (Data collection and GIS compiler)
      Originator: Chris Walls (Data collection)
      Originator: Chris Parks (Data collection)
      Publication_Date: 20050804
      Title:
        CAVES_I69_GPS_IGS: Caves in Southwestern Indiana that Were Visited by Field Researchers as part of a Tier-2 Environmental Impact Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile)
      Geospatial_Data_Presentation_Form: Vector digital data
      Publication_Information:
        Publication_Place: Bloomington, Indiana
        Publisher: Indiana Geological Survey
      Other_Citation_Details: This shapefile was produced in association with another shapefile named "CAVES_I69_IGS."
  Description:
    Abstract:
      CAVES_I69_GPS_IGS is a point shapefile that shows the distribution of caves in southwestern Indiana that are located within 5 miles of a transportation corridor associated with a proposed extension of Interstate 69 from Indianapolis to Evansville, Indiana, and that have been visited by field researchers. The locations of the caves are derived from GPS measurements made by the researchers during their visits.

      Also, the investigators made notes and subjectively evaluated the suitability of each feature as a possible winter hibernaculum for the Indiana bat (Myotis sodalis). Their evaluations were subsequently used to identify and prioritize caves for later biological investigations.
    Purpose:
      The purpose of this shapefile was to assist researchers in prioritizing subsequent biological investigations of caves as winter hibernacula within a 5-mile buffer around a proposed extension of Interstate 69 through southwestern Indiana.
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 20040720
        Ending_Date: 20050804
    Currentness_Reference: Publication date
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: None planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -86.8621
      East_Bounding_Coordinate: -86.5000
      North_Bounding_Coordinate: 39.2617
      South_Bounding_Coordinate: 38.9058
  Keywords:
    Theme:

Theme_Keyword_Thesaurus: Metadata Service Keyword Thesaurus
Theme_Keyword: geoscientificInformation
Theme:
Theme_Keyword_Thesaurus: IGS Metadata Keyword Thesaurus
Theme_Keyword: Indiana Geological Survey (IGS)
Theme_Keyword: cave
Theme_Keyword: caves
Theme_Keyword: karst
Theme_Keyword: Interstate 69 (I69)
Theme_Keyword: global positioning system (GPS)
Theme_Keyword: tools and techniques
Theme_Keyword: Indiana bat
Theme_Keyword: Myotis sodalis
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Indiana
Place_Keyword: Greene County
Place_Keyword: Lawrence County
Place_Keyword: Monroe County
Access_Constraints:
This file is available to anyone, but access may be contingent on written request, specific terms relevant to the agency or person making the request, and (or) current freedom of information statutes in the state of Indiana.
Use_Constraints:
INDIANA GEOLOGICAL SURVEY DATA DISCLAIMER
This data set is provided by Indiana University, Indiana Geological Survey, and contains data believed to be accurate; however, a degree of error is inherent in all data. This product is distributed "AS-IS" without warranties of any kind, either expressed or implied, including but not limited to warranties of suitability of a particular purpose or use. No attempt has been made in either the designed format or production of these data to define the limits or jurisdiction of any federal, state, or local government.
These data are intended for use only at the published scale or smaller and are for reference purposes only. They are not to be construed as a legal document or survey instrument. A detailed on-the-ground survey and historical analysis of a single site may differ from these data.
CREDIT
It is requested that the Indiana Geological Survey be cited in any products generated from this data set. The following source citation should be included: CAVES_I69_GPS_IGS: Caves in Southwestern Indiana that Were Visited by Field Researchers as part of a Tier-2 Environmental Impact Investigation for a Proposed Interstate 69 Transportation Corridor (Indiana Geological Survey, Point Shapefile).

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208

Country: USA
Contact_Voice_Telephone: 812-855-7636
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: IGSinfo@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Native_Data_Set_Environment: ESRI ArcGIS version 9.1 shapefile format, approximately 65 Kb

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The locations of the caves were obtained from field-averaged measurements that were made using hand-held Garmin 76CS GPS units.

Evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalis) are highly subjective and based upon observations by Samuel Frushour and Drew Packman of cave-opening dimensions, cave geometry, air flow, susceptibility to flooding, and other factors.
Logical_Consistency_Report:
Subjective evaluations of caves for suitability as winter hibernacula for the Indiana bat (Myotis sodalist) were made by either of two field investigators (Samuel Frushour and Drew Packman).
Completeness_Report:
This shapefile includes locations for 269 cave openings that were visited by field researchers. These caves are all situated within 5 miles of the transportation corridor for the proposed extension of Interstate 69.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: Plus or minus 10 meters.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: Not a factor in the production of this shapefile.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Indiana Geological Survey
Publication_Date: Unpublished material
Title: Cave and Karst Feature Report
Geospatial_Data_Presentation_Form: Paper field notes
Publication_Information:
Publication_Place: Bloomington, Indiana
Publisher: Indiana Geological Survey
Type_of_Source_Media: Paper
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20040720
Ending_Date: 20050804
Source_Currentness_Reference: 20050804
Source_Citation_Abbreviation: Cave and Karst Feature Reports
Source_Contribution:
Cave locations and observations by Sam Frushour and Drew Packman
regarding suitability of caves as winter hibernacula for the Indiana bat (Myotis sodalis).
Process_Step:
Process_Description:
A Microsoft Excel spreadsheet named "Caves_I69_GPS_IGS.xls" was compiled from field notes by Samuel Frushour and Drew Packman (IGS). These field notes contained measurements of cave locations and the locations where the researchers parked their vehicles before visiting the caves

(derived from hand-held Garmin 76CS GPS units), as well as a unique identification number for each cave. The field notes also contain observations regarding the dimensions of the cave, air flow directions and outside temperatures, moisture conditions, susceptibilities to flooding, and miscellaneous other notes. In most cases, the caves were not entered by the field researchers; when caves were entered, notes were taken regarding the presence of bats and other conditions.

Source_Used_Citation_Abbreviation: Cave and Karst Feature Reports
Process_Date: 20050804
Source_Produced_Citation_Abbreviation: Caves_I69_GPS_IGS.xls
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays

Process_Step:
Process_Description:
Caves_I69_GPS_IGS.xls was opened and saved as a tab-delimited TXT file, which was then added to an ESRI ArcView 3.3 project. The "Add Event Theme" and "Convert to Shapefile" functions were then used to create a shapefile named "CAVES_I69_GPS_IGS."

Source_Used_Citation_Abbreviation: CAVES_I69_GPS_IGS.xls
Process_Date: 20050630
Source_Produced_Citation_Abbreviation: CAVES_I69_GPS_IGS.SHP
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Organization: Indiana Geological Survey
Contact_Person: Denver Harper
Contact_Position: Geologist
Contact_Address:
Address_Type: Mailing and physical address
Address: 611 North Walnut Grove
City: Bloomington
State_or_Province: Indiana
Postal_Code: 47405-2208
Country: USA
Contact_Voice_Telephone: 812-855-1369
Contact_Facsimile_Telephone: 812-855-2862
Contact_Electronic_Mail_Address: dharper@indiana.edu
Hours_of_Service: 0800 to 1700 Eastern Standard Time
Contact_Instructions: Monday through Friday, except holidays
Process_Step:
Process_Description:

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    Process_Contact:
      Contact_Information:
        Contact_Person_Primary:
          Contact_Organization: Indiana Geological Survey
          Contact_Person: Denver Harper
        Contact_Position: Geologist
        Contact_Address:
          Address_Type: Mailing and physical address
          Address: 611 North Walnut Grove
          City: Bloomington
          State_or_Province: Indiana
          Postal_Code: 47405-2208
          Country: USA
        Contact_Voice_Telephone: 812-855-1369
        Contact_Facsimile_Telephone: 812-855-2862
        Contact_Electronic_Mail_Address: dharper@indiana.edu
        Hours_of_Service: 0800 to 1700 Eastern Standard Time
        Contact_Instructions: Monday through Friday, except holidays

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          Sam Frushour; DP, Drew Packman; DH, Denver Harper. The number that appears after the initials
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Attribute_Definition_Source: Indiana Geological Survey
Attribute_Domain_Values:
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  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Indiana Geological Survey
        Contact_Person: Denver Harper
      Contact_Position: Geologist
      Contact_Address:
        Address_Type: Mailing and physical address
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        State_or_Province: Indiana
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        Country: USA
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  Metadata_Standard_Version: FGDC-STD-001-1998

APPENDIX N – POLLUTANT LOADING ESTIMATE TABLES AND FHWA METHODOLOGY

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Exhibit 2 has been removed for confidentiality reasons related to karst.

Exhibit 3 has been removed for confidentiality reasons related to karst.

Exhibit 4 has been removed for confidentiality reasons related to karst.

Exhibit 5 has been removed for confidentiality reasons related to karst.

Exhibit 6 has been removed for confidentiality reasons related to karst.

FHWA HIGHWAY RUNOFF WATER QUALITY TRAINING COURSE

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

Estimated Time for Section:

The CONTENT of this Section

This section introduces impact prediction techniques developed by FHWA and others to assess highway runoff water quality impacts. Several specific procedures will be introduced either by lecture or by case study problems. Specific methods include estimating the highway runoff impact, maintenance practice impacts, groundwater impacts, and aquatic system impacts. Also, a brief overview of water quality models which have been developed to assess the impact of nonpoint pollution on watersheds relative to highway runoff will be provided.

The GOAL of this Section

Participants will become familiar with predicting quality changes in water quality parameters associated with highway runoff water quality.

The PURPOSE of this Section

To introduce participants to different qualitative and quantita- tive techniques for predicting highway runoff water quality impacts.

Listing of Sessions — Time

Session 8.1	Impact Procedures and Data Requirements
Session 8.2	Introduction to Highway Runoff Pollutant Characteristics Predictive Procedures
Session 8.3	Prediction of Pollutant Loadings and Runoff Concentrations on Highway Surfaces - Case Study
Session 8.4	Prediction of Loading Impacts of Highway Runoff - Case Study
Session 8.5	Prediction of Maintenance Impacts
Session 8.6	Prediction of Groundwater Impacts
Session 8.7	Aquatic System Impacts
Session 8.8	Introduction to Water Quality Models for Predicting Water Quality Impacts

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.1: IMPACT PROCEDURES AND DATA REQUIREMENTS

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be introduced to a procedure for the assessment of effects of stormwater runoff from operating highways on receiving waters.
- Be introduced to a general procedure for evaluating potential impacts of highway maintenance practices on water quality.
- Know what data may be required to assess impacts of highway stormwater runoff on quality.

SESSION OVERVIEW:

This session introduces general procedures for assessing potential water quality impacts of highway stormwater runoff and maintenance practices. The specific methods will be introduced in later sessions. An overview of data required to assess water quality impacts of highway stormwater runoff is also presented.

I. INTRODUCTION

Data requirements to assess the need to conduct impact analysis or the potential effects of highway operations on surface water quality are identified in Table 8.1.1. This check list may be supplemented by site-specific data requirements.

II. ASSESSMENT OF HIGHWAY STORMWATER RUNOFF IMPACTS

Determining the need to assess the impact of highway stormwater runoff and the level of analysis depends on a number of factors. Selected factors include:

- The amount of traffic anticipated or currently traveling on the highway.
- The proximity of the highway site to receiving waters and their designated uses (e.g., drinking water, recreation, etc).
- Local and state requirements for control of nonpoint and stormwater point sources.
- Climatic factors, such as frequency and intensity of rainfall.
- The ratio of impervious surface to total watershed area upstream of project site.
- Local controversy.

Figure 8.1.1, illustrates a procedure for assessment of effects of stormwater runoff from operating highways on receiving waters. The first step in the procedure involves determining the anticipated impacts and/or the degree of controversy involved. Possible criteria useful in making the determination are:

- Traffic volumes in excess of 30,000 ADT.
- The highway site located near receiving stream where low dilutive capacities exist.
- Direct discharge of highway runoff to poorly flushed areas of lakes, wetlands, or coastal embayments.

If the decision is made to conduct an analysis, then either a seasonal/annual pollutant loading analysis or an event analysis should be made.

Table 8.1.1. Data for assessing water quality impacts of highway stormwater runoff.

Highway Design Features
- Length
- Number of lanes and lane widths
- Type of access
- Access ramps or intersecting roads
- Paving material
- Type of section(s) involved (at grade, cut, fill)
- Slopes (longitudinal and side)
- Median characteristics (width, paving, barrier type)
- Shoulder characteristics (width, paving, barrier type)
- Characteristics of area outside the shoulders but within the right-of-way (dimensions, topography, vegetation)
- Total impervious surface area

Operating Conditions
- Design average daily traffic (ADT)
- Projected vehicle composition
- Expected daily, weekly and seasonal traffic patterns
- Anticipated average speeds and braking characteristics
- Summary of applicable accident and spill data (from records on similar highways

Drainage System Characteristics (to the extent available during environmental assessment)
- Channel types (closed conduit, paved open channel, bare open channel, vegetated open channel, unchanneled overland flow, etc.)
- Channel dimensions and slopes
- Soils and vegetation characteristics in flow path
- Discharge points
- Collection systems (type, dimensions and spacings of drop boxes, etc.)
- Design flow rates

Hydrologic Characteristics
- Average annual precipitation (rain and snow) and monthly distribution of precipitation
- Receiving water and ground water data --
  - Streams (base flow, annual average flow, peak flow, flood plain maps)
  - Lakes and reservoirs (surface area, mean depth, water residence time)
  - Wetlands (surface area)
  - Groundwater (locations of aquifers, recharge characteristics)
- Summary of available data on point and nonpoint source flows in the watershed

Water Quality and Aquatic Biological Data

- Summary of available receiving water and groundwater monitoring data (water quality; microflora; microfauna, aquatic plants, benthic macroinvertebrates; fish populations, migrations and spawning areas)
- Sensitive or unique habitats
- Threatened and endangered species
- Summary of available data on effluent quality of sources in the watershed
- Beneficial use classification
- Established water quality criteria

Surrounding Land Use Characteristics
- Total watershed area
- Percentage of total area in each land use category (organized as in Tables 3 and 4)

Projected Highway Maintenance Characteristics
- Sanding application (quantity, frequency, particle size description)
- Deicing agent application (type, quantity, frequency, additives used)
- Pesticide application (type, quantity, frequency, toxicity)
- Roadway maintenance (sweeping, washing)
- Right-of-way maintenance (mowing, ditch cleaning, fertilizing, irrigation)

Description of Special Features
- Construction on woodwaste fill
- Detention basins
- Oil and grease traps
- Other mitigative features

Source: Horner et al., 1982

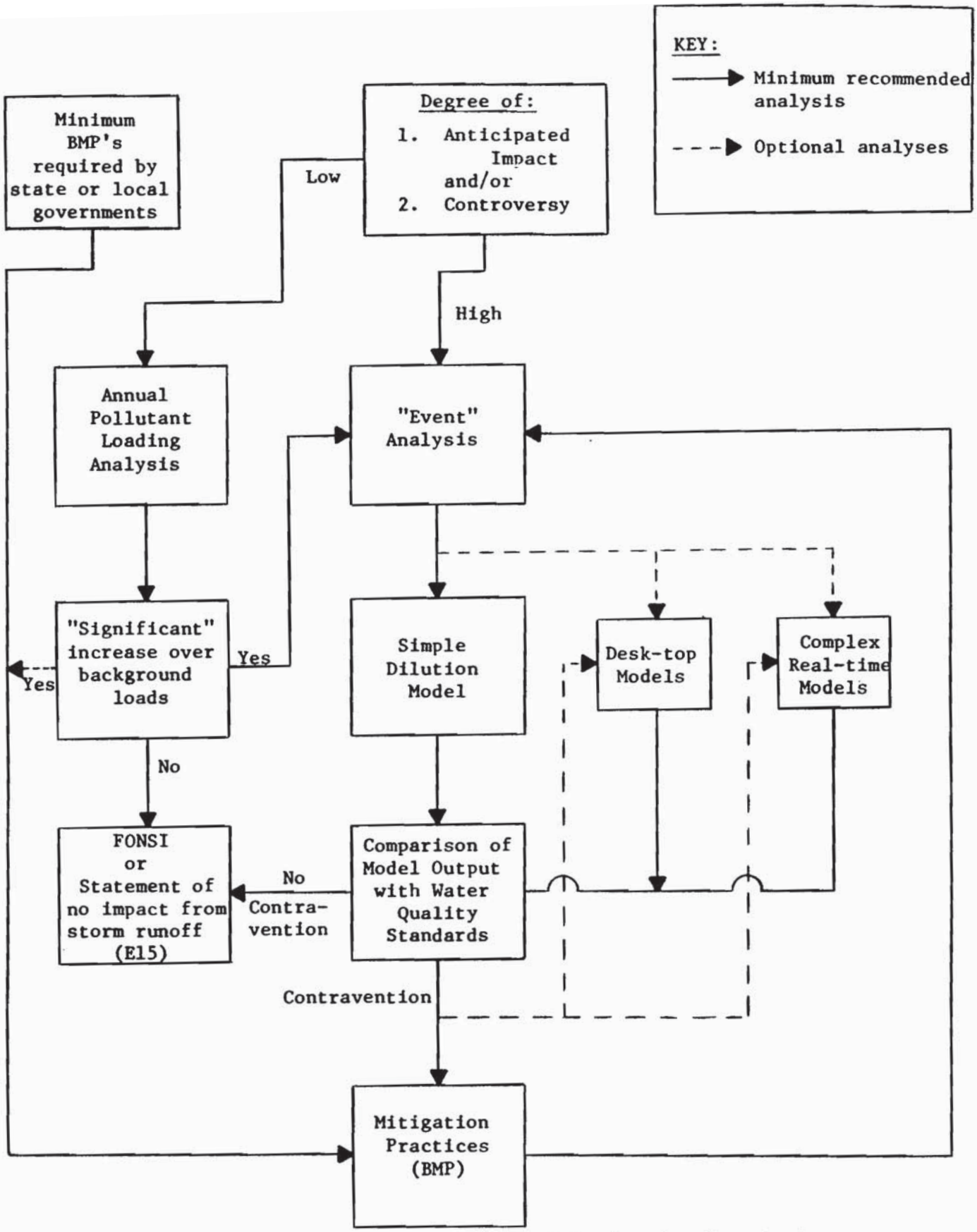


Figure 8.1.1. Simplified procedure for determining levels of analysis required to assess affects of stormwater runoff from operating highways on receiving streams.

Source: Dupuis and Kobriger, 1985.

A. SEASONAL/ANNUAL ANALYSIS

The seasonal/annual analysis determines the highway pollutant loadings relative to other loadings in the watershed. This seasonal/annual pollutant loading analysis may include either a simple determination of loadings (in pounds/yr), or the increase in stream pollutant concentration, using seasonal/annual highway pollutant input and mean flow conditions as a first cut on whether potential water quality problems may occur.

B. EVENT ANALYSIS

If the seasonal/annual analysis indicates the potential for more elaborate analysis, an event analysis may require using predictive model procedures or a simple dilution procedure. The assumption implied in dilution models are conservative, and if they show a standards exceedance, violations are not likely to appear under more exacting conditions.

If a more complex modeling effort is required, several models have been developed that provide the necessary level of analysis. In the majority of cases, these complex, real-time dynamic models would not need to be used.

Which ever approach is used, the results are compared with state water quality standards or, if standards have not been established, then the results may be compared with water quality criteria, to determine if mitigation is required.

Because of the variety of pollutants in highway stormwater runoff and the limited knowledge of the chemical, biological and physical impacts, any results may be subject to a considerable amount of uncertainty. The approaches presented in this section of the training course are intended to provide reasonable estimates of impacts based on the available information to date, and to provide highway agencies with the qualitative and quantitative procedures to make prudent planning decisions regarding highway stormwater runoff and water quality.

III. ASSESSMENT OF MAINTENANCE IMPACTS

Assessment of highway maintenance practice impacts is generally dependent on the extent and magnitude of the activity and its proximity to receiving waters. Session 2.1 provided an overview of when maintenance activity impacts should be assessed. Maintenance activities with potential impacts on water quality that need to be addressed are identified in Figure 8.1.2 with a general impact assessment method or procedure. This method is based on methods which are described in

Sessions 8.5 and 8.7. As with many procedures, it contains some subjective aspects relative to determining potentially significant impacts. It is intended to quantify, to the extent possible, selected maintenance impacts relative to the resource value of the stream, and to evaluate when mitigation measures are warranted. Specific aspects of this general method will be described in later sessions.

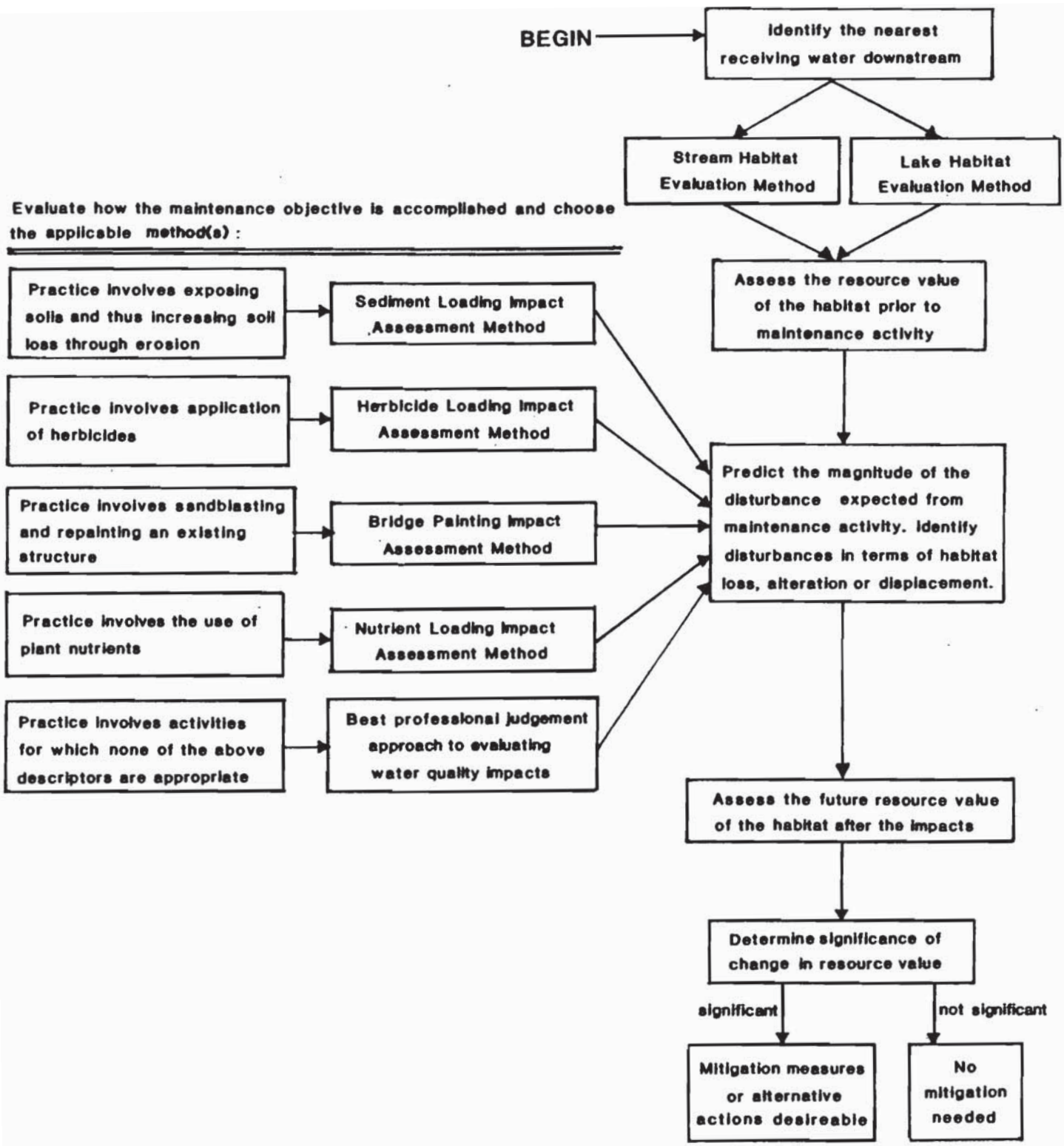


Figure 8.1.2. General impact assessment method for evaluating potential impacts to water quality from highway maintenance practices.

Source: Kramme et al., 1985

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.2: INTRODUCTION TO HIGHWAY RUNOFF POLLUTANT CHARACTERISTICS PREDICTIVE PROCEDURES

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be familiar with the sections of FHWA's Predictive Procedure for Determining Pollutant Characteristics in Highway Runoff.
- Be familiar with other prediction methods developed to estimate highway runoff pollutant characteristics.
- Be knowledgeable about the limitations of the methods presented.

SESSION OVERVIEW:

A lecture will introduce the components of FHWA's Predictive Procedure not previously presented. Also, a brief overview of alternative methods will be examined to determine how they differ from FHWA's Procedure. The limitation of each method will also be discussed.

I. FHWA PREDICTIVE PROCEDURE

A. INTRODUCTION

Previous sessions presented selected components of FHWA's procedure on rainfall evaluation and highway runoff evaluation. An overview of the entire manual procedure and a detailed description of the procedure's remaining component follows. The model procedure is computerized both for mainframe and for personal computer.

The development of the procedure is based upon the monitoring program conducted in 1976 and 1977 at sites in Milwaukee, Wisconsin; Harrisburg, Pennsylvania; Nashville, Tennessee; and Denver, Colorado. Complete details of the monitoring programs can be found in Kobriger et al. (1981c).

B. PURPOSE

The predictive procedure offers highway designers and other interested parties a simplified tool to estimate the quantity and quality of storm generated highway runoff. It consists of a series of equations which can be solved manually or by computer. The procedure is composed of four components corresponding to the following functions:

- Rainfall runoff
- Pollutant build-up
- Pollutant wash-off
- Constituent loadings

The predictive procedure can be used for Environmental Impact Statements (EIS) or to determine the loadings for pollutant discharge effects of various design storms at a particular site. The predictive procedure is not meant to be an all-inclusive model which predicts hydrographs and concentrations versus time, but rather an easy-to-use method of determining the total volume of runoff and total pounds of a pollutant discharged from a highway area. The highway area under consideration is defined as the paved roadway and total nonpaved area which contribute to a particular discharge point.

In addition to EIS applications, the procedure evaluates existing highway systems. Thus, the effects of increased traffic, changes in the curb or barrier configuration, or modifications to the nonpaved area can be determined as they relate to the total pollutant loading. Design storm analyses can be conducted on an existing highway drainage area using the predictive procedure. The pollutant loadings, as predicted for these storms, can then be used to evaluate different water quality impacts through mass balance or modeling analyses. In this manner, the pounds of a pollutant discharged from a highway drainage area can be compared to other pollutant sources within the watershed.

C. GENERAL OVERVIEW

In order to use this method, the following information is required:

- Rain event data including date, total rainfall, estimated rainfall duration, and number of dry days between rainfall events
- Average Daily Traffic (ADT)
- Length of highway expressed as miles
- Drainage area above the point of discharge expressed as acres
- Estimated initial pollution levels expressed as pounds
- Total solids accumulation rate (optional, since the rate may be estimated based on ADT)

All of the above information is readily available to the highway engineer and water quality scientist.

Figure 8.2.1 provides an overview of the FHWA procedure.

1. Pollutant Accumulation Equation

The pollutant accumulation equation of the predictive model is as follows:

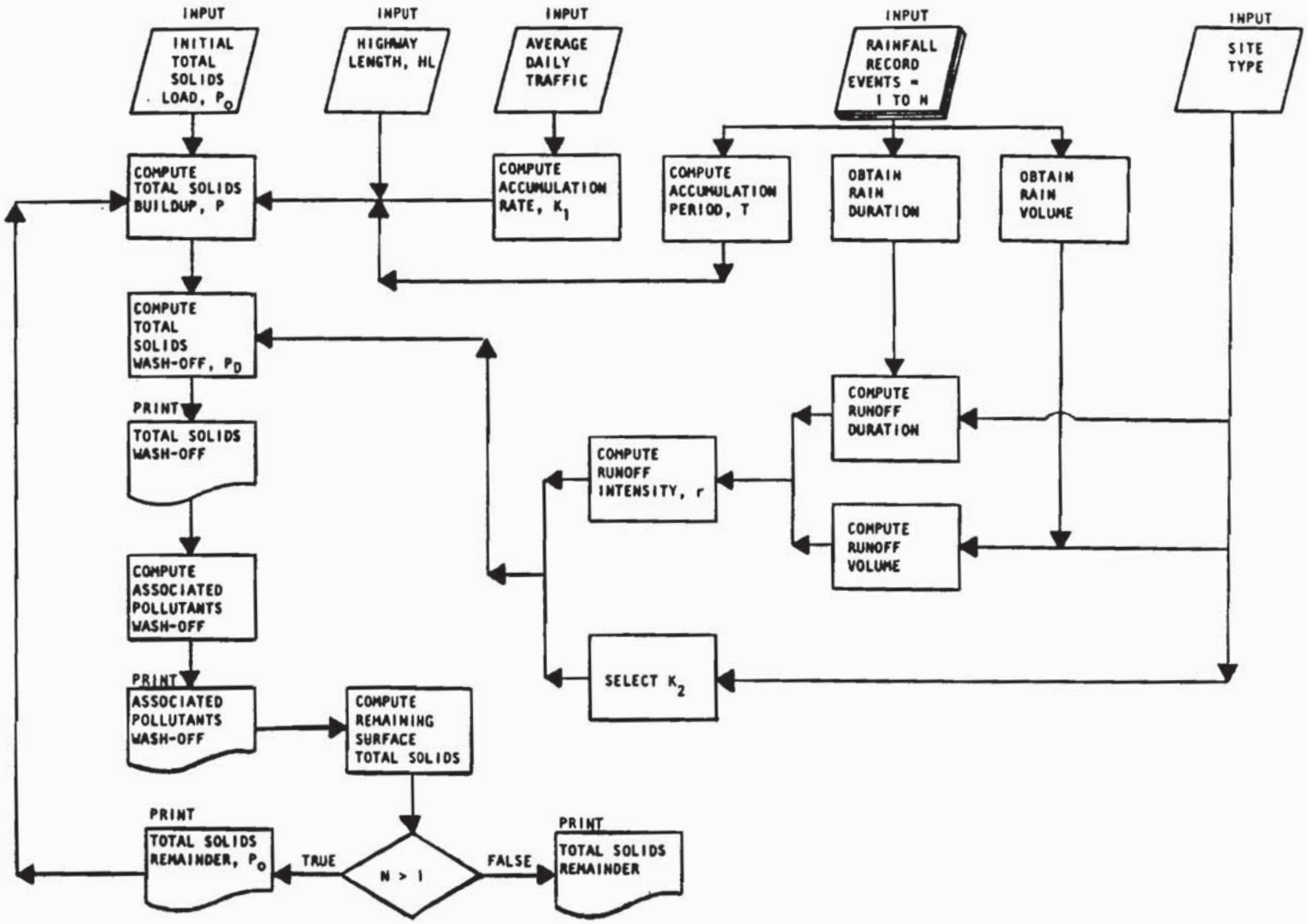
$$P = P_o + (K_1 * HL * T) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:
P = pollutant level after build-up, lb (kg)
P_o = initial surface pollutant load, lb (kg)
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
T = time of accumulation, days (20 day maximum)
HL = highway length, mi (km)

This model predicts the highway surface pollutant load (P) which accumulates during a selected time period (T) at a specified rate (K_1). Surface pollutants accumulate on the surface of all-paved sites (e.g., elevated bridge sections) and on the paved and unpaved surfaces of highway sections which have right-of-way areas (e.g. gravel shoulders, grassy areas, etc.). For purposes of the predictive model, pollutant load refers to that fraction of the total highway load available for wash-off.

The monitoring data from this study were "end-of-the-pipe" wash-off data, which are not a direct measure of pollutant build-up. Therefore, monitoring data could not be used to establish whether pollutant build-up

Figure 8.2.1 Predictive flow diagram



Source: Gupta, M.K. et al., 1981c

on highways is linear, exponential, or another mathematical function. The pollutant accumulation equation assumes that pollutants build up linearly during the accumulation period. This equation is similar to that used in Storage, Treatment, Overflow, Runoff Model (STORM) from Abbott (1976), which is based on a linear pollutant build-up relationship developed from a study on urban runoff in Chicago.

The surface pollutant accumulation variable K_1 is the rate at which the carrier pollutant, total solids, accumulates in pounds per mile per day (kg/km/day). A carrier pollutant exhibits the highest degree of association with all other pollutants being considered. In many mathematical models, the predicted quantity of carrier pollutant is used to estimate the quantity of all other pollutants being modeled. This method eliminates the need for each pollutant to be predicted separately by the model, greatly reducing the number of calculations required. Total solids were chosen as the carrier pollutant for the predictive model developed in this study, because they showed the highest correlation with the other monitored quality parameters when regression analyses were performed. The term total solids (TS) refers to total suspended solids (TSS) plus total dissolved solids (TDS). Under the new nomenclature of Standard Methods, total solids as used in this study, are defined as total residue.

K_1 was developed from monitored data, and is expressed as pounds per mile - day (kg/km-day). The unit miles refers to the actual length of highway section in the contributing drainage area. This is in contrast to curb mile or lane mile, which is a multiple of the highway length. K_1 is site specific, and its value may be based upon actual monitoring data, if it exists, or estimated from average daily traffic. K_1 estimation based on average daily traffic is discussed at the end of this section.

The initial surface pollutant load (P_o) is the pounds of pollutants on the surface at the beginning of the accumulation period. The accumulation period can be intervals within an actual rainfall record, intervals within a series of design storms, or the period prior to a single design storm event.

If an accumulation period follows a large storm event, the initial surface pollutant load will be considered zero (P_o=0). The definition of a large storm is based upon that used in the Stormwater Management Model (SWMM) for the rate of pollutant removal during a storm event. For purposes of the predictive procedure, a large storm event is defined as one with greater than one inch (2.54 cm) of total rainfall, and having at least one hour in which the average intensity is 0.5 inches per hour (1.27 cm/hr). For such a storm, SWMM estimates that approximately 90 percent of the surface pollutants available for wash-off have been removed.

For succeeding rainfall events in a continuous rainfall record, P_o is the surface pollutant load remaining after wash-off from the previous rainfall event. For rainfall records which do not follow a large storm event or for design storms, the initial surface pollutant load must be estimated using a site specific K_1 value, site length, and a specified period of build-up or estimate. An analysis of monitored wash-off data and rainfall records during the subject study suggests that dry periods greater than 20 days over-estimate the surface load; therefore, any dry periods exceeding 20 days are assumed to equal 20. The initial surface pollutant load for a site with a K_1 of 80, and a site length of 5 miles would be:

$$80 \frac{\text{lbs}}{\text{mi-day}} * 5 \text{ mi.} * 20 \text{ days} = 8{,}000 \text{ lbs } (3{,}629 \text{ kg})$$

Any rainfall less than 0.05 inches (0.13 cm) is considered a trace of rain not producing runoff of sufficient volume and rate to effect pollutant wash-off. Figure 8.2.2. indicates the relationship between pollutant build-up and rainfall intensity and volume.

The minimum runoff duration that can be used in calculating average runoff intensity is 0.5 hours. Short duration flows, less than 0.5 hours, are often the result of small storms producing less than 0.1 inches (.25 cm) of flow. Using the high average runoff rates calculated from such storms gives more weight to the pollutant wash-off ability of a small storm that occurs. For this reason, all storms used in the predictive procedure were considered to have a duration of at least 0.5 hours, eliminating overestimates of total solids wash-off for short duration storms. For example, a storm producing 0.05 inches (.12 cm) of runoff in 0.17 hours (10 minutes) would have an average runoff rate calculated using an adjusted runoff duration of 0.5 inch/hr as follows:

$$\begin{aligned} \text{Average runoff rate} &= 0.05 \text{ inch of flow} \div 0.5 \text{ hours} \\ &= 0.10 \text{ inch/hr } (0.25 \text{ cm/hr}) \end{aligned}$$

Otherwise, the average rate calculated from the actual runoff duration (0.17 hr) would be 0.29 inch/hr (0.73 cm/hr) and would cause a large overprediction of pollutant wash-off.

2. K_1 Variable

The total solids accumulation rate (K_1) varies from location to location. Selected K_1 previously reported in the literature are indicated in Table 8.2.1.

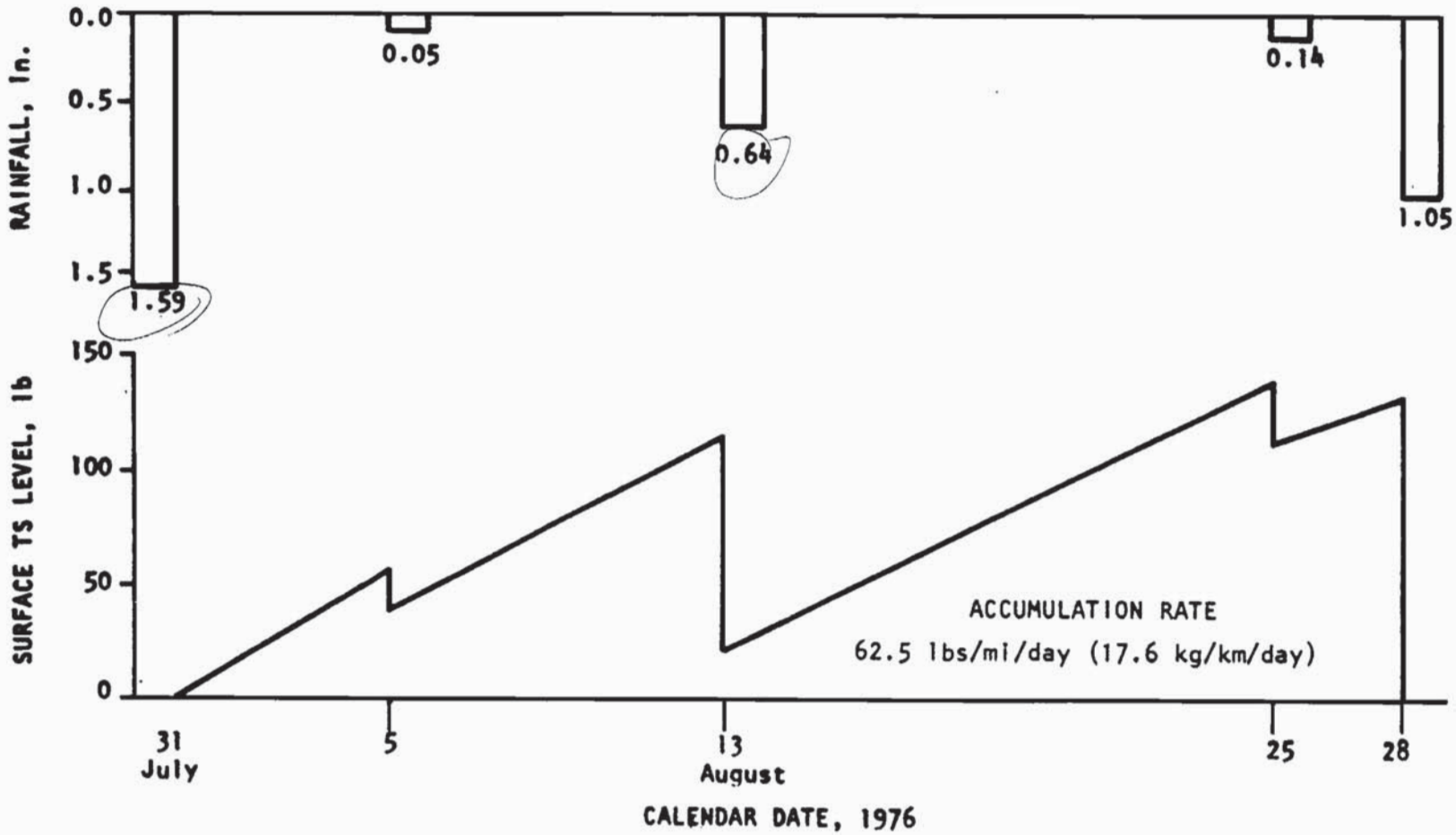


Figure 8.2.2. **Surface total solids level, Milwaukee - Hwy I-794.**

Table 8.2.1. Published K_1 values

Total solids accumulation rate, lb/mi-day	Location	Solids collection Techniques	Reference
1,580	Chicago City Sts.	Sweeping	American Public Works Association, 1969
1,180	11 U.S. City Sts.	Combined sweeping and flushing	Sartor, J.D. and G.B. Boyd, 1972
10.4	Seattle Highway	Runoff analysis	Sylvester, R.O. and F.B. DeWalle, 1972
382	Washington, D.C.	Vacuuming and	Shaheen, D.G., 1975
69.4	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973
26.6	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973a
236.9	Milwaukee (non-winter)	Mass balance for TS 250	Kobriger, N.P., 1984

metric units: lb x 0.454 = kg
mi x 1.609 = km

The total solids accumulation rate was correlated with ADT for the sites included in the monitoring study (Figure 8.2.3). As a result, it is possible to calculate the appropriate solids build-up rate using the following equation, when site specific rates are not available:

$$K_1 = (ADT^{0.89})\ 0.007$$

3. Wash-Off Coefficient (K_2)

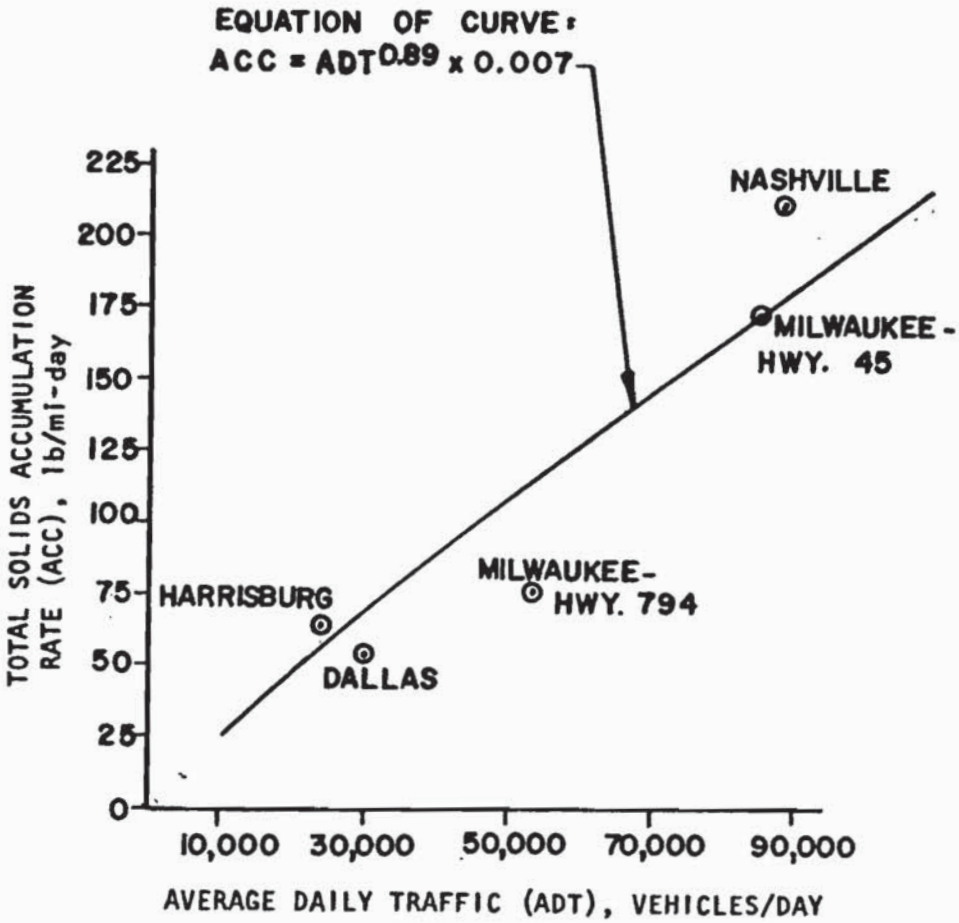
The coefficient K_2 is used in the predictive procedure to remove a portion of the carrier pollutant from the surface of the drainage area. The general wash-off equation in the Corps of Engineer STORM model and U.S. EPA Stormwater Management Model (Huber, 1975) is used as part of this procedure.

$$P_D = P\ (1-e^{-K_2 r})$$

Where: P_D = pounds (kilograms) of pollutant discharged
P = surface load at start of the runoff event.
K_2 = wash-off coefficient
r = average runoff rate, in./hr. (cm/hr)

For purposes of the predictive procedure, a single K_2 value is required for each of the three site categories. Based upon the comparison of individual K_2 values with actual monitoring data, a K_2 value of 6.5 represents sites which contain some curb or barrier, structured drainage, and grassy right-of-way (Type II). A value of 12 represents a rural, flush shouldered site (Type III) which uses grassy

Figure 8.2.3. Selected total solids accumulation rates versus average daily traffic



Source: Kobriger, N.P. et al., 1981

ditch conveyance for the surface runoff. A K_2 value of 5.0, selected for the Type I site, will be used for elevated bridge decks which are completely paved.

The Type III site requires the highest K_2 value in order to wash-off larger amounts of the pollutant load per runoff volume than other sites. This site type's flush shoulder and the nonpaved drainage conditions probably account for the high, since the grassy areas adjacent to the roadway require more pollutant wash-off per event to remove the pollutant load. The Type I site has the lowest K_2 value, indicating that pollutant wash-off is easier from a site that is all paved than a site with both paved and unpaved areas (Type II and III).

4. Constituent Loadings

The final component of the predictive procedure transforms the pounds of total solids washed off into pounds of lead, COD, suspended solids, or any other of the 16 quality constituents available in the model. The prediction of heavy metals, nutrients, solids and other parameters for individual storm events rely upon linear regression equations for predicting each parameter as a function of the total solids load for each site (Tables 8.2.2 and 8.2.3).

For example, the determination of the COD load for the Milwaukee I-794 site is as follows:

$$COD\ (lb) = 0.202\ TS + 5.47$$

where: TS = total solids in pounds

The asterisk in Tables 8.2.2 and 8.2.3 next to equations indicates significance at the 95 percent confidence limits (1). This indicates that one can be 95 percent confident that the sample was not selected from a population for which no correlation exists (i.e., that the correlation coefficient R is equal to zero). An equation may still provide good estimates even if the variables in that equation do not show a significant correlation at the 95 percent confidence level (Gupta et al., 1981c). An equation developed using regression techniques is the best fit of the data being analyzed.

The predictive procedure uses a separate constituent equation for each general site type. Individual equations account for differences between site drainage and solids retention characteristics.

D. PREDICTIVE PROCEDURE RESULTS

Table 8.2.4. summarizes the application results of the procedure to the five monitoring sites, plus a sixth site not included in the development of the procedure.

Table 8.2.2 Constituent equations developed for Type I and Type III sites.

Parameter		Type I Milwaukee I-794	Type III Harrisburg I-40
SS	=	0.53TS - 3.2*	0.32TS - 36.8*
VSS	=	0.191TS + 0.2*	0.061TS-3.3*
TVS	=	0.221TS + 13.3	0.32TS - 32.3*
TKN	=	3.3×10^{-3} TS + 0.16	3.1×10^{-3}TS+ 0.55*
BOD	=	0.023TS + 1.5*	N/A
TOC	=	0.057TS + 0.80*	0.068TS - 5.85*
COD	=	0.202TS + 5.47*	0.087TS + 0.65*
TN	=	1.37×10^{-3} TS + 0.12	1.83×10^{-3} TS+0.054*
TPO_4	=	1.0×10^{-3} TS + 3.0×10^{-4}	2.15×10^{-3}TS - 0.245
Cl^-	=	0.034TS + 2.59	0.135TS + 2.6*
Pb	=	5.6×10^{-3}TS - 0.024	4.1×10^{-4}TS - 0.029*
Zn	=	8.4×10^{-4}TS + 0.014	2.67×10^{-4}TS-0.011*
Fe	=	0.015TS + 0.59	0.014TS - 1.61*
Cu	=	2.9×10^{-4}TS+7.3×10^{-4}	7.4×10^{-5}TS+8.78×10^{-3}*
Cd	=	1.4×10^{-4}TS-1.4×10^{-3}	4.0×10^{-5}TS+0.007
Cr	=	1.6×10^{-4}TS+1.2×10^{-3}	2.3×10^{-4}TS-0.028
Hg	=	-7.6×10^{-7}TS+8.8×10^{-4}	-5.8×10^{-6}TS+0.015*

Note: TS = total solids (lb)
* - Variables correlate at the 95 percent confidence level.
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.3 **Constituent equations developed for Type II sites.**

Parameter	Equation
SS	$0.63TS - 188$
VSS	$0.152TS + 13.5$
TVS	$0.263TS + 243$
TKN	$5.46 \times 10^{-3}TS + 1.28$
BOD	$3.0 \times 10^{-2}TS + 28.3$
TOC	$5.6 \times 10^{-2}TS + 25.2$
COD	$0.193TS + 275.3$
TN	$1.3 \times 10^{-3}TS + 0.713$
TPO_4	$2.25 \times 10^{-3}TS - 0.32$
Cl	$0.042TS + 87$
Pb	$1.02 \times 10^{-3}TS + 0.04$
Zn	$5.84 \times 10^{-4}TS + 0.103$
Fe	$1.96 \times 10^{-2}TS - 5.0$
Ni	N/A
Cu	$3.16 \times 10^{-4}TS + 0.064$
Cd	$4.16 \times 10^{-5}TS + 0.021$
Cr	$4.3 \times 10^{-5}TS + 0.036$
Hg	$2.44 \times 10^{-6}TS + 1.006 \times 10^{-6}$

Note: TS = total solids (lb)
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.4. Summary of Model Versus Actual Monitored Non-Winter Total Pollutant Loads Used to Develop the Predictive Procedures (except the Dallas Site)

Site Location	Total Solids, lb	Suspended Solids, lb	TPO_4, lb	COD, lb	Lead, lb[1]	Iron, lb
Milwaukee I-794						
Actual	1,862	570	1.03	271	5.17	22.94
Predicted	1,640	658	0.86	245	4.55	20.66
Predicted vs. Actual %	-11.9	+15.4	-16.5	-9.6	-12.0	-10.0
Milwaukee Hwy 45						
Actual	55,024	29,123	34.76	6,863	53.6	929.75
Predicted	63,478	36,665	137.11	17,205	65.47	1,115.14
Predicted vs. Actual %	+15.4	+25.9	+294.4	+150.7	+22.2	+24.2
Nashville I-40						
Actual	20,273	10,692	65.81	3,909	24.76	268.06
Predicted	23,325	11,369	30.62	6,294	24.53	367.97
Predicted vs. Actual %	+15.1	+6.3	-53.5	+61.0	-1.0	+37.3
Harrisburg I-81						
Actual	3,655	767	6.43	212	1.40	31.97
Predicted	3,689	835	5.64	170	1.22	36.59
Predicted vs. Actual %	+1.0	+8.9	-12.3	-19.8	-12.9	+14.5
Denver I-25						
Actual	11,016	7,263	13.66	4,338	11.99	252.43
Predicted	15,118	7,189	27.67	7,029	16.04	231.97
Predicted vs. Actual %	+37.2	-1.0	+117.2	+62.0	+33.8	-8.1
Dallas I-45						
Actual	468	204	NA	345	1.18	5.60
Predicted	626	307	NA	169	3.32	14.10
Predicted vs. Actual %	+33.8	+50.5	-	-51.0	+181.4	+151.8

[1]Caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive procedure equation was developed.

As can be seen, the predicted versus the actual monitored data are within one order of magnitude for all values. Total solids and suspended solids in particular, are fairly close, although greater variation exists for other constituents. When predicted versus actual loadings on an event basis are compared, greater variation exists. Thus, the model is best suited for monthly or non-winter period evaluations.

The model is undergoing further evaluation and validation by FHWA in a study initiated in September, 1984, titled Design Procedures to Estimate Pollutant Loadings from Higher Stormwater Runoff. The study is to be completed in FY 1986.

E. MODEL LIMITATIONS

The predictive procedure is a tool for evaluating the effects of increased traffic, changes in the highway configuration, or other design aspects, on the loading of solids or other constituents to the receiving water.

Because of the complex interaction of rainfall, runoff and traffic on a highway, the prediction model has certain limitations. Users of the procedure are encouraged to further study the Predictive Procedures to ensure a full understanding of the components of the model and aid in the interpretation of the results (Kobriger, 1981c).

Specific limitations of the procedure are as follows:

- Geographic locations with low intensity, frequent rainfalls, e.g., Washington state, should not use this procedure. Research (Horner et al., 1982) demonstrates situations where ADT is not a valid variable to estimate pollutant accumulation on the roadway surface. This method will not be acceptable for use in California and states with similar climatic conditions.

- The procedure should be limited to non-winter periods. As such, the results will reflect only a portion of the total loadings that can be expected from a roadway. As shown in a more recent study (Kobriger, 1984), winter pollutant accumulation can be significant, although the dispersion is more complex and highly variable.

- The predictive procedure is better suited to continuous simulation using daily rainfall records covering periods of at least one month, since it is unable to predict surface loads prior to individual events.

- The model assumes the highway area to be uniformly characterized by the three site types that are listed. Significant variations in a site may have widely varying results.

- The predicted pounds of total solids washed off during a rainfall event are dependent upon the model prediction of the surface load at the start of the storm. If the surface load is underestimated, the pounds discharged will be low.

- The use of average runoff rate to remove surface pollutants is the quickest and easiest method. Peak runoff intensities during the runoff hydrograph may be more accurate, but are too complex for this procedure.

- Long dry periods and overlapping storms present predictive problems in determining the pre-storm surface load.

- Construction activities are difficult to simulate unless monitoring data is available to determine K_1 values.

II. FHWA PROCEDURE FOE ESTIMATING POLLUTANT LOADS

1. Determine the pollutant accumulation rate for the project site being evaluated if site specific or other accumulation values are being used:

$$K_1 = (ADT^{0.89}) * 0.007$$

where: K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
ADT = average daily traffic, vehicles/day

Example: If the site has an ADT of 30,000 vehicles per day, the K_1 value that results would be:

$$K_1 = (30{,}000^{0.89}) * 0.007$$
$$= 67.6 \text{ lb/mi-day } (19.1 \text{ kg/km-day})$$

2. a. Using K_1, determine the pounds of total solids on the surface of the project site at the start of the storm event:

$$P = P_o + (K_1 * HL * T)$$

where: P_o = initial surface pollutant load, lb
P = pollutant level after build-up, lb
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
HL = highway length, mi(km)
T = time of accumulation, days (20 days maximum)

The variable P_o is a function of the amount (load) of pollutants estimated to be left on the surface after the last rainfall event. If more than one event is being evaluated, e.g., monthly or seasonal loadings are being determined, the results of P_o are carried through the calculations on an iterative basis by subtracting the pounds washed off from the previous pollutant load. The build-up rate, K_1, is then used for each dry day to add to P_o until the pollutant load at the start of the next event is determined.

The initial estimation of a P_o is made easier if the first storm to be evaluated follows a storm of average rainfall intensity greater than 0.5 inches (1.27 cm) per hour. This large storm is assumed to wash-off essentially all of the available total solids load on the surface. The succeeding dry days are then used to build up the available surface load to the start of storm conditions. Further descriptions of P_o and K_1 are included in the components description of this report.

Example: If the accumulation period is six days, the highway length is 6.5 miles, K_1 is 67.6 16/mi-day (19.1 kg/km-day) (predicted from the ADT of 30,000 vehicles/day) and P_o is zero (assume accumulation period started with a large storm). The pollutant level after build-up (P) would be:

$$
\begin{aligned}
P &= P_o + (K_1 * HL * T) \\
&= 0.0 + (67.6 \text{ lb/mi-day} * 6.5 \text{ miles} * 6 \text{ days}) \\
&= 0.0 + (2{,}636.4 \text{ lbs}) \\
&= 2{,}636.4 \text{ lbs } (1{,}196 \text{ kg}) \text{ of total solids available at the start of event number one.}
\end{aligned}
$$

b. If a large rainfall event does not occur at the beginning of the initial accumulation period of the month or period being evaluated, P_o must be estimated. One method is to evaluate local climatic data to determine the average number of dry days between rainfall events. P_o can then be estimated using the average number of dry days, K_1 and highway length.

Another approach would be to estimate the pollutant load for the first event in the period, and determine the number of dry days since the last rain event prior to the start of the event period actually being evaluated. Note: The event used to establish the accumulation period for the first event in the period or month of concern must be rainfall, not snowfall, otherwise use the first approach. Assume that $P_o = 0$. Then count the number of dry days to determine the load available for the first event for the period. This will slightly underestimate the pollutant load on the highway's surface if this previous event was less than 0.5 in./hr., since it will not account for the load left on the surface. This applies to the first approach as well.

Example (1st approach): If a large storm did not precede the initial accumulation period, and if the average number of dry days between storms was determined to be four, the estimate of P_o would be calculated as follows:

$$P_o = K_1 * HL * T$$
$$= 67.6 * 6.5 * 4$$
$$= 1{,}758 \text{ lb } (797 \text{ kg})$$

3. Calculate load wash-off using the average runoff rate (r) using the following formula:

$$P_D = P(1-e^{-K_2 r})$$

where: P_D = pollutant load discharged (total solids), lb (kg)
P = pollutant load at the storm start, lb (kg)
K_2 = wash-off coefficient r = average runoff rate - inch/hr (cm/hr)

K_2 is selected based upon site characteristics as follows:

K_2 =	Type 1	Type 2	Type 3
	5.0	6.5	12.0

Example: Assuming the site is Type II, the pounds of total solids removed would be determined as follows (P = 2,636 lbs; r = .019 in./hr, assumed here; K_2 = 6.5)

$$P_D = P(1-e^{-K_2 r})$$
$$= 2{,}636\ (1-e^{-(6.5)(0.019)})$$
$$= 306 \text{ lb of total solids discharged } (139 \text{ kg})$$

4. Calculate the surface load remaining after the storm from the above example.

$$P_o = P - P_D$$
$$= 2{,}636 \text{ lb} - 306 \text{ lbs}$$
$$= 2{,}330 \text{ lb of total solids remaining } (1{,}057 \text{ kg})$$

Thus, P_o for the next event is 2,330 lb (1,057 kg). This amount is then added to P (pollutant load after build-up that is available for washoff by next rainfall event.)

5. To calculate loadings, use the equations in Tables 8.2.2 and 8.2.3 for each pollutant of interest for each site type. The results will be expressed as pounds of pollutants discharged at the highway site for each event.

Example: From the previous example, it was determined that 306 lbs of total solids were washed off from the site. To calculate the amount of the pounds Zn washed off:

$$Zn = 5.84 * 10^{-4}TS + 0.103$$
$$= 5.84 * 10^{-4}(306) + 0.103$$
$$= .28 \text{ lbs of Zn}$$

6. Determine the average concentration of Zn in the highway runoff using the following formula (7.48 is a conversion factor to convert volume to gallons):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

Example: From the previous step, the loading of Zn was determined to be .28 lbs. Thus, the average concentration in the runoff would be (Assume Q_{cf} = 7,000):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

$$= \frac{.28 \text{ lbs} * 454{,}000 \text{ mg/lbs}}{7{,}000 \text{ cf} * 7.48 * 3.785 \text{ liters/gallon}}$$

$$= \frac{127{,}120 \text{ mg}}{198{,}182 \text{ liters}}$$

$$= .641 \text{ mg/liter of Zn in highway runoff.}$$

7. Repeat the above calculations to obtain the total solids wash-off for each event and pollutants.

III. CALIFORNIA METHOD FOR ESTIMATING

A. INTRODUCTION

Caltrans has developed a different procedure for estimating highway runoff quality (Howell et al., 1982; Kerri et al., 1985). Its method reflects the findings of studies for sites located in California:

- The number of dry days between storm events and the corresponding cumulative traffic volume before the storm were found to be not statistically significant for estimating constituent loads.

- Equations used to estimate the cumulative loads of the following pollutants were found to be statistically significant at the .05 level, on a storm event basis when:

- Correlated with vehicles during the storm: COD, Filterable Residue (Dissolved Solids), Lead (T), TKN, ZN(T).

- Correlated with total residue: COD, Nonfilterable Residue (Suspended Solids), ZN(T).

- No statistically significant correlations at the .05 level of significance were found with any of the independent variables examined: boron, cadmium, nitrate nitrogen, ammonia nitrogen, total phosphorus, dissolved orthophosphate, oil and grease. Thus, these pollutants cannot be estimated using the Caltrans procedure.

- The method is considered suitable on an event basis.

- The regression equations developed in this research can be used for calculating constituent loads from the paved travelled way and shoulder area. In order to assess the effects of the constituent load on nearby receiving waters - the load must be routed through the drainage system and ultimately to the receiving water - runoff from other sources may be encountered and must be included - highway runoff dilution factors in terms of the receiving water source must be accounted for.

B. PROCEDURE FOR USING THE REGRESSION EQUATIONS

In using the Caltran procedure the following assumptions are made:

- The vehicle fleet and fuels used are relatively the same as the years of actual data collection (1979 through 1981) to build the regression equations.

- The highway is in an urban setting.

- The drainage area of the roadway surface is between 2.00 and 3.00 acres, as this was the smallest area from which data were collected to build the equations. (HL * HW of pavement = 72<3 acres).

- The median, traveled lanes, and shoulders are 100 percent paved.

- The procedure should be used with highways having ADT exceeding 30,000 vehicles, and only when a sensitive receptor, e.g. stream, lake etc., is located adjacent to the facility.

- Runoff from the assumed drainage area is conveyed via open channels to a single point of discharge. (Runoff quantity and quality from the unpaved area adjacent to the paved area was excluded from the research.)

- The storm chosen is an annual one-day rainfall event (two-year return interval) versus actual continuous events evaluation required by FHWA procedure.

- A 24-hour storm is chosen as the storm duration, since a storm lasting 24 hours will be sufficient to wash-off the gutter load and will allow both the AM and PM peak traffic to travel through the site and contribute to the runoff load. A 24-hour storm is used because the future traffic prediction is a 24-hour value.

- A runoff coefficient of 0.90 is used to compute the cumulative runoff volume because the drainage area is completely paved.

1. Using the projected average daily traffic (ADT), compute constituent loads using the linear regression equations below which were evaluated and found to be acceptable.

Eq.1	Pb	= 14.3 + 0.00189 (ADT)
Eq.2	Zn	= 14.3 + 0.00060 (ADT)
Eq.3	FR	= 5360 + 0.140 (ADT)
Eq.4	COD	= 3590 + 0.221 (ADT)
Eq.5	TKN	= 150 + 0.00342 (ADT)

Where: Pb, Zn, FR, COD, and TKN are the cumulative loads in grams for lead, zinc, filterable residue, chemical oxygen demand, and total Kjeldahl nitrogen, respectively, the intercepts represent initial dry loads in grams, while the slopes represent the washoff of a constituent in grams per ADT during storm.

2. To forecast an annual load, divide the depth (amount) of the total annual rainfall (2-year return interval, 365-day value) for the station by the 1-day depth. The result is the theoretical number of 1-day events per year. Multiply each of the daily loads by the number of 1-day events to arrive at an annual load.

3. The flow weighted concentration is computed by dividing the daily event load determined in Step 1 (above) by the 1-day cumulative runoff volume.

4. The following linear regression equations are used to calculate nonfilterable residue loads:

Eq.6	Zn	= 11.5 + 0.00064 (TR)
Eq.7	COD	= 3600 + 0.214 (TR)
Eq.8	NR	= -760 + 0.65 (TR)

Where: TR is total residue in grams, Zn, COD, and NR are the cumulative loads in grams for zinc, chemical oxygen demand, and nonfilterable residue, respectively. The intercepts represent the initial dry loads in grams, while the slopes represent the fraction of constituent found in the total residue load washed from the pavement during the storm. Because total residue is an independent variable for which no easy future value can be obtained, the following procedure should be executed. Substitute values of the total zinc load computed from Equation 2 and the chemical oxygen demand load computed from Equation 4 in Equations 6 and 7 and compute two values of total residue. Then use the average value of total residue to compute the nonfilterable residue load using Equation 8. Compute the flow-weighted concentration as in Step 3 (above).

5. The final step is to check the computed loads and flow-weighted concentrations to make sure that the computed values are bound by the field observations. Table 8.2.5. shows the limits of the observed concentrations and loads.

Table 8.2.5. Limits of observed concentrations and loads of single events from monitored events in California.

Constituent	Concentration (mg/l)		Load (grams)	
	Low	High	Low	High
Total lead	0.17	4.10	4.0	304
Total zinc	0.10	1.80	2.0	84
Filterable residue	16	461	428	50,167
Chemical oxygen demand	23	724	382	26,344
Total kjeldahl nitrogen	0.1	14.0	34	1,070
Nonfilterable residue	18	2,660	143	55,259

Source: Howard et al., 1982

6. Final water quality assessment must be made using the values of loads and concentrations in a receiving water analysis.

C. EXAMPLE PROBLEM USING CALTRAN PROCEDURE

The following example problem is taken directly from Howell (1982) and is reproduced here to demonstrate the use of the Caltran model.

Problem: An urban freeway has been proposed for year 2005 and will have the following dimensions:

46 feet of paved median	=	46 ft
Two 10-foot wide shoulders	=	20 ft
Four 12-foot wide lanes	=	48 ft
		114 ft width

The ADT for year 2005 is 56,800 vehicles. The project will cross a river used for recreation and fishing. Trout (Salmo gairdneri) inhabit the river. Average annual rainfall for the site is 22 inches.

Make the following assumptions:

- The paved width of 114 ft and each 750 ft of freeway length will be drained to a single discharge point.
- Runoff coefficient is 0.90; thus, .90 * rainfall volume = runoff volume.
- A 24-hour storm delivers 2.06 inches of continuous rainfall.
- The vehicle fleet (and fuel used) will be the same in 2005 as it was in 1980. The vehicles are operating normally, i.e., at speeds of 55 miles per hour with no accidents or spills.

Given the above data and assumptions compute:

- The area of the assumed catchment.
- The cumulative volume of runoff (in liters).
- The loads and flow-weighted concentrations of the constituents: lead (Pb), Zinc (Zn), filterable residue (FR), chemical oxygen demand (COD), and total Kjeldahl nitrogen (TKN), and nonfilterable residue, using equations 1 through 5.

1. Area = length (ft) * width (ft) $\left(\frac{1 \text{ acre}}{43{,}560 \text{ ft}^2}\right)$ = acres

$$= 750 * 114 * \frac{1}{43{,}560} = 1.96 \text{ acres}$$

(1.96 acres approaches the lower limit of 2.0 acres, the smallest area from which data were collected to build the equations).

2. Cumulative Runoff Volume = runoff coefficient * rainfall volume

   = [0.90] * [2.06 in] * [1.96 ac] * [3630 ft^3/ac-in] [28.32 l/ft^3]

   = 373,564 call 373,500 liters

3. First, compute the load in grams using the appropriate regression equation, then compute the flow-weighted concentration (conc.) in milligrams per liter:

$$\text{conc.(mg/l)} = \frac{\text{Load (grams)}}{\text{cumulative runoff volume (liters)}} * \frac{\text{1000 milligrams}}{\text{1 gram}}$$

Eq.1	Pb	=	14.3 + 0.00189 (56,800)	
		=	121.65	122 grams
	$\overline{\text{conc.}}$	=	121.65/373,500 * 1,000	
		=	0.326	0.33 mg/l
Eq.2	Zn	=	14.3 + 0.00060 (56,800)	
		=	48.38	48 grams
	$\overline{\text{conc.}}$	=	48.38/373,500 * 1,000	
		=	0.129	0.13 mg/l
Eq.3	FR	=	5,360 + 0.140 (56,800)	
		=	13,312	13,300 grams
	$\overline{\text{conc.}}$	=	13,312/373,500 * 1,000	
		=	35.64	35.6 mg/l
Eq.4	COD	=	3,590 + 0.221 (56,800)	
		=	16,142	16,150 grams
	$\overline{\text{conc.}}$	=	16,142/373,500 * 1,000	
		=	43.22	43.2 mg/l
Eq.5	TKN	=	150 + 0.00342 (56,800)	
		=	344.26	344 grams
	$\overline{\text{conc.}}$	=	344.26/373,500 * 1,000	
		=	0.922	0.92 mg/l

Using the forecasted values of zinc (48 grams) and chemical oxygen demand (16,150 grams), an average value of total residue (TR) can be calculated using equations 6 and 7.

Eq.6 Zn = 11.5 + 0.000640 (TR)

Eq.7 COD = 3600 + 0.214 (TR)

Solve for total residue (TR):
Using (6) TR = 57,031 grams
Using (7) TR = 58,645 grams
Sum = 115,676 grams
Avg = 57,838 57,840 grams

Using Equation 8 and the average value of 57,840 grams for total residue (TR), solve for nonfilterable residue (NR):

Eq.8 NR = -760 + 0.65 (57,840)
= 36,836 grams 36,840 grams
conc. = 36,836/373,500 * 1000
= 98.62 98.6 mg/l

4. Check

The computed values within Table 8.2.5 to see if they are within the limits of the values recorded.

The results must be compared to established water quality criteria, and if any excessive values are found, mitigating measures (or transportation alternatives) may be needed.

IV. WASHINGTON STATE DEPARTMENT OF TRANSPORTATION PROCEDURE FOR WATER QUALITY IMPACTS

A. INTRODUCTION

The State of Washington has developed a procedure (Horner and March, 1982) to assess highway stormwater water quality, in-stream water quality and aquatic ecological impacts of operation highways. The procedure is based on a model (Chui et al., 1982) developed as part of an ongoing multi-year study, sponsored by the Washington Department of Transportation (WSDOT) and conducted by the Department of Civil Engineering of the University of Washington.

This model to estimate cumulative pollutant loadings is applicable when soils, climate, and land use are similar to those at the monitored highway sites used to develop the model. Thus, Oregon, Northern California, and Southern Idaho as well as Washington State, may find the model suitable for assessing the impact of highway stormwater runoff. The impact assessment component of the WSDOT procedure has been incorporated into the FHWA procedure (Session 8.4).

The model for estimating loadings differs in that it relies on vehicles during the storm (VDS) as the primarily independent variable to

estimate pollutant loads. Washington State experiences low intensity, long duration rainfall events unique to this portion of the country. This contrasts with other locations in the country where relatively intense but brief precipitation events occur. As has been shown in the State of Washington, the migration and transport of highway pollutants are more of a function of the kinetic energy provided by moving vehicles than by rainfall (Chui et al., 1982).

The model expresses cumulative runoff pollutant loadings as functions of highway geometry, drainage configuration, and, vehicles during the storm expressed as follows:

Eq.1 $TSS = (K)\ (VDS)\ (C)$

Eq.2 Pollutant loading i = (Kp_i) (TSS Loading)

where:
- TSS = loading of total suspended solids from runoff (lb/highway-mi)
- K = loading constant (lb/1000 VDS/highway-mi)
- VDS = vehicles during the storm (in thousands)
- C = runoff coefficient (ratio of runoff volume to precipitation volume)
- Kp_i = ratio of pollutant i to TSS

The model, in addition to its geographic considerations, is limited in suitability for long-term (monthly or annually) versus individual event projections. This is similar to FHWA's Predictive Procedure (Kobriger, 1981). Loadings in a given locale are highly variable on an event basis, but more constant in a longer time frame when normalized for traffic and using a runoff coefficient.

B. WSDOT ANNUAL POLLUTANT LOADING ASSESSMENT PROCEDURE

The following procedure is taken directly from Horner and Mar (1982) and represents only one portion of the procedure. If based on the initial annual analysis described in the procedure, a monthly evaluation is required and presented here as an example of another possible approach, given the restrictions previously described. It also illustrates the variations between highway sites.

1. Estimate the hr/yr during which the roadway is expected to be wet as equal to the hr/yr of recorded precipitation. The reported hr/yr of recorded precipitation ($\leq$0.01 inch) represents the mean of a number of years of data (1948-1964). Trace quantities are eliminated from consideration, since they generally do not produce runoff. The tabulated data are recommended as an estimate of the hr/yr of wet roadway, recognizing that two counteracting factors are operating: (1) the highway remains wet for some time after precipitation stops; however (2) precipitation does not necessary fall throughout a recorded hour.

2. Estimate the total annual vehicles passing during storms (VDS/yr) as follows:

$$\text{VDS/yr} = \text{ADT} \quad \frac{\text{wet hr/yr}}{\text{24 hr/day}}$$

where: ADT = projected average daily traffic on highway lanes draining to receiving water.

3. Estimate annual highway runoff TSS loading according to:

$$\text{TSS (lb/highway - mi/yr)} = (K) \quad \frac{\text{VDS/yr}}{1000} \; (C)$$

where: K = 6.4 lb TSS/highway-mi/1000 VDS for western Washington
K = 26 lb TSS/highway-mi/1000 VDS for eastern Washington
C = runoff coefficient for the site

The loading constants given apply to new highways and existing highways where traffic increase is anticipated. On existing highways the constants apply whether or not additional lanes are constructed, up to a maximum of four lanes in a single direction, representing the cases contributing to the data base (Little, 1982). With greater widths, pollutants deposited on innermost lanes may be transported less effectively into shoulder drainage, such that K would tend to decrease; however, there was no sampling to test this hypothesis.

Note: If the lanes in one direction only drain to the receiving water, adjust ADT accordingly.

4. Express total annual highway loading (L_H) by multiplying by number of highway-mi.

5. If a mitigation device such as a detention basin is provided, reduce the TSS loading according to the solids removal capability of the device. If highway runoff is discharged to receiving water via a vegetated drainage course, multiply the estimated TSS loading by the appropriate fraction as follows in Table 8.2.6 (after Wang, 1981). Interpolate as necessary.

6. Estimate annual highway loadings of other pollutants from:

$$\text{Loading (lb/yr)} = (K_p) \text{ (TSS Loading)}$$

where: K_p = ratio of pollutant P to TSS (Table 8.2.7.)
TSS Loading previously estimated

Table 8.2.6. Solids removal ability of vegetated drainage course.

Length of Vegetated Drainage Course (ft)	Fraction of Pollutant Remaining
≤30	1
31- 60	0.50
61- 90	0.40
91-120	0.30
121-150	0.26
151-180	0.23
≥180	0.20

Use the modified TSS loading in further calculations.

Source: Wang, 1981

Table 8.2.7 K_p (Pollutant:TSS Ratios) for Various Contaminants in Highway Runoff.

Pollutant	Abbreviation	K_p
Chemical Oxygen Demand	COD	$K_{COD} = 0.4$
Lead (Western Washington)	Pb	$K_{Pb} = 1.5 \times 10^{-4} + (8.7 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Pb} = 5.3 \times 10^{-4} + (2.8 \times 10^{-9})(ADT)$ (Note 1)
Zinc (Western Washington)	Zn	$K_{Zn} = 1.4 \times 10^{-4} + (3.0 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Zn} = 2.0 \times 10^{-4} + (3.2 \times 10^{-7})(ADT)$
Copper	Cu	$K_{Cu} = 7.9 \times 10^{-5} + (2.7 \times 10^{-9})(ADT)$
Nitrate + Nitrite-Nitrogen	NO_3+NO_2-N	$K_N = 2.0 \times 10^{-3}$
Total Kjeldahl Nitrogen (Western Washington)	TKN	$K_{TKN} = 2.7 \times 10^{-3}$
(Eastern Washington)		$K_{TKN} = 1.2 \times 10^{-3}$
Total Phosphorus	TP	$K_{TP} = 2.1 \times 10^{-3}$

Note: (1) Base predicted lead loading on the lead concentration in gasoline at the time in proportion to that during the years of research. During those years, the concentration was 0.13 grams/liter. That concentration is scheduled to be reduced under U.S. Environmental Protection Agency regulations, and that agency can provide information on adherence to the schedule. For estimation purposes, it should be assumed that the proportion of vehicles using leaded gasoline remains constant.

SESSION QUESTIONS:

1. Based on the different procedures, what are the major differences bewteen the predictive procedures presented?

2. What limitations restrict the use of the procedures presented?

3. In what ways may the most applicable procedure presented here be adopted to use in a particular state?

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will be able to:

- Calculate pollutant loadings from other land uses within a watershed, using the simplified method presented.
- Assess the loading impacts from the highway, relative to loadings from other land uses within the watershed.
- Recognize the problems of the method presented, and be introduced to other approaches that might be used when more sensitive analysis is required.

SESSION OVERVIEW:

One approach to assess the potential impacts of pollutant loadings from highways surfaces compares the area loadings from other land uses within the watershed to those loadings estimated from the highway right-of-way.

This session introduces a simplified procedure for conducting an impact analysis. Case Study 8.4 will be distributed and participants will complete the required analysis.

Participants will review questions at the end of the session and discuss the findings and other approaches used when more sensitive analysis is required.

8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

I. DETERMINATION OF BACKGROUND LOADINGS FOR THE DRAINAGE AREA

The following procedure is adapted from Horner and Mar (1982). This simplified procedure may be used for non-winter periods to determine background loadings for a watershed area, based on typical area pollutant loadings and typical runoff concentrations data for selected land uses reported in the literature. The actual loadings and runoff concentrations vary for each location, based on site characteristics (e.g., rural or urban), soil types, and other factors, and the results should be interpreted with caution. The procedure provides a relative indication of highway loads to background loadings, and may determine whether a more detailed evaluation using more complicated procedures is required. The steps of the procedure are:

1. If the receiving water is a stream and if a comprehensive water quality record exists for the stream, proceed to Step 2. Otherwise, go to Step 3.

2. Estimate the mean monthly loading of each pollutant transported by the stream, prior to the presence of the highway (L_s, lb/mo) according to:

$$L_s = 1{,}965\ Q_s C_s$$

where: Q_s and C_s are average quantities for the month in question.

where: Q_s = average stream discharge (cfs)
C_s = average pollutant concentration (mg/l)

The loadings for each month should be aggregated for the period, if the measured flow data are available.

Q_s may be the discharge rate determined for a specific drainage area; however, then C_s must be a flow weighted average for the same flow rate.

If the stream is gaged, obtain Q_s in the U.S. Geological Survey Water Resources Data provided for the most recent water year. If the stream is not gaged, estimate Q_s from the record of a nearby stream with similar watershed characteristics, as follows:

$$Q_s = Q_s^{\ 1} \frac{A_w}{A_w^{\ 1}}$$

where: Q_s = average discharge in runoff receiving stream (cfs)

$Q_s^{\ 1}$ = average discharge in stream of record (cfs)

A_w = runoff receiving stream watershed area (any area units)

$A_w^{\ 1}$ = stream of record watershed area (any area units)

3. Determine the areas (in acres) in Central Business District, Other Commercial, Industrial, Single-Family Residential, Multiple-Family Residential, Cropland, Pasture, and Forested and Open Land used in the watershed draining to the highway runoff discharge point located farthest downstream. If it is projected by the planning agency for the location that development will modify land uses substantially in coming years, conduct the analysis for both present and ultimate land uses.

4. Determine annual area loading (lb/acre/yr) of each contaminant for each land use in the receiving water basin from local data, if they exist, or Table 8.4.1. (Note storm runoff pollutant loadings for specific land use categories.) Where a range is given, use the lower value if a conservative estimate of highway contribution to total loading is desired; otherwise, use the midpoint of the range. If pollutant loading rates are not available for a specific pollutant, then go to Step 7.

5. Approximate the proportion of each annual area loading delivered during the month or period in question according to:

   lb/acre/mo (period)=[(hr ppt during month (period)/annual hr ppt) (lb/acre/yr)] or lb/acre/mo = []

6. Multiply loadings in lb/acre/mo by the respective acres to obtain loadings for the month (period) in question for each land use (L_{Li}). Then sum over all land uses for each pollutant (summation L_{Li}). Record results on Worksheet 8.4.a.

7. From Table 8.4.1a, determine the runoff coefficient for each land use in the watershed, above the discharge point for the project.

8. Multiply the runoff coefficient for each land use by the total seasonal rainfall for the site to obtain the runoff in inches.

9. Convert the runoff in inches to runoff volume by the following equation:

$$Q_{cf} = \frac{R \quad * \quad acres}{12 \quad * \quad 43{,}560}$$

R = runoff in inches
Q_{cf} = runoff in cubic feet

10. Convert Q_{cf} to liters by multiplying by 28.31625.

$R_L = Q_{cf} * 28.31625$

R_L = Runoff in liters

11. Determine total lbs. of pollutant by using the following equation and Table 8.4.2. Record results on Worksheet 8.4.b:

$P_{pD} = R_L * P_{conc} * 2.2046 * 10^{-6}$

where: P_{pD} = total pollutant loading
R_L = runoff volume expressed as liters
P_{conc} = pollutant concentration

12. If the receiving water is a stream, proceed to Step 13. If the receiving water is a lake or wetland, go to Step 15.

13. Estimate point source loadings (L_p) of each pollutant as follows:

L_p (lb/mo) = 1,965 Q_pC_p

where: Q_p and C_p are monthly quantities for the month in question

Q_p = point source effluent flow rate (cfs) (average over year if not continuous). Obtain flow from discharge monitoring report as required by NPDES permit or develop industry typical flow.

C_p = average point source effluent pollutant concentration (mg/l). Obtain from monitoring records or from industry typical discharge concentrations available from U.S. EPA Development Document Series for the specific point source category.

14. Estimate total stream loadings prior to highway presence as:

L_s = summation $L_{Li} + L_p$

Table 8.4.1. Storm runoff pollutant loadings for specific land use categories.

Land	Loading (lb/acre/yr)							
	TSS	COD	Pb	ZN	Cu	$+NO_3$ $_2$	TKN	TP
Central Business District	964	955	6.3	2.7	1.9	4.0	13	2.5
Other Commercial	750	906	2.7	2.9	N/A	0.6	13	2.4
Industrial	50	56	1.8-6.3	3.1-11	0.3-1.0	0.4	2-13	0.8-3.6
Single-Family Residential	15	25	0.1	0.2	0.03	0.3	1-5	0.2-1.3
Multiple-Family Residential	390	297	0.6	0.3	0.3	3.4	3-4	1.2-1.4
Cropland	402	N/A	0.004-0.005	0.03-0.07	0.01-0.05	7.0	1.5	0.3
Pasture	306	N/A	0.003-0.013	0.02-0.15	0.02-0.04	0.3	0.6	0.06
Forested	76	N/A	0.01-0.03	0.01-0.03	0.02-0.03	0.5	2.6	0.08
Open	6	1.8	N/A	N/A	N/A	0.3	1.5	0.06

NOTES:

1. Means given where available; otherwise ranges are reported.

2. N/A -- Not available. (If specific pollutant loadings are not indicated here, then, determine loadings based on mean concentration values.

SOURCE: Horner, R.R. et al., 1982.

Table 8.4.1a Values of runoff coefficients (C) for use in the runoff volume estimation.

Type of surface	Runoff coefficient (C)[a]
Rural Areas	
Concrete or sheet asphalt pavement	0.8-0.9
Asphalt macadam pavement	0.6-0.8
Gravel roadways or shoulders	0.4-0.6
Bare earth	0.2-0.9
Steep grassed areas (2:1)	0.5-0.7
Turf meadows	0.1-0.4
Forested areas	0.1-0.3
Cultivated fields	0.2-0.4
Urban Areas	
Flat residential, with about 30 percent of area impervious	0.40
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep built up area, with about 70 percent of area impervious	0.80
Flat commercial, with about 90 percent of area impervious	0.80

Source: Searcy, 1973.

[a] For flat slopes or permeable soil, use the lower values. For steep slopes or impermeable soil, use the higher values.

Table 8.4.2. Mean urban runoff concentrations by land use (NURP) (U.S. EPA, 1983)

Pollutant	Units	Residential	Commercial	Industrial	Mixed	Open
TSS	mg/l	206.0	160.0	143.0	297.0	218.0
BOD	mg/l	12.0	12.4	9.5	12.4	2.0
TN	mg/l	3.64	2.45	2.32	2.51	1.85
TP	mg/l	0.465	0.493	0.539	0.489	0.188
FCB (winter only)	cells/100 ml	7,099.0	7,099.0	7,099.0	7,099.0	7,099.0
S/S/F	cells/ 100 ml	31,995.0	31,995.0	31,995.0	31,995.0	31,995.0
O&G[a]	mg/l	3.89	13.13	7.1	6.23	.0
Fe	mg/l	2.73	2.73	2.73	2.73	2.73
As	ug/l	4.25	4.25	4.25	4.25	4.25
Cd	ug/l	1.58	1.58	1.58	1.58	1.58
Cr	ug/l	8.51	8.51	8.51	8.51	8.51
Cu	ug/l	19.7	19.7	19.7	19.7	19.7
Pb	ug/l	72.8	72.8	72.8	72.8	72.8
Hg	ug/l	0.5	0.5	0.5	0.5	0.5
Zn	ug/l	103.7	103.7	103.7	103.7	103.7
PCBs	ug/l	2.96	2.96	2.96	2.96	2.96
CHPs	ug/l	9.07	9.07	9.07	9.07	9.07

[a]Data taken from Stenstrom et al., 1984.

15. Express the impact on stream pollutant loadings in terms of the estimated increase due to P_d highway runoff as a percentage of the original stream loadings (L_s). If the estimated increase exceeds 10 percent for any pollutant, then mitigation may be required. If the stream eventually discharges to a lake or wetland, also evaluate the impact on the body of water according to the next Steps 16 and 17.

16. If the immediate or eventual receiving water is a lake or wetland, estimate total loadings for the month in question prior to the highway presence (L_{La}) as equal to summation L_{Li} plus any point source loading (1,965 Q_pC_p).

17. If the immediate or eventual receiving water is a lake, conduct a special analysis to assess the potential impact of phosphorus loading on trophic state as follows:

    a. Convert P_d and L_{La} to kg/mo by dividing by 2.2 lb/kg.

    b. Estimate annual loadings from the monthly or seasonal loadings found previously by proportion (for both P_d and summation L_{Li} + L_B):

$$\text{kg/yr} = \frac{\text{annual hr precipitation}}{\text{hr precipitation during the month}} \text{ (kg/mo)}$$

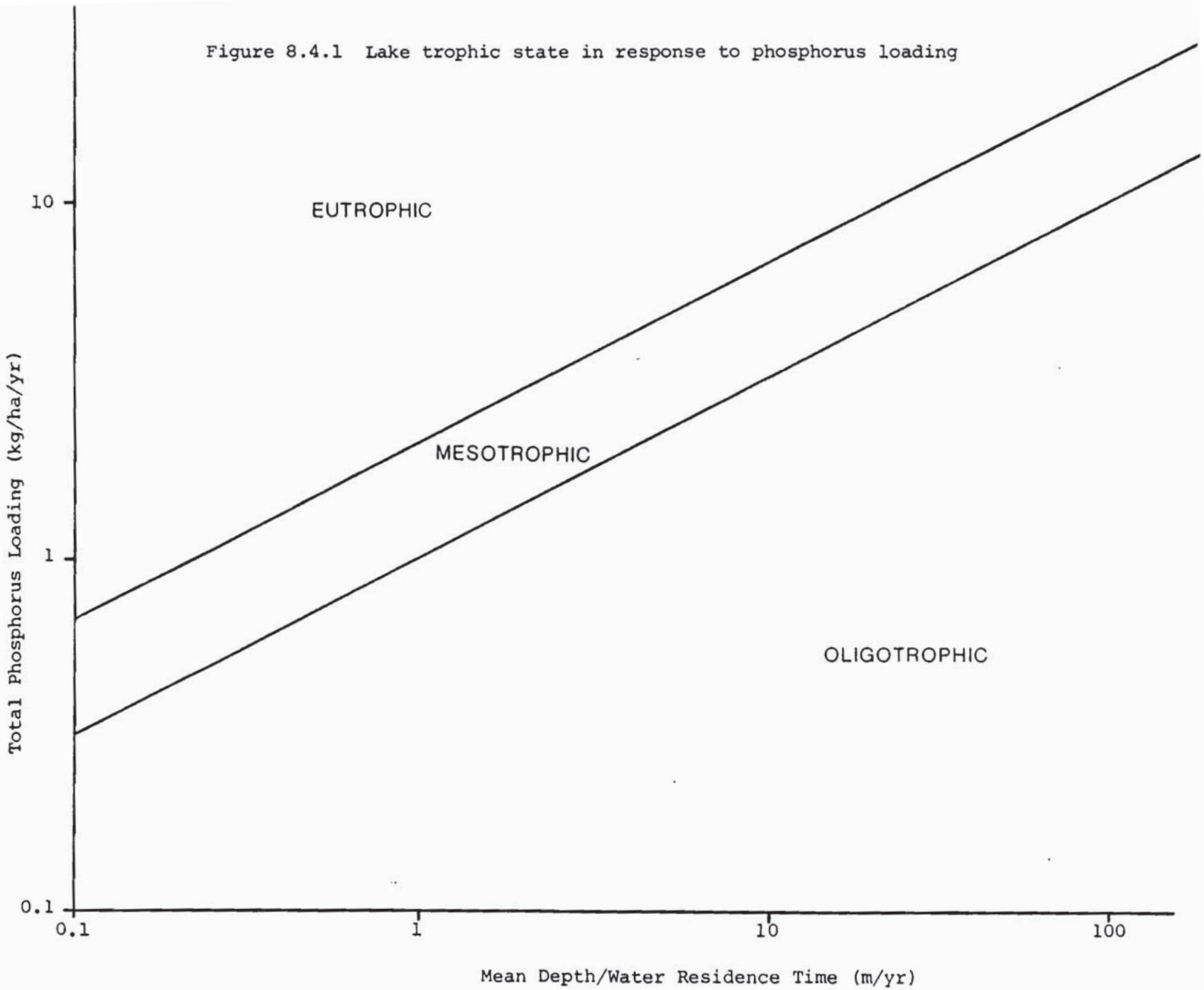
    c. Find the contributions of the highway and all other sources to the lake area total phosphorus (TP) loading (kg/ha/yr) by dividing L_H and L_{La}, respectively, by the lake surface area (A_{La}, ha). [Note: 1 hectare (ha) = 2.47 acres.]

    d. Divide lake mean depth (m) by water residence time (yr), where water residence time = lake volume (any volume units)/outflow rate (any consistent volume/yr units).

    e. Locate the lake on Figure 8.4.1, the trophic state graph (Vollenweider and Dillon, 1974), by using L_{La}/A_{La} as ordinate and the result of the previous step as abscissa.

18. If the highway loading addition does not move the status point near or into a higher trophic category, declare minimal impact on lake eutrophication and analyze impacts associated with maintenance or special problem areas. If a substantial impact on trophic state appears likely, mitigation should be further considered.

Figure 8.4.1 Lake trophic state in response to phosphorus loading



Source: Vollenweider and Dillon, 1974

I-69 EVANSVILLE TO INDIANAPOLIS
Tier 2 Studies
Survey of Karst Features Report Addendum No. 1
Section 4, US 231 to SR 37
Contains Confidential Information

May 11, 2011

Prepared for

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Indiana Department of Transportation

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APPENDICES

Addendum Appendix A: USEPA Comments on DEIS, letter dated October 28, 2010 and letter dated March 9, 2011

Addendum Appendix B: Dye Trace Precipitation Data

Revised Karst Report Appendix J: Karst Features / FEIS Alternatives Mapping and Impact Table

Revised Karst Report Appendix N: Pollutant Loading Estimate Tables and FHWA Methodology

1.0 Introduction

The purpose of Addendum No.1 to the *Section 4 Survey of Karst Features Report* (Karst Report) is to address karst related USEPA comments on the Karst Report received subsequent to publication of the DEIS. Additionally, Karst Report Appendix J, *Karst Features / DEIS Alternatives Mapping and Impact Table* has been updated to include Refined Preferred Alternative 2, and Karst Report Figure 4, *Section 4 Physiographic Regions* has been updated to show the direction of the geologic dip as well as formation/member croplines. Karst Report Section 5.0, *Annual Pollutant Loading*, and Karst Report Appendix N, *Pollutant Loading Estimate Tables and FHWA Methodology* have been replaced. Revised sections of the report are presented herein.

2.0 Resolution of DEIS / Karst Report Comments

Subsequent to the publication of the DEIS, the USEPA provided comments in letters dated October 28, 2010 and March 9, 2011 (**Addendum Appendix A**). Karst related comments have been excerpted from the October 28, 2010 comment letter and are addressed in the following discussions, and as incorporated into FEIS Volume III, *Comments and Responses*.

2.1 AF002-34[1] Karst Feature Importance

Comment:

Recommendation: EPA recommends the FEIS address the following karst impact issues identified in the I-69 Section 4 DEIS:

<u>Analysis of Karst Impacts as part of the Alternatives Consideration Process</u>

We have concerns that the appropriate level of consideration was not given to the various karst feature types presented in the DEIS. As such, the alternatives analysis completed for Section 4 Corridor appears to have considered impacts to the seventeen different karst feature types as equals. With respect to karst resources, in order to adequately assess alternative impacts, consideration must be given to karst feature size, location, infiltration rate, recharge/discharge characteristics, connectivity to groundwater conveyances, potential T&E species impacts, potential water quality impacts, threats to the traveling public, etc. For example, impacts to a sinking stream should not be weighed equally to impacts associated with a low-infiltration sinkhole. The fact that an alternative impacts a lower number of karst features does not necessarily guarantee that it will result in the least amount of environmental impacts. Assigning weights to each karst feature type

[1] FEIS Volume III, *Comments and Responses*, presents comments received on the DEIS, as well as responses to those comments. In Volume III, comments received from Federal agencies were assigned the prefix "AF". This prefix was followed by a number indicating the agency that provided the comment; USEPA was assigned the number 002. This number was followed by a hyphen and then a second number indicating the comment number. For example, Comment AF002-01 is the first comment provided by USEPA.

based on their quality, connectedness, and sensitivity will ensure that the karst impacts associated with each alternative are adequately assessed.

Response:

For the purpose of this report and as discussed below, the following factors were considered in determining karst feature importance:

- Infiltration capacity
- Airflow
- Presence of water
- Location
- Drainage area
- Presence of biological activity

Infiltration Capacity

Karst features such as caves, sinkholes, swallets and sinking streams can all serve as groundwater system recharge points. For Section 4 karst investigations, each karst feature was evaluated on its potential to transmit water and other materials to the subsurface. The following designations were assigned based upon the judgment of professional hydrogeologists:

- High Infiltration - recharge features in which the transport of water and materials to the subsurface is unimpeded
- Medium Infiltration - recharge features in which the transport of water and materials to the subsurface is somewhat impeded by material (rock, soil, other). These features were judged to possess medium infiltration potential
- Low Infiltration - recharge features in which the transport of water and materials to the subsurface is significantly impeded by material (rock, soil, other). These features were judged to possess low infiltration potential.

As stated above, these designations were based on field observations and professional judgment. Infiltration tests were not conducted.

Airflow

For each feature, the presence or absence of air flow was observed in the field and recorded. Inward or outward air movement can be an indication of connection to a larger karst system. Air movement can also be an indication of suitable biological habitat.

Presence of Water

For each feature, the presence of water was observed in the field and recorded. Where flow was observed, the direction of flow, either into or out of features was recorded.

Where no flow was observed, visual evidence of water flow was recorded if present. Additionally, the sound of flowing water inside karst features was also noted.

Location

The location of each karst feature relative to the Section 4 corridor as well as other karst features was considered. Features hydrologically linked to the corridor (or to other features linked to the corridor) were judged to be of higher importance than features not linked to the corridor.

Drainage Area

The amount of surface area within the Section 4 corridor that contributed drainage to a karst feature was also considered. For example, features that received a large amount of surface drainage from land within the corridor were given priority, when possible, in determining which features would be dye traced.

Biological Activity

Primary evidence of biological activity, such as bat guano, was recorded for each karst feature. Other secondary indicators of potentially suitable biological habitat, such as airflow and the presence of water, were also recorded for each feature.

Evaluation Process

The above listed criteria were considered in assigning relative importance to the identified karst features. Karst areas of importance are discussed in Chapter 5.21 of the FEIS and in the original Karst Report. The relative importance of features was considered during the development and evaluation of Section 4 alternatives. Caves were avoided during alignment development. Areas with a high density of karst features were avoided where possible. The criteria were also used to determine which Section 4 karst features would be dye traced. Dye tracing results were used in further alignment evaluation and development.

2.2 AF002-38 - Variability in Flow Conditions as Part of the Pollutant Loading Analysis

Comment:

The pollution loading analysis model presented appears to utilize a high bias on the quantity of water involved in pollutant mobilization. A high water volume coupled with a static pollutant load will result in a lower concentration when compared to regulatory criteria. We recommend that the analysis include a typical versus extreme rain event, mobilizing the same pollutant load. This is important as the results of this analysis will yield a result more representative of natural conditions.

We recommend the FEIS disclose the last time the Indiana Design Manual was updated. We also recommend the FEIS identify the specific portion/s of Indiana Design Manual that contain the specific specifications for the design of storm sewer pipes on Interstates and identify whether or not they have been updated to take into account the expected changes in severity and intensity of precipitation events due to climate change. In addition, we recommend the FEIS specifically identify and discuss the adequacy of those portions of the Indiana Design Manual that deal with designing storm sewer pipes and stormwater management in karst terrain. If some or all of this information is not available or up-to-date, then we recommend the FEIS specifically identify how these concerns will be factored into the design of storm sewer pipes and stormwater management for this proposal. (Note: comment is from USEPA's March 9, 2011 letter)

Response:

The estimates provided are based on a 'typical' rain event. The 2-year/24-hour and 1 year/1-hour rain events are believed to representative of 'typical' rain events in the analysis. According to the Indiana Design Manual, storm sewer pipes on Interstates are to be designed for a 50-year rain event with a 5- or 10-minute duration. Therefore, the 50-year rain event has been included in the analysis and considered an extreme event. The results of the pollutant loading analysis for the Refined Preferred Alternative 2 are discussed in Section 3.0 and shown in **Revised Appendix N**.

In response to the USEPA's March 9, 2011 letter regarding the Draft responses to DEIS comments, the Indiana Design Manual is in its 2011 version. The manual does not indicate when the last time specific design criteria (i.e. storm sewer pipe sizes) were changed. The design criteria of storm sewer pipes is covered in Chapter 29-Section 5.02 and Figure 29-5A. The hydrology used in drainage design is based on historic trends of rainfall amounts and durations. It only takes into account effects due to climate change that have already happened; not what may happen. Chapter 37 of the Indiana Design Manual covers the design criteria for storm-water management and indicates many times that the unique topography of a project site should be taken into account when designing for permanent and temporary erosion control.

2.3 AF002-39 – Blasting in Karst

Comment:

EPA understands that blasting may need to be used quite frequently in karst areas. Blasting can cause structural damage to buildings and wells, and cause the collapse of karst subsurface openings, such as cave walls. The DEIS does not identify the specific measures that will be required before, during and after blasting to insure that the integrity of structures, wells and karst subsurface openings remain intact.

Response:

There is a commitment in the Section 4 Biological Assessment (BA) stating that blasting will be avoided between September 15 and April 15 in areas within 0.5 mile of known Indiana bat hibernacula. All blasting in the Winter Action Area (WAA) will follow the specifications developed in consultation with the USFWS and will be conducted in a manner that will attempt to avoid compromising the structural integrity or alteration of the hydrology of nearby caves serving as Indiana bat hibernacula. All karst features within Section 4 are within the Indiana bat WAA. This same commitment will help in minimizing impacts to water wells and other wildlife.

The INDOT Standard Specification 203.15 Excavating Rock will be followed. INDOT Standard Specifications require specific pre- and post-construction documentation and blasting controls to assure no property damage occurs outside of the INDOT right-of-way as a result of highway blasting. Blasting operations on property adjacent to the right-of-way will be coordinated directly with the owners/operators as a part of the right-of-way acquisition process to address any issues associated with blast zones.

Within the right-of-way, the INDOT Standard Specification 203.15 states that exploratory drilling, for the purpose of determining the existence of cavities affecting underground drainage and possible sinkholes in cut sections, may be required. Any subsurface karst features identified will be treated in accordance with the karst MOU. According to Step 14 of the Karst MOU, if during construction previously unknown karst features are identified and it is found that the mitigation agreement must be altered, all of the agencies will be contacted and agreement reached prior to work continuing in that specific area of the project. Mitigation for impacts to unidentified karst features will be managed in the same manner as mitigation for impacts to identified features. If active groundwater flowpaths are discovered, measures will be taken to perpetuate the flow and protect water quality.

The INDOT Standard Specification 203.15 also states that the amount of explosives per shot for instantaneous firing or the amount of explosives per delay for delay firing shall not be great enough to damage nearby structures, rock formations, or other property. Where commercial building stone formations are located in the effective vicinity, adequate seismograph readings shall be obtained as evidence that blasting operations have not altered existing commercial building stone formations outside the right-of-way limits of the project.

INDOT Standard Specification 203.15 further states when or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the non-execution thereof, such property shall be restored to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as directed, or such damage or injury shall be made good in an acceptable manner.

Prevention/Mitigation

Special planning will be required to limit the impacts of blasting on the karst bedrock/groundwater system in Section 4. The following factors are appropriate to consider with regard to blast vibration levels:

- Charge mass and distance from blast - Charge mass is the mass of explosive used for the blast and distance from blast is the distance the karst feature is from the blast location.
- Face height and orientation - Face height is the vertical height of a quarry or opencast face. Orientation is the direction the karst feature is with regard to the blast location. For example the air vibrations will be greater for a karst feature located in front of the face than one located behind it due to topographic shielding.
- Topographic shielding - The greater the topographic relief or deeper the excavation the greater the topographic shielding. Increased topographic shielding will result in decreased air vibrations.
- Stemming height and type - Stemming height is the distance from the blast to the surface and stemming type is the material used to pack the blast hole. Airblast levels will increase if these factors are not controlled.
- Burden, spacing, and sequential timing - Burden is the material above the blast location. Too much burden can increase ground vibrations while too little burden can produce flyrock and increased air vibrations. Spacing is the distance between blast holes and sequential timing is the time between blasts. The combined effect of burden, spacing and sequential timing can result in wavefront reinforcement, which is an increase in blast vibrations.
- Meteorological conditions - Meteorological conditions such as wind and air temperature can cause blast air vibrations to become concentrated at the surface.

The location of the following karst features should also be considered during the blasting planning process:

- Cave entrances
- Cave passages
- Sinkholes
- Swallets
- Sinking streams
- Springs
- Dye trace-confirmed recharge areas for caves
- Dye trace-confirmed recharge areas for springs

2.4 AF002-49 – Relevant Karst Features

Comment:

What is the difference between "Karst features relevant to the corridor" and "Karst features within the corridor"? What specifically makes a feature relevant?

The report states - *"Mapped Karst features relevant to the corridor: 63 caves, 14 within the corridor.*" *There are 315 known caves located within five miles of the Section 4 corridor.*"

What defines "relevant" to the project if the dye tracing average extent was over 5,200 feet and some traces exceeded 20,000 feet?

Response:

For the purposes of Section 4 karst investigations, land within one mile of the Section 4 corridor was field surveyed to identify karst features. Additionally, karst features that were determined to be relevant to the Section 4 corridor were also documented. A relevant karst feature was any feature that was:

- Linked to the corridor by surface drainage, as confirmed by dye trace
- Linked to the corridor by groundwater flow, as confirmed by dye trace
- Potentially linked to the corridor by surface drainage
- Potentially linked to the corridor by groundwater flow. More specifically, any feature that is not separated from the Section 4 corridor by a known groundwater divide.

2.5 AF002-50 – Purpose and Scope

Comment:

The report states – "*…and Karst experts knowledgeable about the area*". Who are the karst experts that are knowledgeable of the area? Please clarify who was consulted.

Response:

The primary sources consulted regarding the locations of known karst features within the study area are identified in the Introduction and Methodology Sections of the Karst Features Report. These sources included: the Indiana Geological Survey, Indiana Cave Survey, Indiana Karst Conservancy, and the National Speleological Society. Karst geology experts on the consultant team are listed in Chapter 9, List of Preparers in the FEIS. All reported karst feature locations were field verified.

2.6 AF002-051 – Karst Report Figure 4 Revision

Comment:

Provide geologic data on Figure 4 to facilitate interpretation of the influence of the bedrock geology on karst formation within the project limits. Include formation/member croplines as well as structural information [dip direction].

Response:

Revised Karst Report Figure 4 is appended to this document. The figure has been revised to include depiction of the geological dip as well as formation/member croplines.

2.7 AF002-53 – Public Water Supplies

Comment:

The report indicates that groundwater and surface water [including springs] are combined sources of public water supplies in Section 4. However, the report does not address how the project may impact public water supplies. Provide the following:

- Locations of public water supplies relative to alignment.
- Extent of recharge areas for surface/spring water sources of public water supply.
- Depths of public water supply wells with radius of influence information.

Furthermore, the report needs to more directly indicate what karst features provide private/residential water supply. Annotate Figures 29-3 1 to indicate which springs serve as private/residential water supply. We suggest conducting baseline residential water sampling at locations of anticipated impacts over 4 quarters to capture seasonal fluctuation in drinking water quality. Discuss impacts to these sources in the report, as well as the planned impact mitigation measures should these sources be impacted by construction.

Response:

Three public water utilities service the Section 4 area. They are:

- Eastern Heights Utilities
- Van Buren Water, Inc.
- Southern Monroe Water Company

Eastern Heights Utilities is located in Bloomfield, Indiana and covers the Greene County portions of the Section 4 corridor and extends partially into western Monroe County. It obtains water from groundwater wells. Eastern Heights Utilities, Inc. indicated the closest well to the Section 4 corridor is located 4.84 miles away. This well is located along the White River near Newberry, Indiana, which is west of the Section 3/Section 4 terminus. Eastern Heights Utilities, Inc. stated this well is developed in the White River Aquifer.

No impact to this well is anticipated as a result of construction within the Section 4 corridor.

Van Buren Water Inc. serves portions of Richland, Van Buren and Clear Creek Townships in Monroe County. Its service area includes the portion of western Monroe County in the Section 4 corridor. Southern Monroe Water Company serves much of the lower portion of Perry Township, Clear Creek Township, and continues into a small northern portion of Lawrence County. Southern Monroe Water Company service area extends into the Section 4 corridor along Bolin Lane. Both Van Buren Water Inc. and Southern Monroe Water Company obtain water from City of Bloomington. The source for this water is Lake Monroe. The Section 4 corridor is closest to Lake Monroe at its north terminus. At this location the closest drainage to Lake Monroe is 2.5 miles away, and is separated by Clear Creek. No impacts to Lake Monroe, Van Buren Water, Inc., or Southern Monroe Water Company water supplies are anticipated to result from construction within the Section 4 corridor.

Regarding the recommendation to more directly indicate what karst features provide private/residential water supply, the locations of such karst features are not known. Coordination with every property owner regarding water supply within the proposed right-of-way was not undertaken during the NEPA phase of the project. Water supply will be discussed with property owners during the design and right-of-way phases of the project. It should be noted that the project will be developed to adhere to the Karst MOU. As required by Step 8 of the Karst MOU, a monitoring and maintenance plan will be developed for the project. IDNR, IDEM, and USFWS will be provided an opportunity to review this plan. Highway drainage will be treated in accordance with the monitoring and maintenance plan in order to protect groundwater quality.

Runoff will be treated accordingly via natural or designed measures to minimize potential impacts upon such private/residential water supplies. Baseline residential water sampling at locations of anticipated impacts, over 4 quarters to capture seasonal fluctuation in drinking water quality is not anticipated. Additional design information is necessary in order to determine more specifically what karst features will receive highway runoff. In order to determine baseline water quality, sampling of karst features is anticipated as part of the monitoring and maintenance plan developed pursuant to Step 8 of the Karst MOU.

2.8 AF002-55 – Relevant Dye Trace Sampling Point

Comment:

Provide the methodology used in determining what constitutes a "relevant" discharge feature for dye tracing sampling network development.

Response:

After karst features had been selected for dye injection, a sampling network was established. The sampling network consisted of all springs and streams potentially linked

through groundwater to the injection location. Springs that were considered relevant to the dye tracing tests were those that were located at a lower elevation than the injection site and on the same side of a groundwater divide (such as Indian Creek) as the injection site. Roadway crossings of streams were also used as sampling points, due to the possibility of water flowing directly from an injection site to such a stream, as opposed to first discharging from a spring. Stream crossings that were considered relevant to the dye tracing tests were those that were located at a lower elevation than the injection site and on the same side of any groundwater divides as the injection site.

2.9 AF002-56 – Positive Detection Criteria

Comment:

Provide justification for the positive analytical detection criteria listed. As listed, several potential lower level positive results will be discounted. The result of this will be a smaller area of recharge assumed per discharge point. Reinterpret analytical results accepting all positive results above the method reporting limit [signal to noise ratio]. Revise Appendix H figures to reflect changes in interpretation.

Response:

The positive selection criteria used for the dye tracing study is based on the professional judgment of experienced karst geology experts. The purpose of this analytical standard, which discounts certain low level detections, is to prevent false positives from latent background fluorescence sources. Ignoring this analytical standard and accepting all positive results as attributable to this project could jeopardize the validity of the dye tracing studies. The standards used were appropriate for the hydrology of the karst systems in the study area.

2.10 AF002-59 and AF002-73 – Dye Trace flow Conditions

Comment:

(AF002-59)
The report provides a justification to disregard the USEPA recommendation to examine local water table trends when considering flow conditions under which dye traces were conducted. The study needs to consider this to evaluate localized areas where the phreatic surface and epikarst flows are intermingled. This analysis cannot simply be ignored due to difficulty in obtaining the data to do so. Several mentions are made as to the traces being conducted under "high flow" conditions. Provide the methodology for determining when the flow conditions were deemed high. Does this correspond to a seasonal high water table?

(AF002-73)
The second bullet item states "Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides in common." Section 3.0 Results, 3.3 Summary of Dye Tracing Tests states that "When

possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye travelling to all possible discharge points." With this said, this study fails to provide specific information on the flow conditions at the time each of the traces took place to document low flow versus high flow scenarios. Provide documentation which demonstrates that dye tracing activity has taken place during high flow conditions.

This documentation would include information pertaining to the date/time of collection and related rainfall/runoff discharge data. This information is usually documented on field data sheets or a study database.

Response:

Dye tracing tests were conducted under high flow conditions when possible. The terms "high flow" and "low flow" are relative. In order to properly determine flow conditions for a stream or spring, discharge from the feature must be monitored over an extended period of time to account for seasonal variations. For the purposes of Section 4 karst investigations, the following criteria were considered in determining the flow conditions under which a dye tracing test was conducted. If there had been at least 0.5 inches of rainfall in the seven days leading up to dye injection, pre-injection conditions were considered to be high flow. If there had been at least 0.5 inches of rainfall between the time of injection and the time of detection, the post-injection conditions were considered to be high flow. Refer to **Addendum Appendix B**, *Dye Trace Precipitation Data* for a table and graphics pertaining to dye trace precipitation and flow conditions.

Based on the high flow criteria listed above, thirty of the dye tracing tests performed for this study were conducted under high flow conditions, either pre or post injection, and eight were conducted under low flow conditions. Of the eight conducted under low flow conditions, six had flow augmented by the injection of potable water. The remaining two low flow traces had natural flow of approximately two gallons per minute entering the feature.

2.11 AF002-63 – Cave Drainage

Comment:

The drainage area shown for Cave appears to be too small. We recommend the preparer revisit this calculation to ensure that the drainage area included in this Figure is representative of the actual drainage area. Increase to capture the uphill drainage similar to the method used for the remainder of the cave drainage area estimates.

Response:

Cave was located in the field and is reported as 4-1665. The cave was avoided during the development of Section 4 Alternatives. The cave entrance is located outside of the alternatives' rights of way. The mapped portion of the cave extends a distance of approximately 150 ft. The cave entrance extends downward from the surface and is

categorized as a recharge feature. The cave was reevaluated in the field on April 14, 2011 to visually assess drainage patterns to the cave and to determine the presence of flowing water within the cave.

There are two surface drainages between the cave entrance and the alignments that would prevent surface drainage from reaching the cave entrance. Additionally, there are several houses located between the cave entrance and the alternatives. The topographic alteration that occurred when these houses were built should also prevent surface drainage from reaching the cave entrance. During the field visit on April 14, 2011 no flowing water and no signs that water actively flows through this cave were observed. Several rain events had occurred in the days prior to the field visit and streams in the area exhibited moderate to heavy flow. The cave passage appears to be stream abandoned and has a vertical extent of about 25 feet in the St. Louis Limestone.

The delineation of the drainage area for Cave has been revisited and is correctly described in the Karst Report. The surface drainage areas for all karst features, including Cave, were calculated using an ArcHydro batch model. Cave was determined to have a drainage area of 807.55 m^2. The drainage area for Cave was also calculated using topographic contours which resulted in a drainage area of 933.5 m^2. The drainage to the Cave entrance is limited by being located on a hillside within a narrow drainage channel. Additionally, two sinkholes uphill from Cave capture a portion of the up-gradient surface drainage. The surface drainage area for this and other karst features describes only the area that contributes drainage directly to the karst feature and does not describe potential surface drainages that contribute drainage through groundwater flow.

2.12 AF002-70 - New Technology

Comment:

The report states - *"Improved technology should be used to update, maintain, and alter any treatment and containment structures when deemed necessary*." What does this statement mean? Are there some pending technologies that may be applicable? If so, a discussion should be added.

Response:

The referenced statement was intended as a general recommendation to consider new technologies as they become available. During the design and construction phases of this project any new available methodology for karst feature mitigation and construction practices for karst areas will be considered for implementation. Potential resources for new technology include state and federal transportation agencies, transportation agencies abroad and quarry and mining organizations.

2.13 AF002-72 - Critical Features

Comment:

The report states - *"Therefore, the focus of alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features...*". What defines a critical feature? It would be helpful to provide a listing of the critical features considered as part of the alignment evaluation process.

Response:

The location of features considered to be critical features played an important role in the development and comparison of Section 4 Alternatives. Selection of an alternative focused on minimizing impacts to the karst system, and any biological communities within it, by avoiding critical features and dense concentrations of features where possible. The following features were considered to be critical features:

- Cave entrances
- Mapped cave passages
- Sinkholes, swallets, and sinking streams that received a large percentage of their total surface drainage from land within the Section 4 corridor.
- Large springs
- Potential biological habitat
- Areas with a high karst feature density

Critical features were given high priority in the dye trace test selection process. They were also considered for avoidance and in alignment evaluation.

2.14 AF002-74 – Potential Impacts associated with Altering Temperature and Humidity

Comment:

The General Environmental Concerns section fails to acknowledge potential impacts to both the terrestrial and aquatic components of cave environments. Minute changes in temperature, humidity, and water quality can have detrimental affects to what are highly adapted species, intolerant of change. Various studies have documented the vulnerability of cave ecosystems as they relate to disturbances associated with roadway construction. We recommend adding a discussion that acknowledges potential impacts associated with altering the temperature and humidity levels within karst environments.

Response:

Karst biological communities are known to be susceptible to alterations in temperature and humidity within their ecosystem. In accordance with Karst MOU Step 8, a

monitoring and maintenance plan will be developed for affected karst features. Also in accordance with Karst MOU Step 14, if during construction additional karst features are discovered and it is found that the mitigation agreement must be altered, all of the agencies will be contacted and agreement reached prior to work continuing in that specific area of the project. It is also recommended that temporary caps be placed over any exposed karst feature discovered during construction to limit changes to temperature and humidity within the karst ecosystem.

2.15 AF002 - 75 – Alternative Drainage, Bridges, Culverts

Comment:

Include a BMP in Section 8 that consists of diverting roadway drainage [from the full pre-construction drainage area limits] to the upgradient roadway offset to minimize "severance" of recharge and subsequent impacts to spring discharges and habitat alteration. For example, efforts should be made to bridge or culvert drainage so as to not severe flow and recharge to springs.

Response:

Maintaining natural recharge patterns is critical to limiting the impact to karst springs and the karst groundwater system. Bridges and culverts will be used to maintain flows crossing the highway where appropriate. Piping surface flow from upgradient areas is another possible method to limit alterations to recharge patterns. Alternative drainage will be used where possible; each location will be evaluated on an individual basis during the design phase of the project.

2.16 AF002-76 – Liners / Karst Monitoring

Comment:

There is no mention of a karst monitoring plan which evaluates cave community disturbances. We recommend that a monitoring plan be implemented that evaluates the physical habitat and includes population censusing prior to, during, and postconstruction for those caves with a hydrologic connection to the corridor. Protocols for cave community censusing have been described by Dr. Jullian Lewis, the primary author of the Section 4 Cave Fauna study. This monitoring plan should also be considered as a potential mitigation measure in the Section 4 Final Environmental Impact Statement (FEIS). Clarify "lined ditches" in this section. Ditches should include an impermeable geosynthetic liner to prevent infiltration of runoff before reaching detention/treatment basins.

Response:

During the post-NEPA design phase of project development a monitoring and maintenance plan for karst features will be developed in accordance with Karst MOU

Step 8 and in coordination with the Karst MOU signatory agencies. The completion of additional cave fauna surveys will be evaluated at that time.

Lined ditches may involve compacted clay liners, geosynthetic clay liners, flexible membrane liners, concrete, Portland cement, or asphalt liners. Compacted clay liners are the most likely form of liner for the project. The type of liners used will be determined during the design phase.

3.0 Cave

Cave, identified as feature 4-0943 in the Karst Report, will now be referred to as Cave in all future karst related documents for the I-69 project.

4.0 Revised Karst Report Section 5.0, *Annual Pollutant Load Estimates* and Revised Karst Report Appendix N, *Pollutant Loading Estimate Tables and FHWA Methodology.*

The text provided below replaces the text presented in Draft Karst Report Section 5.0, *Annual Pollutant Load Estimates*. Appendix N of the Draft Karst Report is replaced with **Revised Appendix N**, *Pollutant Loading Estimate Tables and FHWA Methodology*.

The Karst Memorandum of Understanding (MOU) dated 1993 between INDOT, IDNR, IDEM, and the USFWS delineates guidelines for construction of transportation projects in karst regions of the state. The MOU is provided in FEIS Appendix AA, as Karst Report Appendix A. As part of the I-69 project, the USEPA has also been invited to participate in the MOU activities review process. The MOU signatory agencies and the USEPA have been informed that Steps 1-4 of the Karst MOU will be followed as part of the National Environmental Policy Act (NEPA) study for Sections 4 and 5 of the I-69 project. Step 2 of the Karst MOU states the following "….Calculations of estimates of annual pollutant loads from the highway and drainage within the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan…."

This section summarizes key points from the research gathered as part of the karst pollutant loading estimations for the Tier 2 EIS of I-69 Section 4 in Greene and Monroe Counties. It also discusses the attempts made and limitations to compute the pollutant loadings as a desk top exercise, or without actual field sampling, using a Federal Highway Administration (FHWA) published process.

INDOT's Previous Karst Study on SR 37

In April 1996, Earth Tech prepared "Results of MOU-Related Karst Studies for Indiana State Road 37, Lawrence County, Indiana (1992-1995)" for INDOT. This document described the Karst MOU and documented the results of the BMP's used both during and after construction. The project was to reconstruct SR 37 from a two-lane highway to

four-lane divided between SR 60 (Mitchell) to US 50 (Bedford). In general, INDOT used the following steps to fulfill the Karst MOU:

1. Survey all karst features directly or indirectly affected by the project
2. Delineate sub-surface drainage routes using dye-tracing.
3. Install drainage structures (Best Management Practices (BMPs)) such as settlement basins, peat filters and rock filters to all karst features within the right-of-way. The size and type of each BMP was estimated based on the drainage area and type of karst feature. According to the report, the choice of the BMP was an estimation with the understanding that monitoring of the BMP is essential to assure its effectiveness.
4. Collect samples of runoff at the BMP's both during and after construction and test for pollutants (e.g. lead, zinc, copper, etc.). These samples were collected during six storm events between February 1993 and August 1995. The concentrations of pollutants were compared to Indiana's Water Quality Standards for aquatic life and drinking water.
5. Observe the BMP effectiveness at conveying stormwater during rain events. Most BMPs proved effective, although some need to be enlarged or their drainage basins enlarged to assure water was not going to pond onto the roadway.

The study concluded that less than 2 years after construction, the pollutant concentrations in the runoff were reduced to what one would expect prior to construction. As long as the filter systems operate as designed, no long term effects to karst features is expected.

In the short term (within two years after construction), high levels of Total Suspended Solids (TSS) and Total Recoverable Metals (TRM) (copper, lead, zinc, etc.) were found. This was likely due to the fact the BMPs were installed prior to earthwork and grading activities. Therefore, even though the BMP filters and normal erosion control measures were monitored, the filters were typically found to be clogged. The clogging of certain filters occurred during construction due to the high amount of earthwork. The study does not give a recommendation on how to remediate this. This condition likely contributed to the higher than normal levels of TSS and TRM during and immediately after construction. Once beyond construction (around 2 years later), the clogging was almost none-existent since the new earthwork had stabilized; therefore the TSS and TRM returned to pre-construction levels.

Kentucky's Previous Karst Study on I-65 at Mammoth Cave

As part of the literature research conducted, a report completed by the Kentucky Transportation Center, "Evaluation of Methods to Protect Water Quality in Karst Areas: Phase I" was reviewed. This study, done for the Kentucky Transportation Cabinet in October 2003, analyzed pollutant loads to karst features near an interchange of I-65 and an entrance to Mammoth Cave. The procedures detailed in the study match those of Indiana's Earth Tech report. Field samples were collected to find the pollutant concentrations and those values compared to national standards. Their findings were

highway runoff pollutant loadings were minimal. Additional phases of the research report were to study other karst features throughout the state, and report a methodology that could be used for loading calculations and BMP design. One of the authors was contacted to check the status of additional phases to the study; however none have been completed at this time.

Karst Features to Analyze

The karst survey identified almost 1,500 karst features in the karst study area. About 450 features are located within the 2,000' wide corridor of Section 4, 107 inside the proposed right-of-way for Refined Preferred Alternative 2 under the Initial design criteria and 87 for the Low Cost design criteria. The drainage areas for all these features were estimated in **Revised Appendix N**. It was assumed that any karst feature inside the construction limits would be capped, so its pollutant load estimate is zero. A karst feature had to be outside the construction limits yet inside the proposed right-of-way to be eligible for analysis. The number of features that fits this criterion for the initial criteria is 27 and for the low-cost criteria is 20.

The first step was to identify an approximate station along the I-69 centerline for a feature. Using this station, the karst feature was then identified on a plan and profile drawing. Using the profile, the approximate limits of the right-of-way drainage area were estimated (i.e. runoff area). These limits were determined by beginning at the feature and going "uphill" along the profile until a crest or culvert was reached (whichever came first).

The calculation of the pollutant loadings into the karst features required some assumptions; primarily when delineating how much of the proposed right-of-way would drain into the karst feature. Three main assumptions were made, all likely erring on the side of a higher pollutant loading than what will realistically occur after construction:

1. It was assumed that the entire right-of-way width would drain into the karst feature. In many cases, this is highly unlikely. For instance, if a karst feature is located on the backslope of a ditch along the southbound lane, there is no guarantee that highway run off from the median or ditch along the northbound lane would drain to the karst feature on the other side of the road. More often than not, the road acts as a barrier, preventing runoff from being conveyed from one ditch to the other. The only exception would be if a cross culvert or median drain would convey drainage to a karst basin.
2. Also, where multiple karst features are located within the same right-of-way drainage area, the pollutant loading calculation for each feature assumed no run off would drain into the other features. In all likelihood, the karst features would share the runoff volumes.
3. Finally, the roadside and median ditches are designed for conveyance and outlet into streams and creeks, not into karst features such as sinkholes or swallets. Therefore, it is reasonable to assume runoff may not find its way to a feature,

instead traveling along the ditch grades and culverts as designed and constructed. The pollutant loading calculation assumed the entire right-of-way would drain into the karst feature, and not be conveyed elsewhere.

FHWA Highway Runoff Water Quality Training Course

FHWA conducted the *FHWA Highway Runoff Water Quality Training Course* on water quality and storm water runoff from highways. INDOT staff attended this course. Section 8 of this workshop dealt with models and studies that have been developed to predict pollutant loads without field measurements. The first part of the model calculates pollutant load estimates and was developed in the late 1970's using field data from monitoring programs in various states. The second part estimates the pollutant concentrations and compares them to water quality standards. The third part estimates the pollutant loads in the "background," or what occurs before the highway is built. This methodology is the standard methodology used by INDOT for Step 2 of the Karst MOU pollutant loading requirements and is included in **Revised Appendix N**.

Part 1: Pollutant Loadings from Highway Runoff

In order to estimate the pollutant loading from the highway runoff, the length of the road that would drain into the karst feature must be estimated. This was found by plotting the karst feature's station on a profile view, and then measuring upgrade from the feature to the nearest crest or cross culvert, whichever came first. The pollutant loading calculation assumes the *entire* highway right-of-way along this length would drain into the karst feature. This is unlikely, given the three drainage ditches (two roadside and the median) are not designed to convey drainage to karst features. For instance, if a karst feature is located inside the roadside ditch along the southbound lanes, there is no guarantee (and in fact is very unlikely) that cross culverts would be installed to convey drainage from the other roadside ditch and the median under the road to the karst feature.

The model estimates the pollutant loading by first determining the load of total solids. Once that load is found, regression equations are used to determine the load for other various pollutants (lead, copper, zinc, etc.). The theory behind this is solids act as "carriers" for other pollutants, so the higher the solids the higher the metals and other pollutants. The estimated pollutant load prior to the rain event is calculated using the daily traffic estimate. It is assumed that the road has not been washed of pollutants in 20 days, which the study's analysis determined to be an adequate length of time for an accurate initial load estimate. The initial pollutant load is then modified to account for the runoff rate. This rate was calculated using National Oceanic and Atmospheric Administration (NOAA) data for varying degrees of rain events: 1-year/1-hour, 2-year/24-hour, 5-year/24-hour and 50-year/10-minute rain frequencies. The 2-year/24-hour and 1-year/1-hour rain events are believed to representative of 'typical' rain events in the analysis. According to the Indiana Design Manual, storm sewer pipes on Interstates are to be designed for a 50-year rain event with a 5- or 10-minute duration. Therefore, the 50-year rain event will be included in the analysis and considered an

extreme event. The rate also takes into account the drainage control on the highway, in this case, open median and ditches, and the length of highway within the drainage basin of the particular karst feature. The I-69 project was considered a Type III roadway, which is indicative of a rural highway with paved shoulders which uses grassy ditch conveyance for the surface runoff.

Once the runoff and rain data is taken into account, the pollutant loading of total solids at each karst feature was calculated. Regression models are then used to determine the pollutant load (pounds) for other pollutants. For karst features with very small drainage areas, some of the regression equations produce values in the negative. It should be assumed, for these cases, the load is zero. Table 1 in Exhibits 1-8 are included in **Revised Appendix N** which displays the pollutant mass loadings for reach of the rain events for both the Initial and Low Cost design criteria.

Part 2: Pollutant Concentrations from Highway Runoff

The pollutant loadings calculated in Part 1 can then be modified into concentrations. The loadings are divided by the volume of rain water (for a particular rain event) inside the right-of-way that would drain into the karst feature. Table 2 in Exhibits 1-8 in **Revised Appendix N** shows the results of the pollutant concentration estimates (for each rain event using the Initial and Low Cost design criteria).

Concentrations of pollutants are then compared to Indiana's Water Quality Standards for aquatic life and drinking water. These standards are from Indiana Administrative Code (327 IAC 2-1-6) and assume a hardness of 250 mg/L. The four pollutants that are exceeded the most often are lead, total nitrogen, cadmium and mercury. **Table 3** and **Table 4** below summarize the results for those four pollutants for each rain event analyzed. The more intense the rain event, the more wash-off of the highway will result and the less settling of solids in the ditches, hence the 1-year/1-hour event shows more pollutants exceeding the water quality standards. The FHWA course materials state that caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive equation was developed.

Table 3. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Refined Preferred Alternative 2 - Initial Design Criteria[2]

Initial Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	Lead	Total Nitrogen	Cadmium	Mercury	Lead	Total Nitrogen	Cadmium	Mercury
1year-1hour	19	27	27	27	0.033 (40532)*	0.523 (41608)	0.053 (41608)	0.107 (41608)
2year-24hours	0	27	15	21	--	0.189 (41608)	0.020 (41608)	0.041 (41608)
5year-24hours	0	27	10	20	--	0.155 (41608)	0.016 (41608)	0.033 (41608)
50year-10min.	20	27	27	27	0.033 (40532)	0.527 (41608)	0.054 (41608)	0.108 (41608)

* The number in parenthesis, for example (40532), refers to the number of the karst feature with the pollutant concentration listed in the table.

Table 4. Summary of Karst Features Exceeding Water Quality Standards for Lead, Total Nitrogen, Cadmium and Mercury for Refined Preferred Alternative 2 - Low Cost Design Criteria

Low Cost Design Criteria	*No. of Features Exceeding Water Quality Standards*				*Highest Concentration (mg/L)*			
Rain Event	Lead	Total Nitrogen	Cadmium	Mercury	Lead	Total Nitrogen	Cadmium	Mercury
1year-1hour	17	20	20	19	0.168 (40620)*	0.840 (40620)	0.043 (40132)	0.079 (40132)
2year-24hours	8	20	9	14	0.050 (40620)	0.257 (40620)	0.016 (40132)	0.030 (40132)
5year-24hours	4	20	8	9	0.044 (40620)	0.224 (40620)	0.013 (40132)	0.025 (40132)
50year-10min.	17	20	20	19	0.170 (40620)	0.847 (40620)	0.043 (40132)	0.080 (40132)

* The number in parenthesis, for example (40620), refers to the number of the karst feature with the pollutant concentration listed in the table.

Part 3: Pollutant Loadings from Karst Drainage Area (Prior to Highway Construction)

This section calculates how much pollutant would enter a water way upstream of the highway discharge. For this study, this is taken as the pre-construction calculation, or what is currently entering the karst feature prior to the highway's construction. Using the drainage area of each karst feature and the NOAA rainfall data, a runoff volume inside the drainage basin is calculated. The FHWA Water Quality Manual provides mean concentrations levels for certain pollutants, which are used with the runoff volume to determine the pollutant load. Some of the pollutants analyzed in Parts 1 and 2 were not included in this analysis because runoff concentrations were not provided. These concentrations are based on urban land uses, which is typically much higher than pollutant concentrations from rural areas. When comparing these pre-construction pollutant concentrations, three pollutants are shown to exceed the lowest of Indiana's water quality standards: lead, total nitrogen, and mercury. These are three of the four pollutants that exceeded standards most often when looking at the highway runoff. Table

[2] The lowest of the three Water Quality Standards listed in the IAC is 0.01 mg/L for lead, 0.01 mg/L for total nitrogen, 0.0023 mg/L for cadmium and 0.00014 mg/L for mercury.

3 in Exhibits 1-8 in **Revised Appendix N** lists the estimated pollutant mass loads for the pre-construction condition for each of the rain events analyzed.

5.0 New Cave

Discovery

A new cave was discovered within the Section 4 Refined Preferred Alternative right-of-way (R/W) by the property owner. Its location was learned through recent landowner coordination efforts. The cave entrance was not in existence according to the landowner when the karst team was on the property in 2005. An opening into the cave collapsed recently, in the past two years. The information reported below was gathered in a consistent manner with the methods used under the National Environmental Policy Act (NEPA) study. Drill holes are planned to investigate this feature for design and engineering considerations.

New information regarding this cave was provided to the karst team for evaluation in January of 2011. The karst team, consisting of Jason Krothe and Garre Conner, visited the property on January 25th to examine the cave. The owner was not at home and a business card was left on the door. The cave entrance was quickly located and photographed (See Figure 1). Project team members did not enter the cave because it had steep sides covered with ice. The feature appeared unstable due to several weeks of freeze-thaw events. A GPS coordinate was recorded and the area was walked for any additional signs of previously unrecorded cave entrances. The drainage area for the cave is estimated to be approximately 1,581 sq. ft. The discharge at the cave is estimated to be less than ½ gallon/minute.

Figure 1 – Cave entrance

On March 8, 2011, the karst team, consisting of Jason Krothe, George Chesnick, and Garre Conner, visited the property again. The property owner was not home so a business card laws left on the door. A brush trail had recently been cut by the geotechnical team. This trail passed within about 50 feet of the new surface opening. The geotechnical team marked the cave entrance with a wooden lath and flagging to warn of this unstable feature. The geotechnical team drilled holes in the area and coordinated with Garre Conner to stake four additional holes close to the feature. Boring locations were selected to provide more engineering information related to this feature in the right-of-way and its possible extension. These holes are planned to be drilled when the team can next access the property.

The entrance shaft appeared different in March than it did in January, with more collapse and shifting of talus, but no appreciable change in size. An opening on the east side was observed. Garre Conner entered the cave using a rope and proper safety equipment. The structure of the cave was unstable. Rocks and debris fell from its ceiling. The cave, consisting of a small void or rectangular room in sandstone, revealed a narrow dissolution canyon below in limestone. Dimensions were 20 ft by 12 ft and 5 ft high as shown in Figure 2. A rope was used to descend into the canyon to determine its dimensions, hydrological properties, and to look for indications of biological activity. Photos were taken and a video camera was used to record surface features. Owing to the cave's instability, an oriented sketch was drawn in lieu of a tape and compass survey.

Sketch has been removed for confidentiality reasons related to caves.

Figure 2 - Cave Sketch and Photos (Pictures above show a view through the entrance pit, the upper sandstone void, and the lower limestone canyon. Photos, G.A.C.)

Geology

This cave entrance is located along a short segment of sandstone escarpment projecting southward from the ridge. This can be seen on the topographic quadrangle. The lower portion of the Big Clifty sandstone is deeply weathered into large talus, floating joint blocks. The cylindrical collapse reveals a deeply weathered bedrock and soil including small rounded sandstone talus. The opening on the east gives entry to a rectangular room, approximately 12 ft wide, 20 ft long, and 5 ft high. The sandstone ceiling is intensely jointed and very unstable. Small amounts of water that infiltrate and drip were observed. There had been substantial rain in the days preceding. The east end of the room reveals a large joint block of sandstone wedged across the lower narrow vadose canyon enlarged in the Beech Creek limestone. This lower passage is about 2 ft wide, 15-20 ft tall, and extends 50 to 80 ft to an obstructions at both ends. Inspection of the lower passage found depositional cave popcorn. Popcorn is a term for the thin layer of rough surface on the wall that has depositional calcium carbonate, a type of cave mineral deposit. Some dissolution fluting on the walls was observed. Horizontal extension of this canyon extended to the west at least 30 ft, but was blocked by sandstone that fell from the cave's ceiling. Eastward the canyon is very narrow and extended approximately 50 feet to a tight bend. The canyon floor was covered with fallen rock and there was no discernable

karst flowpath, although surfaces were not dry. The karst flowpath that once dissolved the cave, the karst conduit, has had its flow rates diminished. This is evidence of a reduced or severed recharge area. There was no perceivable airflow. Temperature was estimated to be relatively warm (probably above 10 degrees C in March) compared to a typical cave that fits the criteria for an Indiana bat hibernacula. The topography on the surface suggests a feature paralleling the scarp that terminates at both ends and is covered by talus and soil. The lower end, thought to be to the west, ends at a steep ravine. There was ample water moving downward through the outside ravine, but no karst flowpath could be seen at the base of the limestone discharging into the ravine. A small surface depression due south of the entrance about 150 ft at the toe of the slope may be evidence of a paleo-spring, that could have been connected to a vadose canyon. A dye trace would require several thousand gallons of water on a remote site and building of a roadway, as is sometimes used to investigate connectivity of the karst conduits. However, for this feature, most of the dye would probably perch on the floor sediment and would possibly be released during excavation or earthwork. That would not be desirable because later, dye would be in cut material that might be put into fill material somewhere else. The dye could later become wet and mobilize.

Relict Cave

This karst solution cave in limestone appears to be an erosion remnant, a relict cave. Erosion has severed and removed earlier extensions of the cave to the east and west. The original cave system that included this segment has been truncated. Its recharge area was severed by erosion along the valley wall as the scarp retreated northward. The term cave used in this description is consistent with the definition of a cave used in the I-69 Section 4 and Karst Report. These caves form by dissolutional enlargement in limestone. Prior to the breakthrough that initiates enlargement of a karst conduit there is a long fracture trace extending from a recharge area, water supply, to a point along a stream where a spring can form. For the cave to exist, it must form at a rate faster than the land surface can erode downward. Eventually the land surface erodes down below the level of the rock units that contain the cave. There is a period of time where conduits in a cave system are severed by erosion and isolated segments exist until the land surface is lowered below the level of the cave.

Engineering Analysis

This relict cave is located within an area of the project where the proposed grade of the new roadway will be approximately 15 feet below the existing ground line. As such, the engineering recommendation for the treatment of the relict cave is: 1) lower the proposed grade of the roadway to a point below the elevation of the cave (essentially, “cut out” the relict cave); 2) backfill remaining portion of the relict cave with aggregate/granular material or 3) implement an inverse graded aggregate filter. Additional geological, hydrogeological and geotechnical analysis will be required within the detailed design phase before a complete engineered solution can be developed. INDOT anticipated

encountering this type of cave feature. It will not adversely affect the design or cost of the project.

Biology

No insects, invertebrates, bats or other fauna were observed inside the cave on March 8, 2011. Bat fecal pellets, urine stains or odors were not observed. There were no claw marks on the surfaces from raccoons or smaller rodents. A few gnat-like insects were observed hovering at the entrance of the cave shaft.

Evaluation Criteria for Indiana Bat Hibernacula

Karst biological studies were conducted from 2004 through 2006 for Section 4's Environmental Impact Statement. During that time, the karst team coordinated and shared information regarding karst features and caves being documented in the field. This coordination included Section 7 Consultation with U.S. Fish and Wildlife Service (USFWS), Indiana Department of Natural Resources (IDNR), and signatories to the Karst MOU (1993). This consultation involved the development of an Indiana bat (*Myotis sodalis*) Winter Action Area (WAA). The WAA is the total area that falls within a 5-mile radius centered on each of the known Indiana bat hibernacula that have entrances located within 5 miles of the proposed 3C corridor. The Indiana Geological Survey and their karst experts located and verified approximately 347 caves in this area and evaluated them for their potential as Indiana bat hibernacula. There were 14 hibernacula entrances that were identified within 5 miles of the corridor and that were analyzed within the Tier 1 WAA. The evaluation of caves throughout the Indiana bat WAA is documented in the I-69 Evansville to Indianapolis Tier 2 Studies Cave Reconnaissance for Indiana Bat Hibernacula, January 26, 2006. The cave rankings as habitat as a part of that report were reviewed by numerous cave and bat experts, including USFWS.

The evaluation criteria for an Indiana Bat Hibernaculum are listed below:

The purpose of the original cave study was to determine the suitability of caves as winter habitat for the Indiana bat using the criteria listed below:

- a chimney air flow effect,
- multiple cave openings,
- a large volume that stores cool air,
- constant winter air temperatures ranging from 3 to 6° C
- bats as recorded in the database in this cave, and
- the size and diversity needed as a hibernacula

The low winter temperatures in caves are absolutely essential for an Indiana bat hibernacula. The larger volume caves change their temperature slower than smaller caves or isolated relict caves. The ventilation driven by a chimney effect is important for development of a low temperature cave and good air quality. Some humidity is

important, but wet caves are often unacceptable. Multiple entrance caves allow for ventilation. Also good flyways about the entrances are favorable to the Indiana bat. A good flyway is defined by topography, stream banks, and wooded areas favorable for insect foraging, often near a cave.

The new cave on the property is not a lengthy cave, nor does it store a large volume of cool air. It is only 80 ft at its maximum length. The temperature of the cave in March 2011 was likely above 10 degrees Centigrade, which is above the optimum temperature for Indiana bat winter habitat. No chimney air flow effect was observed. Finally, no evidence of Indiana bats was observed during the field review in March 2011. During the January observation this entrance was not sufficiently open to indicate that bats could ingress or egress. Due to the cave's length, size, configuration, temperature, and the lack of Indiana bat indicators, it is the opinion of the karst geologist who entered the cave that it would not meet the criteria as an Indiana bat hibernaculum. This opinion is based on field observations of the cave as well as 40 years of experience with caves and coordination with bat experts.

Karst Memorandum of Understanding

This relict cave on the Property was recently brought to the attention of INDOT by the property owner. The NEPA process has included the first 4 steps of the Karst MOU signed by INDOT, IDNR, IDEM and USFWS on October 13, 1993. Steps 5-17 in the Karst MOU will be completed with the Karst MOU signatories during design and construction of the roadway.

The Karst MOU includes general coordination on drainage, field checks, hazardous material traps, monitoring and maintenance plans, low salt and no spray, agreements, assurances, hazardous emergence response, monitoring of construction, review of mitigation agreement, visual inspections, discovery of Federal or State Listed Species, and an annual review of document.

A biological field survey of the cave was held on March 8, 2011. No federal or state listed species were discovered during the review.

Conclusion

Evaluation criteria for Indiana bat hibernacula are established and proven over several decades of study in the Midwest by Indiana bats experts. It is Mr. Conner's opinion that this cave does not meet the criteria for an Indiana bat hibernaculum.

The cave has formed due to a collapse upward event allowing the sandstone to fill a limestone void. Upward collapse is defined as the ceiling of a cave or mine void falling in due to gravitational pull. The void is propagated upward to the surface in small increments until there is a surface opening. The entrance of the cave will likely collapse over time. Presently the cave is unstable and unsafe. It is recommended that the property

owner erect a simple wire fence around the entrance and flag appropriately to protect people and animals.

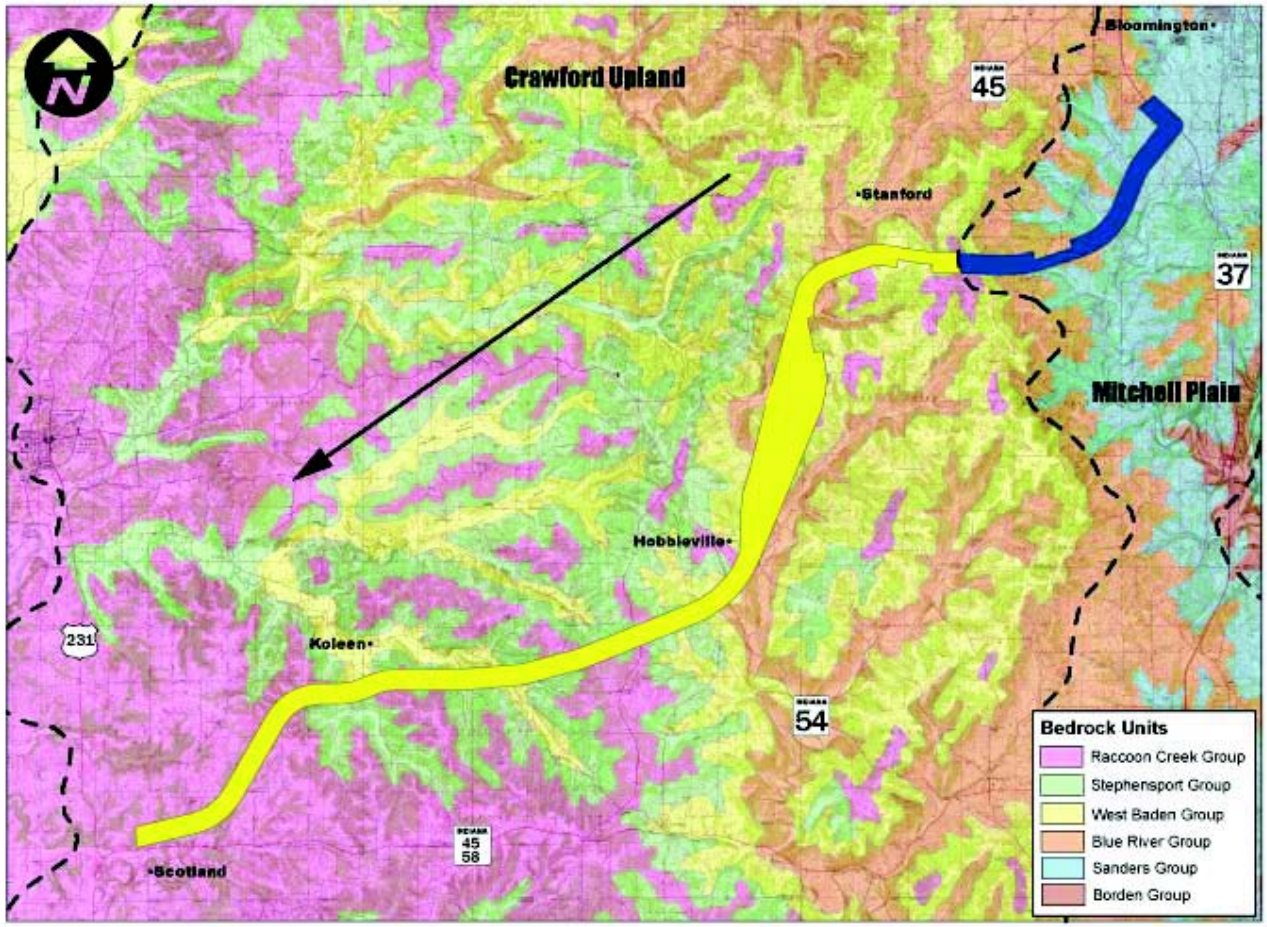

Figure 4: Section 4 Physiographic Regions and Bedrock Units
I-69 Evansville to Indianapolis
Tier 2 Studies, Section 4

Legend
- Section 4 Crawford Upland
- Section 4 Mitchell Plain
- Physiographic Boundaries
- Bedrock Dip*

*Regional average is southwest at thirty feet per mile.

Addendum Appendix A

USEPA Comments on DEIS, letter dated October 28, 2010

USEPA Comments in Response to Draft Comment Responses, letter dated March 9, 2011

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

OCT 28 2010

REPLY TO THE ATTENTION OF:

E-19J

Robert F. Tally, Jr., Division Administrator
Federal Highway Administration - Indiana Division
575 North Pennsylvania St., Room 254
Indianapolis, IN 46204

Michael B. Cline, Commissioner
Indiana Department of Transportation
100 North Senate Ave., Room N642
Indianapolis, Indiana 46204

RE: I-69 Evansville to Indianapolis, Tier 2 Draft Environmental Impact Statement (DEIS) for Section 4: Crane NSWC to Bloomington, Indiana. CEQ No. 20100281

Dear Mr. Tally and Mr. Cline:

The U.S. Environmental Protection Agency Region 5 (EPA) reviewed the Federal Highway Administration (FHWA)/Indiana Department of Transportation (INDOT) I-69 Tier 2 Section 4 Draft Environmental Impact Statement (DEIS), pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA), and Section 309 of the Clean Air Act. The Section 4 Tier 2 DEIS is the fourth of six Tier 2 DEISs EPA reviewed for the 142-mile-long I-69 Indianapolis to Evansville Project. Section 4 extends approximately 22 miles from just east of US 231 to State Road 37 (SR 37).

The DEIS-identified Preferred Alternative is Alternative 2, comprised of subsection alignments 4A-2, 4B-1, 4C-2, 4D-1, Hybrid 4E-1/4E-2, 4F-3, 4G-2 and 4H-2, with three proposed interchanges (Option 1) at SR 45, Greene/Monroe County Line (with the South Connector Road Option) and SR 37. The Greene/Monroe County Line interchange with an approximately 1-mile long connector road to SR 45/SR 445 was introduced as a potential new interchange location for Section 4 after the Tier 1 FEIS/Record of Decision (ROD).

EPA rates the DEIS preferred alternative as "EC-2, Environmental Concerns-Insufficient Information." In order to fully assess environmental impacts, additional analysis regarding the vulnerability of water resources should be undertaken. In order to fully protect the environment, additional mitigation measures should be identified in the Final EIS (FEIS). An explanation of our rating system can be found in the enclosure entitled, "Summary of Rating Definitions and Follow-Up Actions." Our detailed

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comments are also enclosed. Our detailed comments incorporate our reaction to INDOT's responses to our earlier comments regarding compensation mitigation as a result of the mitigation field visit. Our detailed comments also include EPA's technical review of the Section 4 Karst Report (unredacted version).

Protection of Water Resources in Karst and Other Challenging Environments

EPA concerns relate primarily to the project having the potential for direct and indirect adverse impacts to surface and groundwater quality and quantity in relation to streams/ponds/wetlands, drinking water supplies (wells and springs) and associated public health risks, particularly in karst areas and other challenging environments. All relevant measures to protect these resources should be incorporated into the project's final design, construction and operation. The DEIS identifies some measures that might be taken during final design and construction. However, the DEIS defers identification of specific design, construction and operation mitigation measures and best management practices (BMPs) for the preferred alternative until final design, after the Record of Decision (ROD).

We recommend that the FEIS explain INDOT's proposed project development and contracting process for Section 4 and provide a process timeline and approval authority for incorporation of project-specific design elements/features and BMPs required by INDOT for project construction and operation. We understand that decisions regarding the best approach to take during construction when encountering a karst feature will be made at that time specifically for each particular karst feature encountered. However, at the very least, we recommend the FEIS provide a list/matrix of appropriate design elements and BMPs for specific situations that are likely to be encountered during final project design, construction and operation and include cost estimates for each design feature and BMP. We suggest this list/matrix could serve as the starting point from which INDOT, the Karst MOU resource agencies, the designer and/or construction contractor may choose from to mitigate impact to karst features.

We commend FHWA and INDOT for convening a panel of local development experts to estimate how I-69 may affect growth in the project area. The geology in portions of the Section 4 project area presents challenges for providing effective wastewater treatment for homes and businesses. The document acknowledges the potential adverse impacts to water resources. However, the FEIS needs additional analysis and discussion to better identify those areas where surface and/or groundwater resources may be more vulnerable. This includes the areas identified as the project's anticipated induced growth areas. The DEIS considers various growth inducing and limiting factors in various portions of the document, generally in the narrative. A spatial analysis will help identify areas of greater vulnerability from single or overlapping factors from the natural and built/managed environments. A clear spatial presentation will enable all reviewers and decision-makers to know where these areas are in the communities. We describe the parameters of such a map in our detailed comments.

Streams

Stream impacts are the major aquatic issue for Section 4. Overall stream quality is understated in the DEIS. The amount and quality of stream relocation or permanent

loss from this project ranges between 17.6 and 21.4 miles, compensatory mitigation must be provided to offset this loss.

Compensation mitigation efforts identified in the DEIS have not advanced much from the Tier 1 documentation. However, we are aware that much work has been taking place since Tier 1. We recommend the FEIS reflect the full scope of the compensation mitigation efforts that have already taken place and include a discussion and up-to-date version of the compensation mitigation plan for Section 4.

Some of our enclosed project comments relate to the future Clean Water Act (CWA), Section 404 permitting process. We wish to raise questions or potential issues early, so that they can be better resolved. EPA's position is that the quantity and quality of federal jurisdictional stream resources proposed to be permanently lost in this Section 4 project will need formal compensatory mitigation in CWA Section 404 permitting, no matter what permitting tool is chosen by the Louisville District of the Corps of Engineers. Any of these streams which prove to be outside of current Federal jurisdiction should be mitigated under any applicable State jurisdiction and/or voluntarily under NEPA. We anticipate continued technical involvement and comments during the NEPA and 404 processes.

Air Quality

The DEIS correctly identifies Greene County is a maintenance area for the 8-hour ozone standard. The County is currently in attainment of the standard and is under an approved maintenance plan. The DEIS identifies that the conformity determination requirements for the I-69 project in Greene County will be determined after further agency consultation. The FEIS/ROD will include the regional and project level conformity demonstration updated as appropriate to reflect the proposed implementation timeline. The results of any conformity analysis will be discussed in the FEIS. Patricia Morris is the EPA Region 5 Air and Radiation Division (ARD) contact for this project and may be reached by calling 312/353-8656 or at morris.patricia@epa.gov.

EPA Class V Permits

The DEIS identifies that the project may need an EPA Class V injection well permit. In our detailed comments, we provide the clarifying language regarding EPA's Underground Injection Control (UIC) program and Class V permits under the Safe Drinking Water Act, and recommend it be incorporated into the FEIS. We also discuss the process for determining whether a Class V permit will be required. For additional information regarding EPA Class V permits and UIC program, contact Ross Micham, UIC Branch at 312/886-4237 or at micham.ross@epa.gov.

Summary of Overall Project Impacts

We request the Section 4 FEIS include the updated running tally of the impacts to resources of concern of the overall I-69 Indianapolis to Evansville project. In the NEPA documents for Sections 2 and 3 this tally was found in Appendix ZZ. The resources being tallied and tracked should now include the various karst feature types (cave openings, swallets, sinkholes, sinking streams, etc). The DEIS indicates that a precise tally of cumulative impacts is not readily attainable. EPA suggests that at least an

estimate of cumulative impacts is attainable and requests that they be included in the FEIS running tally of impacts.

We reiterate our request that the Section 4 FEIS and the future Tier 2 EISs for Sections 5 and 6 include a detailed explanation of the tracking system that INDOT is using to insure that the overall I-69 project's impacts are identified and all Tier 1 and Tier 2 NEPA mitigation measures as well as regulatory mitigation requirements are successfully implemented.

If you have any questions about EPA's comments, please contact Virginia Laszewski at 312-886-7501 or email her at laszewski.virginia@epa.gov. When the Section 4 FEIS is available, please send us 3 hard copies and 5 CDs, for our review.

Sincerely,

Kenneth A. Westlake
Chief, NEPA Implementation Section
Office of Enforcement and Compliance Assurance

Enclosures: 2

cc: U.S. Army Corps of Engineers – Louisville District, Attention: CELRL-OP-F, P.O. Box 59, Louisville, KY 40401-0059 (Greg McKay)
U.S. Fish and Wildlife Service, Region 3, Bloomington Ecological Services Office, 620 S. Walker Street, Bloomington, IN 47403-2121 (Scott Pruitt)
Indiana Department of Environmental Management, Office of Water Quality, Section 401Water Quality Certification Program, 100 N. Senate Avenue, MC 65-40, Indianapolis, IN 46204-2251 (Randy Braun)
Indiana Department of Natural Resources, 402 W. Washington St., Rm W264, Indianapolis, IN 46204 (Matt Buffington)

EPA Comments Concerning the I-69 Evansville to Indianapolis,
Tier 2 Draft Environmental Impact Statement
Section 4 – Crane NSWC to Bloomington, Indiana
CEQ No. 20100281

Our detailed comments incorporate our responses to INDOT's responses to EPA comments regarding compensation mitigation as a result of the mitigation field visit. The detailed comments also include EPA's technical review of the Section 4 Karst Report (unredacted version). EPA comments follow this order:

WATER RESOURCES
- Overview
- Interchanges and Indirect Impacts to Water Quality and Public Health
- Wetlands and Open Water Impacts
- Stream Impacts
    - Perennial and Riffle-Poll Streams
    - Intermittent and Ephemeral Streams
    - All Streams
- Mitigation and Compensatory Mitigation

KARST RESOURCES
- Analysis of Karst Impacts as part of the Alternatives Consideration Process
- Potential Impacts to Unknown Subsurface Karst Features
- Potential Impacts on Drinking Water Quantity and Quality
- Variability in Flow Conditions as Part of the Pollutant Loading Analysis
- Karst Fauna Study Methodology
- Construction Blasting
- Identification of Mitigation Measures for Karst Areas

AIR QUALITY
- Air Conformity
- Mobile Source Air Toxics (MSAT)
- Greenhouse Gases/Climate Change
- Air Quality Mitigation During Construction

EPA CLASS V PERMITS

EPA Technical Adequacy Review of the I-69 Evansville to Indianapolis Tier 2 Studies – Survey of Karst Features Report, Section 4, US 231 to SR 37, Contains Confidential Information, dated June, 2010.

SECTION 4 DEIS - DOCUMENT CLARITY – ERRATA: FIGURES/MAPS, TABLES, DEFINITIONS

WATER RESOURCES

Overview

Our concerns regard water quality, stream and wetland impacts and focus on: indirect impacts from an additional highway interchange, technical refinements when discussing wetlands and open water impacts, greater attention needed for the display and analysis and quality of stream impacts, effectively reducing temporary construction impacts, and providing the right kinds and amounts of compensatory mitigation for the unavoidable adverse impacts of the preferred alternative. Please note that where our following comments also pertains to INDOT's response to EPA's original field mitigation site visit comments, the specific original comment # is provided after the response in red font, e.g., (Response #9).

Streams: Stream impacts are the major aquatic issue for Section 4 of the proposed I-69 highway. Overall stream quality is understated in the DEIS and needs more attention in the FEIS. Specific locations and structures to reduce stream impacts at specific stream reaches need to be clearly depicted in the FEIS. Special attention needs to be given to sedimentation control for construction impacts for this large, cross-country project in steep terrain. Best Management Practices (BMPs) uniquely suitable for this situation must be identified and used.

Compensatory Mitigation: In the DEIS, conceptual compensatory mitigation for wetland and stream impacts is similar to that developed in the Tier I FEIS. More work is ongoing and needs to be reflected in the FEIS. Wetland and forest mitigation requirements should be calculated in acres. Stream mitigation requirements should be calculated in linear feet, for restoration and/or enhancement involving *both* banks of the stream. Riparian buffers in specified minimum widths need to be used to protect stream stability and quality.

Clean Water Act (CWA) Section 404: Some of our project comments relate to the future CWA Section 404 permitting process. We wish to raise these questions early, so that they can be better resolved. We anticipate continued technical involvement and comments during the NEPA and 404 processes.

EPA's position is that the quantity and quality of stream resources proposed to be relocated or permanently lost in this project, 93,100-112,801 linear feet (about 17.6 to 21.4 miles), will need formal compensatory mitigation in CWA 404 permitting, no matter what permitting tool is chosen by the Louisville District of the Corps of Engineers. Any of these streams which prove to be outside of current Federal jurisdiction should be mitigated under any applicable State jurisdiction and/or under NEPA. (Response #9)

Interchanges and Indirect Impacts to Water Quality and Public Health

An additional interchange at the Greene-Monroe County line, connecting west to SR 45, is added to the original Tier 1 interchange alternatives and included as part of the preferred alternative for the Section 4 Tier 2 DEIS. The proposed Greene-Monroe County Line interchange connects into SR 45 about 5-6 miles north of the previously proposed and retained SR 45 interchange. This additional third interchange would add

greater accessibility to this stretch of SR 45 and to the regional/local road network, including a direct connection to SR 445 and SR 54, providing greater access to the rural areas of southwest Monroe, eastern Greene and northwest Lawrence Counties.

Accessibility and traffic congestion statistics at the proposed interchanges have been examined in the DEIS. There is the need to consider the impacts of allowed/induced development in a sensitive area as a water quality and public health issue. Highway interchanges can promote immediate nodes of commercial development for traveler services and community needs. They can also allow or promote access to more remote residential and commercial locations. Access to and from the proposed new interchange has shifted the immediate development area to the west through an approximately 1-mile long connector road. The DEIS identifies that the shift was made for accessibility from SR 45 and in part to move the local access connection slightly beyond an area with a higher amount of karst geology.

Eastern Greene County and nearby areas of western Monroe and likely northwest Lawrence Counties rely exclusively on on-site wastewater treatment through septic systems. We are concerned about the potential for indirect impacts from the development that the new highway interchange will accommodate and promote in this attractive but sparsely developed rural area. The DEIS identifies that water quality impacts from poorly functioning wastewater treatment systems could potentially adversely affect surface and groundwater, drinking water wells and sensitive karst resources from additional development. However, discussion of the topic of indirect impacts to water, karst resources and public health is limited in the DEIS. It is an important consideration in this specific area and it needs to be augmented in the FEIS. The topic should be analyzed and presented in a spatial as well as a narrative format, explained as a whole, in order to fully inform the decision makers, review agencies and interested public.

Recommendation: We recommend the FEIS include a figure/map that identifies and depicts southwest Monroe County, east-central and southeast Greene County and northwest Lawrence County, the Preferred Alternative alignment with interchanges and connector roads and the following spatially represented information:

- the extent of the service areas of the various existing public and private rural water supply utilities,
- the extent any service areas for community wastewater collection, including the potential sewer extension from Bloomington,
- the extent of the residential areas that are served by their own individual drinking water wells and on-site septic systems,
- the location of karst features/densities, including specific identification of areas that include springs used for potable water,
- extent of areas with shallow bedrock, soils identified as to their suitability for use with on-site septic systems,
- the extent of areas where there are special health department or land use controls for septic system design and/or installation, each County's (Greene, Monroe, Lawrence) existing and proposed planned development areas in and near the identified induced growth areas,
- the extent of induced growth areas.

The figure/map should specifically identify those areas where surface and groundwater resources are particularly vulnerable due to one or more human or natural factors. The analysis should include identification and consideration of the recently adopted Greene County Comprehensive Plan, the Bloomfield Comprehensive Plan, the Greene County Economic Development Corporation's I-69 Corridor Plan, and the Monroe County Comprehensive Land Use Plan and its Transportation Corridor Plan for SR 37 / I-69. The FEIS should include a narrative discussion of the analysis and identify additional mitigation measures that could be undertaken by INDOT and/or local, county or state governments.

Many local conditions are challenging for the effective design, technical operation and maintenance of on-site wastewater treatment systems in the Section 4 project area. These constraints can include soil suitability, slope, high bedrock, karst areas with groundwater connectivity (and the potential for wastewater problems to impact groundwater and surface water). In addition, spread-out rural residential, commercial and industrial development makes wastewater collection by sewers cost-prohibitive for most areas. The Zanesville silt loam soil areas found along SR 45, for example, have limited permeability and wetness, limiting the use of standard septic drainage fields. Even when systems are properly designed and constructed, the effective long-term management and success of on-site wastewater treatment systems are difficult because they rely on the actions of multiple property owners.
Recommendation: We recommend the analysis include the consideration of any established or recommended local land use tools, or state/county public health tools that address residential and commercial development and long-term, effective on-site wastewater treatment.

Chapters 4 and 5 of the DEIS have a very limited discussion of local land use planning and regulation, and how that would inform this issue. Both Greene and Monroe Counties accepted I-69 planning grants and produced documents, including a first-time land use plan for Greene County, which is largely rural and has no zoning ordinance. The issues, discussion, results and conclusions of these grants with respect to indirect, induced, or anticipated increased growth, and its management, are not included in the DEIS, other than mention of areas of increased industrial/business park uses and a "Bloomington Urbanizing Area." Appendix T, on the planning grants, consists of a single page, indicating the participating communities with I-69 planning grants.

While many small pieces of the information can be found throughout the DEIS, a complete and orderly presentation, assessment (both narrative and spatial) assessment and conclusions on the issue of indirect/induced/allowed growth is missing and must be part of the FEIS. The study area for this assessment needs to contain available information on northwest Lawrence County, since that County would also have increased accessibility due to I-69.

<u>Wetlands and Open Water Impacts</u>

The DEIS has covered wetlands and open water resources impacts throughout the document. Efforts to avoid and minimize impacts to wetlands and ponds have been

made. The proposed bridging of the wetland-stream complex at Black Ankle Creek by Koleen is desirable, as shown in Figure 6-2.
Recommendation: We note a technical misstatement on wetland "delineation" on p. 6-58, and possibly elsewhere in the DEIS. A wetland *determination* has been made, based on field observations, and gives us a much better idea about wetland resources than considering the National Wetlands Inventory maps alone. This is an acceptable level of information for the NEPA process. A formal wetland *delineation* will be done, using a specific required methodology, as part of any application for a Clean Water Act Section 404 permit.

Of the approximately 41.5 acres within the project study corridor, the DEIS has estimated impacts to 5.26 to 13.09 acres of wetlands/open waters. Project design work should endeavor to further reduce the amount of wetland and open water impact, where possible. As with streams, special attention needs to be given to protecting the "avoided" wetlands from sedimentation impacts during construction. Ample amounts of compensatory mitigation are being proposed to offset any unavoidable losses to wetlands. Please see more on compensatory mitigation below.
Recommendation: A technical clarification on the EPA role in Federal jurisdiction should be made on pages S-46, 5-429, 5-635 and possibly elsewhere: EPA reviews and has the authority to make the final decision on the Federal jurisdictional determinations as part of its responsibility in jointly administering Section 404 of the Clean Water Act. We recommend this be corrected in the FEIS.

Stream Impacts

Permanent and temporary stream impacts are a major aquatic issue and source of adverse aquatic impacts for Section 4 of the proposed I-69 highway. Substantial amounts of data are included in Appendix M, the Draft Stream Assessment Report, with each stream segment in the study area identified and provided with an assessment of its structural quality, including the survey data sheets.

The text of the DEIS sums up the considerable length of stream channels proposed to be permanently adversely impacted by the cross-country location of a major new highway. Proposed Alternative 2 will potentially impact 16,316 to 22,658 linear feet (LF)—about 3.0 to 4.3 miles--of stream channels. The exact amount of impact will depend on a mosaic of project design selections made post-FEIS/ROD, in part, by choosing between the initial design criteria and the low-cost design criteria for each of the preferred alternative's eight subsection alignments. While the quantity of stream impacts are highlighted in the DEIS, the quality of the water resources being lost or modified is not sufficiently discussed. Full use has not been made of the stream data collected. In the following comments, we expand on this topic and make recommendations for better incorporation of stream quality information into the text of the FEIS.

Perennial and Riffle-Pool Streams: With one possible exception, all of the perennial streams inventoried in the study corridor, totaling 6,674 to 9,404 linear feet, have a riffle-pool structure, as indicated in the data sheets of the Ohio Qualitative Habitat Evaluation Index (QHEI) in Appendix M. The one possible exception may be Black Ankle Creek (stream S4-076) which was scored during bank-full conditions, which may have obscured

the stream structure. The QHEI assessment for the creek should be field verified under more representative conditions. The important information on structural quality is not included in Results narrative of the stream assessment report or a clear theme in the text of the DEIS. Riffle-pool streams need to be discussed as a stream resource and quality topic, as well as a mitigation topic (Response #6). Streams with a riffle pool structure are regulated as Special Aquatic Sites, as are wetlands, under the Section 404(b)(1) Guidelines, at 40 CFR Part 230.45. For the future 404 permitting purposes, alternatives avoiding Special Aquatic Sites are presumed to exist for non-water-dependent activities, such as highways, and impacts to riffle-pool streams and wetlands must be avoided. While this is a matter that will be significant during 404 permitting, it is important information to include in the FEIS as an indication of the quality of the resource within the project area and as a reminder of areas to avoid. From our review of the DEIS, it appears that most or all of the riffle-pool streams will be bridged. This is highly desirable and needs to be confirmed or clarified.
Recommendation: We recommend incorporating the important information on stream structural quality as identified above into the main discussions of the FEIS and into the Results narrative of the stream assessment report.
Recommendation: We request that the FEIS clarify whether most or all of the riffle-pool streams will be bridged.

Intermittent and Ephemeral Streams: The study corridor contains 20,286 to 25,701 linear feet (3.8 to 4.9 miles) of intermittent streams and 66,150 to 77,696 linear feet (12.5 to 14.7 miles) of ephemeral streams. For the discussion of stream resources and quality, the box on page 5-443 presents a "thumbnail sketch" of the stream resources in the study area and sums up the ephemeral streams as being of low to moderate quality. This is misleading. A notable aspect of Section 4 is the higher stream quality and the lack of stream alteration compared to the streams of other sections of the proposed I-69 highway in Indiana. Stream structural assessment scores using the Ohio's Headwater Habitat Evaluation Index (HHEI) methodology, and the data in that summary box, show that of the 273 assessed segments, 78 are the top quality Class III (unmodified channels, by definition of the class) and 68 are Class II with a natural channel or high scoring Class II with a modified channel. This total of 146 segments represents 53.5 percent of the study area, with intermittent and ephemeral streams being of very good quality or higher. The perennial stream reaches in the Alternative 2 path have habitat quality scores ranging through the good to the exceptional ranges. Part of this is manifest in their riffle-pool structure. Although the HHEI and QHEI ratings carry no specific regulatory actions in Indiana, they point to the quality range of a resource where impacts can be substantial under the Section 404(b)(1) Guidelines in permitting.
Recommendation: We recommend additional information regarding stream quality data as identified above be appropriately incorporated in the discussion of stream quality in the FEIS and in consideration of the environmental impacts of the proposed project.

The DEIS depictions and text of the Preferred Alternative 2's route across the terrain in this complex study area, make it laborious to associate the areas of permanent impact and impact reduction to specific stream reaches. The stream surveys have an orderly numbering system and these inventory numbers are used in Appendix A of Appendix M and Table 5.19-5. However, the identification of the stream segments impacted need to be carried into the discussions of specific impacts in the narrative of the text. For

example, some aquatic resources (stream channels, floodplains and wetlands) will be bridged. Page 5-445 discusses bridging at certain areas by the name of the stream, but some named streams have multiple inventory segments in the study area. Adding the inventory numbers to the discussion, possibly supplemented with a new associated table, will more clearly present stream impacts in the FEIS.
Recommendation: We recommend the stream inventory numbers be added to the maps and discussion to more clearly present stream impacts in the FEIS. If possible, supplement with an associated table.

Some stream crossings in Table 5.19-5 have zero feet of impact; it is not clear if this is because that stream reach is completely avoided by the anticipated pathway choices for the preferred alternative or if it represents compete bridging of that stream segment, with no structural piers, or something else. The bridge/grade separation maps for the alternatives are presented in Figure 6.2. Streams are highlighted here on the aerial photo base maps, but do not have the numerical identification code for the specific stream segments. The project reviewer or decision official must make a visual cross walk with map series 6.2 and the location-coded map set in Appendix M.
Recommendation: To provide more clarity in the FEIS, please label the maps of Figure 6.2 with the stream segment inventory numbers and be specific, by stream segment number, in the narrative and tables of the FEIS for the exact stream reaches being affected (or potentially affected, depending on the final design option selected).

<u>All Streams</u>: It is unclear if any of the crossings may need associated stability measures for the bridging that may result in dredging or filling the riffle-pool stream and its banks. This might include such activities as channel re-alignment, rip rap or bridge pier placement. In situations where channel stabilization is planned, stream bank bioengineering methods should be evaluated as an alternative to rip rap. Rip rap may also be used to protect the toe slope stability of a silt-clay stream bank, rather than adding the weight of armoring the entire slope, in specific situations. These methods would also contribute to wildlife value, since rip rap makes animal passage under bridges more difficult. Alternative 2 involves 39-44 potential stream relocations, which will each impact stream quality and potentially affect channel stability equilibrium above or below the direct impact area.
Recommendation: We recommend the FEIS identify the stream crossings that may require stability measures for the bridging that may result in dredge or filling the riffle-pool stream and its banks.

Well-designed box culverts are a preferable choice to pipe culvert design. Page 5-445 indicates 34 crossings with either 3-sided structures wider than 29 ft. or oversized culverts.
Recommendation: The FEIS should indicate the construction choice (or at least alternative choices) proposed for each specific stream crossing. The text should indicate the size and design of a "large culvert." If this is information developed in the analysis of wildlife issues, its location should also be cross-referenced from the water discussion in the FEIS.

Temporary Construction Impacts: Temporary construction impacts to streams have the potential to be severe in Section 4. Constructing a new highway to Interstate

standards, cross-country over steep terrain with valuable aquatic resources, will be challenging. Stream quality must be effectively protected. The set of Best Management Practices (BMPs) commonly used for Indiana highway construction may be inadequate for a large project in steep topography. Consultation with other States and sources for suitable BMP approaches and practices in steep, hilly terrain should be used to protect streams and water quality in Section 4. Project-appropriate construction BMPs will also be under our consideration in Clean Water Act Section 404 permitting.
Recommendation: We recommend the FEIS identify the specific construction BMPs that could be used to successfully protect surface and groundwater quality under the variety of conditions, such as steep slopes and karst terrain, associated with Section 4.

Mitigation and Compensatory Mitigation

Compensatory Mitigation: Compensatory mitigation needs to be provided for unavoidable dredging or filling of streams, including relocations. This can be done by natural channel preservation, or in some cases, stream restoration or enhancement. EPA and the Corps of Engineers jointly administer Section 404 of the Clean Water Act. Under current practices, stream impacts in Indiana are being assessed by linear feet rather than acres. On page 7-45, assessing impacts by acres underestimates the impacts to the linear nature and behavior of streams and mitigation needs and costs to offset unavoidable losses.

The approach to stream, wetland and upland forest mitigation for permanent losses was not substantially advanced in the DEIS document from Tier I concepts. Tier I presented a reasonable conceptual approach for searching for sites to provide conservation and restoration benefits for lost aquatic resources, forest restoration and non-aquatic endangered species concerns, within several geographic focus areas.

Additional project planning work on potential sites for mitigation has occurred since Tier 1, but was not reflected in the DEIS. Just before the DEIS was issued, EPA and other resource agencies were included in a site tour and briefing for a number of prospective mitigation sites in the geographic focus areas. All sites had some merit for certain aspects of mitigation for one or more resource concerns. We will continue to provide separate technical input on these sites.
Recommendation: We recommend the FEIS document the progress on compensation mitigation work that INDOT and their contractors have made and continue to make since the Tier 1 ROD.
Recommendation: The FEIS should discuss and include the up-to-date compensation mitigation plan. This may be in greater detail for secured sites and more general for sites under consideration.

The DEIS does not reflect the big job that stream mitigation will need to be, even when stream preservation is integrated into the forested and other mitigation sites. Because the DEIS underestimates the amount of stream compensation needed, further work may need to be done to locate a sufficient quantity and quality of stream mitigation.
Recommendation: The FEIS should identify how juggling of mixed-use mitigation objectives will be accomplished and which values may prevail over others in the site selection process. (Response #1 and #2)

From an aquatic resources perspective, a promising wetland and stream mitigation approach would be to work on sites where it is possible to restore drained wetlands next to a stream. From the water's edge, this would include maintaining or enhancing a healthy riparian corridor in native vegetation, at least 100-ft. on each side from the mid line of the stream, for a 200-ft. corridor. If appropriate, some natural stream channel restoration or enhancement would be included. Restoring hydrology on hydric soils in adjacent bottomland farmland or fields would be the start of a sound, self-sustaining process to restore wetlands. Beyond the wetland, upland forest restoration would complete the mitigation landscape complex. All species used for mitigation should be native to this region of Indiana.

As a difficult-to-replace aquatic resource, stream mitigation may encompass preservation under the EPA-Corps Mitigation Rule. A good opportunity for stream preservation will be within the I-69 Section 4 forest preservation mitigation sites. Additional linear feet of stream mitigation could come from stream corridor enhancement projects within reforestation sites.

Several potential mitigation sites along Plummer Creek near Koleen show promise, especially if they can be merged together into a larger parcel. A combination of mitigation activities would fit together well together here. This can start with stream channel restoration and moving the channel away from the road, allowing the natural positioning within its floodplain over time. The new location must provide space for a suitable minimum 200-ft wide riparian buffer corridor, to protect the perennial stream. Any wetland restoration associated with this complex should first rely on the opportunities from altering old agricultural drainage, rather than by extensive berming or excavation.

Stream channels occurring in areas of shallow or exposed bedrock are best preserved or protected by a riparian corridor, rather than by attempted channel modification "improvements."

Recommendation: We recommend wetland and forest restoration be calculated in acres and stream corridor restoration/enhancement be calculated in linear feet, encompassing both banks as one stream length, rather than counting double linear credit for work on both banks. No less than 50 feet of buffer on either side of an intermittent or ephemeral stream, for a minimum 100-ft. corridor, should be used. Opportunities for the buffer to be even wider are desirable.

CWA Section 404: EPA's position is that the quantity and quality of Federal jurisdictional stream resources proposed to be relocated or permanently lost in this project, 93,100 to 112,801 linear feet (17.6 to 21.4 miles), will need formal compensatory mitigation in 404 permitting, no matter what permitting tool is chosen by the Louisville District of the Corps of Engineers. Any of these streams which prove to be outside of current Federal jurisdiction should be mitigated under any applicable State jurisdiction and/or voluntarily under NEPA. (Response #9)

This is a much more extensive quantity of stream mitigation than the calculations by acres assumed in the DEIS. Stream mitigation needs to maximize preserving and restoring the existing natural drainage network. It should not rely on simply inserting "naturally-structured" channels with reduced catchment size in new locations. Projects are substantially more effective when both banks of the stream can be protected through riparian corridors. Unfortunately, land parcel boundaries are often drawn up with a stream as a boundary.
Recommendation: When assembling parcels for mitigation sites from the known array of prospective sites with interested cooperating owners, we recommend additional inquiries be conducted to see if the landowners on any excluded opposite stream bank are willing to consider a riparian corridor easement. Including the opposite bank would add to the quality, quantity, long-term effectiveness, and stability of the stream restoration or enhancement project.

As mitigation plans are made, suitable wetland and stream mitigation performance standards will need to be developed, incorporating both physical and biological standards.

Conservation Easements: The DEIS identifies that INDOT intends to purchase mitigation easements to protect mitigation sites in perpetuity. The mitigation lands will be turned over to an appropriate government conservation and management agency; will contain deed restrictions identifying them as mitigation sites and protecting them from further disturbance; will be planted with mixture of native trees largely composed of species having high value as potential Indiana bat roost trees; will include buffer areas around Indiana bat hibernacula; and will include obtaining easement for other protection measures for Indiana bat hibernacula. (DEIS pp. 7-4 through 7-6, 7-26, and 7-37 through 7-39.) (INDOT Answer #14)
Recommendation: We recommend the FEIS clarify whether INDOT will provide sufficient funds to the government conservation and management agency to support maintenance of the sites in perpetuity and the education of current and future landowners about the mitigation projects and about being good land and water stewards. In addition the FEIS should identify whether there will be a way to enforce or correct any misplaced actions/inactions by the easement-granting landowners that may adversely impact the integrity of the mitigation site. The easement agreements should be clear about whose job it will be to enforce the terms of the easements. (Response #14)

KARST RESOURCES

Recommendation: EPA recommends the FEIS address the following karst impact issues identified in the I-69 Section 4 DEIS:

<u>Analysis of Karst Impacts as part of the Alternatives Consideration Process</u>
We have concerns that the appropriate level of consideration was not given to the various karst feature types presented in the DEIS. As such, the alternatives analysis completed for Section 4 Corridor appears to have considered impacts to the seventeen different karst feature types as equals. With respect to karst resources, in order to adequately assess alternative impacts, consideration must be given to karst feature size, location, infiltration rate, recharge/discharge characteristics, connectivity to

groundwater conveyances, potential T&E species impacts, potential water quality impacts, threats to the traveling public, etc. For example, impacts to a sinking stream should not be weighed equally to impacts associated with a low-infiltration sinkhole. The fact that an alternative impacts a lower number of karst features does not necessarily guarantee that it will result in the least amount of environmental impacts. Assigning weights to each karst feature type based on their quality, connectedness, and sensitivity will ensure that the karst impacts associated with each alternative are adequately assessed.

Potential Impacts to Unknown Subsurface Karst Features

The DEIS acknowledges that the methodology developed for the karst survey included only those karst features that could be visually observed (i.e. surface features). The DEIS states that direct impacts to caves were avoided during alternative development and thus no direct impacts to known cave habitats and/or cave biota are anticipated. At the same time, the DEIS acknowledges that unidentified subterranean karst features are present and an unknown number of those features will be encountered during highway construction. How can a determination of no direct impacts to cave habitat or cave biota be made given the acknowledged lack of information related to subsurface karst features, specifically their size and location? The lack of subsurface karst feature data poses a severe threat to karst environments during construction of the proposed highway facility. The importance of identifying subsurface karst features early in the design phase is important as the exposure of subsurface karst complexes and the severance of groundwater conveyances can have negative consequences, particularly to karst fauna and flora and the quantity and quality of private/residential water supply features.

Potential Impacts on Drinking Water Quantity and Quality

The DEIS identified numerous private groundwater wells within and adjacent to the Section 4 corridor. Furthermore, the DEIS indicates that in some cases karst springs are utilized as a private/residential water supply alternative. The proposed action could potentially result in changes in drainage patterns to and from karst features if construction were to eliminate recharge features, sever conduits, and reduce flows. The result could be a reduction in water availability for landowners who rely on said water supply features for residential or agricultural uses.

Karst recharge features act as direct conduits to groundwater conveyances and supplies. Stormwater runoff, both during and following construction of the proposed highway facility, is a serious threat to groundwater quality if appropriate pre-construction and post-construction BMPs are not identified, implemented, and maintained. Induced development resulting from construction of the proposed highway facility can also impact groundwater quality through the addition of septic systems and impervious surfaces within karst zones of susceptibility.

Karst Fauna Study Methodology

The Section 4 cave inventory effort identified 63 caves within the study area, including 14 caves with entrances located within the Section 4 corridor. As noted in Section 4 Survey of Karst Features Report, 6 caves "within and in proximity" to the Section 4 Corridor were sampled to determine the presence of invertebrates. These sites were

selected based on known hydrologic connections to the corridor confirmed by dye tracing which had been completed at that time the Karst Fauna Study was performed.
EPA understands that a cave fauna survey that includes all accessible caves within, or directly adjacent to, the Section 4 corridor would better characterize cave fauna and further demonstrate a commitment to "meet Indiana's transportation needs in an environmentally sensitive manner that protects the habitat of all species," as outlined in the 1993 Karst MOU. The additional cave fauna studies would assist in providing a better understanding of all potential direct and indirect/secondary impacts associated with construction of the proposed action, while also helping with the selection and refinement of mitigation measures and best management practices for protecting the biological integrity of karst resources.

Variability in Flow Conditions as Part of the Pollutant Loading Analysis
The pollution loading analysis model presented appears to utilize a high bias on the quantity of water involved in pollutant mobilization. A high water volume coupled with a static pollutant load will result in a lower concentration when compared to regulatory criteria. We recommend that the analysis include a typical versus extreme rain event, mobilizing the same pollutant load. This is important as the results of this analysis will yield a result more representative of natural conditions.

Construction Blasting
EPA understands that blasting may need to be used quite frequently in karst areas. Blasting can cause structural damage to buildings and wells, and cause the collapse of karst subsurface openings, such as cave walls. The DEIS does not identify the specific measures that will be required before, during and after blasting to insure that the integrity of structures, wells and karst subsurface openings remain intact.

Identification of Mitigation Measures for Karst Areas
With respect to highway construction, EPA understands that one of the most important mitigation BMPs is the lining of drainage ditches. These features concentrate water in areas that may not have been subjected to surface flow in the past. We understand that a study conducted by the Tennessee Department of Highways discovered that 74% of the sinkholes observed during the study were located in the highway ditch lines. Further, 91% of the sinkholes opened up in unlined drainage ditches.

The identification and estimates of the types of BMPs that are going to be required on a project is important so that the contractor can prepare a responsive bid. This will be especially true for a Design/Build project delivery since we understand that the schedule is usually very tight and construction claims are not contractually allowed.

The following is a partial listing of mitigation or protection BMPs that have been used in karst terrains across the United States.

Ditch Lining BMPs
- Compacted Clay Liners
- Geosynthetic Clay Liners
- Flexible Membrane Liners
- Concrete, Portland cement or asphalt.

Sinkhole Remediation BMPs

- Bridging Alternatives
    - Land bridges (below grade)
    - Culvert or bridges
    - Reinforcing within cave
    - Ground Modification
    - Geopier with cap
    - Piles with caps
- Filling Alternatives
    - Rock Pads
    - Large Rockfill
    - Compaction Grouting (soil)
    - Cement Grouting (voids)
    - Dynamic Compaction
    - Excavation, overlapping geotextiles, soil backfill
    - Excavation, concrete cap, soil backfill.

Other Karst Feature Protection BMPs

- Avoidance
- Earth Berm Construction
- Gabion Berm Construction
- Open Standpipe Installation
- Concrete Catch Basin Installation

The identification and implementation of construction and storm water related BMP's for a karst environment is extremely important because of the physical and environmental sensitivity of karst features, flora, and fauna. It is of critical importance that the potential or preferred BMP's for mitigating or protecting karst features be identified early as possible in the design process (preliminary design stage). EPA understands that this is particularly important for a Design/Build (D/B) project delivery since this method is extremely time sensitive and contingencies for further investigation or consensus building are generally not part of the project schedule. We understand that BMP's should be included in either the D/B project specifications or in the Preliminary D/B plans that will be used to produce the D/B bid.

Recommendation: We recommend the FEIS explain INDOT's proposed project development and contracting process for Section 4. Please provide a process timeline and approval authority for incorporation of project-specific design elements/features and BMPs required by INDOT for project construction and operation. We understand that decisions regarding the best approach to take during construction when encountering a karst feature will be made at that time, specifically for each particular karst feature encountered. However, at the very least, we recommend the FEIS provide a list/matrix of appropriate design elements and BMPs for specific situations that are likely to be encountered during final project design, construction and operation and include cost estimates for each design feature and BMP. We suggest this list/matrix could serve as the

starting point from which INDOT, the Karst MOU resource agencies, the designer and/or construction contractor may choose from to mitigate impacts to these karst features.

AIR QUALITY

Air Conformity: The DEIS (Section 5.9, page 5-243) correctly identifies Greene County is a maintenance area for the 8-hour ozone standard. The County is currently in attainment of the standard and is under an approved maintenance plan. The conformity determination requirements for the I-69 project in Greene County will be determined after further agency consultation (page S-48). The FEIS/ROD will include the regional and project level conformity demonstration updated as appropriate to reflect the proposed implementation timeline (S-49). The DEIS goes on to state that the results of any conformity analysis will be discussed in the FEIS (5.9.7 Conformity Findings (page 5-243).
Recommendation: EPA recommends the FEIS include the FHWA conformity determination, discussion and supporting documentation.

Mobile Source Air Toxics (MSAT) (Section 5.9, pages 5-233 – 5-243). A qualitative assessment of mobile source air toxics (MSAT) is provided in the DEIS. However, it is unclear why forecasted average daily traffic (ADT) of vehicles per day for roadway segments in Section 3 were used instead of Section 4 (page 5-234, first full paragraph).
Recommendation: We recommend the FEIS use ADT specific to Section 4 or explain the rationale for using Section 3 ADT in the Section 4 MSAT analysis.

Greenhouse Gases/Climate Change (Section 5.9, page 5-235): One paragraph in the DEIS is devoted to addressing greenhouse gas emissions associated with the project and climate change. The DEIS states that FHWA does not believe it is informative at this point to consider greenhouse gas emissions in an EIS. The DEIS goes on to identify that FHWA is actively engaged in activities with the USDOT to assess the risks to transportation systems and services from climate change.
Recommendation: We recommend the FEIS identify and discuss any anticipated effects of climate change on the project. For example, discuss any effects that predicted increases in the number and/or intensity of precipitation events due to climate change may have on sizing bridge spans, culvert openings, and stormwater management measures in order to accommodate such events and ensure public health and safety.

Air Quality Mitigation During Construction (Section 7.3, page 7-16): Even though Section 4 is a relatively rural area, exposure to diesel exhaust by construction workers and those nearby construction sites can have serious health implications. In order to protect air quality in the project area during construction, we recommend INDOT consider additional strategies to reduce diesel emissions, such as project construction contracts that require the use of equipment with clean diesel engines and the use of clean diesel fuels, and limits on the length of time equipment is allowed to idle when not in active use (EPA recommends idling not exceed 5 minutes).

The Section 4 FEIS should discuss the feasibility of utilizing construction contracts that require the use of equipment with clean diesel engines and the use of clean diesel fuels,

and limits on the length of time equipment is allowed to idle when not in active use. In addition, the FEIS should identify whether or not INDOT will consider or commit to implementing these and/or additional strategies, including but not limited to, formalizing INDOT actions for the entire I-69 project by developing and implementing a construction emissions reduction plan as recommended in our June 3, 2009, letter regarding the I-69 Tier 2 Section 3 DEIS.

UNDERGROUND INJECTION CONTROL (CLASS V PERMITS)

Permits (Section 5.23.8 EPA Class V Permits, and Chapter 7 (page 7-43)
EPA would determine on a case-by-case basis whether or not an individual permit would be required for any Class V well under the Safe Drinking Water Act.
Recommendation: We suggest the following changes be made in the FEIS for Chapter 7 (Mitigation, page 7-43) regarding Class V permits: Instead of stating " . . . A permit would be required if underground sources of drinking water would be negatively impacted" it is more accurate to state, "EPA would determine if a permit is required for any Class V injection well that may contaminate an underground source of drinking water."

Recommendation: Regarding, Chapters 5.21.4 (page 5-596) and Chapter 5.23.8 (page 5-637) we offer the following clarifying language for the FEIS:
"Class V injection well permits may be required for various types of projects. For example such a permit could be required by EPA Region 5 if a Class V injection well is located within the karst region of the state, a sole source aquifer area, a state designated source water protection area for a public water supply, or anywhere untreated fluids discharged through a Class V well may otherwise endanger an underground source of drinking water. If there are measures in place to prevent contamination of groundwater, a Class V well could be authorized by rule rather than by a permit. A Class V Well Inventory Form would need to be provided to EPA Region 5 prior to construction of a Class V injection well so that EPA could determine if a Class V injection well permit will be required for any Class V wells. For the I-69 project, if the inventory information provided indicates that any injection well would likely contaminate any underground source of drinking water, a permit would be required. Any permit would need to be applied for and obtained prior to construction of the Class V well."

For additional information regarding EPA Class V permits and UIC program, contact Ross Micham, at 312/886-4237 or at micham.ross@epa.gov.

EPA Technical Adequacy Review of the I-69 Evansville to Indianapolis Tier 2 Studies - Survey of Karst Features Report, Section 4, US 231 to SR 37, Contains Confidential Information, dated June, 2010.

[Note: A redacted version of the Karst Features Report is included in Appendix AA of the Section 4 DEIS.]

Karst Fauna Study Methodology

The Section 4 cave inventory effort identified 63 caves within the study area, including 14 caves with entrances located within the Section 4 corridor. As noted in Section 4 Survey of Karst Features Report, 6 caves "within and in proximity" to the Section 4 Corridor were sampled to determine the presence of invertebrates. These sites were selected based on known hydrologic connections to the corridor confirmed by dye tracing which had been completed at that time the Karst Fauna Study was performed.
EPA understands that a cave fauna survey that includes all accessible caves within, or directly adjacent to, the Section 4 corridor would better characterize cave fauna and further demonstrate a commitment to "meet Indiana's transportation needs in an environmentally sensitive manner that protects the habitat of all species," as outlined in the 1993 Karst MOU. The additional cave fauna studies would assist in providing a better understanding of all potential direct and indirect/secondary impacts associated with construction of the proposed action, while also helping with the selection and refinement of mitigation measures and best management practices for protecting the biological integrity of karst resources.

Variability in Flow Conditions as Part of the Pollutant Loading Analysis

The pollution loading analysis model presented appears to utilize a high bias on the quantity of water involved in pollutant mobilization. A high water volume coupled with a static pollutant load will result in a lower concentration when compared to regulatory criteria. We recommend that the analysis include a typical versus extreme rain event, mobilizing the same pollutant load. This is important as the results of this analysis will yield a result more representative of natural conditions.

Executive Summary

Results, Karst Mapping [Pages vii through vii]

What is the difference between "Karst features relevant to the corridor" and "Karst features within the corridor"? What specifically makes a feature relevant?

The report states - *"Mapped Karst features relevant to the corridor: 63 caves, 14 within the corridor. " There are 315 known caves located within five miles of the Section 4 corridor."*

What defines "relevant" to the project if the dye tracing average extent was over 5,200 feet and some traces exceeded 20,000 feet?

1.0 Introduction

1.1 Purpose and Scope

[Page 1]
The report states - *"...and Karst experts knowledgeable about the area"*. Who are the karst experts that are knowledgeable of the area? Please clarify who was consulted.

1.5 Geologic Setting

[Page 4]
Provide geologic data on Figure 4 to facilitate interpretation of the influence of the bedrock geology on karst formation within the project limits. Include formation/member croplines as well as structural information [dip direction].

1.5.5 Mining Operations [Page 6]
The report states - *"Based on the results of field reconnaissance and coordination with IDNR and IGS, these excavations have apparently become overgrown and non-discernable due to their shallow nature."* This statement does not address the potential impacts of these abandoned underground mine workings. Unregulated 'house' or 'farm' mines are known to extend several hundred feet from outcrop entrances. Shallow workings are of greater concern than deep abandoned workings. To state that they are "overgrown and non-discernable" does not define the potential construction risk, future roadway collapse, acid mine discharge potential, or habitat loss. Many abandoned mines are roosting places for a number of bat species.

1.6 Hydrogeologic Setting

1.6.1 Water Supply [Page 8]
The report indicates that groundwater and surface water [including springs] are combined sources of public water supplies in Section 4. However, the report does not address how the project may impact public water supplies. Provide the following:

- Locations of public water supplies relative to alignment.
- Extent of recharge areas for surface/spring water sources of public water supply.
- Depths of public water supply wells with radius of influence information.

Furthermore, the report needs to more directly indicate what karst features provide private/residential water supply. Annotate Figures 29-31 to indicate which springs serve as private/residential water supply. We suggest conducting baseline residential water sampling at locations of anticipated impacts over 4 quarters to capture seasonal fluctuation in drinking water quality. Discuss impacts to these sources in the report, as well as the planned impact mitigation measures should these sources be impacted by construction.

2.0 Methodology

2.2 Karst Feature Identification

[Page 14]

The report states - *"Under the Karst MOU, if during construction unknown features are identified, the MOU signatory agencies will be contacted and an agreement regarding the proposed treatment of the feature reached prior to work continuing in that specific area of the project."* How would treatment for a discovered karst feature be different from a known karst feature? If a swallet is 'discovered' during construction that was not inventoried during design, would the mitigation be any different? If treatment options are not discussed for features uncovered during construction until construction begins, serious construction delay claims can be expected.

2.3 Dye Tracing Methodology

[Page 16]
Provide the methodology used in determining what constitutes a "relevant" discharge feature for dye tracing sampling network development.

2.4 Dye Trace Field and Laboratory Procedures

[Page 19]
Provide justification for the positive analytical detection criteria listed. As listed, several potential lower level positive results will be discounted. The result of this will be a smaller area of recharge assumed per discharge point. Reinterpret analytical results accepting all positive results above the method reporting limit [signal to noise ratio]. Revise Appendix H figures to reflect changes in interpretation.

2.5 Pollutant Load Estimates

2.5.1 Pollutant Loads from Highway and Right of Way [Page 20]
Does the pollutant model rely on dilution based on current flow conditions? If so, the cited assumptions are invalid. The text assumes karst features, presumably recharge sources, will be capped and filled. Subsequent statements indicate spring boxes will be utilized to perpetuate natural flow conditions. How will the construction plans ensure beheaded drainage is routed to ensure flow conditions of the pollutant loading model are preserved?

Conduct background testing of pollutant loads representative of actual pre-construction conditions to refine the pollutant load model.

The final paragraph cites the trend of SR 37 construction regarding Total Suspended Solids (TSS)/Total Recoverable Metals (TRM) data as returning to pre-construction conditions within two years. How can the owners ensure this without an assessment of the "pre-construction conditions"? Conduct baseline sampling of pollutants of interest and present the results in the revised report.

2.6 Review of IDNR Water Well Data

[Page 20]
The report provides a justification to disregard the USEPA recommendation to examine local water table trends when considering flow conditions under which dye traces were

conducted. The study needs to consider this to evaluate localized areas where the phreatic surface and epikarst flows are intermingled. This analysis cannot simply be ignored due to difficulty in obtaining the data to do so. Several mentions are made as to the traces being conducted under "high flow" conditions. Provide the methodology for determining when the flow conditions were deemed high. Does this correspond to a seasonal high water table?

3.0 Results

[Pages 21 through 61]
Based on inadequacies of the experimental design, results presented may not be representative of existing conditions. USEPA will re-evaluate based on the additional information requested.

3.1 Karst Features

3.1.1 Caves [Pages 22 through 45]
Throughout the cave discussion the phrase "where appropriate and practicable" is used extensively. Who is going to determine what is "appropriate and practicable"? It is confusing whether the report is or is not recommending that the karst features be mitigated.

The discussion of caves both in the executive summary and the report body mention that certain caves are 500 feet from the corridor and therefore will not be impacted. Other karst transportation studies have indicated that cave dwelling fauna are known to forage over 500 feet from cave openings. This is not just from the cave entrance but any swallet, fracture, or other karst window. With respect to caves, direct or indirect/secondary impacts have the potential to extend beyond the entrance or underground extent of the opening.

Figure 9 [Page 75]
The drainage area shown for] Cave appears to be too small. We recommend the preparer revisit this calculation to ensure that the drainage area included in this Figure is representative of the actual drainage area. Increase to capture the uphill drainage similar to the method used for the remainder of the cave drainage area estimates.

4.0 Surveys of Section 4 Caves

Includes Appendix K – Survey of Section 4 Cave Fauna [Page 62]
The Section 4 cave inventory effort identified 63 caves within the study area. This included 14 caves with entrances located within the proposed corridor. As noted in the subject report, 6 caves "within and in proximity" to the Section 4 Corridor were sampled to determine the presence of invertebrates. These sites were selected based on known hydrologic connections to the corridor confirmed by dye tracing which had been completed at that time. While the methodology and technical accuracy of the karst fauna survey is not in question, we question why such a small percentage of caves were inventoried as part of the karst fauna analysis. It is our understanding that additional dye tracing activity has been conducted since completion of the December 2006 cave

fauna study. As noted in Section 7.0 Summary and Conclusions, 7.2 Dye Tracing, Page 108, an additional 4 cave features were discovered to have a hydrologic connection to the corridor as a result of dye tracing activities; none of which were included in the 2006 Cave Fauna study. This includes [redacted] Cave, [redacted] Cave, [redacted] Cave, and [redacted] Cave.

We recommend that the final report contain expert opinion from the principal author, Dr. Julian Lewis, as to why such a small percentage of caves were sampled. We recommend INDOT consider that any accessible cave within the project study area, or that which could be influenced by surface or subsurface hydrology associated with the corridor, be surveyed. This includes those caves with hydrologic connections, as identified through the most recent round of dye tracings completed for Section 4. The additional cave fauna survey should also include any additional cave features that are not hydrologically connected and yet may contain unique cave fauna populations worthy of consideration.

EPA suggests that a cave fauna survey that includes all accessible caves within, or directly adjacent to, the project study area would better characterize project study area cave fauna and further demonstrate a commitment to "meet Indiana's transportation needs in an environmentally sensitive manner that protects the habitat of all species," as outlined in the 1993 karst MOU. Additional cave fauna studies would also assist in providing a better understanding of all potential direct and indirect/secondary impacts associated with construction of the proposed action; while also helping refine best management practices for protecting the biological integrity of cave resources.

5.0 Annual Pollution Load Estimates

[Pages 64 through 65]

INDOT's Previous Karst Study on SR 37

The report states that the treatment feature (peat filters and rock filters) "clogged" between the end of construction and the 2-year post-construction period of monitoring. How does the report justify implementing a treatment alternative that was demonstrated to be ineffective?

Kentucky's Previous Karst Study on I-69 at Mammoth Cave

It appears as though the subsection titled, *Kentucky's Previous Karst Study on I-69 at Mammoth Cave,* should be I-65 not I-69.

[Pages 66 through 67]
The model presented utilizes a high bias on the quantity of water involved in pollutant mobilization. This high water volume, with a static pollutant load, will result in lower concentrations when comparing with regulatory criteria. Provide analysis of a typical [vs. extreme] rain event, mobilizing the same pollutant load, which may be more representative of anticipated conditions.

EPA would like to see a comparative analysis of low flow (average rainfall event) conditions versus a high flow conditions (extreme rainfall event). Evaluating varying flow conditions is key component of pollutant loading studies as the volume of water represents the denominator of the calculation and thus has an impact on loading concentrations. If a pollutant load remains constant throughout the study, a higher volume of water will essentially dilute the concentration and thus the results will fall below regulatory criteria. Providing a comparative analysis of high flow versus low flow conditions would provide results which better represent natural conditions.

6.0 Potential Measures to Minimize Impacts to Karst

6.4 Operation and Maintenance

[Page 70]
Is void filling an "appropriate and practicable" mitigation strategy? Void filling will isolate the underground opening on either side of the fill. Animal migration, water flow, and air flow would be drastically impacted. The damming effect could redirect the water into other ecosystems that are currently dry or cause a blow out on the ground surface or beneath an embankment section. In addition, introducing cementateous products into the voids would impact the temperature due to the heat of hydration, which could have a negative impact on the fauna.

Did the report examine the use of geogrid or geotextile layers in the lower reaches of construction embankment or roadway subgrades? This practice has been shown to be effective in mitigating piping/collapse of embankment over karst terrains.

The report states - *"Examination of the areas that receive runoff from the highway to detect soil piping or opening of buried karst features."* What is the recommended frequency of these inspections? Who is qualified to perform them? Whose responsibility is it to perform them?

The report states - *"Improved technology should be used to update, maintain, and alter any treatment and containment structures when deemed necessary."* What does this statement mean? Are there some pending technologies that may be applicable? If so, a discussion should be added.

The report mentions elsewhere that minimal salt use will be a strategy used for minimizing roadway pollution. This strategy should be included in this list as well.

7.0 Summary and Conclusions

[Page 107]
The report states - *"Therefore, the focus of alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features...."*. What defines a critical feature? It would be helpful to provide a listing of the critical features considered as part of the alignment evaluation process.

7.5 General Environmental Concerns

[Page 114]
The second bullet item states "Groundwater flowpaths in a karst setting can vary under different flow conditions and groundwater flow across surface drainage divides in common." Section 3.0 Results, 3.3 Summary of Dye Tracing Tests states that "When possible, dye tracing tests were conducted under natural high flow conditions. High flow conditions increase the likelihood of dye travelling to all possible discharge points." With this said, this study fails to provide specific information on the flow conditions at the time each of the traces took place to document low flow versus high flow scenarios. Provide documentation which demonstrates that dye tracing activity has taken place during high flow conditions.

This documentation would include information pertaining to the date/time of collection and related rainfall/runoff discharge data. This information is usually documented on field data sheets or a study database.

The General Environmental Concerns section fails to acknowledge potential impacts to both the terrestrial and aquatic components of cave environments. Minute changes in temperature, humidity, and water quality can have detrimental affects to what are highly adapted species, intolerant of change. Various studies have documented the vulnerability of cave ecosystems as they relate to disturbances associated with roadway construction. We recommend adding a discussion that acknowledges potential impacts associated with altering the temperature and humidity levels within karst environments.

7.6 General Engineering Concerns

[Page 115]
Include a BMP in Section 8 that consists of diverting roadway drainage [from the full pre-construction drainage area limits] to the upgradient roadway offset to minimize "severance" of recharge and subsequent impacts to spring discharges and habitat alteration. For example, efforts should be made to bridge or culvert drainage so as to not severe flow and recharge to springs.

8.0 Recommendations

8.1 Best Management Practices

[Page 115 through 116]
There is no mention of a karst monitoring plan which evaluates cave community disturbances. We recommend that a monitoring plan be implemented that evaluates the physical habitat and includes population censusing prior to, during, and post-construction for those caves with a hydrologic connection to the corridor. Protocols for cave community censusing have been described by Dr. Jullian Lewis, the primary author of the Section 4 Cave Fauna study. This monitoring plan should also be considered as a potential mitigation measure in the Section 4 Final Environmental Impact Statement (FEIS).

Clarify "lined ditches" in this section. Ditches should include an impermeable geosynthetic liner to prevent infiltration of runoff before reaching detention/treatment basins.

Filling of karst features should be minimized to avoid introduction of non-native materials into the karst ecosystem. Where practical, employ impermeable geosynthetic liners with overlying geogrid embankments constructed to bridge karst features beneath the roadway.

General Comments

It appears that the potential impacts to the cave flora and fauna are not fully defined in this report. Additionally, the extent of the cave systems (i.e. mapped limits) and the potential impacts of the project on the caves and the potential impacts of the caves on the project are very lightly addressed.

It appears that the preliminary engineering aspects are also lightly discussed. Other than potential hydrogeologic impacts, there is no mention of how the construction activities will impact the karst features. Are the depths to caves or other openings going to be explored? Will driven piles be acceptable foundation alternatives? Will construction vibration affect delicate cave features and ecosystems?

SECTION 4 DEIS - DOCUMENT CLARITY – ERRATA: FIGURES/MAPS, TABLES, DEFINITIONS

Errata Notes on Tier 2 Section 4 DEIS, I-69 (Indianapolis to Evansville)

Table of Contents
Problem: (p.xxiii, Disk 1, Appendix A and Appendix B). Appendix A and Appendix B are misrepresented here as containing the *Business Needs Survey* and the *Traffic Modeling Technical Report*, respectively. Disk 1 (CD) with the these Appendices contain just the opposite documentation.
Recommendation: Recommend the text be corrected here and in Chapter 3 (p. 3-4, last line of 2nd paragraph) and Chapter 5 (p. 5-183, last line on page) to refer the reader to the correct Appendices for the *Traffic Modeling Technical Report* (Appendix A) and the *Business Needs Survey* (Appendix B).

Problem: (p.xxiii, Disk 2, Appendix Y). Appendix Y Bald Eagle Permits. There is no Appendix Y on Disk 2).
Recommendation: Recommend Appendix Y be listed as "NOT USED" or identified as CONFIDENTIAL information.

Summary
Problem: (p.S-43, Table S.8-2 – Comparison of Tier 1 Costs and Impacts to Tier 2 Preferred Alternative). Alternative 2 incorrectly identifies 4F-2 instead of 4F-3 as part of the preferred alternative.
Recommendation: Recommend this table be corrected to show that 4F-3 instead of 4F-2 is considered part of the Preferred Alternative.

5.23.8 Class V Injection Well Permit (p.5-637)
Problem: The potential for an EPA Class V permit is not mentioned with the other permits in the DEIS SUMMARY Chapter.
Recommendation: The Class V Injection Well Permit be mentioned as a possible permit and its applicable requirements that may need to be complied in the Summary Chapter of the EIS.

Chapter 3 – Alternatives
Problem: (p.3-17). The listing of "key resources" such as Historic Properties, Wetlands, Cemeteries, Caves and Major Springs, Forests . . . are not represented on this page in a consistent and meaningful manner. For example: Cemeteries, Caves and Major Springs are depicted as subcategories under "Historic Properties." Wetlands are part of the Historic Properties paragraph. This appears to be a document formatting problem.
Recommendation: Recommend this area of the FEIS be correctly formatted.

Chapter 4 – Affected Environment
Section 4.3.1.7 Karst and Springs
Problem/Solution: (p.4-80, Paragraph 2, line 3: This text should more accurately read "....which may remove ~~or kill~~ some organic contaminants or kill some biological contaminants."

Problem/Solution: (p. 4-80, Paragraph 2, lines 4 through 5): Delete the sentence that states "Careful project planning will help minimize the effects of I-69 upon groundwater quality within the karst system." This is not appropriate for the affected environment discussion; such conclusions should be limited to the environmental consequences chapter.

Problem/Solution: (p. 4-81, Paragraph titled "Taylor Ridge to SR 54", line 4). The word "swallet" and other karst features should be added to the EIS glossary.

Problem: (p.4-4, Figure 4.1-1 – Study Area). This figure shows the wrong extent of Monroe County.
Recommendation: Recommend Figure 4.1-1 correctly depict the extent of Monroe and Lawrence Counties.
Problem: (p.4-117, Figure 4.3-5, page 3 of 6, Wetlands). See Problem immediately identified above.

Chapter 5- Environmental Consequences
Problem: (p.5-7, 4th paragraph, 7th line). What is the page or pages that should be identified here: "(See 5.6.3.1, *Traffic Conditions*, p. _)"?
Recommendation: Recommend this reference in the FEIS include the appropriate page or page numbers.

Problem: (p.5-179, FIGURE 5.5-1 – Section 4 Study Area). This figure shows the wrong extent of Monroe County.
Recommendation: Recommend Figure 5.5-1 correctly depict and label the extent of Monroe and Lawrence Counties.

Problem: (p.5-183, 5.6.2.1 General, last line). The reader is directed to Appendix B for a copy of the *Traffic Modeling Technical Report.* Appendix B contains the *Business Needs Survey.*
Recommendation: Recommend the reference for the *Traffic Modeling Technical Report* here be changed to Appendix A in the FEIS

Problem: (p.5-234, Section 5.9-Air Quality, MSATs, first full paragraph). Traffic projection numbers here are for Tier 2 Section 3 (between US 50 and US 231), not Section 4 (between US 231 and SR 37).
Recommendation: The EIS provide the correct traffic numbers for Section 4.

Problem: (p.5-236, last paragraph). The text refers the reader to Table 5.9-2 for summarized results of the CO hot spot-analysis. Table 5.9-2 (p.5-242) only presents information regarding Modeled Vehicle Miles Traveled. It is Table 5.9-1 (p5-238) that has the CO information.
Recommendation: The EIS provide the correct referral for CO information.

Problem/Solution: (p.5-241, first word). Change "tow" to "two".

Problem/Solution: (p.5-241, first full paragraph, second to last line). Change "rick" to "risk", and "form" to "for".

Problem: Table 5.21-2 (pp. 5-586 through 5-587). In Table 5.21-2, caves are designated as 0-100', 100'-1000', 1000'-5000', or >5000'. What are these designations? Are they based on known dye tracing distances? Are they based on distances from the Alternatives evaluated?
Recommendation: Please explain these designations. Please provide a footnote similar to the note included for flow rates at the bottom of this table that explains the significance of these designations.

Problem: (p.5-652, 2nd line). The reader is referred to "see pages ### and ###."
Recommendation: Provide the page numbers that the reader should be referred to.

Problem: (p.5-657, Lower White River Watershed, line 6). The reader is referred here to Table 5.19-6 for information regarding major streams and tributaries within the r-o-w. However, Table 5.19-6 Summary of Potential Stream and Riparian Corridor Impacts (p.5-459) does not provide this information. Did you mean Table 5.19-7 (pages 5-461 – 5-471)?
Recommendation: We recommend the EIS refer the reader to the correct intended Table.

Problem: (p.6-663, 7. Define a baseline condition for the resources, ecosystems and human communities, Wetlands, line 3). The reader is referred to Table 5.19-3 to find information that "illustrates the general quality of each wetland or wetland complex and provides a comparison of wetlands affected by each proposed alternative." Table 5.19-3 does not provide the intended information. Do you mean Table 5.19-4, pp. 5-437 to 5-441?
Recommendation: We recommend the FEIS identify the correct intended Table to refer the reader to.

APPENDIX CC – ANALYSIS OF INDIRECT IMPACTS
Problem: (pp. 4 and 7). Text here refers the reader to Appendix A for the map that shows the TAZs used for this analysis. However, Appendix A is not included in the DEIS documentation.
Recommendation: Recommend Appendix A of the DEIS Appendix CC be included in the FEIS documentation.
Problem: (pp. 5 and 6). The text here claims that a table on page 6 shows the rank of TAZs by percentages of land cover which is ag or other open land; however, there is no formal table on page 6.
Recommendation: Recommend the reference to a table be deleted here or take the percentage information on page 6 and put it into table format.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAR 09 2011

REPLY TO THE ATTENTION OF:

E-19J

Michael Grovak
Chief, Transportation Planning and Economics
Bernardin, Lochmueller & Associates
P.O. Box 403
Brookston, Indiana 47923

RE: EPA Responses to FHWA/INDOT's I-69, Section 4 Draft Responses to [DEIS] Comments, dated 02/21/2011

Dear Mr. Grovak:

The U.S. Environmental Protection Agency Region 5 (EPA) reviewed the above-referenced document. Our detailed comments are provided in the enclosure to this letter.

Our review indicates that until we have the opportunity to review all the relevant information in the Final Environmental Impact Statement (FEIS), we do not know whether the Federal Highway Administration (FHWA)/Indiana Department of Transportation (INDOT) draft responses to our DEIS comments are adequate.

Based on our review of the draft responses, it appears that FHWA/INDOT do not expect the FEIS will include the additional identification and analysis of vulnerable resources in areas likely to experience development/induced-growth associated with a Monroe/Greene County Line Interchange that we had requested. This is a concern, and we continue to recommend this information be included in the FEIS. In addition, we would like to reiterate the importance of the stream resources in Section 4. We continue to recommend and expect that additional information, analysis and identification of up-to-date mitigation efforts will be included in the FEIS.

If FHWA/INDOT and you have any questions regarding our responses to the FHWA/INDOT responses to our DEIS comments, please contact Virginia Laszewski of my staff. Virginia may be reached by calling 312/886-7501 or by email laszewski.virginia@epa.gov.

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Thank you for the opportunity to comment. We look forward to reviewing and commenting on the I-69 Section 4 FEIS.

Sincerely,

Kenneth A. Westlake
Chief, NEPA Implementation Section
Office of Enforcement and Compliance Assurance

Enclosure: 1

cc: Michelle Allen, FHWA-Indiana Division, 575 North Pennsylvania St., Room 254, Indianapolis, IN 46204
Steve Sperry, Indiana Department of Transportation, 100 North Senate Ave., Room N642, Indianapolis, Indiana 46204

EPA's 03/09/2011 Responses to FHWA/INDOT's I-69, Section 4
Draft Responses to [DEIS] Comments, dated 02/21/2011

EPA Comment Specific to All FHWA/INDOT Draft Responses:
For each FHWA/INDOT response that claims additional information is incorporated into the FEIS, please identify in the FHWA/INDOT response the FEIS related Chapter/s, Appendix, Section/s, Table/s and page/s where the reader may find the information. For example, the FHWA/INDOT response for **AF002-08:** EPA Class V Permits, states only: "This information has been incorporated into the FEIS." Where exactly in the FEIS can the reader find this incorporated information?

EPA defers final comment on the adequacy of FHWA/INDOT draft responses to our DEIS comment/s until we have had the opportunity to review all relevant information in the FEIS with supporting documents.

The following EPA comments regarding FHWA/INDOT's draft responses generally follow the numbering sequence used by FHWA/INDOT in their 02/21/2011, draft responses document.

AF002-02 and 03 and 40: We appreciate that *"A table has been added to Chapter 5.21 and Chapter 7 of the FEIS listing potential BMPs and mitigation measures."* However, the draft response does not provide specifics, for example:

1) Will this table identify appropriate design elements as well as BMPs for specific situations that are likely to be encountered during final project design, construction and operation and include cost estimates for each design feature and BMP, as we recommended?
2) Will a table, as EPA suggested, serve as the starting point from which INDOT, the Karst MOU signatory agencies, the designer and/or construction contractor will choose from to mitigate impact to karst features?

EPA defers further comment regarding the FHWA/INDOT's draft responses until we have had the opportunity to review all the relevant information in the FEIS.

INDOT/FHWA Response: *"The project development and contracting process for Section 4 has not yet been determined."* Please explain how and when this decision will be made and include this explanation in the FEIS. If the decision is made post-NEPA, the FEIS should provide a detailed explanation of how FHWA and INDOT will ensure that, if the project moves forward, resource impacts due to alignment/interchange siting, design, construction and operation will be first avoided, then minimized, and for those impacts that cannot be avoided and minimized, compensated.

AF002-04 and 16 and 15: FHWA/INDOT's response indicates they acknowledge the need for a spatial analysis of vulnerable areas (p.15); however, they indicate that the FEIS will not include a consolidated figure/map that depicts all the information we requested. Consequently, it appears that additional analysis has not been done since the DEIS and there will be no identification and discussion in the FEIS to better identify those areas where surface and/or groundwater resources may be more vulnerable. It also appears that no further attempt to

analyze indirect impacts to water quality and public health has been undertaken post-DEIS. There is no affirmative FHWA/INDOT response that would indicate the FEIS will include a narrative discussion of the analysis and identify additional mitigation measures that could be undertaken by INDOT, and/or local, county, or state officials/governments. Consequently, it appears that the FEIS will not include further information and discussion on this important public health and safety issue. EPA retains its concerns and recommends this information be included in the FEIS.

FHWA/INDOT identify that springs used for individual potable water supplies are present in the project vicinity, these cannot be shown due to national security regulations. EPA recommends the FEIS cite the specific national security regulation and section that stipulates that springs used for individual potable water supplies cannot be shown/disclosed to state and/or federal resources agencies and/or the public.

AF002-15: *"Considering these distances and the circuitous routes of the available local roads, a net change in accessibility into southwest Monroe County and northwest Lawrence County from Greene/Monroe County line interchange is not anticipated."* We recommend the FEIS more clearly identify the specific areas that are likely to undergo induced development due to the proposal and analyze the vulnerability of the specific surface/groundwater and wildlife resources due to this growth. The FEIS should then identify all mitigation measures that could be undertaken by local, county, and state agencies and FHWA to protect these resources.

AF002-05: The FHWA/INDOT response claims that FEIS Chapters 5.19.3.4 and 7 have been updated to include additional discussion of stream mitigation. The FEIS will contain the Biological Assessment (BA) as Appendix JJ1 which includes additional, more defined mitigation information. However, the response does not identify that the full scope of compensation mitigation efforts that have already taken place will be discussed in the FEIS nor included an up-to-date version of the compensation mitigation plan for Section 4, as we recommended. We continue to recommend this information be included in the FEIS.

AF002-06: FHWA/INDOT imply that adverse impacts to a particular stretch of stream will not be "mitigated" if that stretch of stream does not fall under Corps and/or IDEM jurisdiction. Will mitigation sequencing (avoidance, minimization, compensation) be followed or not for non-jurisdictional stream stretches? Please use the term mitigation, especially when referring to jurisdictional water resources, mitigation to mean first avoid impacts, then minimize impacts and then compensate for those remaining impacts that cannot be avoided or further minimized.

AF002-07 and 41: Air Quality. We recommend the response in the FEIS identify the appendix where the reader may find the emissions analysis report.

AF002-08: EPA Class V Permits. FHWA/INDOT indicate they have incorporated EPA's information in the FEIS. Please identify where in the FEIS the reader may find this incorporated information.

AF002-09: Summary of Overall Project Impacts. The FHWA/INDOT response indicates the running tally information (including karst) will be incorporated into the FEIS (Appendix KK).

Thank you. However, the response does not identify that cumulative impacts will be part of the running tally. Because at least an estimate of cumulative impacts is attainable, EPA continues to request that running tally of cumulative impacts be including in the table in Appendix KK.

DETAILED COMMENTS

WATER RESOURCES

Watersheds and Wetlands Branch Comments on the I-69 Section 4 Draft Responses to Comments

Here, we cluster our responses to the numbered comments by categories 1 through 5, see below. Some items are likely resolved, some have been acknowledged and promises are made for an improved FEIS, and some have received a limited response. Even when items are said to be addressed or integrated into the main text of the document, it is not yet possible to tell if the subject matter is simply acknowledged there or if it is addressed more substantially as an environmental issue. We can't tell in advance of seeing the FEIS document.

Category 1—Better Presentation of Existing Information/Graphics/Maps and Editorial Clarity

AF002-19: Clarity on wetland determination; this should be resolved.

AF002-20: Clarity on jurisdiction and EPA; this should be resolved.

AF002-24, -25: Identify numbers on stream segments and relate to text discussions: it appears that this will be resolved; we will see if legibility is an issue.

Overall: It appears that category 1 issues will be addressed in the FEIS.

Category 2—Bring Key Material on Streams into the Text of the FEIS

AF002-05: Updates on stream mitigation: some material to be included in chapters 5, 7 and the Biological Assessment. We will need to wait for the FEIS see how extensive this is and if the treatment is commensurate with streams being the major surface water impact category for Section 4. The Biological Assessment is foremost a document for addressing Federal Endangered Species Act issues. Unless directed to it from other portions of the FEIS that deal with surface water, the material could be difficult to find for a reviewer interested in aquatic issues. Note that the ESA-listed species but not Federal species issues. Note that the ESA-listed species for this project are non-aquatic species.

AF002-12: Structures and stream crossings: preliminary information on this is to be in Chapter 5.19 and in Appendix M. FEIS is based on preliminary information. True information on the impacts will not be known until final design and are proposed to be controlled by (conventional?) Best Management Practices (BMPs) and Rule 5, the IDEM sediment and erosion

control process. It is not clear if these are adequate for the terrain. The FEIS should offer a more detailed discussion of BMPs and Rule 5 as they will be applied to this project during design.

AF002-13: Moving forward past the Tier I FEIS on the details of compensatory mitigation for streams is important for this FEIS; information is to be included in the Biological Assessment. See our concern in 2-5, above, and possibility of important aquatic information being difficult to find in the text. We concur with using linear feet as the measurement unit for stream mitigation, rather than acres--good. FHWA/INDOT will "try" to get mitigation on both sides of the stream, or adjust the formula for how much needs to be provided. Analysis and commitments for this subject may not be commensurate with the severity of quantity and quality of the aquatic impact. We will have to see how thorough the FEIS sections are and what commitments are made to provide ample, ecologically effective compensatory mitigation.

AF002-21: In the DEIS, full use was not made of the stream data collected; FEIS will integrate habitat quality rating of stream impacts. We will check to see how effectively this is done.

AF002-22: Perennial and riffle-pool streams: incorporate quality information into the FEIS text and maximize avoidance through bridging. We will check to see how effectively this is done.

AF002-23: Intermittent and ephemeral streams; incorporate quality information into the FEIS text and assess impacts. We will check to see how effectively this is done, and if the significance of the resource is balanced or underplayed.

Overall: Success in resolving Category 2 issues is unclear until we review the FEIS document. It appears that existing stream information will be used more fully and brought forward into the text. The analysis of the information on stream quality, stream impacts, and approaches to stream mitigation are pivotal to a sound FEIS which adequately addresses aquatic resources. This will depend on how clearly information is presented in the FEIS and how its analysis has advanced from the Tier I and the Tier 2 DEIS.

Category 3—Clearly Stating the Project Being Proposed and the Alternatives for the Management of Its Construction to Reduce Impacts

AF002-12: See Category 2 (above).

AF002-15: The point of EPA's DEIS comment is that one more interchange was added to the Tier 2 proposal, making two rather than one interchange in addition to the two end points of Section 4. This grouping of interchanges appeared to be the leading contender, preferred alternative in the DEIS. Our comments were based on adding an additional interchange to the total number proposed to be built, as opposed to the trade-offs between the respective merits of the county line and the SR 54 locations. Our comments on the county line interchange assumed the proposed "connector road ramp" west to the SR 445 and SR 54 areas. Please better discuss the change in accessibility specifically provided by building this additional county line interchange in the FEIS. We will need to see how this is covered in the FEIS.

AF002-20: Avoid streams and wetlands in subsequent design of the project; more commitment on this in Chapters 5.19 and 7 of the FEIS. We will need to see these sections of the FEIS.

AF002-22, -26: Stream bridging: it appears that there will be more clarification coming on this in the FEIS, but the degree of detail may be limited on stability measures, other than for riffle-pool crossings.

AF002-27: Culvert choices: it appears there will be some cross-referencing of preliminary information.

AF002-28: Temporary construction impacts: it appears that this project will rely solely on IDEM's erosion control plan requirements. It is not clear how the unique terrain (for Indiana) will be addressed and if the "tools" available through the erosion control plan will be adequate by themselves to manage the environmental impacts of constructing a new-terrain road in sensitive areas.

Overall: For all of these issues, EPA will need to see the FEIS text and how far the commitments to reduce environmental effects are advanced. These issues should not be deferred until a later stage in the process.

Category 4—Land Use and Water Quality and Public Health Effects from Permitted or Induced Growth in Sensitive Areas

AF002-04: See 02-16, below.

AF002-15: See above in Category 3. Why build an interchange to promote accessibility if there is no change in accessibility? If arguments are made in the FEIS about specific local roads, having a map which illustrates them would be helpful.

AF02-16: Compiling spatial information together to analyze for environmental impacts. The narrative response is insufficient. Use the information from these various sources *mapped together and analyzed together* to see if there are overlapping areas which may be more vulnerable to the effects of development. Our particular concern is for surface and ground water. This point is critical to the public health and natural environment of the study area and understanding the impacts of the proposed project in the FEIS.

AF002-17: Land use and public health tools for effective on-site wastewater treatment. While the codes are listed, no analysis is made of their effectiveness of their provisions, management and enforcement, long-term. If development is proposed for environmentally vulnerable areas, will these tools suffice to protect it?

AF002-18: Incorporate local planning information into the FEIS, especially for Greene County. It is not clear if the response contains the extent of the information available from the plans, or a summary of the topics which the plans discuss in greater detail. Appending these portions of the plans to the FEIS would help.

Overall: Very limited progress was made on these topics and the FEIS is likely to be insufficient. An EIS needs to not only gather information, but to assess and make use of it in describing the environmental effects of project alternatives. The information sources are there, and duly cited, but need to be presented more clearly, and in a spatial format to analyze and address the effects of interchange location and induced growth from the proposed project. Areas susceptible to adverse environmental impacts should be avoided.

Category 5—Future Clean Water Act Section 404 Issues and Compensatory Mitigation, Especially for Streams

AF002-06, -14: Advance concerns for the 404 process from EPA. The response is that this will be figured out later by the Corps of Engineers and IDEM, including jurisdiction and mitigation. Given the widespread use of general permits for linear transportation projects in Indiana, there is unlikely to be full public disclosure and interagency involvement in working out these issues.

AF002-29: Limited progress has been made in describing the ongoing efforts to provide adequate compensatory mitigation, especially for stream losses, since the Tier I FEIS. The limited progress model appears to persist although efforts are ongoing; some general concepts/approaches are mentioned and will be part of the Biological Assessment appended to the FEIS, which is first and foremost an endangered species tool.

AF002-30: The FEIS should address how various mixed-use mitigation objectives will be accomplished, and which values will be foremost. This will be determined later, see below.

AF002-31, -32: EPA provided some input on selecting good mitigation sites and incorporating the option of stream corridor restoration and enhancement. The response is general but shows promise for being expanded upon, for a more adequate FEIS, by explaining further which principles will be carried into the detailed 404 permitting work and what the rationale is for the ongoing work (since at least 2010) in site identification for potential mitigation. We appreciate that the negotiations on specific mitigation sites may be ongoing, and therefore, now may not be the time to describe them in detail.

AF002-33: Long term management and land use tools for mitigation sites. Please be sure this information is included in the text of the FEIS as well as in the comment-and-response section. While it is the State's responsibility as long as the State has ownership/easements, is there also a practical way to be sure this happens, within the INDOT organizational structure and budget process?

Overall: While it is true that mitigation details will be resolved in the Section 404 permitting process, in which EPA also plays a role, the environmental effects to the likely quantity and quality of stream miles affected by this project demand attention to how these adverse impacts will be offset, as part of the FEIS analysis.

[End Wetlands and Watersheds Comments]

KARST RESOURCES

AF002-34: Analysis of Karst Impacts as part of the Alternatives Consideration Process. We recommend the response identify exactly where in the FEIS can the reader find the documentation that supports claims made in this FHWA/INDOT response.

Also, please define "area of importance."

AF002-35: Potential Impacts to Unknown Subsurface Karst Features.

AF002-36: Potential Impacts on Drinking Water Quantity and Quality. Inadequate response. Exactly what BMPs are being considered? It is uncertain that existing conditions are in place to protect water quality from induced development and septic systems.

AF002-37: *"The exact location of indirect development with relation to specific karst features cannot be determined, and cave fauna surveys throughout all Traffic Analysis Zones (TAZs) anticipated to experience indirect development in karst areas were not conducted. Such surveys would not inform an alternative selection."*

Why can't the locations of specific karst features be identified for those areas that have the potential for indirect development due to the proposal? Wouldn't the identification of karst features associated with each potential interchange's indirect impact development areas along with the analysis of each associated local, county, and state regulation inform the vulnerability of water resources to potential impacts and thus inform the selection of the location of interchanges and/or identification of mitigation measures that should be undertaken by local, county and/or state authorities to protect those resources? This information would inform the expanded indirect impacts assessment we recommended be included in the FEIS.

AF002-38: Variability in Flow Conditions as Part of the Pollutant Loading Analysis. Given the FHWA/INDOT response, we recommend the FEIS disclose the last time the Indiana Design Manual was updated. We also recommend the FEIS identify the specific portion/s of Indiana Design Manual that contain the specific specifications for the design of storm sewer pipes on Interstates and identify whether or not they have been updated to take into account the expected changes in the severity and intensity of precipitation events due to climate change. In addition, we recommend the FEIS specifically identify and discuss the adequacy of those portions of the Indiana Design Manual that deal with designing storm sewer pipes and stormwater management in karst terrain. If some or all of this information is not available or up-to-day, then we recommend the FEIS specifically identify how these concerns will be factored into the design of storm sewer pipes and stormwater management for this proposal?

AF002-39: Construction Blasting. This response is not protective enough. We recommend the FEIS address the following questions. How will FHWA/INDOT ensure that water wells and karst subsurface openings located outside the Indiana bat's Winter Action Area will be protected from damage and/or collapse due to blasting? Does INDOT Standard Specification 203.15 for Excavating Rock have specific precautions to ensure that water wells and subsurface opening in karst areas will not be damaged? For example, are subsurface openings and/or water wells

located outside the highway right-of-way considered "property under INDOT Standard Specification 203.15?" What about those subsurface openings that may be located within the highway right-of-way?

AF002-40: Identification of Mitigation Measures for Karst Areas. *"See Response AF002-03."* FHWA/INDOT continue to say that detailed mitigation measures for karst features will be developed during final design. We appreciate that *"A table has been added to Chapter 5.21 and Chapter 7 of the FEIS listing potential BMPs and mitigation measures."* However, the draft response does not provide specifics, for example: 1) Will this table identify appropriate design elements as well as BMPs for specific situations that are likely to be encountered during final project design, construction and operation and include cost estimates for each design feature and BMP, as we recommended? 2) Will a table as we suggested serve as the starting point from which INDOT, the Karst MOU signatory agencies, the designer and/or construction contractor will choose from to mitigate impact to karst features?

"The project development and contracting process for Section 4 has not yet been determined." Please explain how and when this decision will be made and include this explanation in the FEIS. If the decision is made post-NEPA, the FEIS should provide a detailed explanation of how FHWA and INDOT will ensure that if the project moves forward resource impacts due to alignment/interchange siting, design, construction and operation will be first avoided, then minimized and, for those impacts that cannot be avoided and minimized, finally compensated.

AIR QUALITY

AF002-41: Air Conformity. *"See Response to AF002-07."*
AF002-07 and 41: Air Quality. We recommend this FEIS response identify the specific FEIS appendix where the reader may find the emissions analysis report.

AF002-42: Mobile Source Air Toxics (MSAT). *"Section 5.9.2 has been corrected . . ."* EPA defers comment on the adequacy of this FHWA/INDOT response until we review all relevant information in the FEIS.

AF002-43: Greenhouse Gases/Climate Change. EPA continues to recommend the FEIS identify and discuss any anticipated effects of climate change on the project. For example, please identify and discuss any effects that predicted increases in the number and/or intensity of precipitation events, due to climate change, may have on sizing bridge spans, culvert openings, and stormwater management measures for this proposal in order to accommodate such precipitation events and ensure public health and safety.

AF002-44: Air Quality Mitigation During Construction. EPA understands that the FHWA/INDOT response here means that INDOT will not commit to do more to protect air quality in the project area during project construction than that which is currently required by law or regulation.

UNDERGROUND INJECTION CONTROL (CLASS V PERMITS)

AF002-45 and 46: Permits. *"Recommended text changes have been made in the FEIS."* EPA will review the FEIS to verify our recommended changes have been.

EPA Technical Adequacy Review of the I-69 Evansville to Indianapolis Tier 2 Studies – Survey of Karst Features Report, Section 4, US 231 to SR 37, contains Confidential Information, dated June, 2010.

AF002-47: Karst Fauna Study Methodology. *"Please see response to comment AF001-17 and AF002-37."* To only list/refer to the names of County Ordinances and County Codes that regulate the design, construction, installation, location, maintenance and operation of on-site wastewater treatment systems without analysis and discussion of their adequacy to effectively address residential and commercial development and long-term, effective on-site wastewater treatment does not adequately respond to our DEIS comment/recommendation. In addition, the recitation of some of the Greene County Comprehensive Plan's "policy objectives," the Monroe County SR37 Corridor Plan's "recommendations," "policy statements" from Monroe County's November 5, 2010, Draft Comprehensive Plan, "Natural Features Goals" from Lawrence County's 2009 Strategic Plan, and a one sentence statement from the City of Bedford 2010 Comprehensive Plan is not an analysis and discussion of the adequacy of existing local, county and state provisions currently in place to effectively address residential and commercial development and long-term, effective on-site wastewater treatment.

AF002-37: "The exact location of indirect development with relation to specific karst features cannot be determined, and cave fauna surveys throughout all Traffic Analysis Zones (TAZs) anticipated to experience indirect development in karst areas were not conducted. Such surveys would not inform an alternative selection." Why can't the locations of specific karst features be identified for those areas that have the potential for indirect development due to the proposal? Wouldn't the identification of karst features associated with each potential interchange's indirect impact development areas along with the analysis of each associated local, county, and state regulation inform the vulnerability of water resources to potential impacts and thus inform the selection of the location of interchanges and/or identification of mitigation measures that should be undertaken by local, county and/or state authorities to protect those resources? This information would inform the expanded indirect impacts assessment we recommended be included in the FEIS.

EPA reiterates that our previously recommended information and analysis be included in the FEIS.

AF002-48: *"Please see response to comment AF002-38."*
AF002-38: *Variability in Flow Conditions as Part of the Pollutant Loading Analysis. "The estimates provided are based on a "typical" rain event. The 2-year/24-hour and 1-year/1-hour rain events are believed to [be] representative of "typical" rain events in the analysis. According to the Indiana Design Manual, storm sewer pipes on Interstates are to be designed for a 50-year rain event with a 5- or 10-minute duration. Therefore, the 50-year rain event will be*

included in the analysis and considered an extreme event." Given the FHWA/INDOT response, we recommend the FEIS disclose the last time the Indiana Design Manual was updated. We also recommend the FEIS identify the specific portion/s of Indiana Design Manual that contain the specific specifications for the design of storm sewer pipes and stormwater management on Interstates and identify whether or not they have been updated to take into account the expected changes in the severity and intensity of precipitation events due to climate change. In addition, we recommend the FEIS specifically identify and discuss the adequacy of those portions of the Indiana Design Manual that deal with designing storm sewer pipes and stormwater management in karst terrain. If some or all of this information is not available or up-to-date, then we recommend the FEIS specifically identify, how these concerns will be factored into the design of storm sewer pipes and stormwater management for this proposal?

Executive Summary
AF002-49: *"Appropriate Sections of the Survey of Karst Features Report have been revised in an Addendum to the Report to clarify what was considered a relevant karst feature."* A definition of "relevant karst" is provided. EPA defers comment until we have had the opportunity to review the relevant information in the Tier 2 FEIS for Section 4.

1.0 Introduction

1.1 Purpose and Scope
AF002-50: The names of the "Karst experts" are not provided here in this response, only names of organizations are identified here. We recommend the names of the "Karst experts" be included here in the FEIS.

1.5 Geologic Setting

AF002-51: We appreciate that additional information as we requested will be added to Figure 4 in the FEIS. However, EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment until we have had the opportunity to review the relevant additional information in the FEIS.

1.5.5 Mining Operations
AF002-52: It is not clear here whether the "geotechnical studies" referred to in this FHWA/INDOT response will be done for a certain level of design short of "final design" prior to the FEIS or ROD? If not, as with many of FHWA/INDOT's other responses to EPA comments on the DEIS, it appears that INDOT is putting off the additional geotechnical studies until final design for the preferred alternative to define the potential construction risk, future roadway collapse, acid mine discharge potential, or habitat loss. EPA will provide additional response once we have had the opportunity to review the FEIS.

1.6 Hydrogeologic Setting

1.6.1 Water Supply
AF002-53: We appreciate that the Survey of Karst Features Report has been revised in an Addendum to the Survey of Karst Features Report. EPA expects to review the new information

in this Addendum as part of our FEIS review.

However, the rest of the FHWA/INDOT responses provided here appear to indicate that EPA's other recommendations for additional information and/or testing will not be undertaken by INDOT and consequently this information will not be included in the FEIS. For example, the response identifies that FHWA/INDOT do not know which karst features provide private/residential water supply. Why not? We continue to recommend this information be included in the FEIS. In addition, we recommend FEIS identify exactly what will be discussed with the property owners and renters regarding their drinking water supply during INDOT's design and right-of-way phases of the project.

FHWA/INDOT defer to the Karst MOU as the reason why they are not providing baseline water quality sampling information in the FEIS. The claim is made that the baseline water quality sampling of karst features is anticipated as part of the monitoring and maintenance plan that will be developed as part of the stipulations in the Karst MOU, which it appears won't be done until additional design information is obtained.

2.0 Methodology
2.2. Karst Feature Identification
AF002-54: *"Treatment options for known features will be developed during the design process and will be known prior to construction."* Once again, it appears that the identification of treatment options for known and unknown karst features will be postponed until after the FEIS, during final design.

2.3 Dye Trace Methodology
AF002-55: We appreciate that an Addendum (see response AF002-53) has been added to the Survey of Karst Features Report and a definition of "relevant" is provided. However, EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment until we have had the opportunity to review the FEIS and the relevant additional information.

General Comments
6.0 Potential Measures to Minimize Impacts to Karst
6.4 Operation and Maintenance
AF002-68: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the relevant additional information in the FEIS. This would include, but is not limited to, our review of the additional description of the BMPs that will be considered for implementation in Chapter 5.21 of the FEIS

AF002-69: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the relevant additional information in Chapters 5.21 and 7 of the FEIS.

AF002-70: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the FEIS revised information that is included in an Addendum to the Survey of Karst Features Report.

AF002-71: It appears that FEIS will not include a minimal salt use strategy as we recommended. We continue to recommend such a strategy be included in the FEIS.

7.0 Summary and Conclusions

AF002-72: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the FEIS revised information that is included in an Addendum to the Survey of Karst Features Report.

7.5 General Environmental Concerns

AF002-73: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the FEIS revised information that is included in an Addendum to the Survey of Karst Features Report.

7.6 General Engineering Concerns

AF002-75: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review all relevant information in the FEIS.

8.0 Recommendations

8.1 Best Management Practices

AF002-76: Does this FHWA/INDOT response mean that a monitoring and maintenance plan will be developed as part of the stipulations in the Karst MOU and in coordination with the Karst MOU signatory agencies? EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review relevant additional information in the FEIS.

AF002-77: *"Please refer to the response to comment AF002-68."* EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment/s until we have had the opportunity to review the relevant additional information in the FEIS. This would include, but is not limited to, Chapter 5.21 of the FEIS that has been updated to provide additional description of the BMPs that will be considered for implementation.

AF002-78: EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment until we have had the opportunity to review the relevant information in the FEIS.

AF002-79: *"The Survey of Karst Features Report was not intended to identify the manner in which construction activities may impact karst features. This information is contained in Chapter 5.21 of the FEIS."* EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comment until we have had the opportunity to review the relevant information in the FEIS. We are concerned that INDOT does not intend to identify depths to openings of karst features and foundation alternatives until post-NEPA design and construction.

Errata Notes on Tier 2 Section 4 DEIS, I-69 (Indianapolis to Evansville)

AF002-80 to 101: It appears that FHWA/INDOT agree with all our recommendations and will correct the FEIS accordingly. However, EPA defers comment on the adequacy of this FHWA/INDOT response to our DEIS comments regarding errata, until we have had the opportunity to review the relevant sections of the FEIS.

Addendum Appendix B

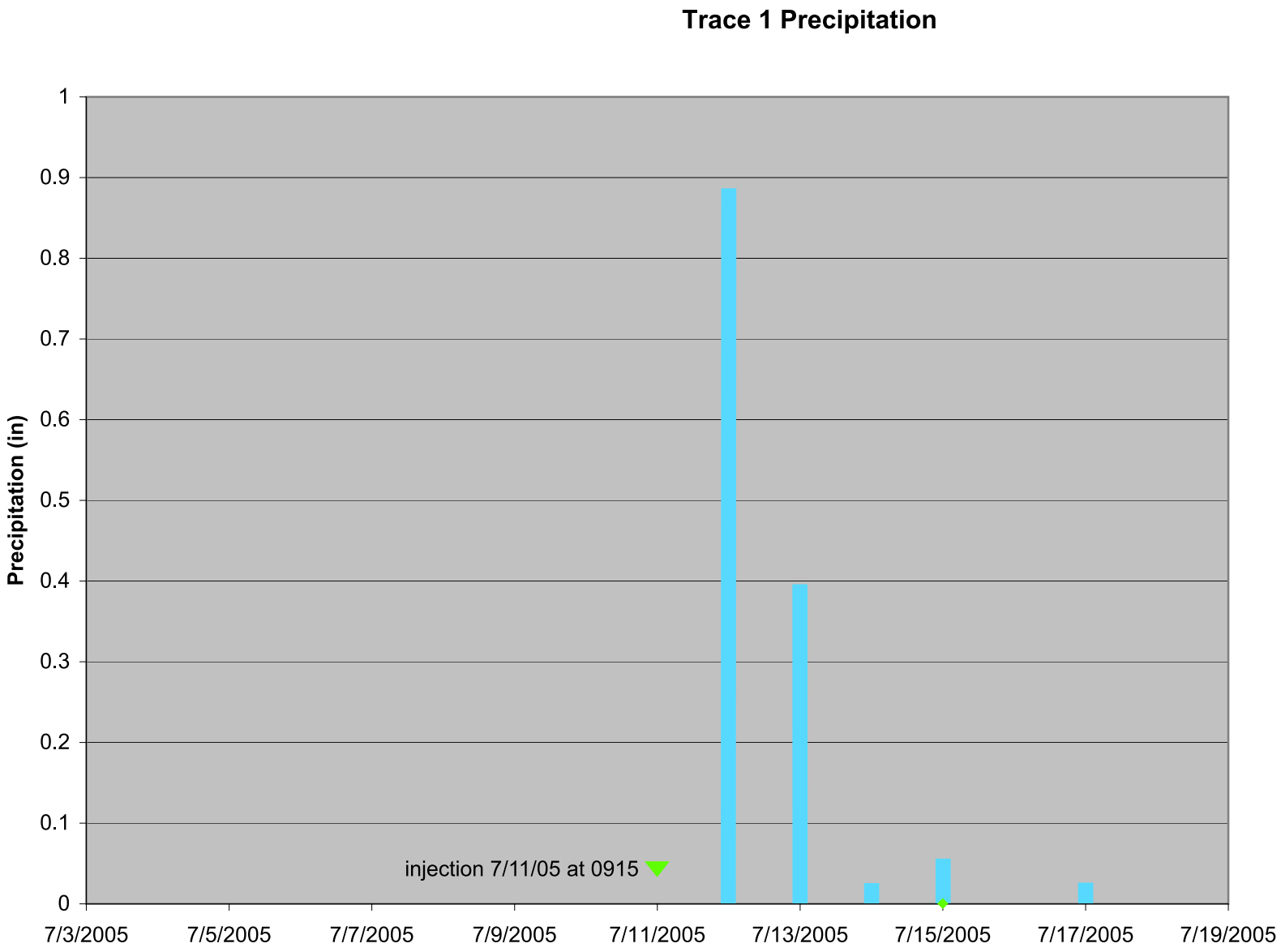
Dye Trace Precipitation Data

Appendix B Table 1: Dye Tracing Precipitation Data

Name of Dye Trace	Injection	Detection	Pre-injection precip (in)	Post-injection precip (in)	Pre-injection flow*	Post-injection flow*
Trace 1	7/11/05 9:15 AM	7/15/05 10:30 AM	0	1.34	low	high
Trace 2	1/2/06 9:40 AM	1/4/06 3:42 PM	1.48	0.51	high	high
Trace 3	1/26/06 9:45 AM	1/26/06 5:08 PM	0.19	0	low	low
Trace 1	5/13/09 11:30 AM	5/14/09 5:58 AM	1.75	4.35	high	high
Trace 2	6/29/09 10:40 AM	7/15/09 11:15 AM	0.69	1.47	high	high
Trace	12/29/05 3:00 PM	1/2/06 1:20 PM	1.19	0.38	high	low
Trace	1/4/10 12:00 AM	1/5/10 12:00 AM	0.13	0	low	low
Trace 1	6/10/05 4:30 PM	6/13/05 10:55 AM	0.4	2.38	low	high
Trace 2	12/14/05 11:00 AM	12/20/05 11:30 AM	0.38	0.32	low	low
Trace	1/16/06 3:45 PM	1/17/06 12:33 PM	1.47	0.46	high	low
Trace 1	9/8/05 11:45 AM	9/26/05 3:20 PM	0	3.61	low	high
Trace 2	9/15/05 10:50 AM	9/28/05 1:54 PM	0.03	3.58	low	high
Trace 3	10/11/05 5:00 PM	11/10/05 4:00 PM	0.01	1.45	low	high
Trace 1	12/16/05 11:40 AM	12/29/05 1:07 PM	0.7	1.19	high	high
Trace 2	12/16/05 5:30 PM	12/29/05 1:07 PM	0.7	1.19	high	high
3 Trace	4/27/09 11:15 AM	4/27/09 9:32 PM	0.66	0	high	low
Trace 1	12/21/05 10:00 AM	12/23/05 10:52 AM	0.37	0	low	low
Trace 2	12/21/05 10:30 AM	12/23/05 10:52 AM	0.37	0	low	low
Cave Trace	7/21/09 11:30 AM	7/22/09 7:21 AM	0.62**	2.23**	high	high
Cave Trace 1	9/10/09 9:55 AM	10/9/09 2:30 PM	0.04	6.54	low	high
Cave Trace 2	9/4/09 12:30 PM	9/27/09 5:30 AM	0.24	2.71	low	high
Trace	9/23/09 9:30 AM	10/13/09 9:49 AM	2.77	6.11	high	high
Trace	10/13/05 5:15 PM	10/17/05 9:51 AM	0.01	0	low	low
Trace	8/2/05 9:15 AM	8/15/05 12:12 PM	0.73	1.03	high	high
Trace	9/4/09 10:20 AM	9/9/09 11:23 AM	0.24	0.04	low	low
Trace 1	11/15/05 12:30 PM	11/21/05 2:17 PM	1.02	2.13	high	high
Trace 2	11/15/05 11:00 AM	11/21/05 2:50 PM	1.02	2.13	high	high
Cave Trace	10/7/09 10:30 PM	10/8/09 7:15 AM	1.26	0	high	low
Trace	8/26/09 10:45 AM	8/27/09 10:00 AM	0.5	0	low	low
Trace	6/14/05 2:30 PM	6/18/05 1:11 PM	2.47	0	high	low
Cave Trace	8/30/05 12:45 PM	9/1/05 10:00 AM	0.97	3.25	high	high
Trace	12/29/05 10:50 AM	12/30/05 2:40 PM	1.19	0	high	low
Trace	8/18/05 10:30 AM	9/6/05 11:15 AM	2.14	6.43	high	high
Trace	6/12/05 12:16 PM	6/12/05 8:45 PM	0.76	0	high	low
Trace 1	5/12/05 10:30 AM	5/12/05 2:30 PM	1.06	0	high	low
Trace 2	7/21/05 9:20 AM	7/22/05 10:45 AM	0.46	1.5	low	high
Trace 3	5/14/05 1:00 PM	5/14/05 1:15 PM	1.94	0	high	low
Trace	10/23/05 10:45 AM	10/29/05 11:00 AM	0.75	0.27	high	low

*High flow and low flow characterizartions for this table are relative. For the purposes of Section 4 karst investigations, the following criteria were considered in determining the flow conditions under which a dye tracing test was conducted. If there had been at least 0.5 inches of rainfall in the seven days leading up to dye injection, pre-injection conditions were considered to be high flow. If there had been at least 0.5 inches of rainfall between the time of injection and the time of detection, the post-injection conditions were considered to be high flow. In order to properly determined low flow vs high flow, stream and spring discharges would need to be monitorred over the course of a year.

**Precipitation data were collected in the morning of the date listed. Field notes indicated dry conditions prior to injection with heavy rainfall the evening after and the following day. Precipitation data adjusted to reflect this.


Trace 1 Precipitation
Precipitation (in)
1
0.9
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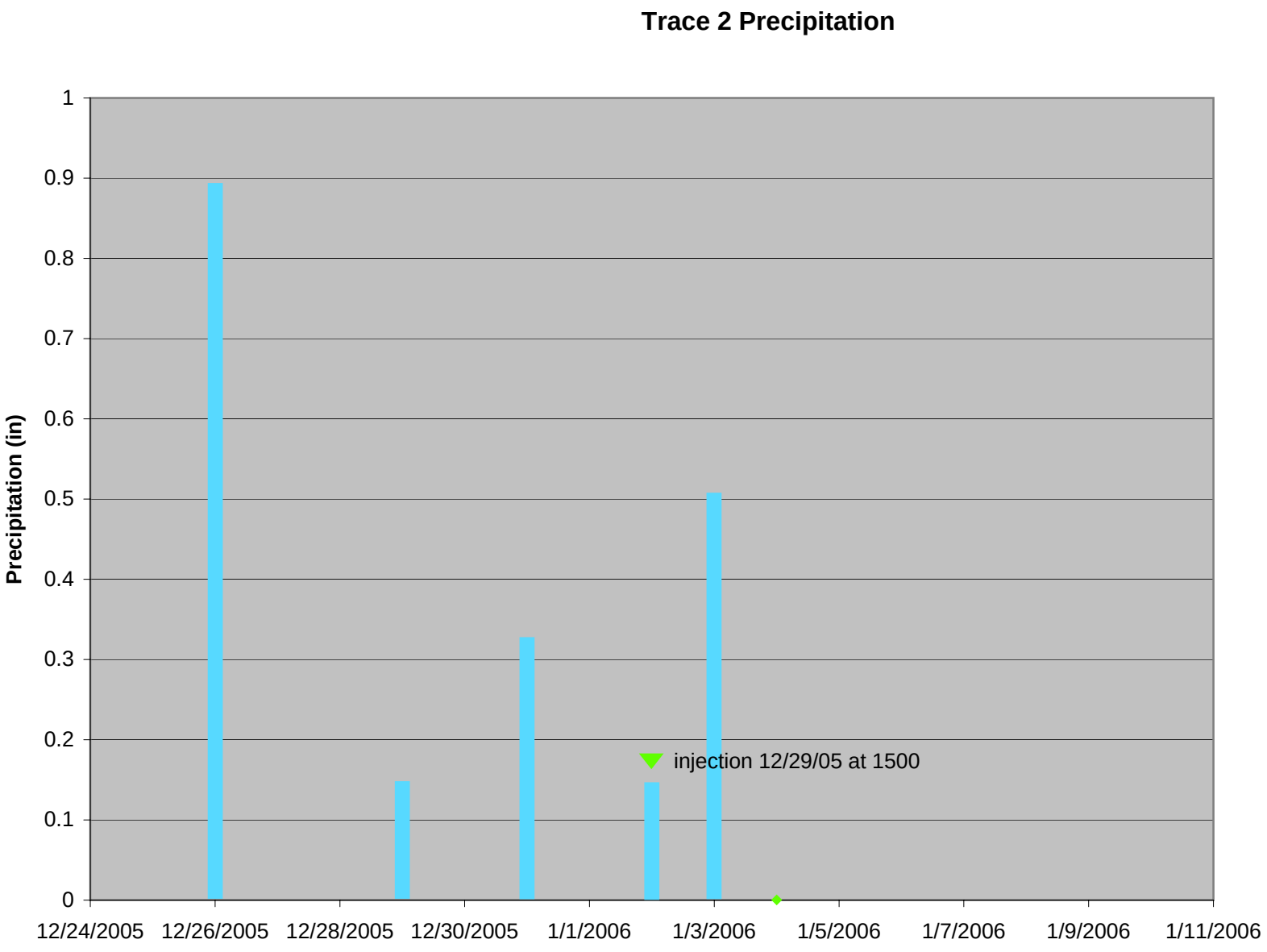
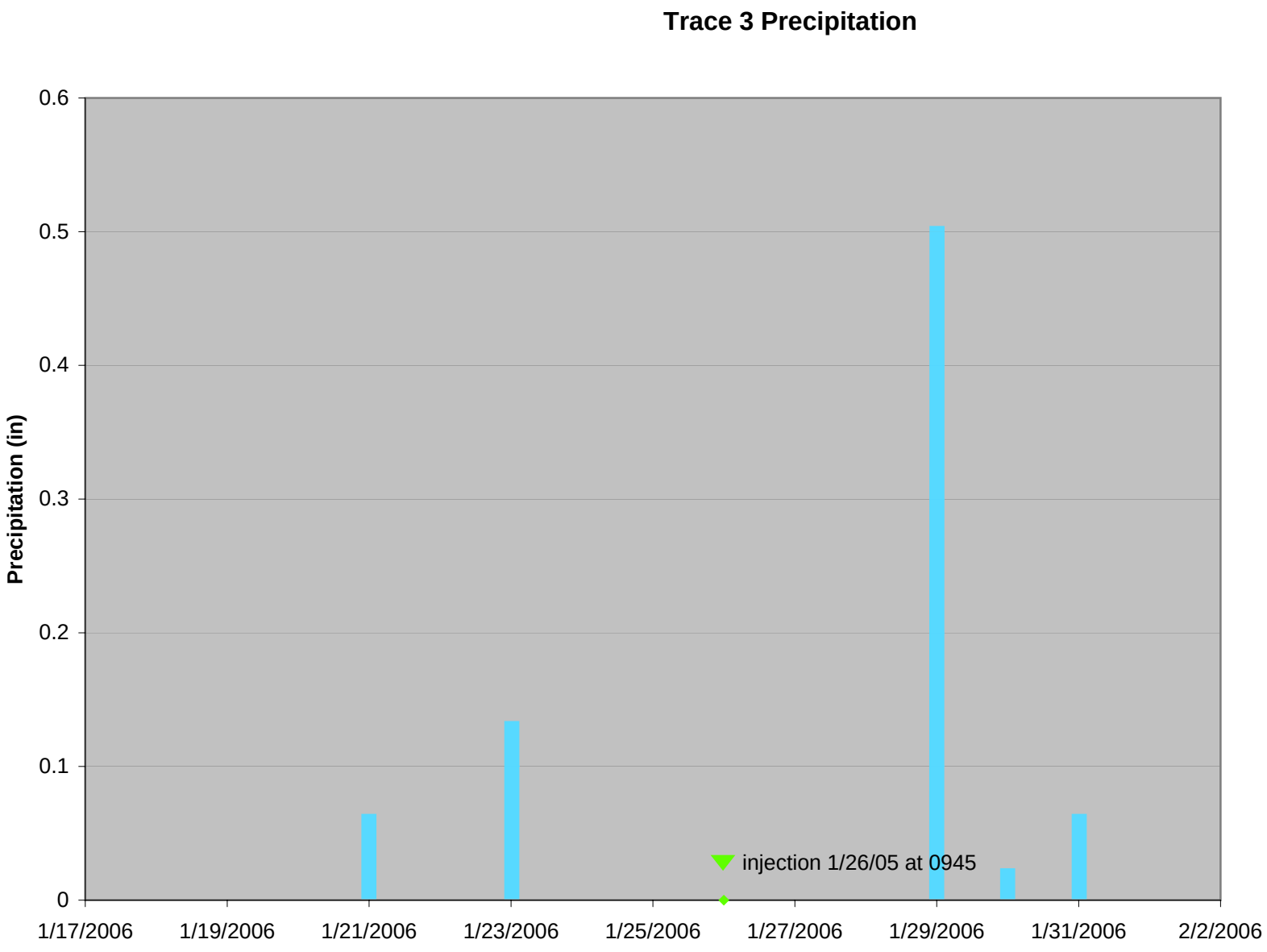
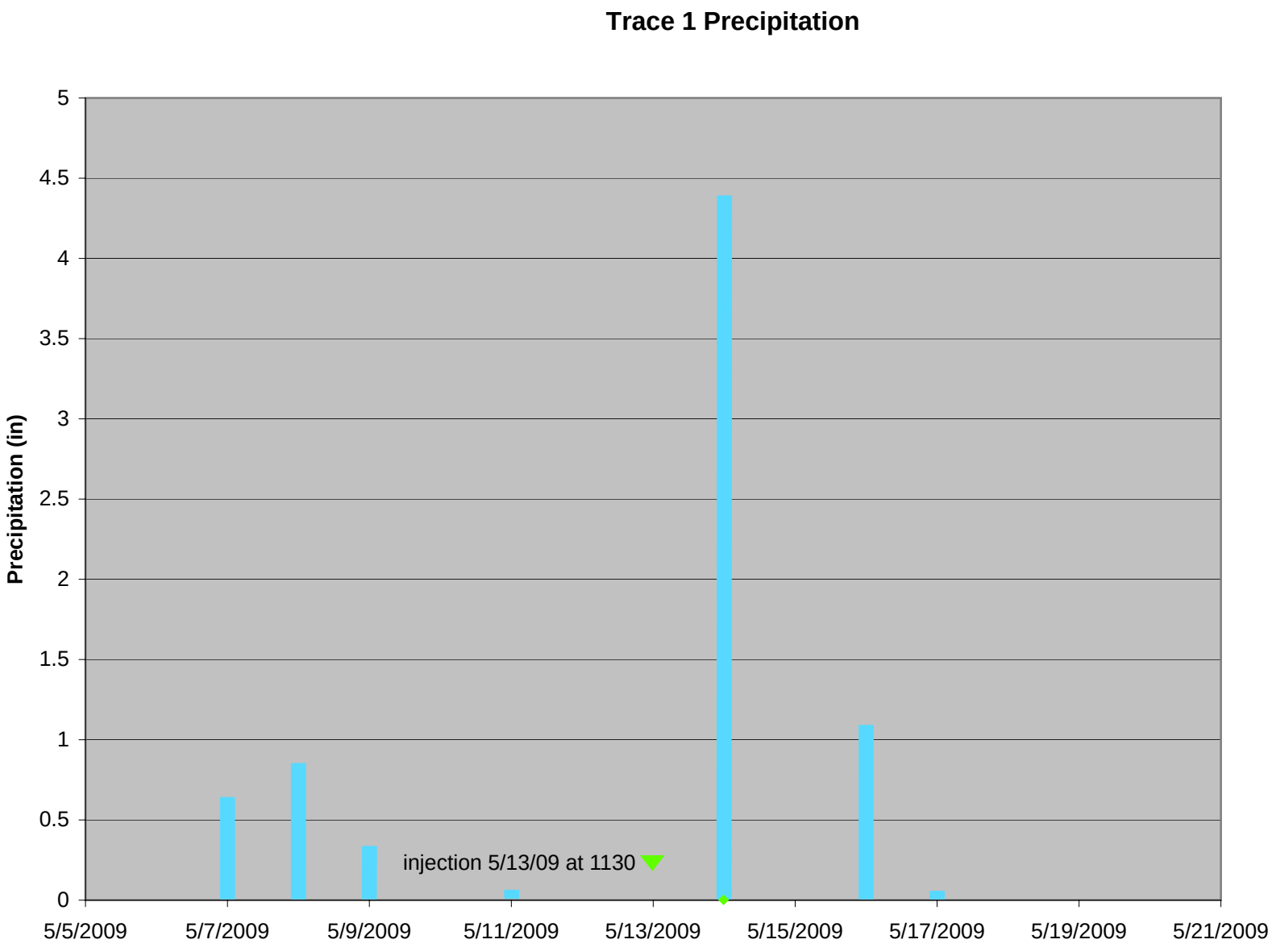
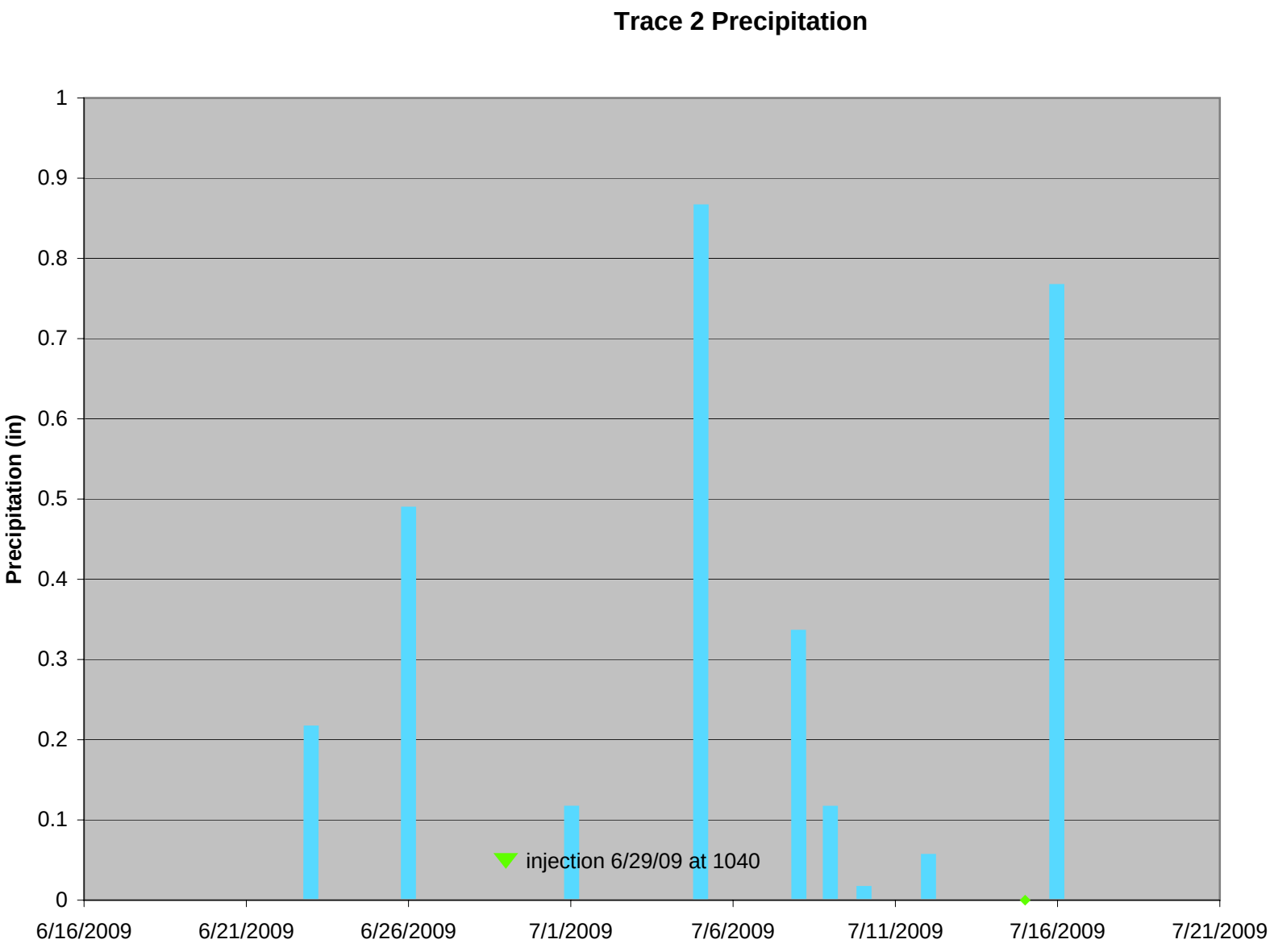
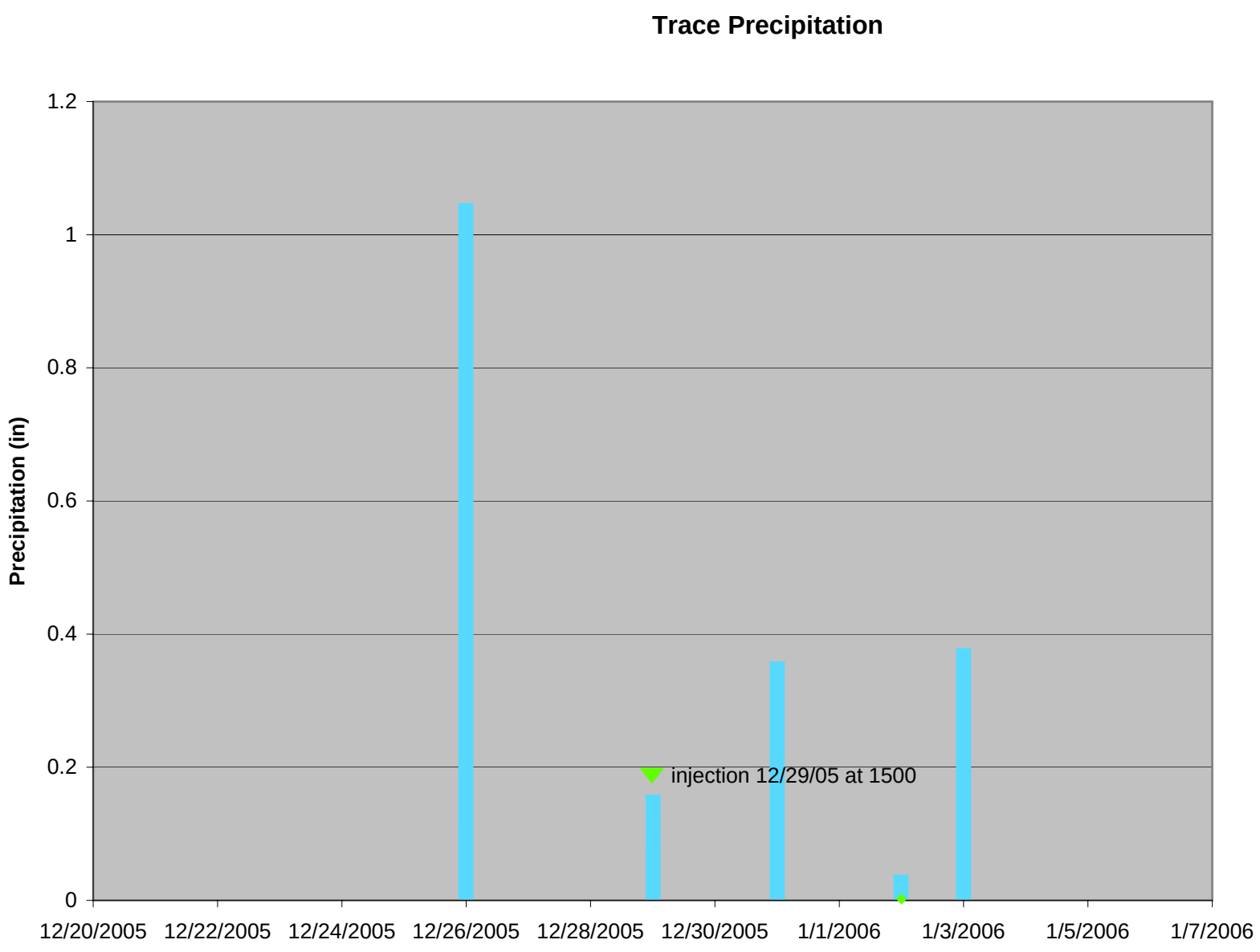
7/17/2005
7/19/2005

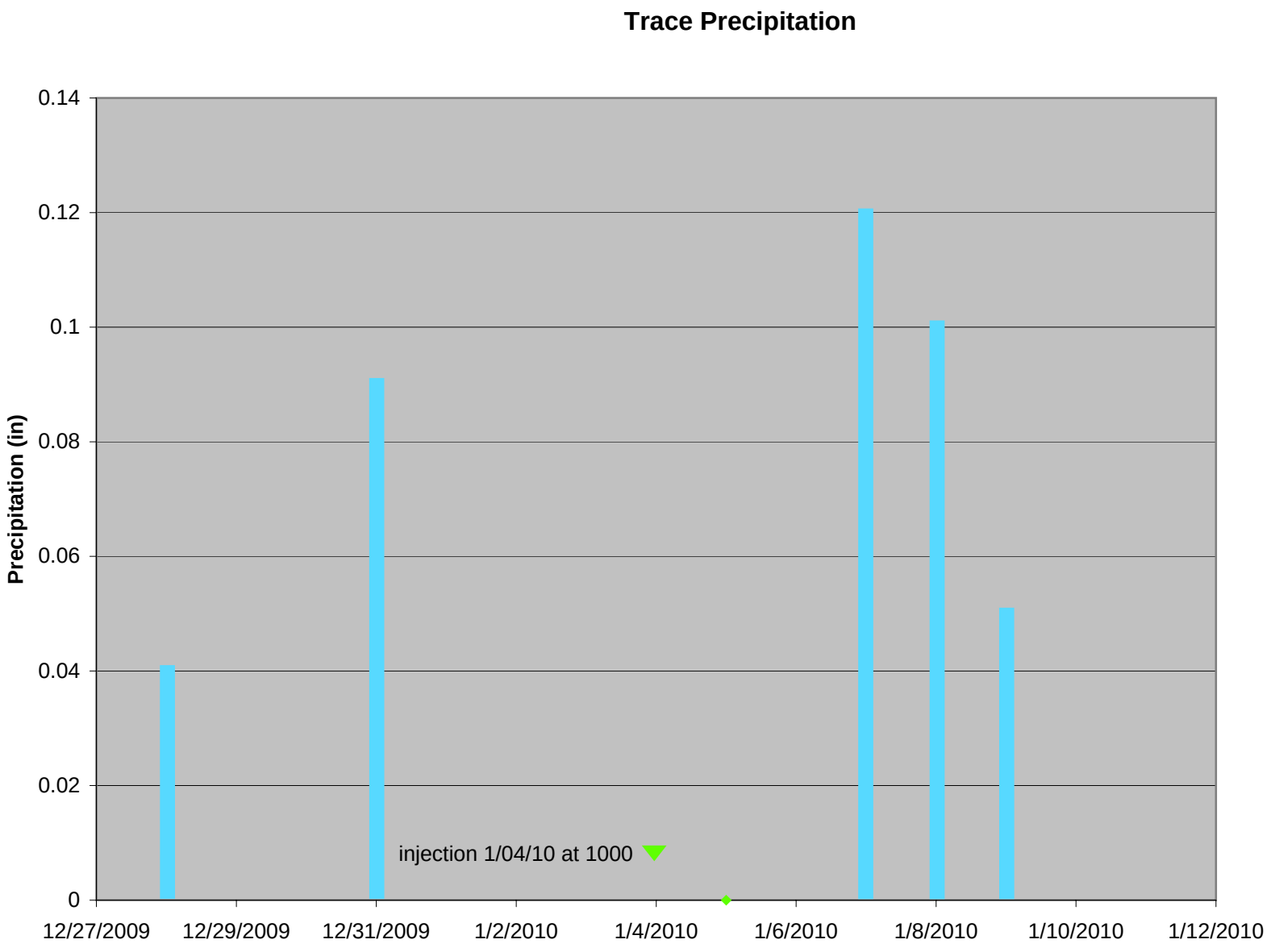

Trace 2 Precipitation
Precipitation (in)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
injection 12/29/05 at 1500
12/24/2005
12/26/2005
12/28/2005
12/30/2005
1/1/2006
1/3/2006
1/5/2006
1/7/2006
1/9/2006
1/11/2006

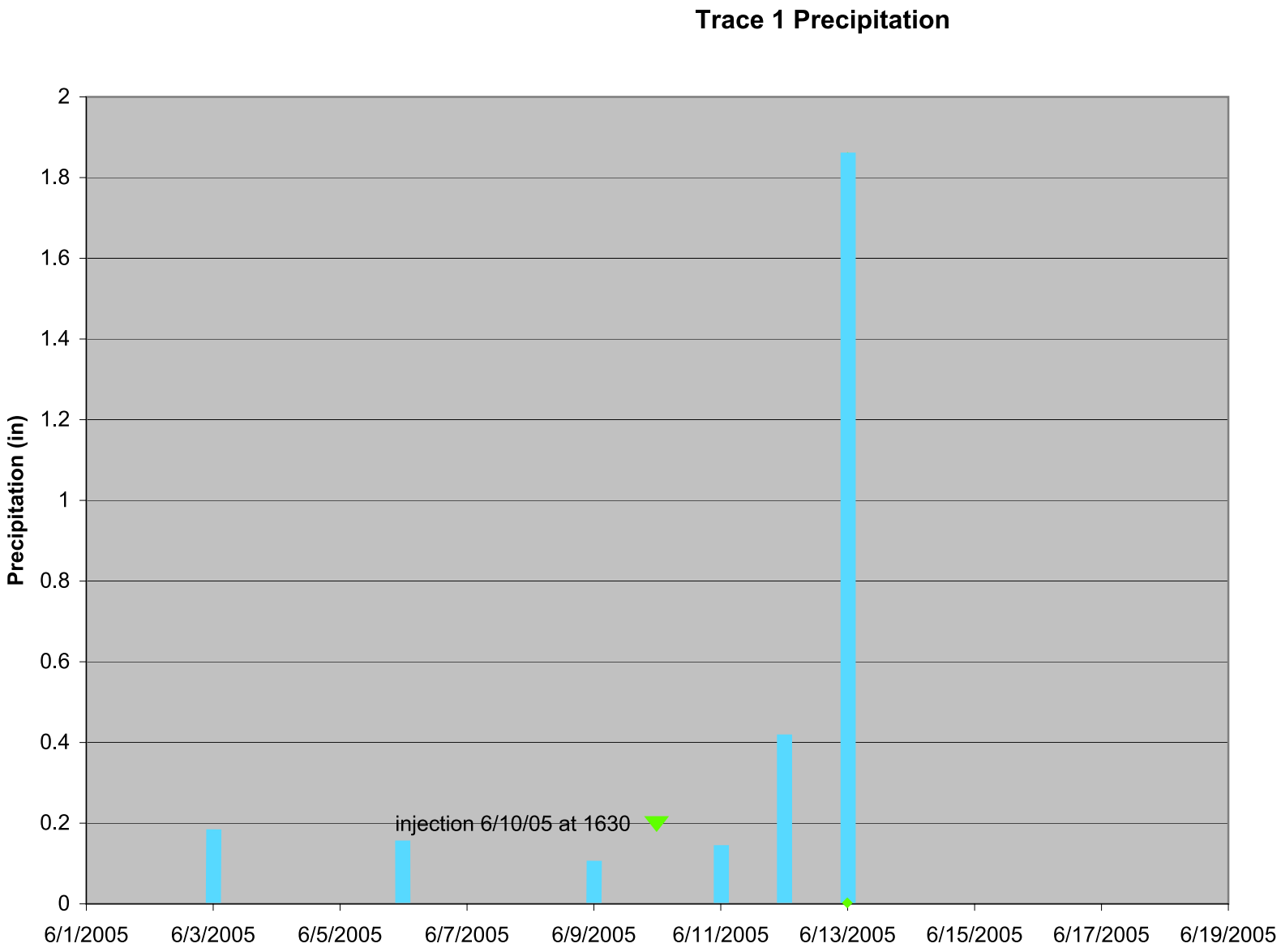

Trace 3 Precipitation
Precipitation (in)
0.6
0.5
0.4
0.3
0.2
0.1
0
1/17/2006
1/19/2006
1/21/2006
1/23/2006
1/25/2006
1/27/2006
1/29/2006
1/31/2006
2/2/2006
injection 1/26/05 at 0945

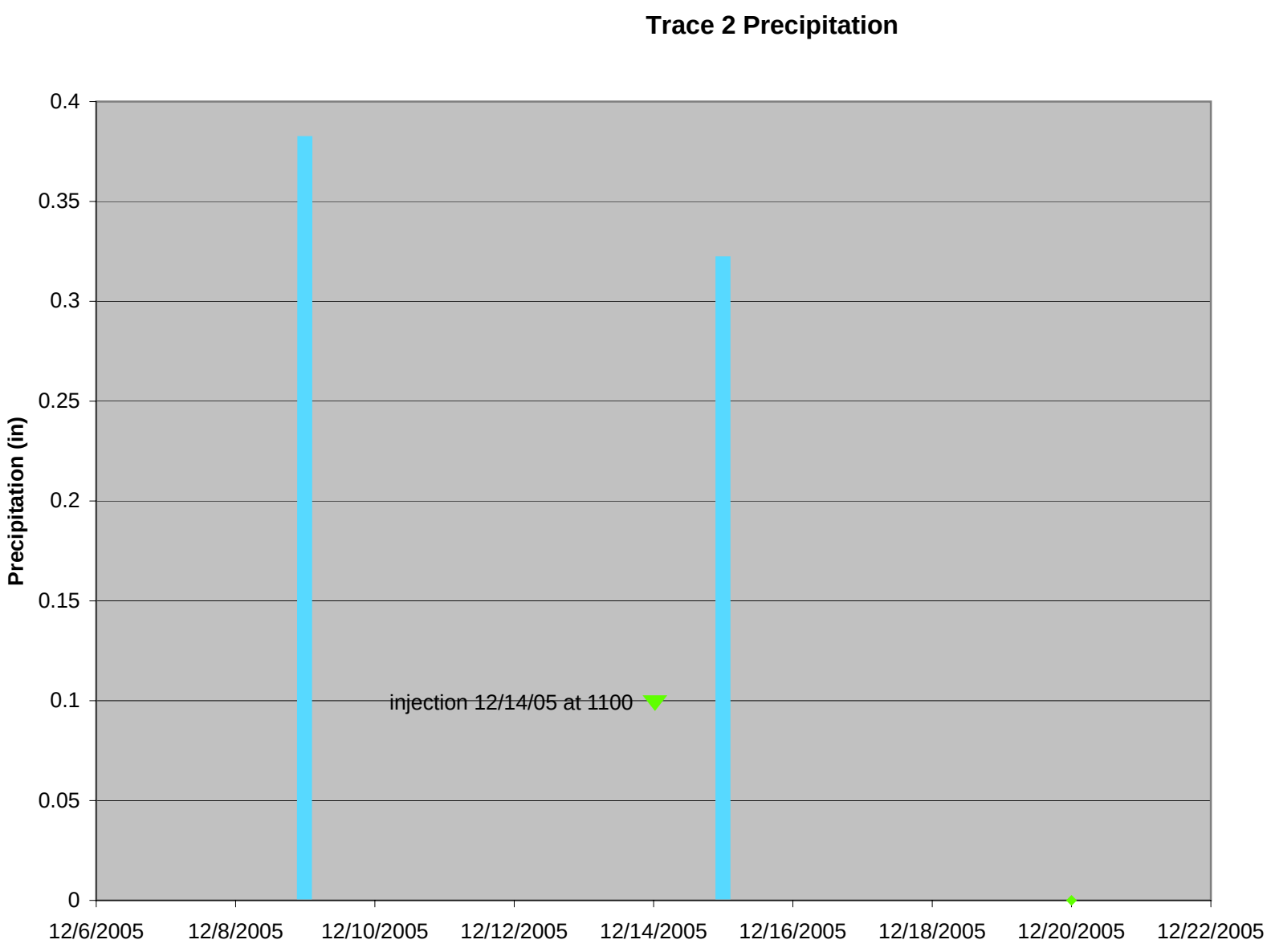

Trace 1 Precipitation
Precipitation (in)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
injection 5/13/09 at 1130
5/5/2009
5/7/2009
5/9/2009
5/11/2009
5/13/2009
5/15/2009
5/17/2009
5/19/2009
5/21/2009

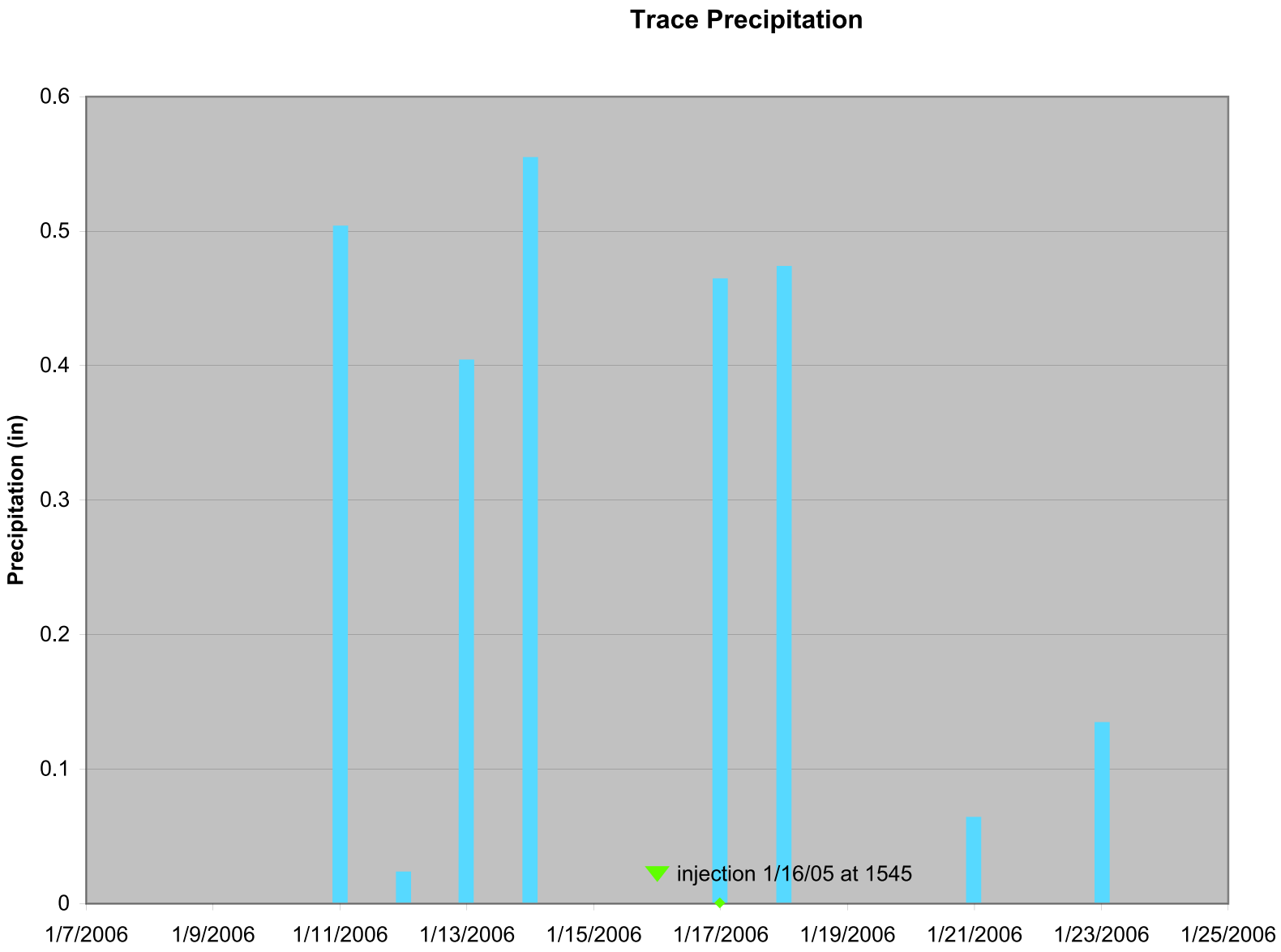

Trace 2 Precipitation
Precipitation (in)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6/16/2009
6/21/2009
6/26/2009
7/1/2009
7/6/2009
7/11/2009
7/16/2009
7/21/2009
injection 6/29/09 at 1040

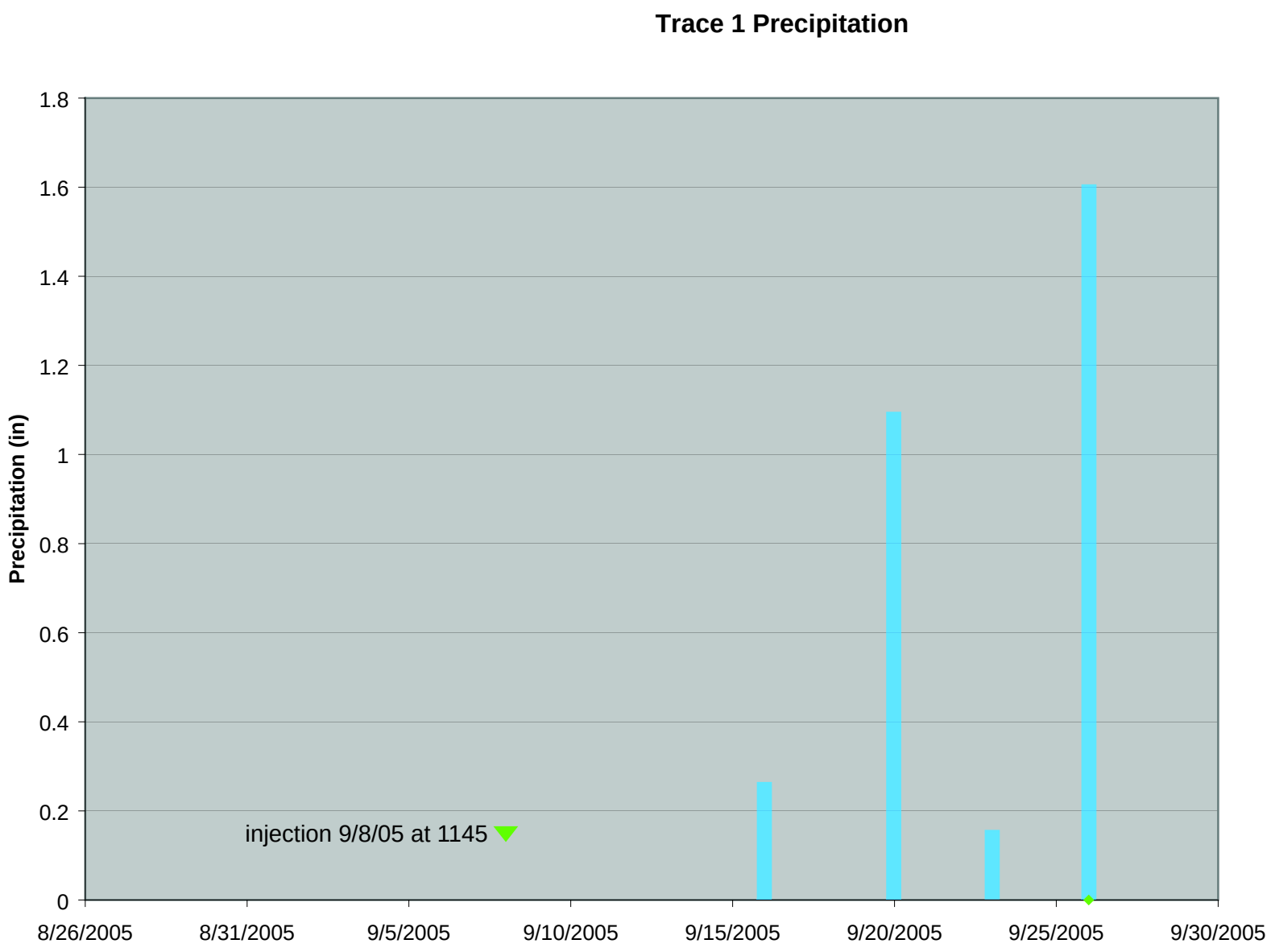

Trace Precipitation
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
injection 12/29/05 at 1500
12/20/2005
12/22/2005
12/24/2005
12/26/2005
12/28/2005
12/30/2005
1/1/2006
1/3/2006
1/5/2006
1/7/2006

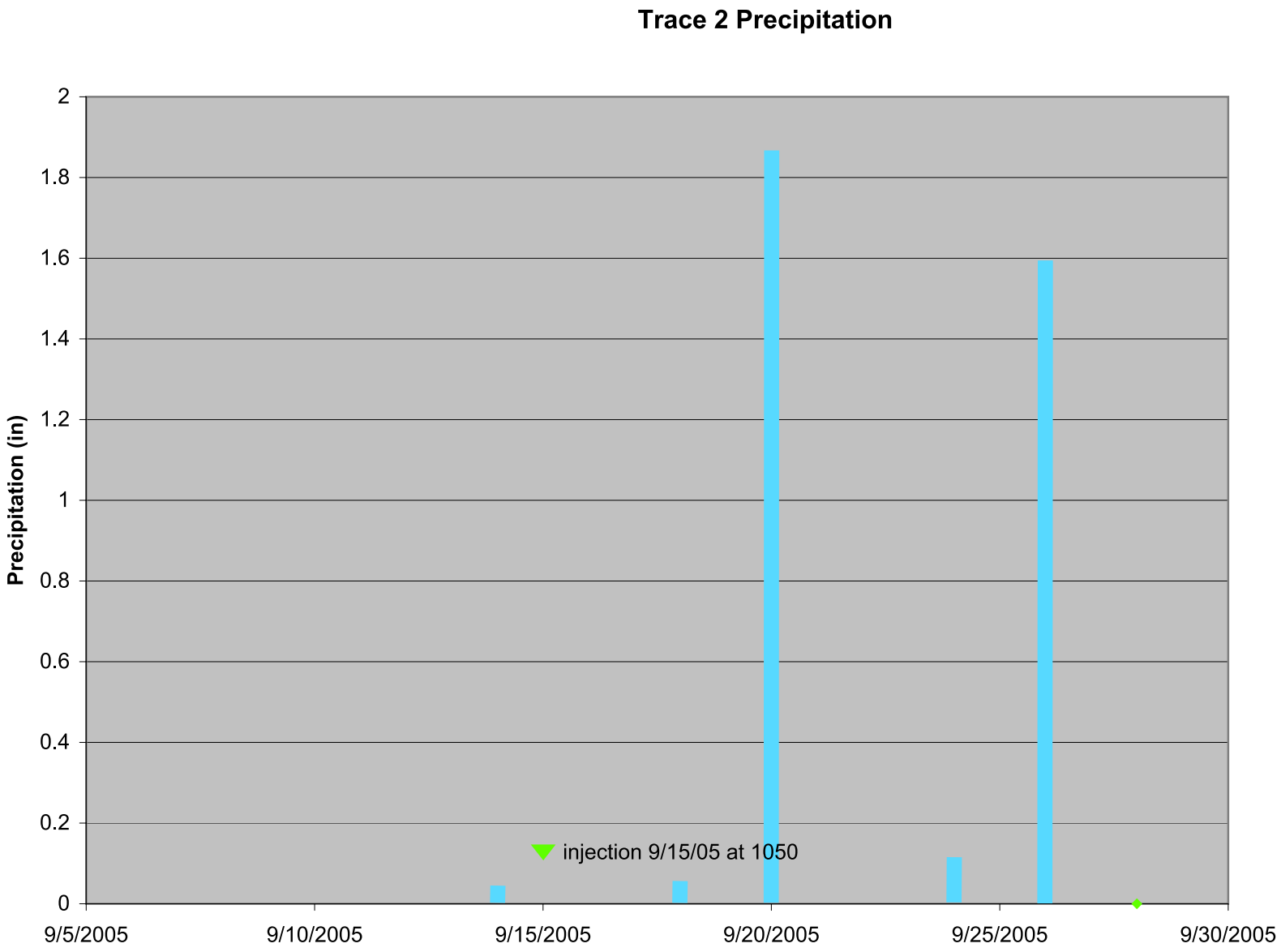

Trace Precipitation
Precipitation (in)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
injection 1/04/10 at 1000
12/27/2009
12/29/2009
12/31/2009
1/2/2010
1/4/2010
1/6/2010
1/8/2010
1/10/2010
1/12/2010

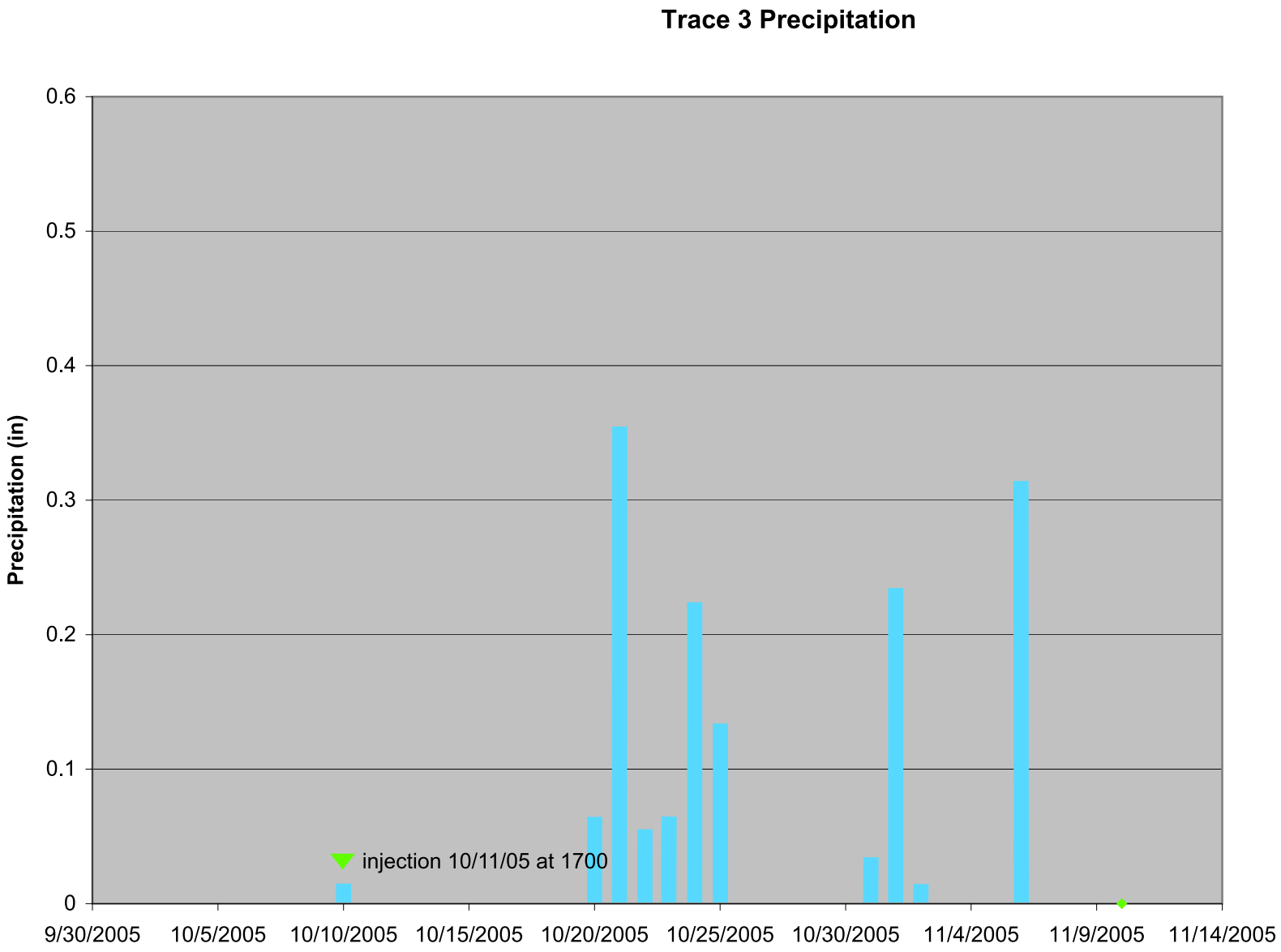

Trace 1 Precipitation
Precipitation (in)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 6/10/05 at 1630
6/1/2005
6/3/2005
6/5/2005
6/7/2005
6/9/2005
6/11/2005
6/13/2005
6/15/2005
6/17/2005
6/19/2005

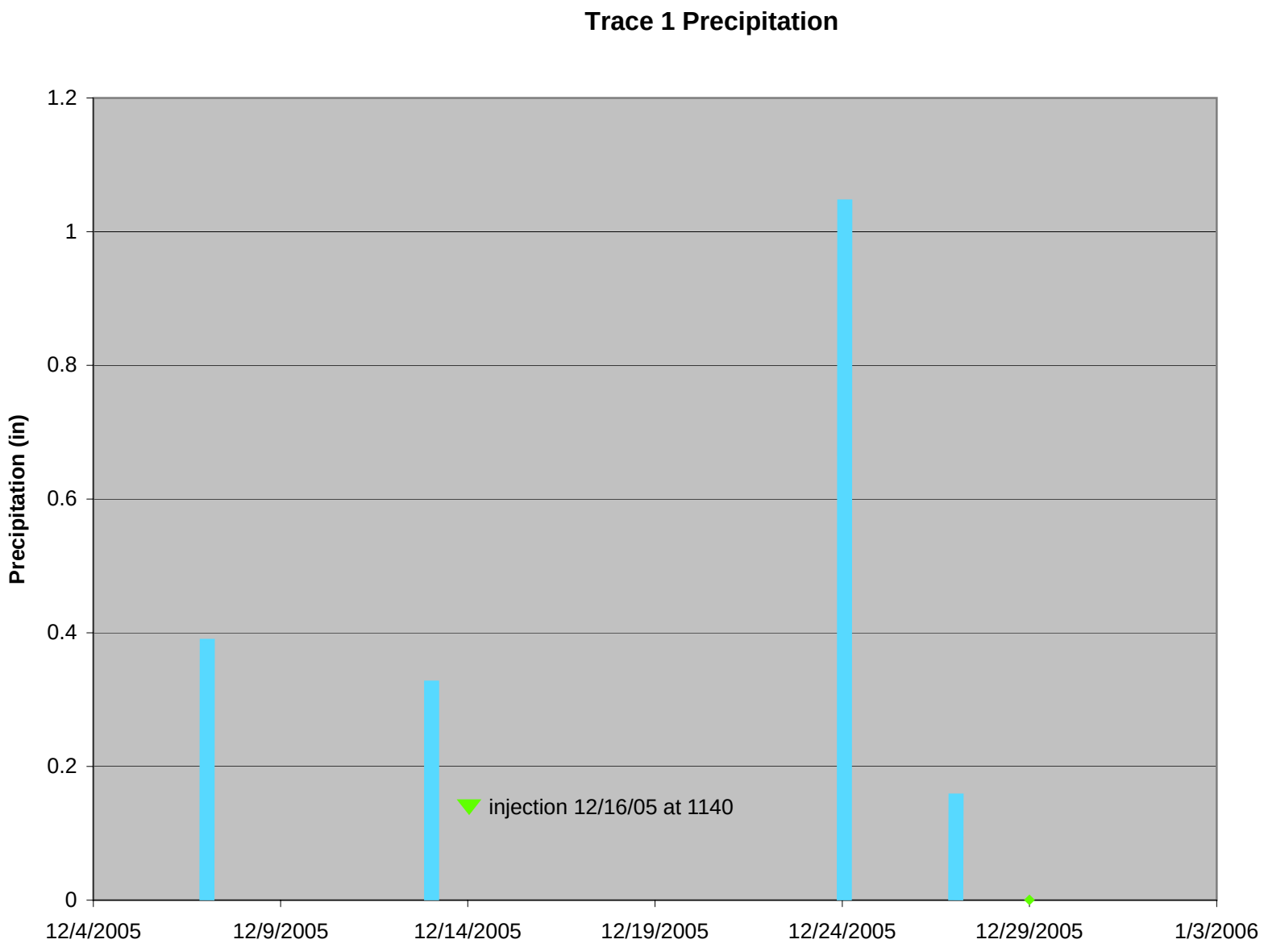

Trace 2 Precipitation
Precipitation (in)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
injection 12/14/05 at 1100
12/6/2005
12/8/2005
12/10/2005
12/12/2005
12/14/2005
12/16/2005
12/18/2005
12/20/2005
12/22/2005

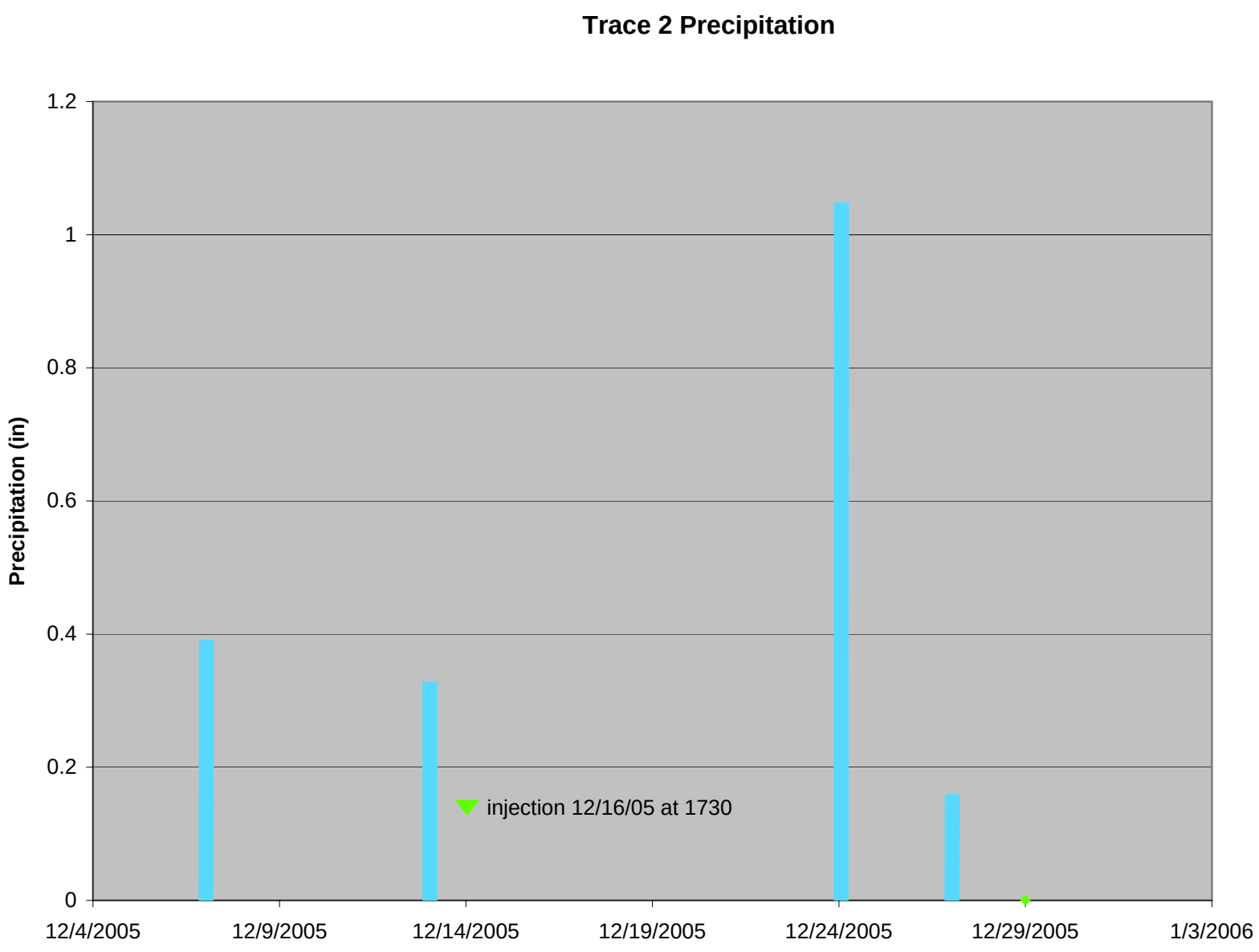

Trace Precipitation
Precipitation (in)
0.6
0.5
0.4
0.3
0.2
0.1
0
1/7/2006
1/9/2006
1/11/2006
1/13/2006
1/15/2006
1/17/2006
1/19/2006
1/21/2006
1/23/2006
1/25/2006
injection 1/16/05 at 1545

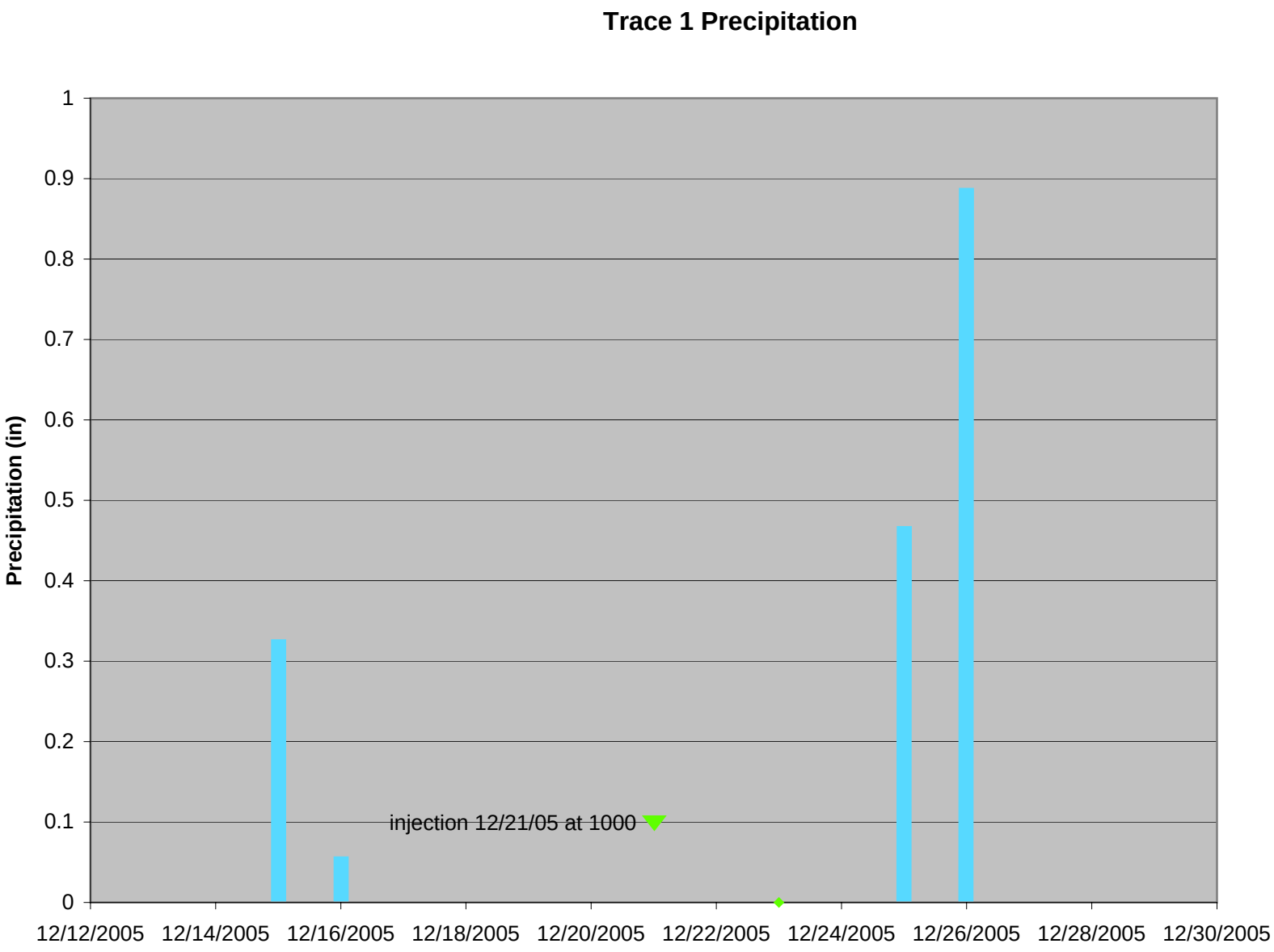

Trace 1 Precipitation
Precipitation (in)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 9/8/05 at 1145
8/26/2005
8/31/2005
9/5/2005
9/10/2005
9/15/2005
9/20/2005
9/25/2005
9/30/2005

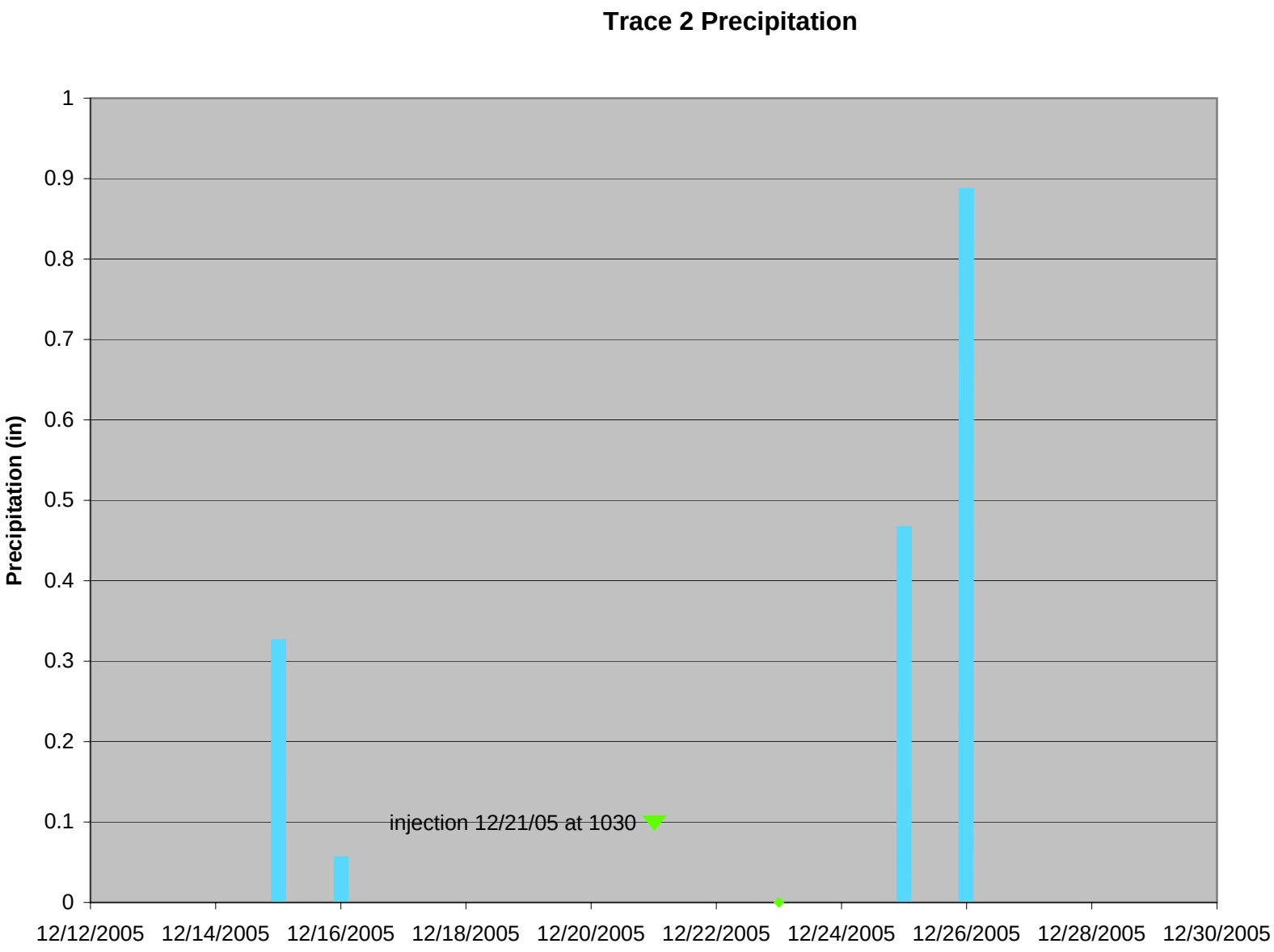

Trace 2 Precipitation
Precipitation (in)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
9/5/2005
9/10/2005
9/15/2005
9/20/2005
9/25/2005
9/30/2005
injection 9/15/05 at 1050

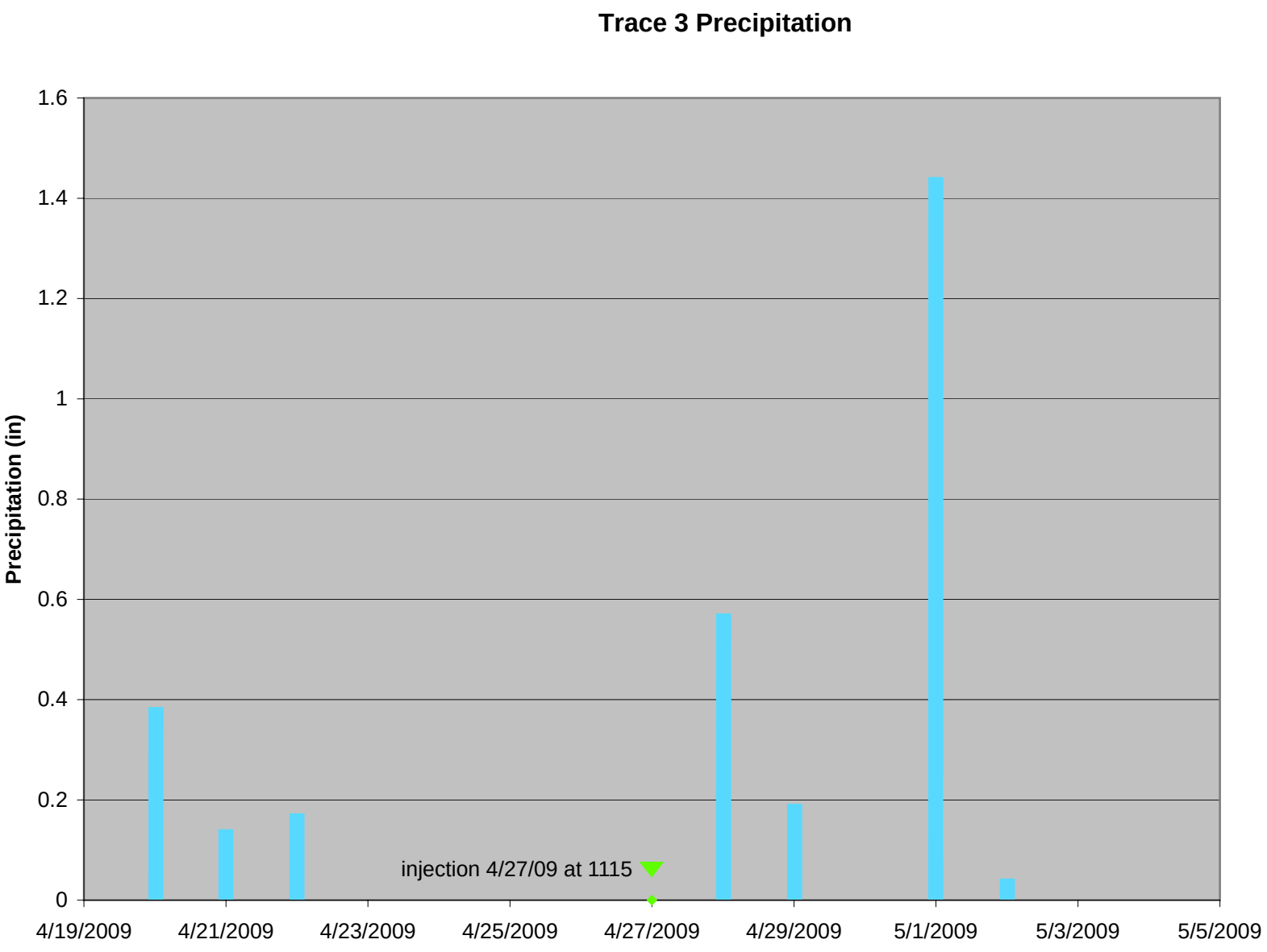

Trace 3 Precipitation
Precipitation (in)
0.6
0.5
0.4
0.3
0.2
0.1
0
injection 10/11/05 at 1700
9/30/2005
10/5/2005
10/10/2005
10/15/2005
10/20/2005
10/25/2005
10/30/2005
11/4/2005
11/9/2005
11/14/2005

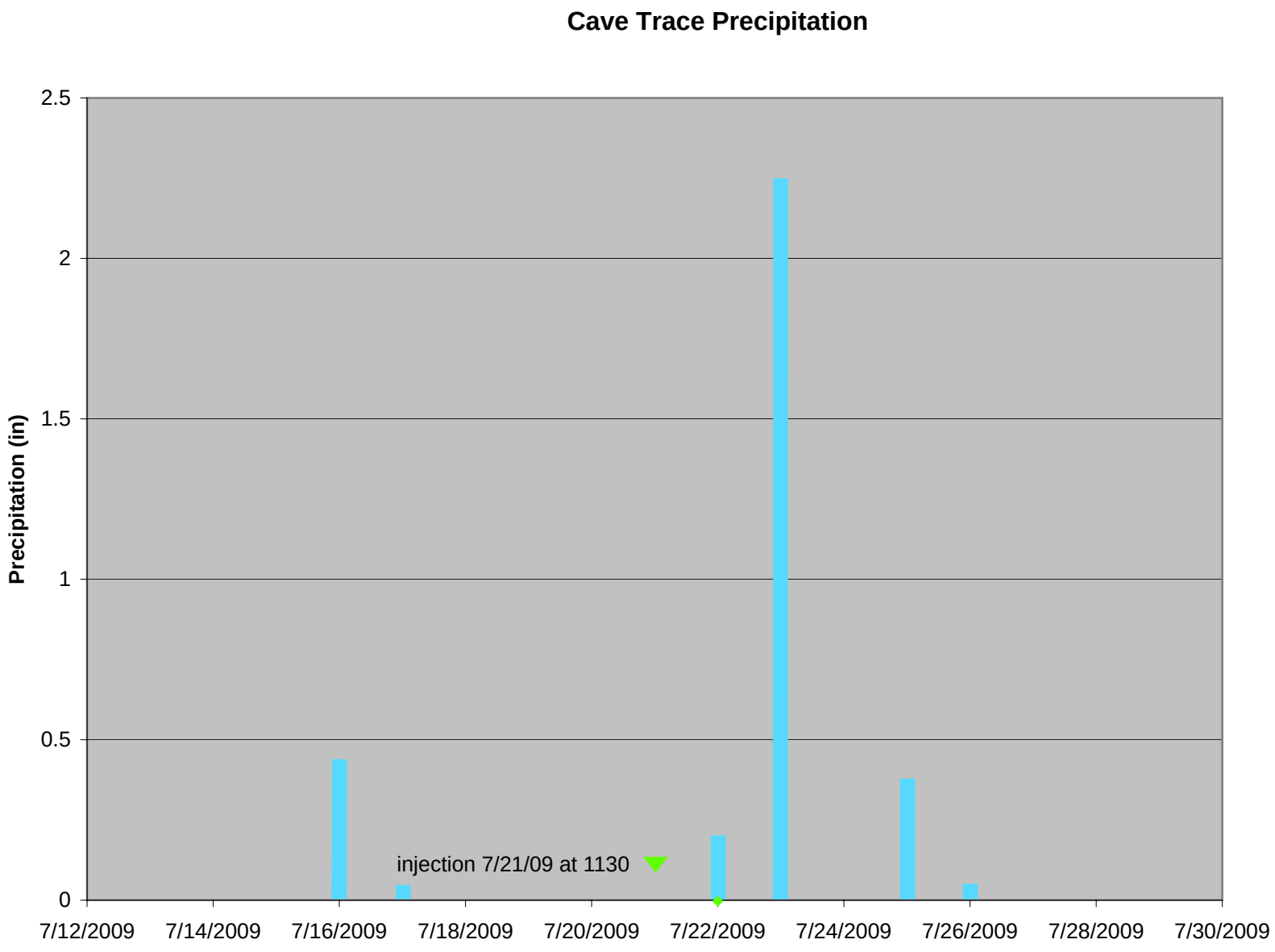

Trace 1 Precipitation
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
12/4/2005
12/9/2005
12/14/2005
12/19/2005
12/24/2005
12/29/2005
1/3/2006
injection 12/16/05 at 1140

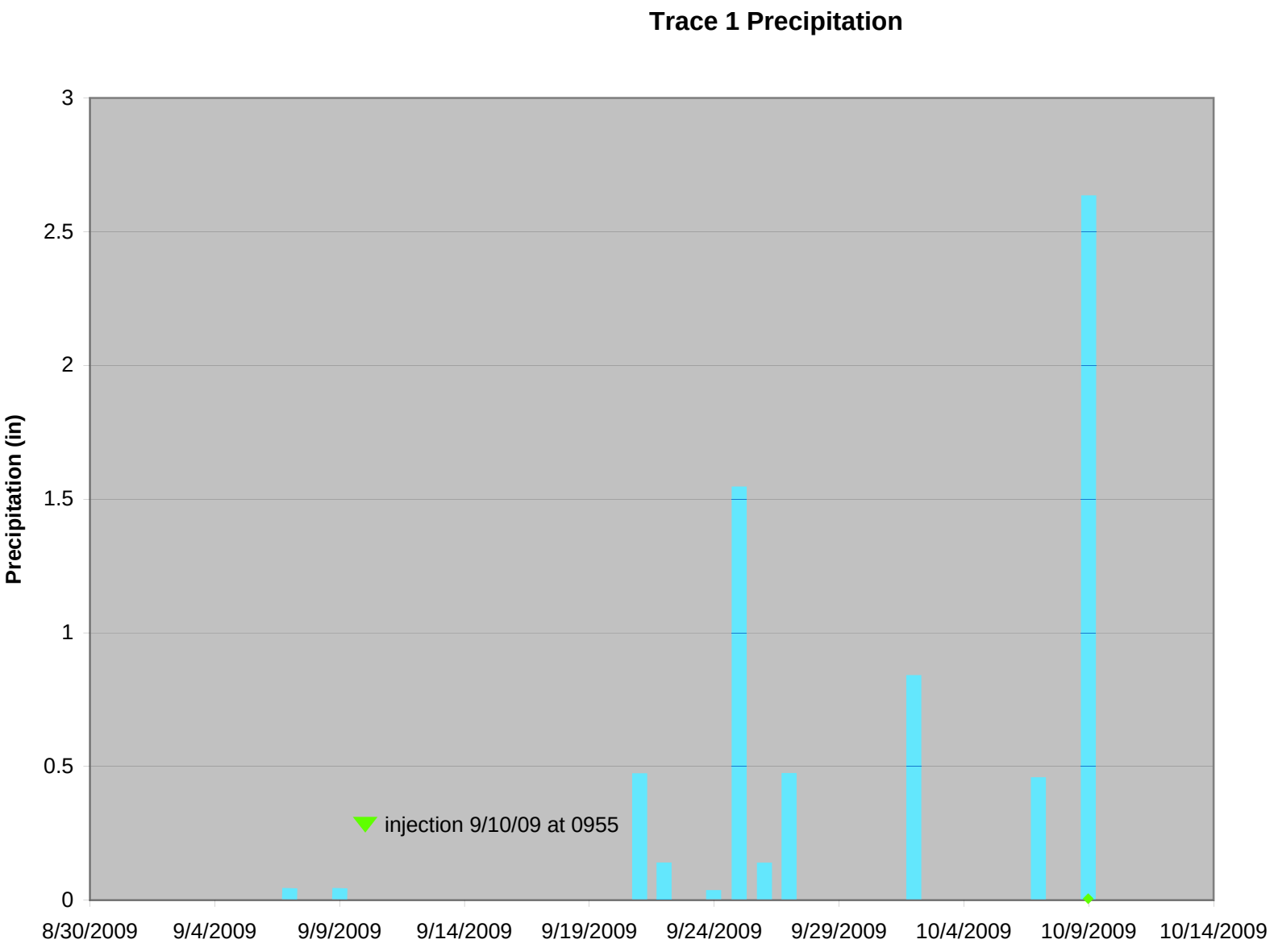

Trace 2 Precipitation
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
injection 12/16/05 at 1730
12/4/2005
12/9/2005
12/14/2005
12/19/2005
12/24/2005
12/29/2005
1/3/2006

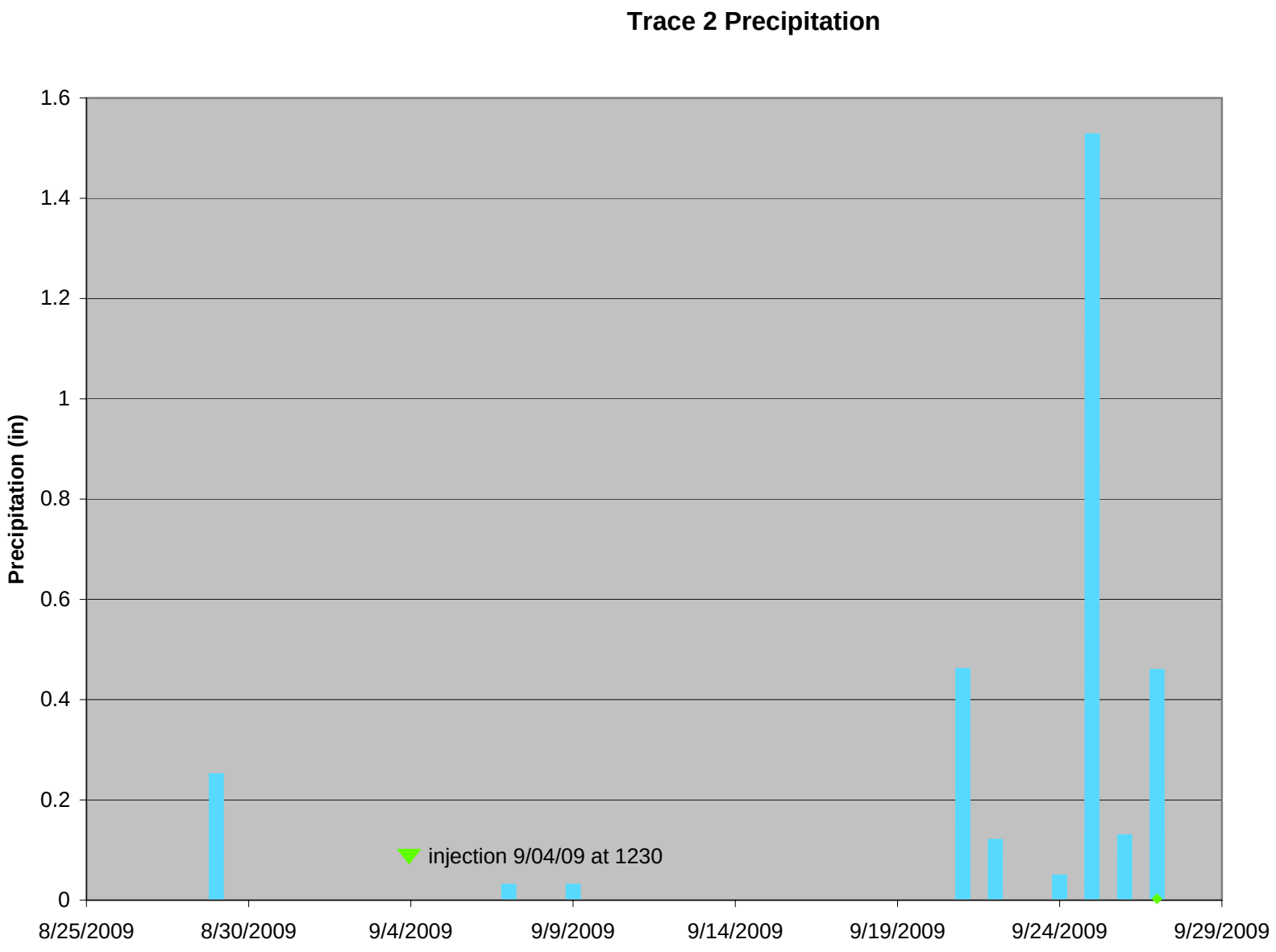

Trace 1 Precipitation
Precipitation (in)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
injection 12/21/05 at 1000
12/12/2005
12/14/2005
12/16/2005
12/18/2005
12/20/2005
12/22/2005
12/24/2005
12/26/2005
12/28/2005
12/30/2005

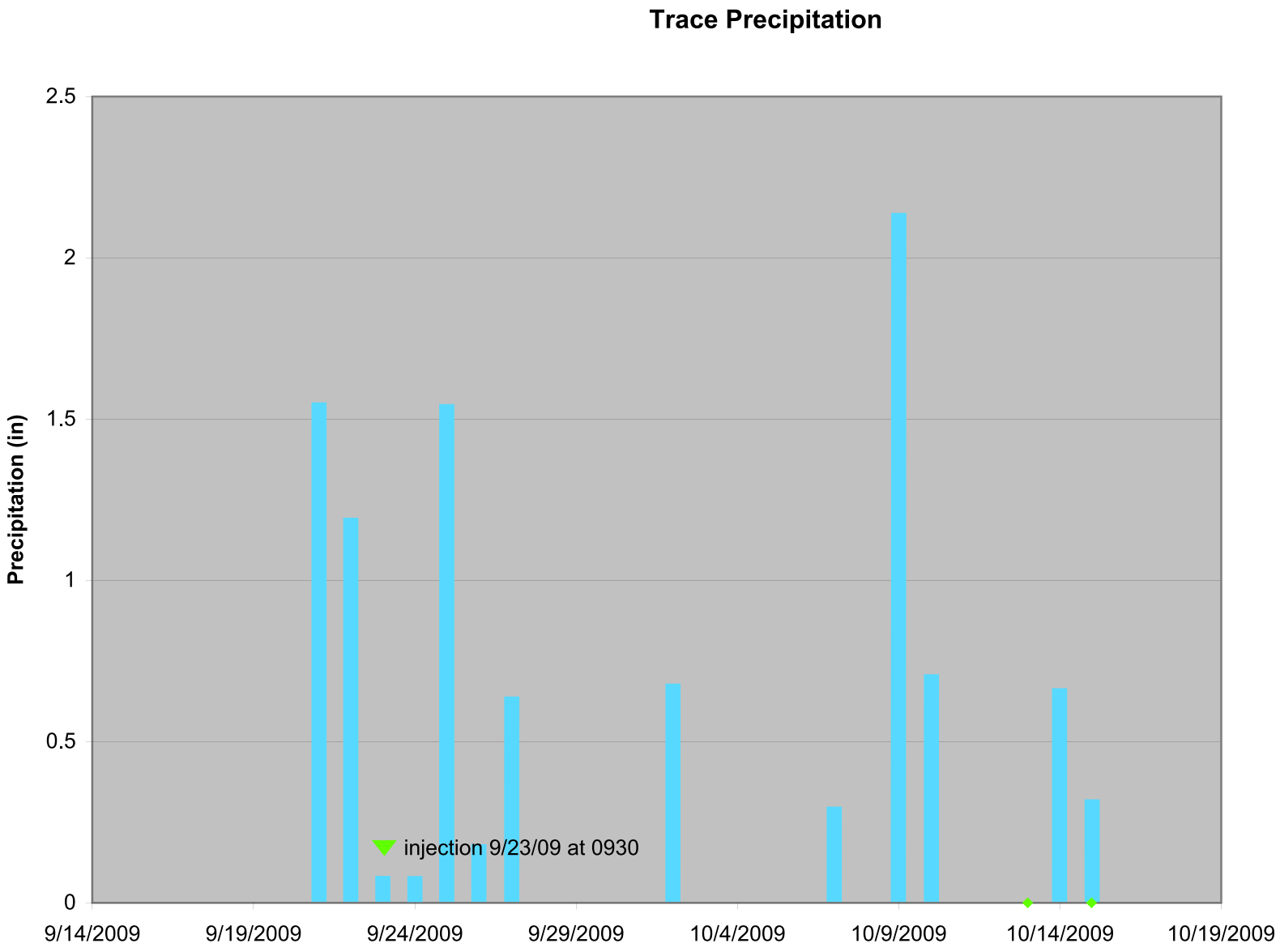

Trace 2 Precipitation
Precipitation (in)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
injection 12/21/05 at 1030
12/12/2005
12/14/2005
12/16/2005
12/18/2005
12/20/2005
12/22/2005
12/24/2005
12/26/2005
12/28/2005
12/30/2005

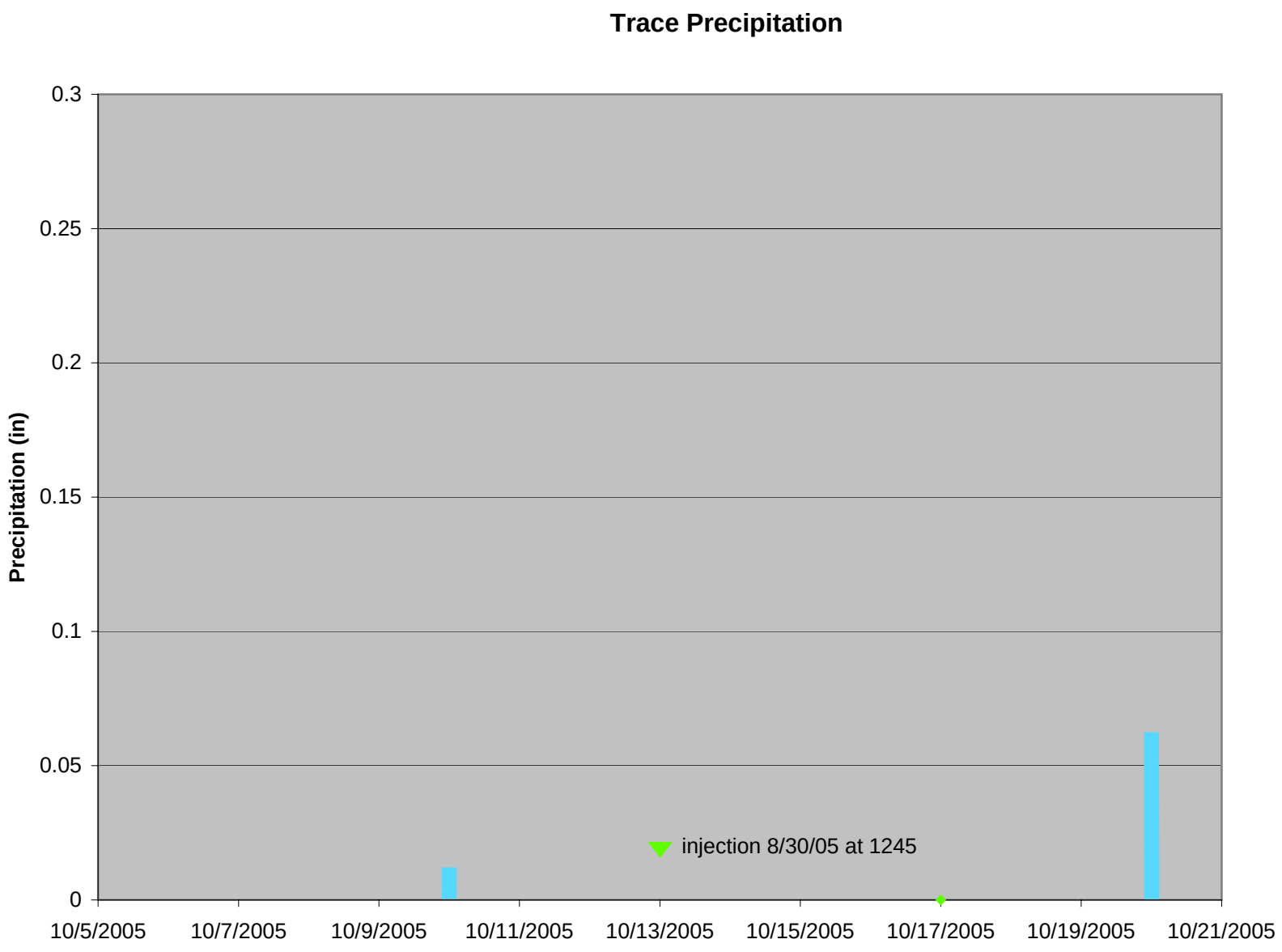

Trace 3 Precipitation
Precipitation (in)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 4/27/09 at 1115
4/19/2009
4/21/2009
4/23/2009
4/25/2009
4/27/2009
4/29/2009
5/1/2009
5/3/2009
5/5/2009

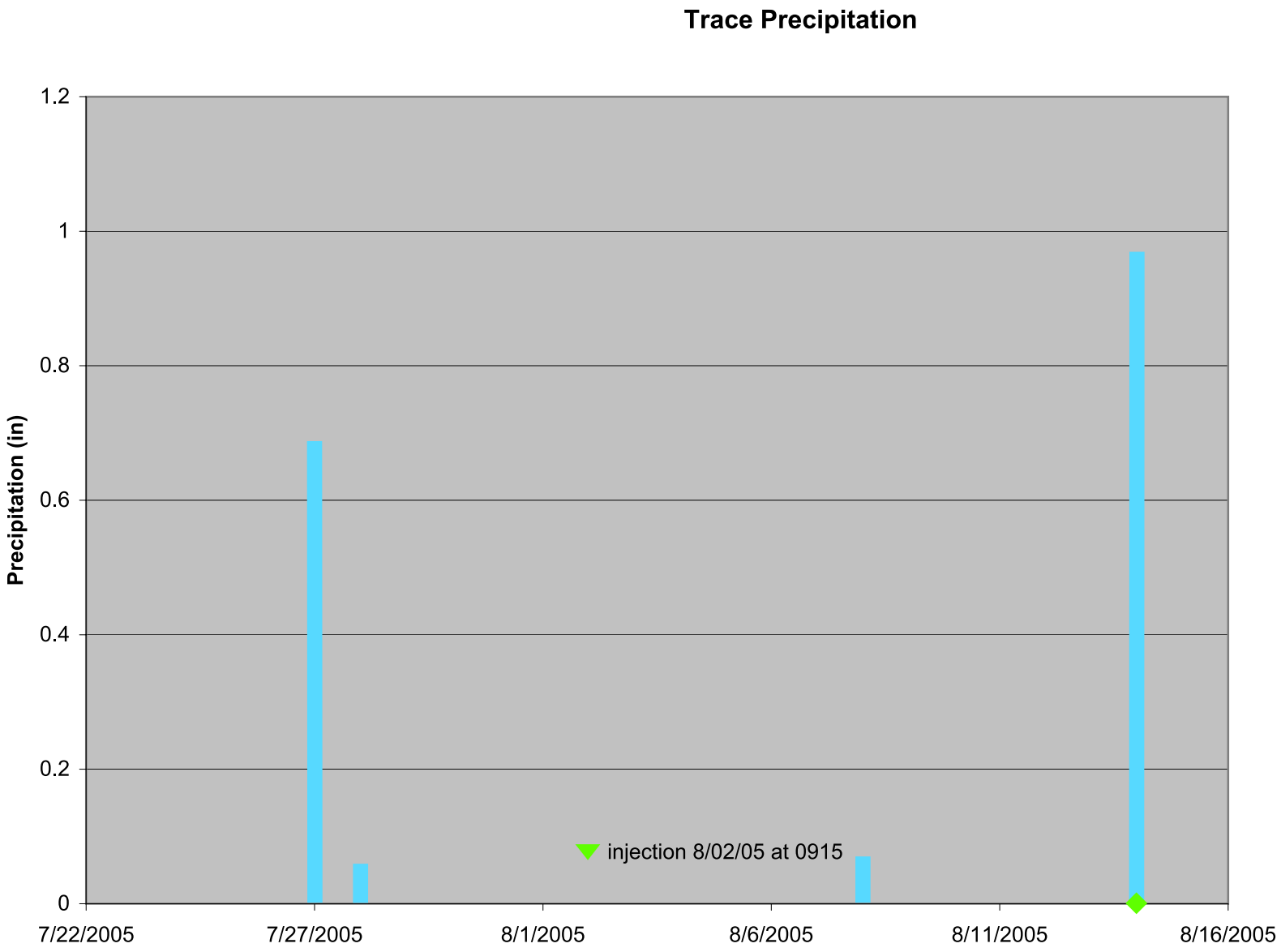

Cave Trace Precipitation
Precipitation (in)
2.5
2
1.5
1
0.5
0
injection 7/21/09 at 1130
7/12/2009
7/14/2009
7/16/2009
7/18/2009
7/20/2009
7/22/2009
7/24/2009
7/26/2009
7/28/2009
7/30/2009

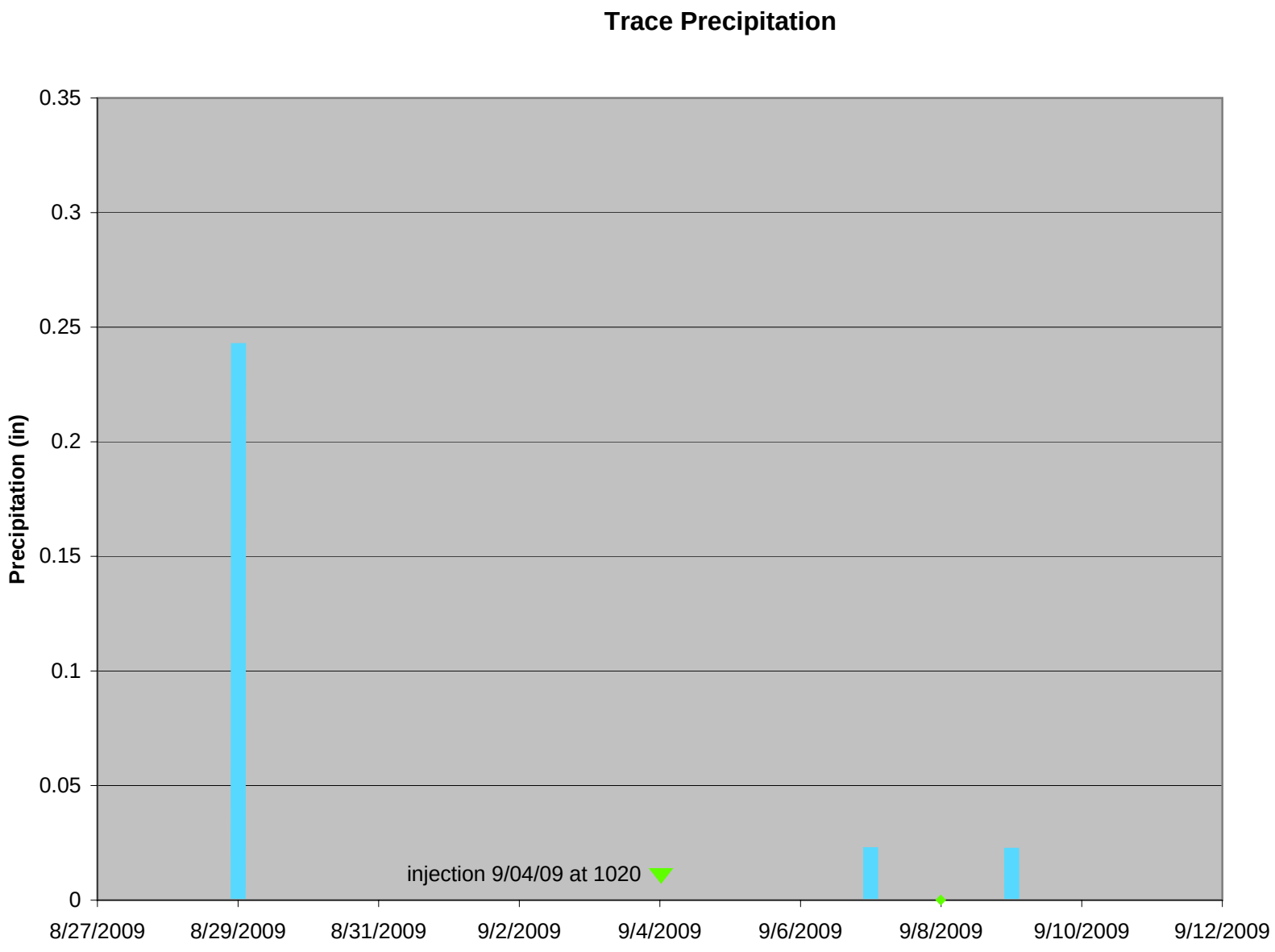

Trace 1 Precipitation
Precipitation (in)
3
2.5
2
1.5
1
0.5
0
injection 9/10/09 at 0955
8/30/2009
9/4/2009
9/9/2009
9/14/2009
9/19/2009
9/24/2009
9/29/2009
10/4/2009
10/9/2009
10/14/2009

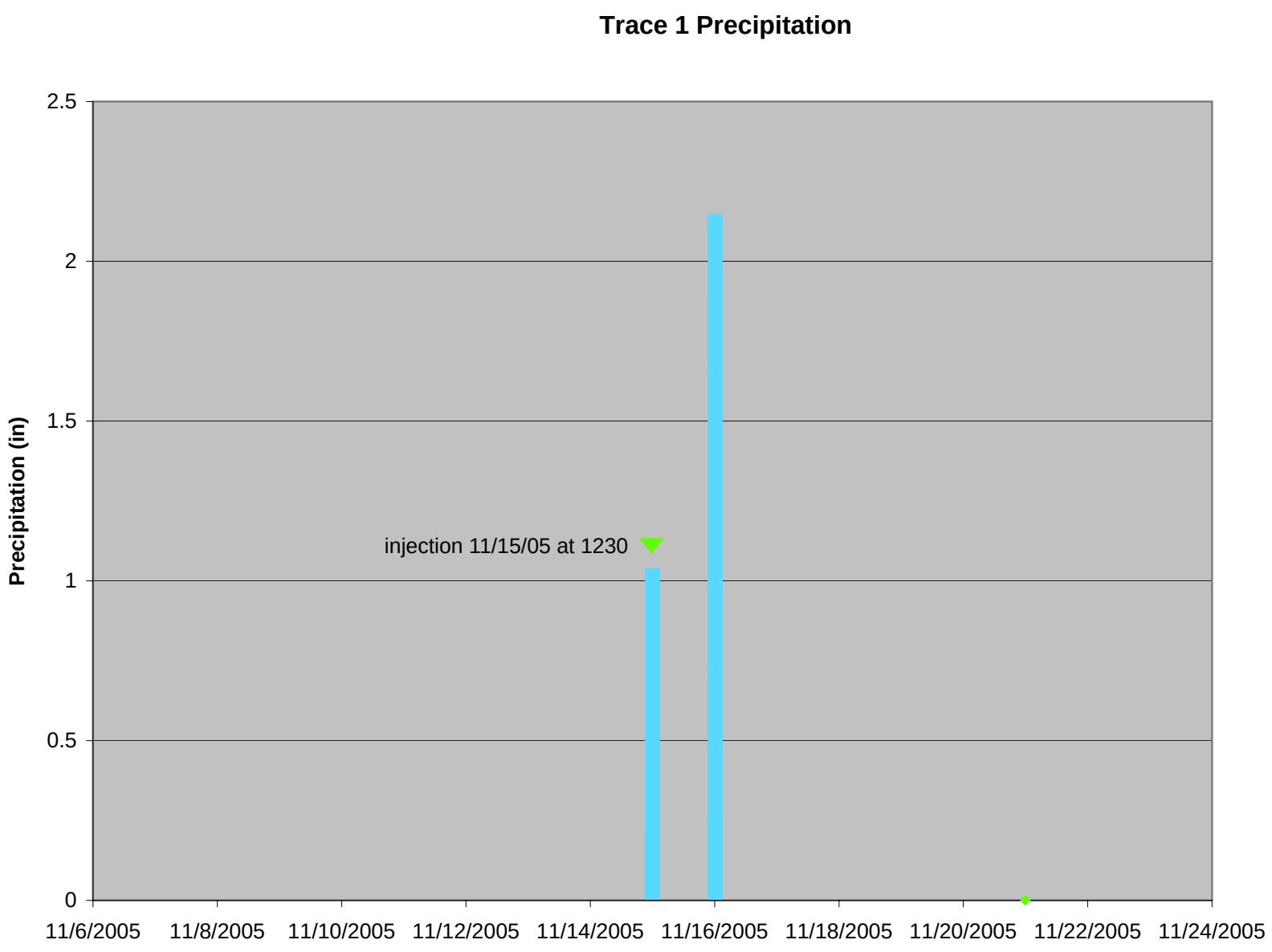

Trace 2 Precipitation
Precipitation (in)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 9/04/09 at 1230
8/25/2009
8/30/2009
9/4/2009
9/9/2009
9/14/2009
9/19/2009
9/24/2009
9/29/2009

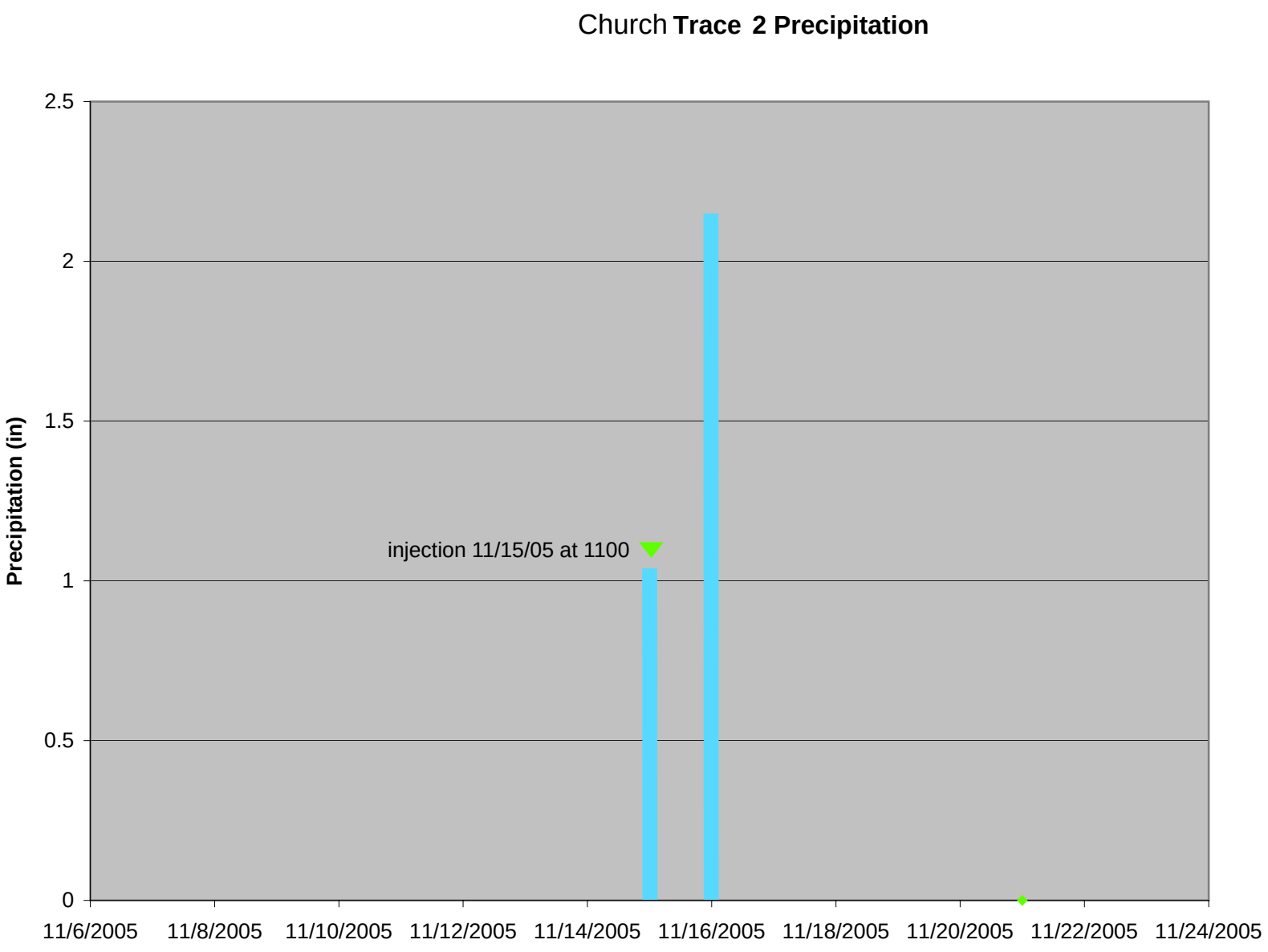

Trace Precipitation
Precipitation (in)
2.5
2
1.5
1
0.5
0
injection 9/23/09 at 0930
9/14/2009
9/19/2009
9/24/2009
9/29/2009
10/4/2009
10/9/2009
10/14/2009
10/19/2009

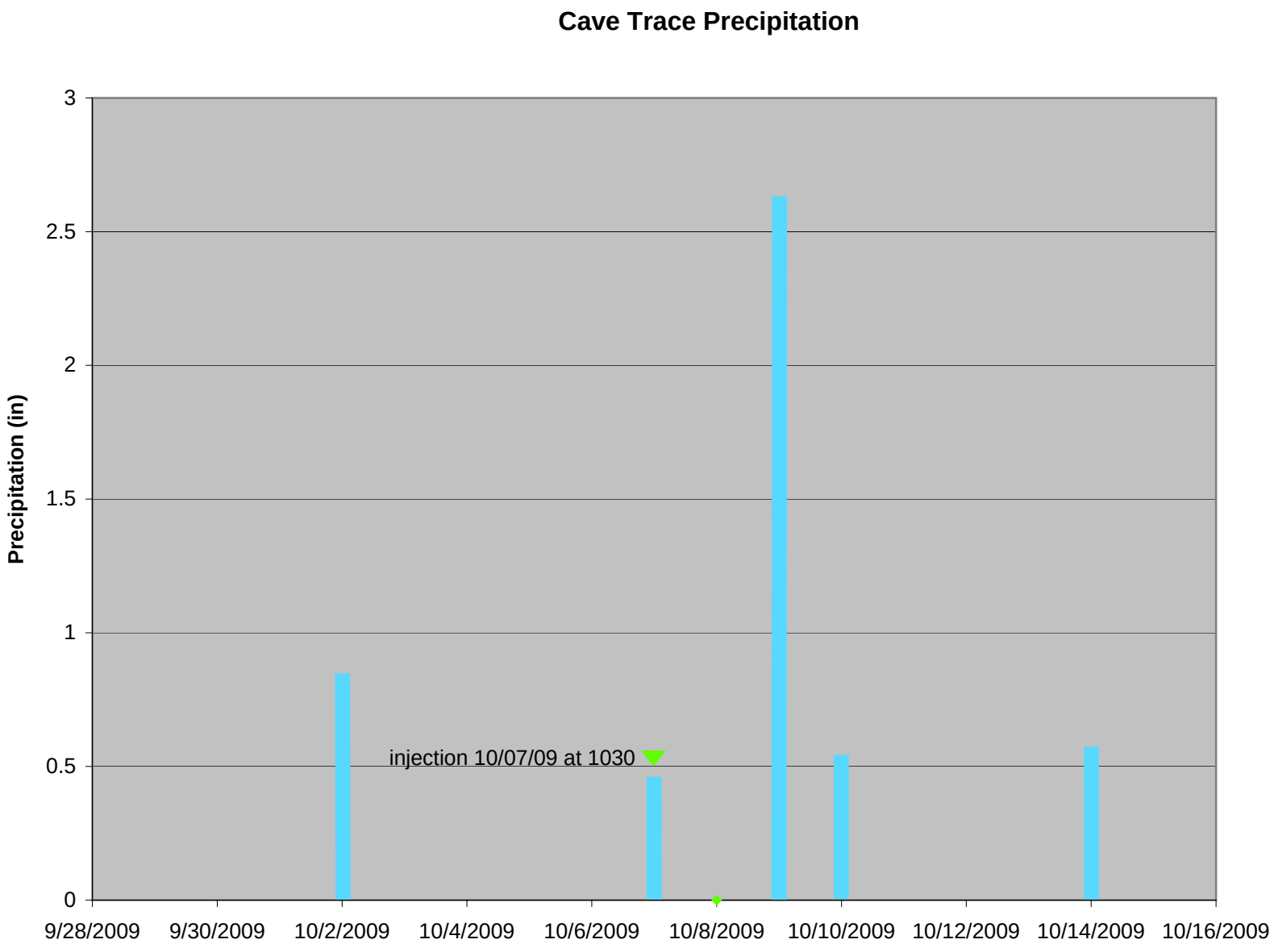

Trace Precipitation
Precipitation (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
injection 8/30/05 at 1245
10/5/2005
10/7/2005
10/9/2005
10/11/2005
10/13/2005
10/15/2005
10/17/2005
10/19/2005
10/21/2005

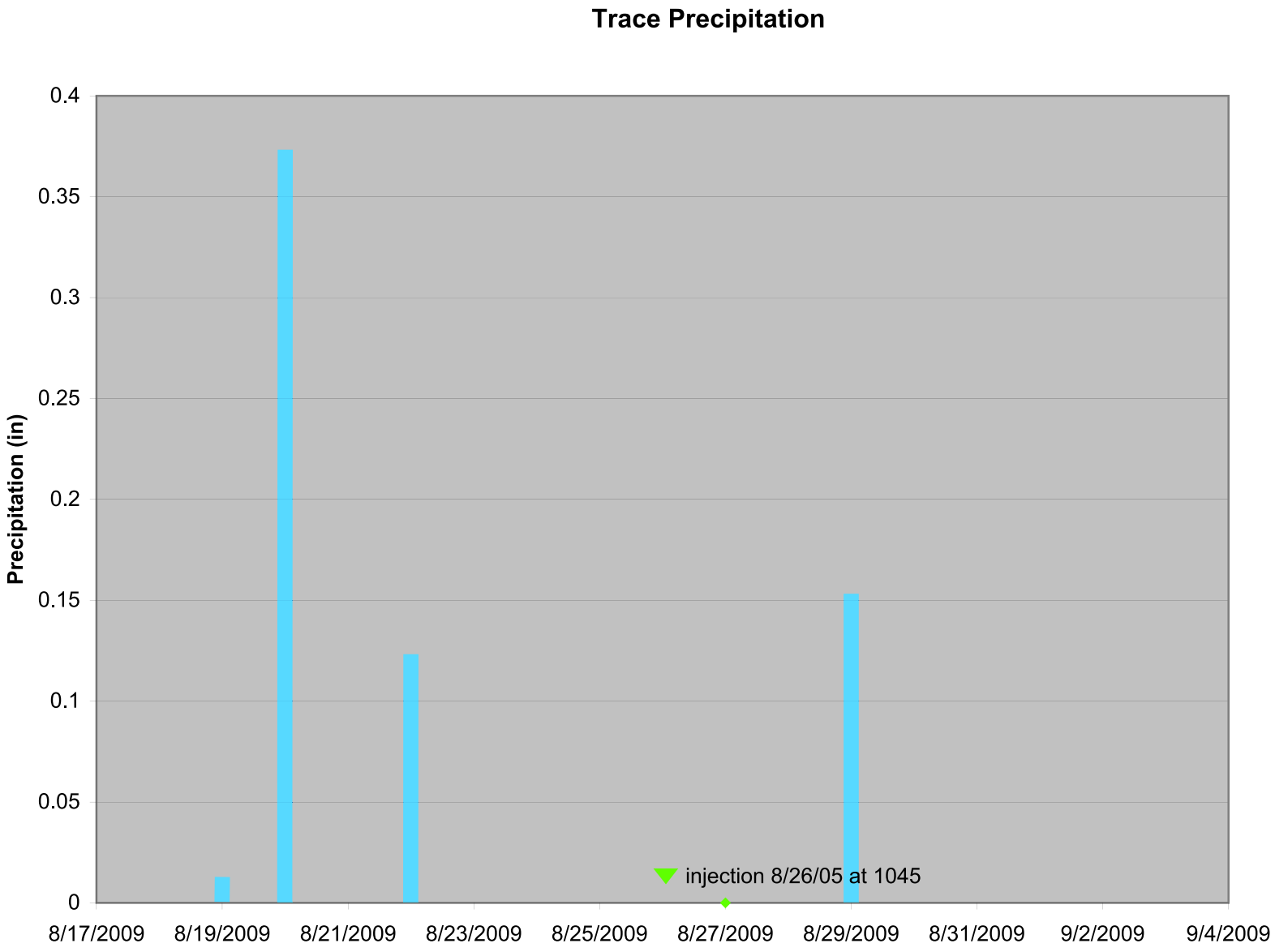

Trace Precipitation
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
7/22/2005
7/27/2005
8/1/2005
8/6/2005
8/11/2005
8/16/2005
injection 8/02/05 at 0915

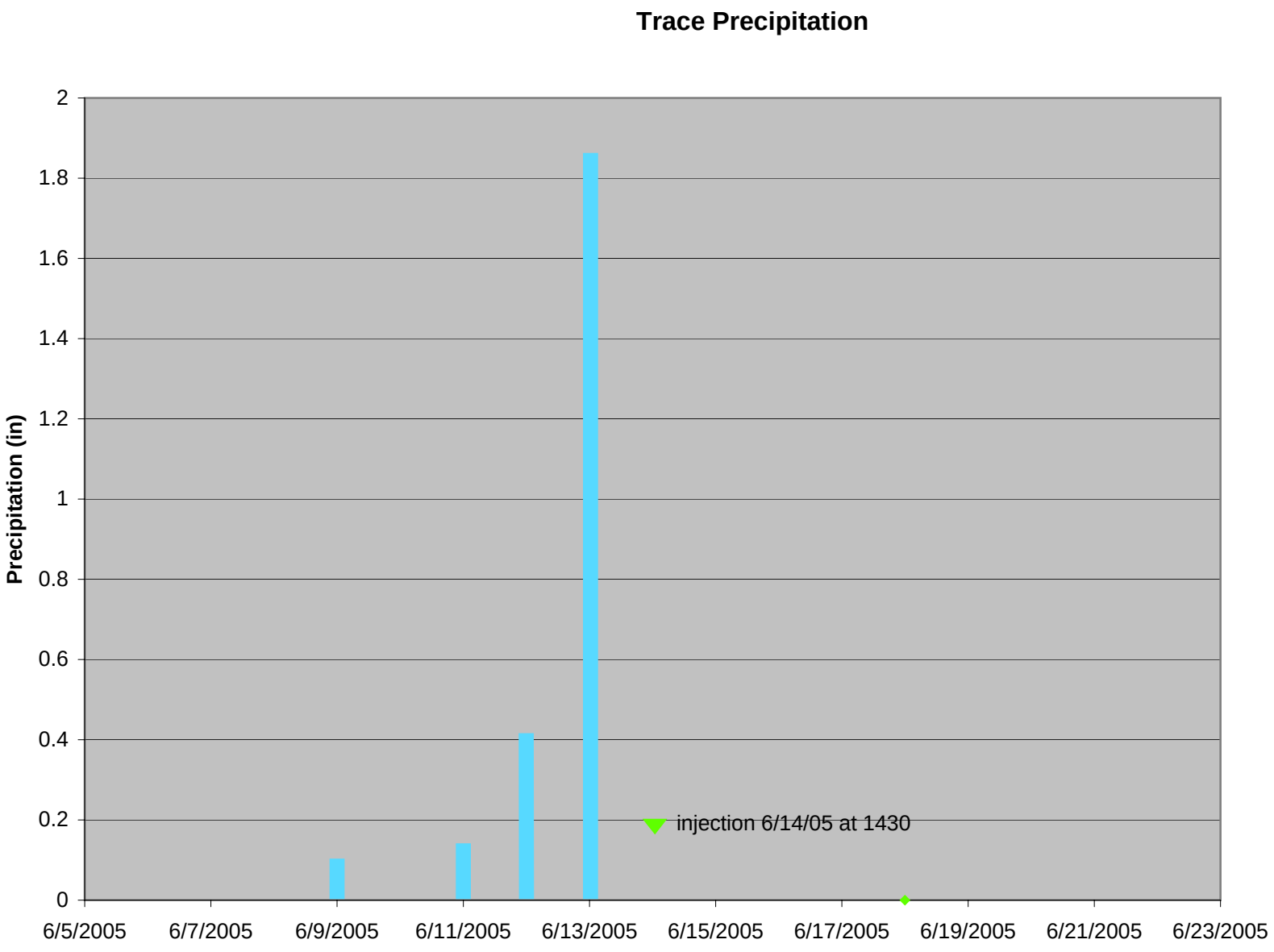

Trace Precipitation
Precipitation (in)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
injection 9/04/09 at 1020
8/27/2009
8/29/2009
8/31/2009
9/2/2009
9/4/2009
9/6/2009
9/8/2009
9/10/2009
9/12/2009

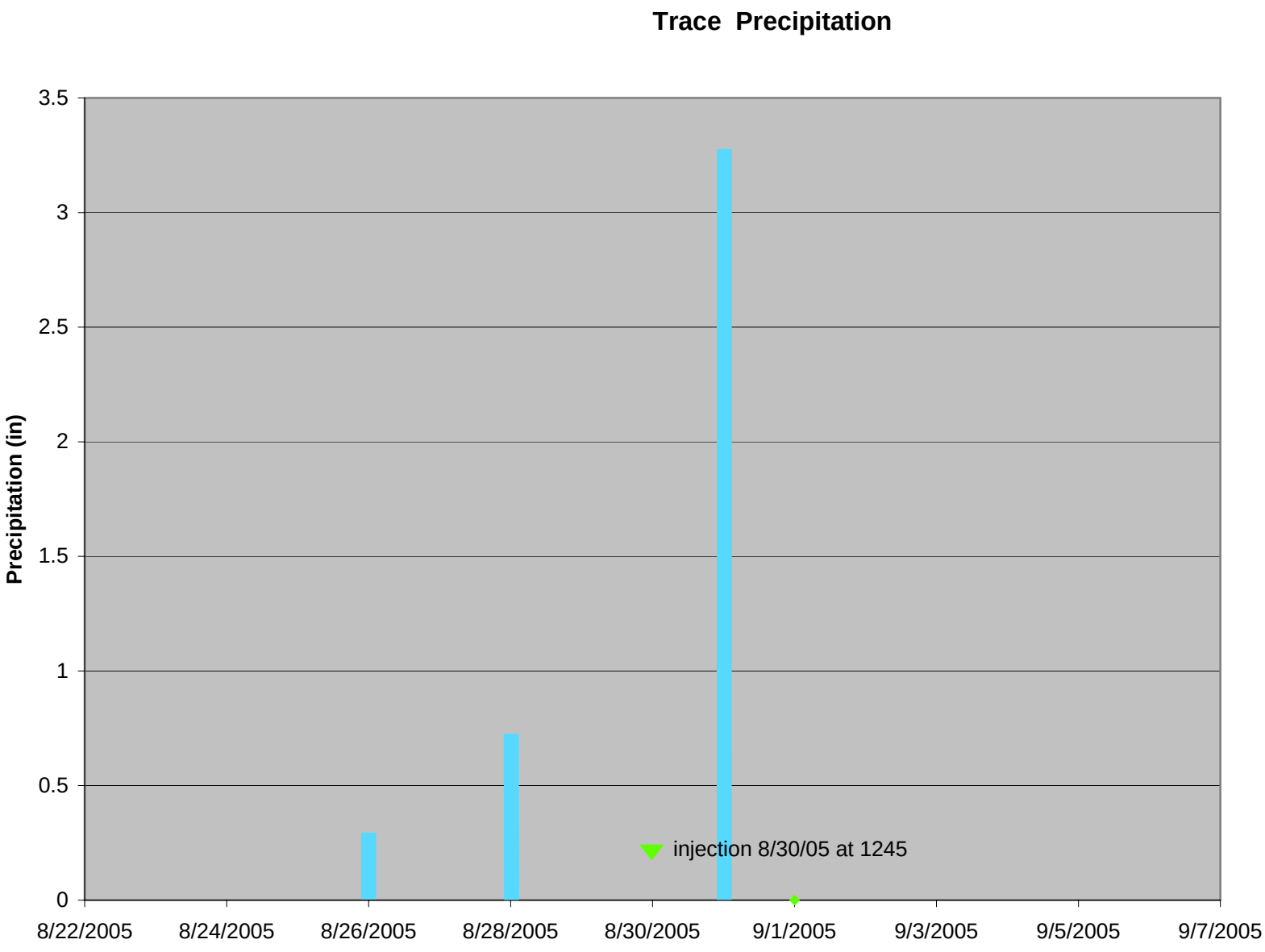

Trace 1 Precipitation
Precipitation (in)
2.5
2
1.5
1
0.5
0
injection 11/15/05 at 1230
11/6/2005
11/8/2005
11/10/2005
11/12/2005
11/14/2005
11/16/2005
11/18/2005
11/20/2005
11/22/2005
11/24/2005

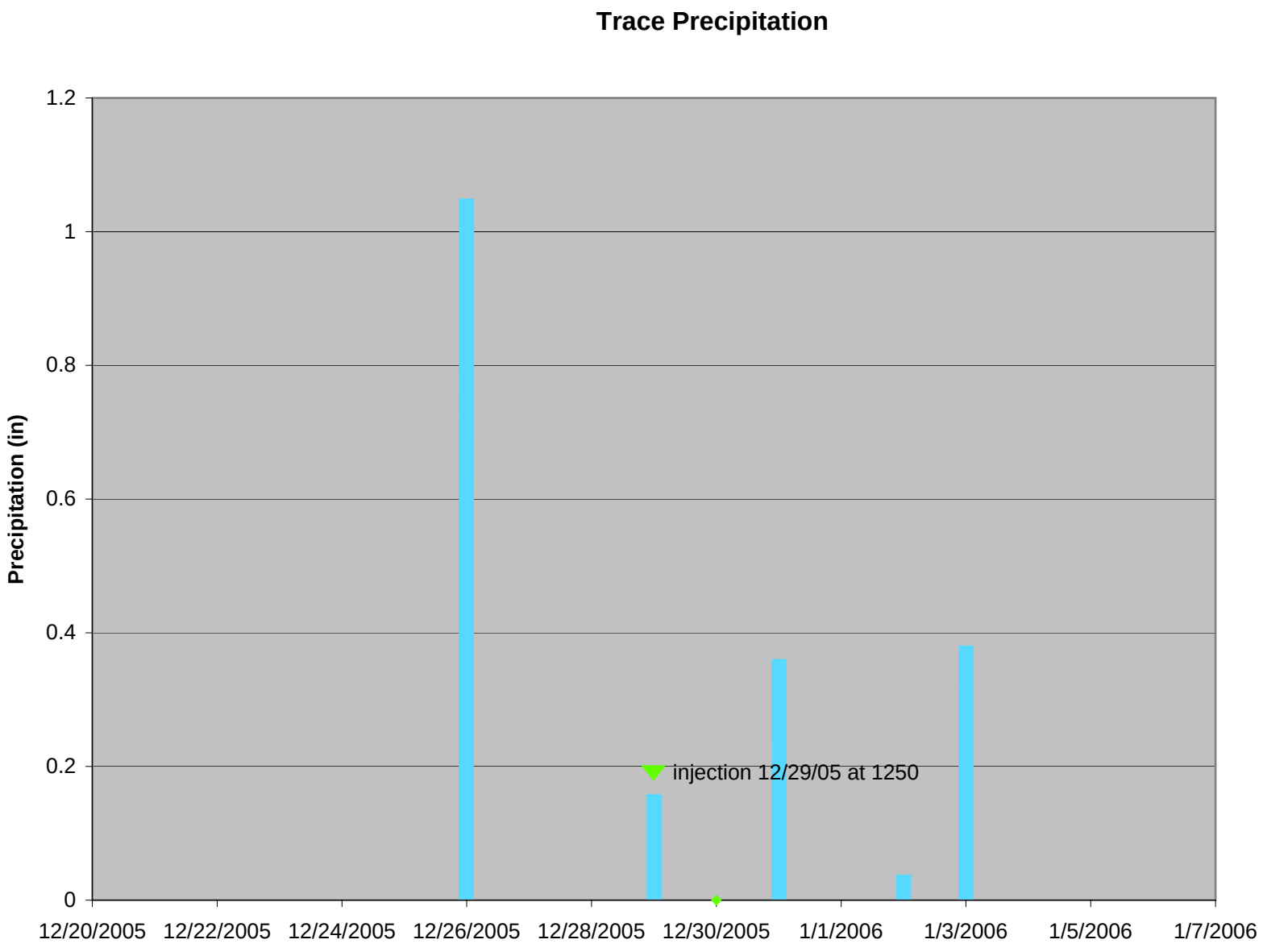

Church Trace 2 Precipitation
Precipitation (in)
2.5
2
1.5
1
0.5
0
injection 11/15/05 at 1100
11/6/2005
11/8/2005
11/10/2005
11/12/2005
11/14/2005
11/16/2005
11/18/2005
11/20/2005
11/22/2005
11/24/2005

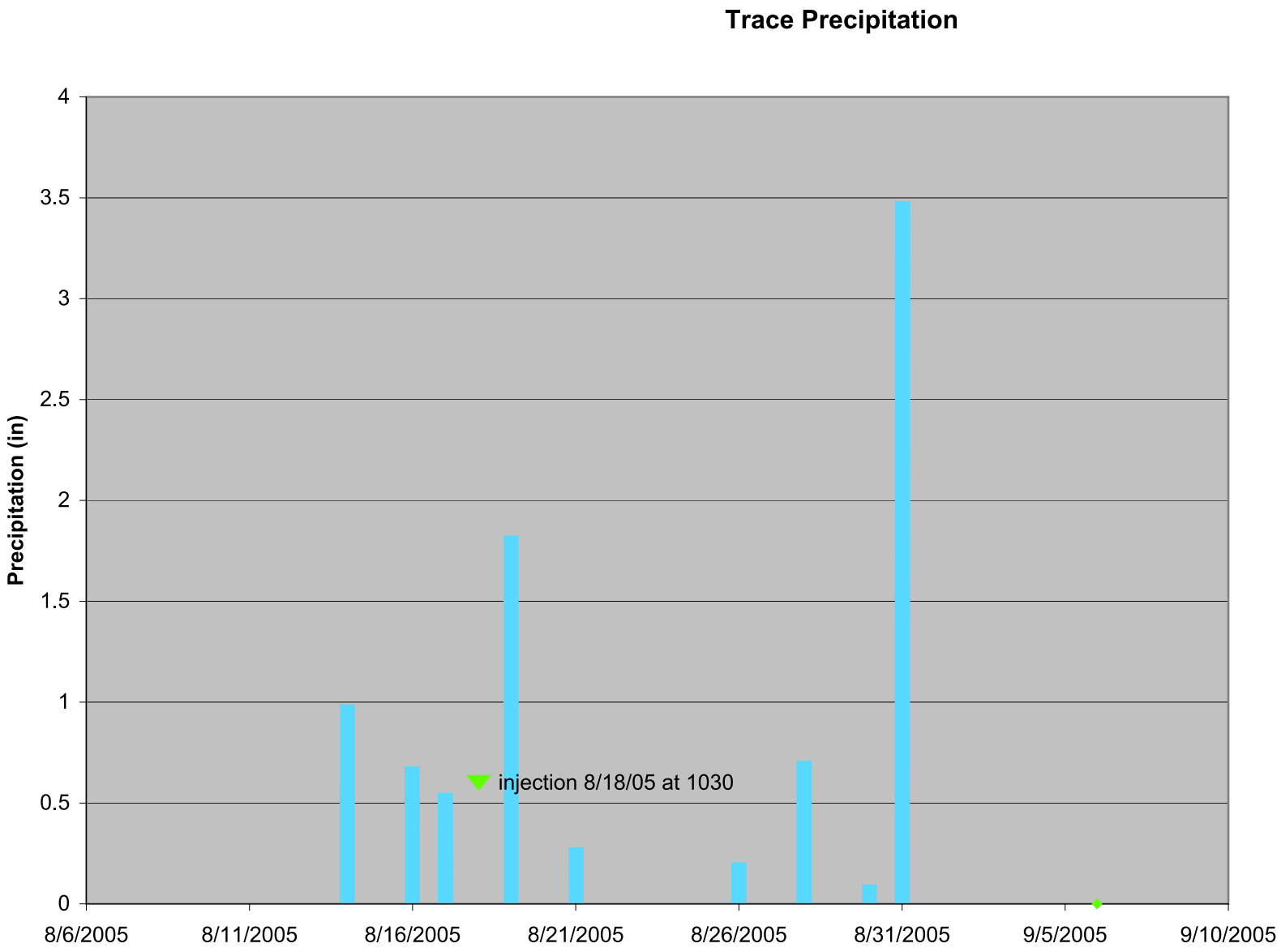

Cave Trace Precipitation
Precipitation (in)
3
2.5
2
1.5
1
0.5
0
injection 10/07/09 at 1030
9/28/2009
9/30/2009
10/2/2009
10/4/2009
10/6/2009
10/8/2009
10/10/2009
10/12/2009
10/14/2009
10/16/2009

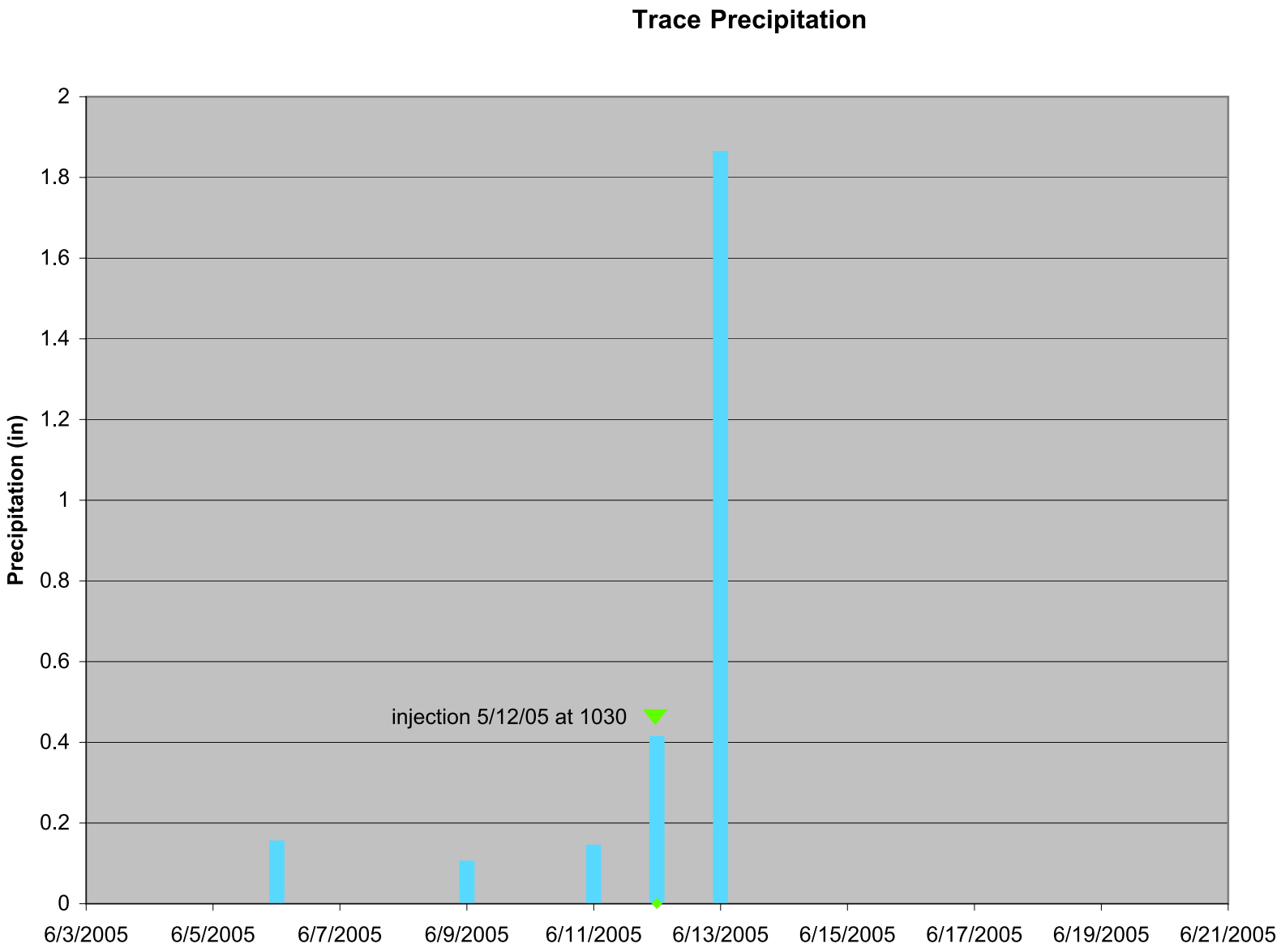

Trace Precipitation
Precipitation (in)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
8/17/2009
8/19/2009
8/21/2009
8/23/2009
8/25/2009
8/27/2009
8/29/2009
8/31/2009
9/2/2009
9/4/2009
injection 8/26/05 at 1045

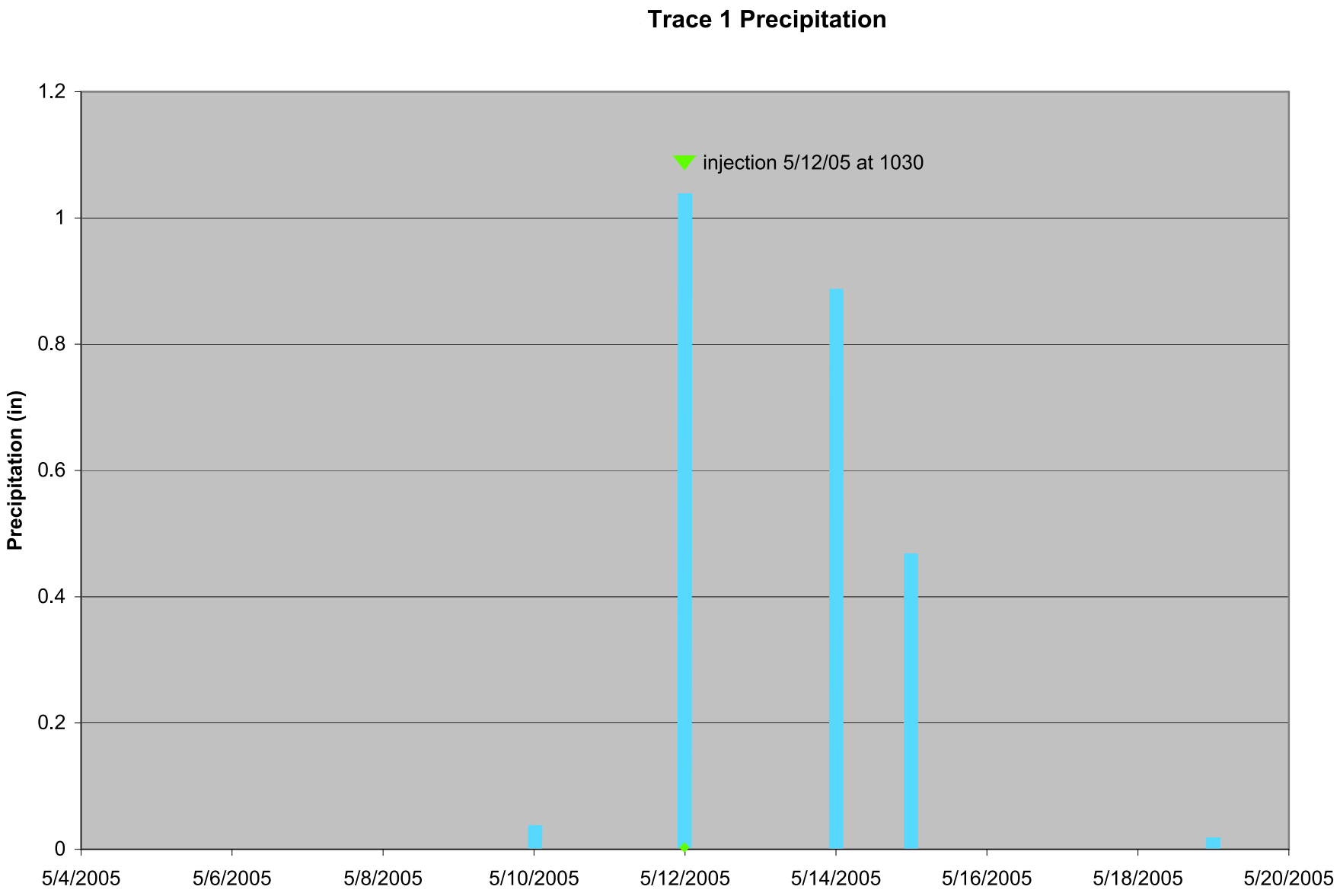

Trace Precipitation
Precipitation (in)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
6/5/2005
6/7/2005
6/9/2005
6/11/2005
6/13/2005
6/15/2005
6/17/2005
6/19/2005
6/21/2005
6/23/2005
injection 6/14/05 at 1430

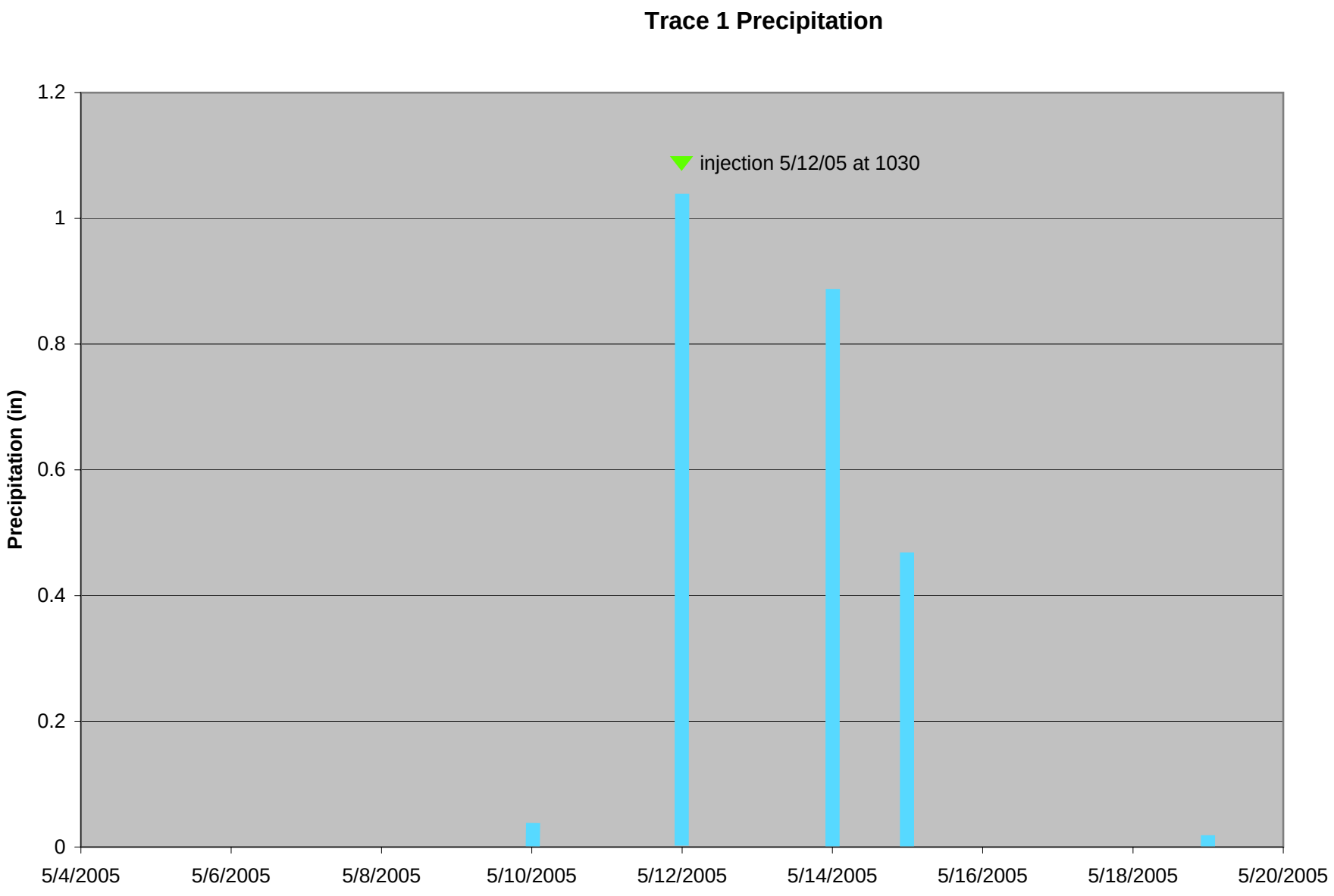

Trace Precipitation
Precipitation (in)
3.5
3
2.5
2
1.5
1
0.5
0
8/22/2005
8/24/2005
8/26/2005
8/28/2005
8/30/2005
9/1/2005
9/3/2005
9/5/2005
9/7/2005
injection 8/30/05 at 1245

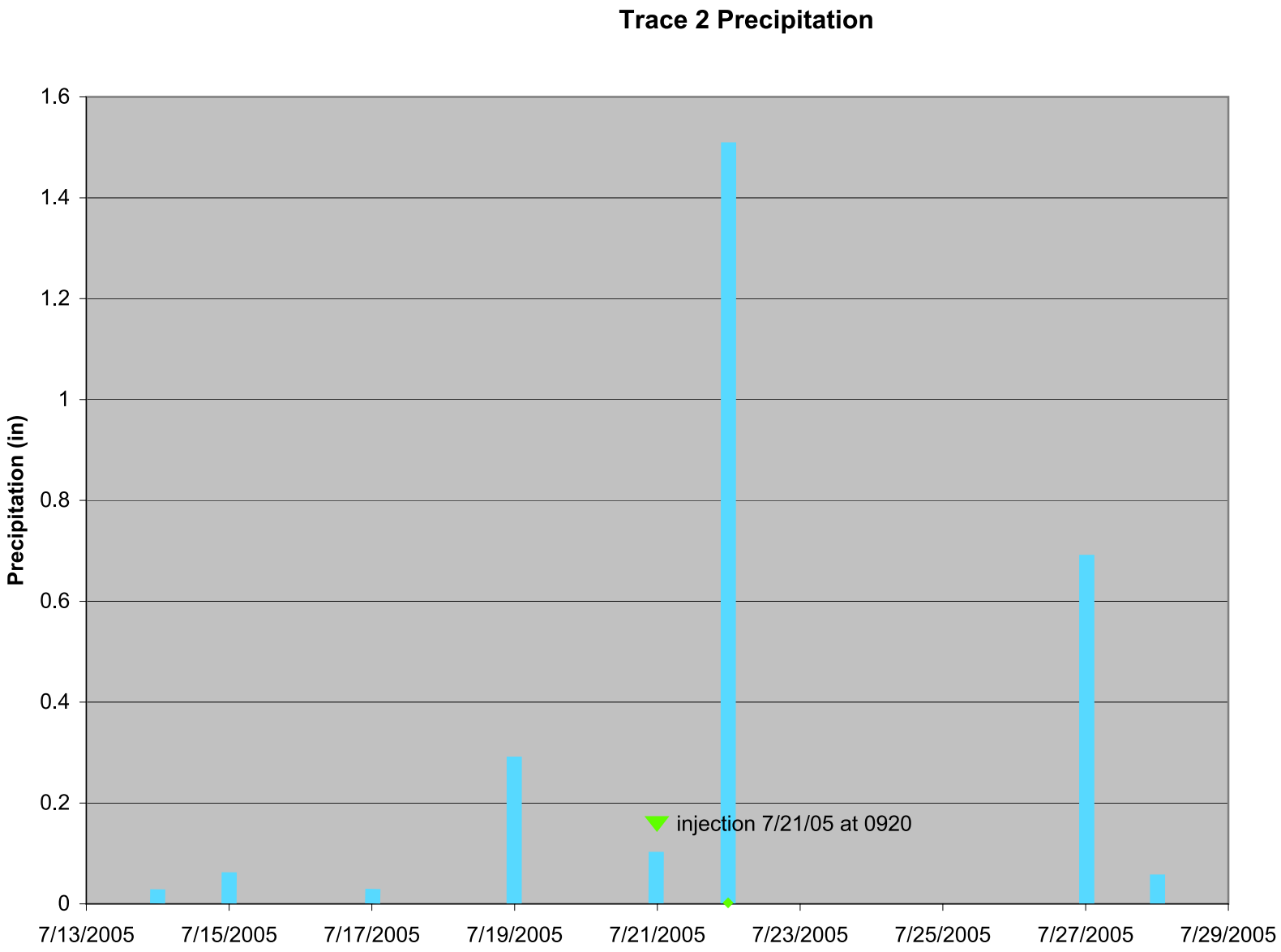

Trace Precipitation
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
12/20/2005
12/22/2005
12/24/2005
12/26/2005
12/28/2005
12/30/2005
1/1/2006
1/3/2006
1/5/2006
1/7/2006
injection 12/29/05 at 1250

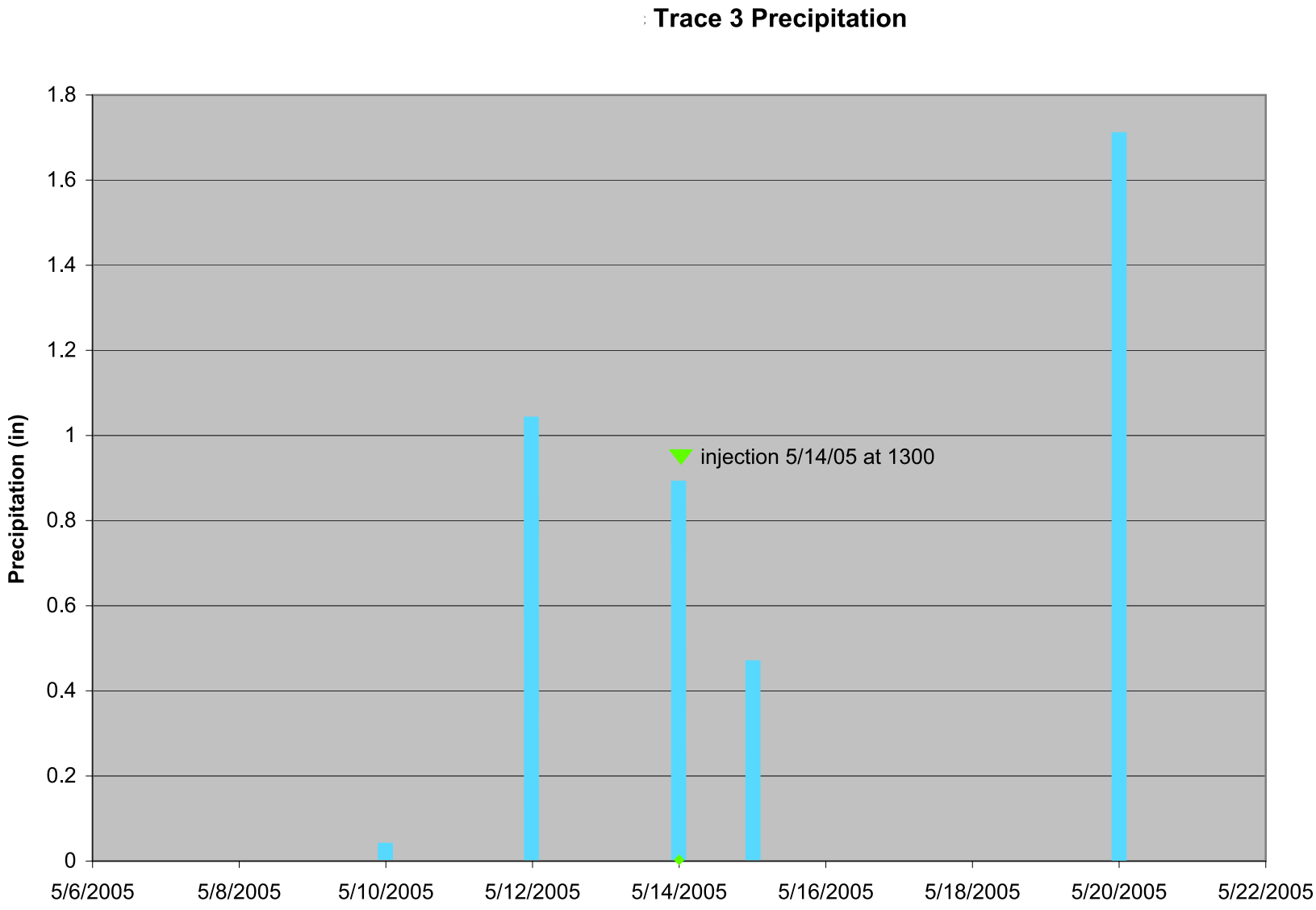

Trace Precipitation
Precipitation (in)
4
3.5
3
2.5
2
1.5
1
0.5
0
8/6/2005
8/11/2005
8/16/2005
8/21/2005
8/26/2005
8/31/2005
9/5/2005
9/10/2005
injection 8/18/05 at 1030

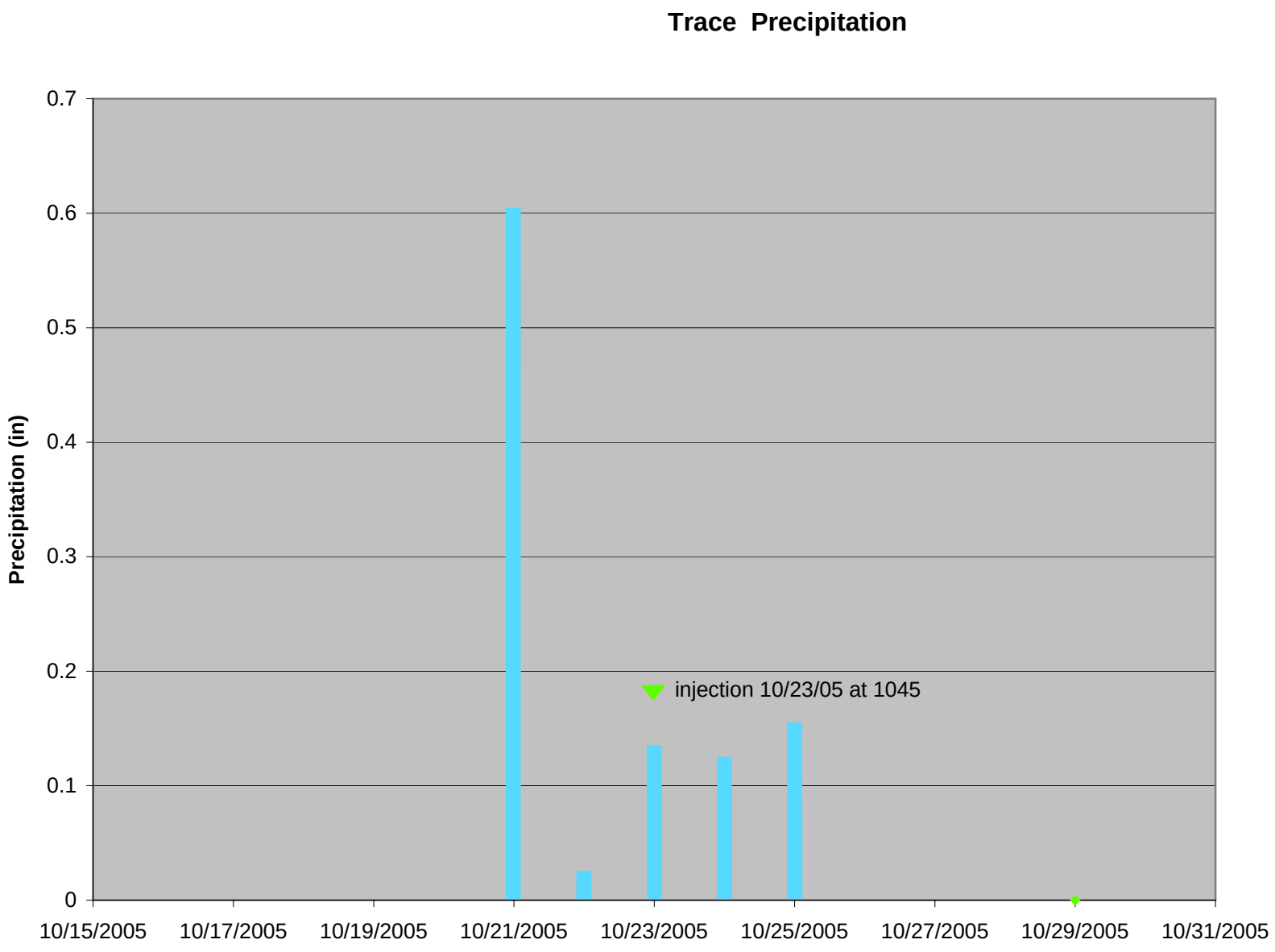

Trace Precipitation
Precipitation (in)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 5/12/05 at 1030
6/3/2005
6/5/2005
6/7/2005
6/9/2005
6/11/2005
6/13/2005
6/15/2005
6/17/2005
6/19/2005
6/21/2005


Trace 1 Precipitation
injection 5/12/05 at 1030
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
5/4/2005
5/6/2005
5/8/2005
5/10/2005
5/12/2005
5/14/2005
5/16/2005
5/18/2005
5/20/2005


Trace 1 Precipitation
injection 5/12/05 at 1030
Precipitation (in)
1.2
1
0.8
0.6
0.4
0.2
0
5/4/2005
5/6/2005
5/8/2005
5/10/2005
5/12/2005
5/14/2005
5/16/2005
5/18/2005
5/20/2005


Trace 2 Precipitation
Precipitation (in)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
7/13/2005
7/15/2005
7/17/2005
7/19/2005
7/21/2005
7/23/2005
7/25/2005
7/27/2005
7/29/2005
injection 7/21/05 at 0920


Trace 3 Precipitation
Precipitation (in)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
injection 5/14/05 at 1300
5/6/2005
5/8/2005
5/10/2005
5/12/2005
5/14/2005
5/16/2005
5/18/2005
5/20/2005
5/22/2005


Trace Precipitation
Precipitation (in)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
injection 10/23/05 at 1045
10/15/2005
10/17/2005
10/19/2005
10/21/2005
10/23/2005
10/25/2005
10/27/2005
10/29/2005
10/31/2005

Revised Karst Report Appendix J

Karst Features / FEIS Alternatives Mapping and Impact Table

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40003	Spring	0-1 gpm			X	X	X	X	X	X	X	X
40006	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
40007	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40008	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
40009	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
40010	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
40068	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40069	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X	X	X
40084	Sinkhole	Low			X	X	X	X	X	X	X	X
40085	Spring	0-1 gpm			X	X	X	X	X	X	X	X
40087	Sinkhole	Medium	X	X								
40092	Sinkhole	Low			X	X	X	X	X	X	X	X
40094	Sinkhole	High				X		X		X		X
40095	Sinkhole	Low	X	X								
40096	Sinkhole	High	X	X								
40097	Sinkhole	Medium			X	X	X	X	X	X	X	X
40098	Sinking Stream	High			X	X	X	X	X	X	X	X
40099	Sinkhole	Low			X	X	X	X	X	X	X	X
40100	Sinkhole	Low			X	X	X	X	X	X	X	X
40103	Sinkhole	High			X	X	X	X	X	X	X	X
40105	Sinkhole	Low				X				X		X
40106	Sinkhole	Medium			X	X	X	X	X	X	X	X
40107	Sinkhole	Medium				X	X	X		X		X
40109	Sinkhole	Medium			X	X	X	X	X	X	X	X
40110	Sinkhole	Low				X				X		X

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40111	Sinkhole	Medium			X	X	X	X	X	X	X	X
40113	Sinkhole	Low			X	X	X	X	X	X	X	X
40129	Sinkhole	Low				X				X		X
40130	Sinkhole	Medium			X	X			X	X	X	X
40131	Sinkhole	Medium			X	X			X	X	X	X
40132	Sinkhole	Medium			X	X			X	X	X	X
40140	Sinkhole	Low				X				X		X
40142	Sinkhole	Low	X	X								
40164	Spring	0-1 gpm				X		X		X		X
40168	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
40171	Sinkhole	High	X		X		X		X		X	X
40173	Swallet	High	X	X	X	X	X	X	X	X	X	X
40181	Swallet	Medium										X
40182	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40183	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40204	Swallet	High	X		X		X		X		X	X
40215	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40217	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40286	Sinkhole	Medium				X		X				X
40293	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
40372	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
40381	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
40410	Sinkhole	Medium			X	X	X	X			X	X
40411	Sinkhole	Medium	X	X					X	X		
40412	Sinkhole	Low	X	X					X	X		

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40414	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
40422	Sinkhole	Medium		X								
40423	Sinkhole	Low	X	X								
40428	Spring	2-10 gpm				X		X		X		X
40429	Spring	0-1 gpm				X		X		X		X
40430	Swallet	Medium			X	X	X	X	X	X	X	X
40432	Sinkhole	Low	X	X								
40433	Sinkhole	High	X	X								
40434	Sinkhole	Medium	X	X								
40435	Sinkhole	Medium	X	X								
40437	Sinkhole	High		X								
40448	Sinkhole	Low	X	X								
40500	Sinkhole	Medium		X								
40509	Spring	2-10 gpm			X	X	X	X			X	X
40514	Sinkhole	Low		X						X		
40515	Sinkhole	Low	X	X					X	X		
40530	Sinkhole	Low					X	X				
40532	Sinkhole	Medium			X	X			X	X	X	X
40533	Sinkhole	High			X	X			X	X	X	X
40535	Sinkhole	Low	X	X								
40536	Sinkhole	High	X	X								
40538	Sinkhole	Medium	X	X								
40539	Sinkhole	High	X	X								
40540	Sinkhole	Low		X								
40541	Sinkhole	Low	X	X								

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40544	Sinkhole	High		X								
40546	Sinkhole	Medium		X								
40547	Sinkhole	High	X	X								
40548	Sinkhole	High	X	X								
40549	Sinkhole	High		X								
40550	Sinkhole	High	X	X								
40551	Sinkhole	Low	X	X								
40552	Sinkhole	Medium	X	X								
40553	Sinkhole	Low	X	X								
40554	Sinkhole	Medium	X	X								
40555	Sinkhole	Low	X	X								
40556	Sinkhole	High	X	X								
40557	Sinkhole	High	X	X								
40558	Sinkhole	Low	X	X								
40620	Sinkhole	Low			X	X			X	X	X	X
40621	Sinkhole	Medium			X	X			X	X	X	X
40622	Sinkhole	Low	X	X	X	X			X	X	X	X
40623	Sinkhole	Low	X	X		X				X		X
40624	Sinkhole	Medium	X	X		X				X		X
40625	Sinkhole	Low	X	X								
40626	Sinkhole	Low	X	X								
40627	Sinkhole	Low	X	X								
40628	Sinkhole	Low	X	X								
40629	Sinkhole	Low	X	X								
40630	Sinkhole	Medium	X	X								

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
40631	Sinkhole	Low	X	X	X	X			X	X	X	X
40632	Sinkhole	Low			X	X			X	X	X	X
40633	Sinkhole	Low			X	X			X	X	X	X
40634	Sinkhole	Low	X	X	X	X			X	X	X	X
40635	Sinkhole	Medium			X	X			X	X	X	X
40640	Sinkhole	Low						X				
40641	Sinkhole	High					X	X				
40642	Sinkhole	High					X	X				
40643	Sinkhole	High					X	X				
40658	Sinkhole	Medium					X	X				
40659	Sinkhole	Medium					X	X				
40708	Sinkhole	Medium					X	X				
40709	Sinkhole	Medium					X	X				
40710	Sinkhole	High					X	X				
40711	Sinkhole	High					X	X				
40712	Sinkhole	Low					X	X				
40713	Sinkhole	Low						X				
40714	Sinkhole	Low					X	X				
40715	Sinkhole	Low					X	X				
40786	Sinkhole	High	X	X	X	X			X	X	X	X
40813	Spring	2-10 gpm	X	X								
40814	Spring	11-100 gpm	X	X								
40908	Spring	0-1 gpm			X	X			X	X	X	X
41020	Spring	2-10 gpm	X	X	X	X	X	X	X	X	X	X
41027	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
41037	Spring	0-1 gpm		X		X		X		X		
41038	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41065	Spring	2-10 gpm	X	X					X	X		
41066	Spring	2-10 gpm		X								
41073	Spring	0-1 gpm	X	X					X	X		
41099	Spring	2-10 gpm	X	X	X	X	X	X	X	X	X	X
41151	Spring	2-10 gpm					X	X				
41152	Spring	0-1 gpm						X				
41188	Spring	0-1 gpm		X		X		X		X		X
41196	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41200	Spring	2-10 gpm	X	X	X	X	X	X	X	X	X	X
41202	Spring	0-1 gpm		X		X		X		X		X
41215	Spring	2-10 gpm	X	X					X	X		
41216	Spring	2-10 gpm	X	X					X	X		
41222	Swallet	High	X	X	X	X	X	X	X	X	X	X
41238	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
41239	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41301	Sinkhole	Medium	X	X					X	X		
41424	Sinking Stream	High			X	X			X	X	X	X
41430	Sinkhole	Low	X	X			X	X				
41432	Sinking Stream	High	X	X	X	X	X	X	X	X	X	X
41437	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41445	Sinkhole Zone	Medium	X	X								
41455	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
41456	Swallet	High	X	X	X	X	X	X	X	X	X	X

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
41457	Spring	2-10 gpm	X	X	X	X	X	X	X	X	X	X
41458	Spring	2-10 gpm	X	X	X	X	X	X	X	X	X	X
41459	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
41460	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41461	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
41462	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X	X	X
41463	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
41464	Sinkhole Zone	Medium	X	X	X	X	X	X	X	X	X	X
41465	Sinkhole	Medium	X	X		X		X		X		X
41466	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
41483	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41512	Spring	0-1 gpm		X		X		X		X		
41520	Spring	2-10 gpm			X	X	X	X	X	X	X	X
41521	Spring	2-10 gpm	X	X								
41529	Spring	2-10 gpm	X	X								
41530	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41603	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
41604	Sinkhole	Low	X	X	X	X	X	X	X	X	X	X
41605	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41608	Sinkhole	Low				X		X		X		X
41614	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41700	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
41711	Sinkhole	Medium	X	X	X	X	X	X	X	X	X	X
41714	Sinkhole	High	X	X	X	X	X	X	X	X	X	X
41715	Sinkhole	High	X	X	X	X	X	X	X	X	X	X

Appendix J, Table 1: Karst Feature Impacts by Alternative

Feature Number	Feature Type	Infiltration/Discharge Rate	Alternative 1		Alternative 2 (Preferred)		Alternative 3		Alternative 4		Refined Preferred Alternative 2	
			Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria	Low-Cost Design Criteria	Initial Design Criteria
41744	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41756	Spring	0-1 gpm		X		X		X		X		X
41757	Spring	0-1 gpm		X		X		X		X		X
41758	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41759	Spring	0-1 gpm	X	X	X	X	X	X	X	X	X	X
41760	Spring	0-1 gpm		X		X		X		X		X
41761	Cave	0-100 feet	X	X	X	X	X	X	X	X	X	X
Total Features Impact			108	122	88	107	88	103	94	113	88	108

Karst Features/FEIS Alternatives Mapping have been removed for confidentiality reasons related to caves.

Revised Karst Report Appendix N:

Pollutant Loading Estimate Tables and FHWA Methodology

Exhibit #1: 1 Year - 1 Hour Rain Event using Initial Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Highway)															
ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.06	0	81	81	0.004	0.015	0.011	-10.854	1.565	-6.354	0.801	-0.337	7.704	0.202	-0.071	13.546	-0.475	0.010	-0.009	0.015
40094	sinkhole		0.01	0	13	13	-0.024	0.010	-0.008	-32.705	-2.532	-28.205	0.590	-4.980	1.763	0.077	-0.217	4.328	-1.431	0.008	-0.025	0.015
40105	sinkhole		0.11	0	149	149	0.032	0.020	0.029	10.767	5.619	15.267	1.011	4.258	13.582	0.326	0.075	22.667	0.471	0.013	0.006	0.014
40107	sinkhole		0.15	0	203	203	0.054	0.024	0.043	28.064	8.862	32.564	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
40110	sinkhole		0.17	0	230	230	0.065	0.026	0.051	36.910	10.521	41.410	1.264	9.813	20.690	0.476	0.250	33.696	1.615	0.016	0.025	0.014
40129	sinkhole		0.10	0	133	133	0.026	0.019	0.025	5.788	4.685	10.288	0.963	3.200	12.229	0.298	0.041	20.567	0.253	0.012	0.003	0.014
40140	sinkhole		0.05	0	74	74	0.001	0.014	0.009	-13.049	1.153	-8.549	0.780	-0.803	7.107	0.190	-0.085	12.620	-0.571	0.010	-0.011	0.015
40164	spring		0.28	0	374	374	0.124	0.036	0.089	82.773	19.120	87.273	1.708	19.559	33.159	0.738	0.558	53.045	3.621	0.022	0.058	0.013
40204	swallet		0.04	0	54	54	-0.007	0.013	0.003	-19.503	-0.057	-15.003	0.718	-2.174	5.353	0.153	-0.129	9.897	-0.853	0.009	-0.016	0.015
40217	sinkhole		0.12	0	164	164	0.038	0.021	0.033	15.616	6.528	20.116	1.058	5.288	14.901	0.354	0.107	24.713	0.683	0.014	0.010	0.014
40286	sinkhole		0.01	0	15	15	-0.023	0.010	-0.007	-31.886	-2.379	-27.386	0.598	-4.806	1.986	0.082	-0.212	4.673	-1.395	0.008	-0.024	0.015
40414	sinkhole		0.08	0	102	102	0.013	0.016	0.016	-4.040	2.842	0.460	0.867	1.111	9.557	0.241	-0.025	16.421	-0.177	0.011	-0.004	0.014
40429	spring		0.28	0	374	374	0.124	0.036	0.089	82.773	19.120	87.273	1.708	19.559	33.159	0.738	0.558	53.045	3.621	0.022	0.058	0.013
40509	spring		0.16	0	210	210	0.057	0.024	0.045	30.358	9.292	34.858	1.201	8.421	18.908	0.438	0.206	30.932	1.328	0.015	0.020	0.014
40532	sinkhole		0.31	0	420	420	0.143	0.040	0.101	97.515	21.884	102.015	1.851	22.692	37.167	0.822	0.657	59.264	4.266	0.024	0.069	0.013
40623	sinkhole		0.10	0	138	138	0.028	0.019	0.026	7.426	4.992	11.926	0.978	3.548	12.674	0.307	0.052	21.258	0.325	0.013	0.004	0.014
40624	sinkhole		0.08	0	102	102	0.013	0.016	0.016	-4.040	2.842	0.460	0.867	1.111	9.557	0.241	-0.025	16.421	-0.177	0.011	-0.004	0.014
41027	sinkhole		0.15	0	203	203	0.054	0.024	0.043	28.064	8.862	32.564	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
41188	spring		0.02	0	20	20	-0.021	0.010	-0.006	-30.248	-2.072	-25.748	0.613	-4.458	2.431	0.091	-0.201	5.364	-1.323	0.008	-0.023	0.015
41202	spring		0.30	0	407	407	0.138	0.039	0.098	93.420	21.116	97.920	1.812	21.822	36.054	0.799	0.630	57.537	4.087	0.023	0.066	0.013
41437	sinkhole		0.24	0	328	328	0.105	0.033	0.076	68.031	16.356	72.531	1.566	16.427	29.151	0.654	0.459	46.826	2.976	0.020	0.047	0.013
41465	sinkhole		0.29	0	389	389	0.130	0.038	0.093	87.687	20.041	92.187	1.756	20.604	34.495	0.766	0.591	55.118	3.836	0.023	0.061	0.013
41608	sinkhole		0.01	0	10	10	-0.025	0.010	-0.008	-33.524	-2.686	-29.024	0.582	-5.154	1.541	0.073	-0.223	3.982	-1.467	0.007	-0.026	0.015
41756	spring		0.15	0	203	203	0.054	0.024	0.043	28.064	8.862	32.564	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
41757	spring		0.11	0	149	149	0.032	0.020	0.029	10.767	5.619	15.267	1.011	4.258	13.582	0.326	0.075	22.667	0.471	0.013	0.006	0.014
41758	spring		0.09	0	122	122	0.021	0.018	0.021	2.119	3.997	6.619	0.927	2.420	11.231	0.277	0.016	19.019	0.093	0.012	0.000	0.014
41760	spring	[illegible]	0.17	0	230	230	0.065	0.026	0.050	36.713	10.484	41.213	1.262	9.772	20.636	0.474	0.249	33.613	1.606	0.016	0.025	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	1.21	in	Volume of rainfall for 1 year-1 hour (NOAA)
Rain Duration =	1	hr	Duration of rainfall for 1 year-1 hour (NOAA)
r =	1.210	in/hr	Run off rate

Exhibit #1: 1 Year - 1 Hour Rain Event using Initial Criteria

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Average Concentration															
ID	**Type**	**Approx. Station**	**Run-Off Area inside R/W**	**Run-off Volume inside R/W**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(feet)	**(acres)**	**(cf)**			**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
40010	sinkhole		3.27	14,363			0.005	0.017	0.012	-12.118	1.747	-7.094	0.895	-0.376	8.601	0.226	-0.079	15.124	-0.530	0.011	-0.010	0.016
40094	sinkhole		0.62	2,710			-0.141	0.058	-0.045	-193.495	-14.981	-166.871	3.489	-29.462	10.432	0.458	-1.287	25.603	-8.465	0.044	-0.148	0.088
40105	sinkhole		5.33	23,411			0.022	0.014	0.020	7.375	3.849	10.458	0.692	2.917	9.303	0.223	0.051	15.526	0.323	0.009	0.004	0.010
40107	sinkhole		10.00	43,923			0.020	0.009	0.016	10.246	3.235	11.889	0.430	2.896	6.676	0.155	0.070	10.940	0.448	0.006	0.007	0.005
40110	sinkhole		8.49	37,292			0.028	0.011	0.022	15.871	4.524	17.807	0.544	4.220	8.897	0.204	0.108	14.490	0.694	0.007	0.011	0.006
40129	sinkhole		5.36	23,521			0.017	0.013	0.017	3.946	3.194	7.014	0.656	2.182	8.337	0.203	0.028	14.022	0.173	0.008	0.002	0.010
40140	sinkhole		2.85	12,525			0.002	0.018	0.011	-16.707	1.477	-10.946	0.999	-1.028	9.100	0.243	-0.109	16.158	-0.731	0.013	-0.014	0.019
40164	spring		14.86	65,255			0.031	0.009	0.022	20.341	4.699	21.446	0.420	4.806	8.148	0.181	0.137	13.035	0.890	0.005	0.014	0.003
40204	swallet		1.94	8,521			-0.013	0.024	0.006	-36.702	-0.107	-28.234	1.350	-4.092	10.073	0.288	-0.242	18.626	-1.606	0.017	-0.029	0.028
40217	sinkhole		6.60	28,981			0.021	0.012	0.018	8.641	3.612	11.131	0.585	2.926	8.245	0.196	0.059	13.674	0.378	0.007	0.005	0.008
40286	sinkhole		1.20	5,278			-0.069	0.030	-0.021	-96.886	-7.227	-83.212	1.816	-14.602	6.034	0.249	-0.644	14.199	-4.239	0.023	-0.074	0.045
40414	sinkhole		5.02	22,068			0.009	0.012	0.012	-2.936	2.065	0.334	0.630	0.808	6.944	0.175	-0.018	11.932	-0.128	0.008	-0.003	0.010
40429	spring		14.86	65,255			0.031	0.009	0.022	20.341	4.699	21.446	0.420	4.806	8.148	0.181	0.137	13.035	0.890	0.005	0.014	0.003
40509	spring		11.86	52,074			0.018	0.007	0.014	9.348	2.861	10.734	0.370	2.593	5.823	0.135	0.064	9.525	0.409	0.005	0.006	0.004
40532	sinkhole		15.98	70,204			0.033	0.009	0.023	22.274	4.999	23.302	0.423	5.183	8.490	0.188	0.150	13.537	0.974	0.005	0.016	0.003
40623	sinkhole		6.24	27,427			0.016	0.011	0.015	4.342	2.919	6.973	0.572	2.074	7.410	0.179	0.030	12.429	0.190	0.007	0.002	0.008
40624	sinkhole		4.49	19,715			0.011	0.013	0.013	-3.286	2.312	0.374	0.705	0.904	7.773	0.196	-0.020	13.356	-0.144	0.009	-0.004	0.012
41027	sinkhole		8.18	35,929			0.024	0.011	0.019	12.526	3.955	14.534	0.526	3.541	8.161	0.190	0.085	13.374	0.548	0.007	0.008	0.006
41188	spring		1.59	6,993			-0.047	0.024	-0.013	-69.362	-4.750	-59.043	1.407	-10.222	5.575	0.210	-0.461	12.301	-3.035	0.018	-0.053	0.034
41202	spring		23.56	103,491			0.021	0.006	0.015	14.475	3.272	15.173	0.281	3.381	5.586	0.124	0.098	8.915	0.633	0.004	0.010	0.002
41437	sinkhole		20.28	89,060			0.019	0.006	0.014	12.249	2.945	13.060	0.282	2.958	5.249	0.118	0.083	8.431	0.536	0.004	0.009	0.002
41465	sinkhole		29.78	130,810			0.016	0.005	0.011	10.749	2.457	11.301	0.215	2.526	4.229	0.094	0.072	6.757	0.470	0.003	0.008	0.002
41608	sinkhole		0.51	2,232			-0.178	0.069	-0.059	-240.825	-19.294	-208.499	4.179	-37.024	11.068	0.523	-1.602	28.606	-10.536	0.053	-0.184	0.107
41756	spring		8.18	35,929			0.024	0.011	0.019	12.526	3.955	14.534	0.526	3.541	8.161	0.190	0.085	13.374	0.548	0.007	0.008	0.006
41757	spring		6.00	26,354			0.019	0.012	0.017	6.552	3.419	9.290	0.615	2.591	8.265	0.198	0.045	13.793	0.287	0.008	0.004	0.009
41758	spring		4.91	21,566			0.016	0.013	0.016	1.575	2.972	4.921	0.689	1.800	8.351	0.206	0.012	14.142	0.069	0.009	0.000	0.011
41760	spring		9.27	40,717			0.026	0.010	0.020	14.459	4.129	16.231	0.497	3.848	8.127	0.187	0.098	13.238	0.633	0.006	0.010	0.005
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #1: 1 Year - 1 Hour Rain Event using Initial Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	Type	Karst Drainage Basin	Run-Off Volume in Basin	Run-Off Volume in Basin			Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(acres)	(cf)	(Liters)			(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole	0.02	26	746			0.000	0.000	0.000	0.359						0.003			0.004	0.000	0.000	0.000
40094	sinkhole	4.29	5,653	160,069			0.026	0.007	0.037	76.929						0.653			0.963	0.001	0.003	0.000
40105	sinkhole	0.02	26	746			0.000	0.000	0.000	0.359						0.003			0.004	0.000	0.000	0.000
40107	sinkhole	0.06	79	2,239			0.000	0.000	0.001	1.076						0.009			0.013	0.000	0.000	0.000
40110	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
40129	sinkhole	0.06	79	2,239			0.000	0.000	0.001	1.076						0.009			0.013	0.000	0.000	0.000
40140	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
40164	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40204	swallet	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40217	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
40286	sinkhole	0.2	264	7,462			0.001	0.000	0.002	3.586						0.030			0.045	0.000	0.000	0.000
40414	sinkhole	4.01	5,284	149,621			0.024	0.006	0.034	71.908						0.610			0.901	0.001	0.003	0.000
40429	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40509	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40532	sinkhole	0.18	237	6,716			0.001	0.000	0.002	3.228						0.027			0.040	0.000	0.000	0.000
40623	sinkhole	0.02	26	746			0.000	0.000	0.000	0.359						0.003			0.004	0.000	0.000	0.000
40624	sinkhole	0.22	290	8,209			0.001	0.000	0.002	3.945						0.033			0.049	0.000	0.000	0.000
41027	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
41188	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41202	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41437	sinkhole	3.53	4,651	131,711			0.021	0.006	0.030	63.301						0.537			0.793	0.000	0.002	0.000
41465	sinkhole	0.12	158	4,477			0.001	0.000	0.001	2.152						0.018			0.027	0.000	0.000	0.000
41608	sinkhole	0.22	290	8,209			0.001	0.000	0.002	3.945						0.033			0.049	0.000	0.000	0.000
41756	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41757	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41758	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41760	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000

INPUTS

C =	0.3		Runoff coefficient
R =	0.363	in	Total runoff

Mean Runoff Concentrations for Urban Open Land Use

218	mg/L	TSS
1.85	mg/L	TN
2.73	mg/L	Fe
0.00158	mg/L	Cd
0.00851	mg/L	Cr
0.0197	mg/L	Copper
0.0728	mg/L	Lead
0.0005	mg/L	Hg
0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #2: 2 Year - 24 Hour Rain Event using Initial Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Highway)															
ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.06	0	81	64	-0.003	0.014	0.006	-16.198	0.563	-11.698	0.750	-1.472	6.251	0.172	-0.107	11.291	-0.709	0.010	-0.013	0.015
40094	sinkhole		0.01	0	13	10	-0.025	0.010	-0.008	-33.548	-2.690	-29.048	0.581	-5.159	1.534	0.073	-0.223	3.972	-1.468	0.007	-0.026	0.015
40105	sinkhole		0.11	0	149	118	0.019	0.018	0.021	0.970	3.782	5.470	0.916	2.176	10.919	0.270	0.009	18.534	0.042	0.012	-0.001	0.014
40107	sinkhole		0.15	0	203	161	0.037	0.021	0.032	14.704	6.357	19.204	1.049	5.095	14.653	0.349	0.101	24.328	0.643	0.013	0.009	0.014
40110	sinkhole		0.17	0	230	183	0.046	0.022	0.038	21.727	7.674	26.227	1.117	6.587	16.562	0.389	0.148	27.291	0.951	0.014	0.014	0.014
40129	sinkhole		0.10	0	133	106	0.014	0.017	0.017	-2.984	3.040	1.516	0.878	1.336	9.844	0.247	-0.018	16.866	-0.131	0.011	-0.004	0.014
40140	sinkhole		0.05	0	74	59	-0.005	0.013	0.005	-17.941	0.236	-13.441	0.733	-1.843	5.777	0.162	-0.118	10.556	-0.785	0.009	-0.014	0.015
40164	spring		0.28	0	374	297	0.093	0.031	0.068	58.144	14.502	62.644	1.470	14.326	26.463	0.597	0.393	42.655	2.544	0.019	0.040	0.013
40204	swallet		0.04	0	54	43	-0.011	0.012	0.000	-23.066	-0.725	-18.566	0.683	-2.931	4.384	0.133	-0.153	8.394	-1.009	0.009	-0.018	0.015
40217	sinkhole		0.12	0	164	130	0.024	0.018	0.024	4.819	4.504	9.319	0.953	2.994	11.965	0.292	0.035	20.158	0.211	0.012	0.002	0.014
40286	sinkhole		0.01	0	15	12	-0.024	0.010	-0.008	-32.898	-2.568	-28.398	0.588	-5.021	1.711	0.076	-0.219	4.246	-1.439	0.007	-0.025	0.015
40414	sinkhole		0.08	0	102	81	0.004	0.015	0.011	-10.788	1.577	-6.288	0.802	-0.322	7.722	0.203	-0.070	13.574	-0.472	0.010	-0.009	0.015
40429	spring		0.28	0	374	297	0.093	0.031	0.068	58.144	14.502	62.644	1.470	14.326	26.463	0.597	0.393	42.655	2.544	0.019	0.040	0.013
40509	spring		0.16	0	210	167	0.039	0.021	0.033	16.525	6.698	21.025	1.067	5.482	15.148	0.359	0.113	25.096	0.723	0.014	0.010	0.014
40532	sinkhole		0.31	0	420	333	0.108	0.033	0.078	69.850	16.697	74.350	1.583	16.813	29.645	0.664	0.472	47.593	3.056	0.020	0.049	0.013
40623	sinkhole		0.10	0	138	110	0.016	0.017	0.018	-1.684	3.284	2.816	0.890	1.612	10.197	0.255	-0.009	17.415	-0.074	0.011	-0.003	0.014
40624	sinkhole		0.08	0	102	81	0.004	0.015	0.011	-10.788	1.577	-6.288	0.802	-0.322	7.722	0.203	-0.070	13.574	-0.472	0.010	-0.009	0.015
41027	sinkhole		0.15	0	203	161	0.037	0.021	0.032	14.704	6.357	19.204	1.049	5.095	14.653	0.349	0.101	24.328	0.643	0.013	0.009	0.014
41188	spring		0.02	0	20	16	-0.022	0.010	-0.007	-31.598	-2.325	-27.098	0.600	-4.744	2.064	0.084	-0.210	4.795	-1.382	0.008	-0.024	0.015
41202	spring		0.30	0	407	323	0.103	0.033	0.075	66.598	16.087	71.098	1.552	16.122	28.761	0.645	0.450	46.221	2.914	0.020	0.046	0.013
41437	sinkhole		0.24	0	328	260	0.078	0.028	0.058	46.439	12.307	50.939	1.356	11.838	23.281	0.530	0.314	37.716	2.032	0.017	0.032	0.013
41465	sinkhole		0.29	0	389	309	0.098	0.032	0.071	62.046	15.234	66.546	1.508	15.155	27.524	0.619	0.419	44.301	2.715	0.019	0.043	0.013
41608	sinkhole		0.01	0	10	8	-0.026	0.009	-0.009	-34.199	-2.812	-29.699	0.575	-5.297	1.357	0.069	-0.228	3.697	-1.496	0.007	-0.026	0.015
41756	spring		0.15	0	203	161	0.037	0.021	0.032	14.704	6.357	19.204	1.049	5.095	14.653	0.349	0.101	24.328	0.643	0.013	0.009	0.014
41757	spring		0.11	0	149	118	0.019	0.018	0.021	0.970	3.782	5.470	0.916	2.176	10.919	0.270	0.009	18.534	0.042	0.012	-0.001	0.014
41758	spring		0.09	0	122	97	0.011	0.016	0.015	-5.898	2.494	-1.398	0.849	0.717	9.052	0.231	-0.037	15.637	-0.258	0.011	-0.006	0.014
41760	spring	[illegible]	0.17	0	230	182	0.046	0.022	0.038	21.571	7.645	26.071	1.115	6.554	16.520	0.388	0.147	27.225	0.944	0.014	0.014	0.014

			INPUTS
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	3.16	in	Volume of rainfall for 2 year-24 hour (NOAA)
Rain Duration =	24	hr	Duration of rainfall for 2 year-24 hour (NOAA)
r =	0.132	in/hr	Run off rate

Exhibit #2: 2 Year - 24 Hour Rain Event using Initial Criteria

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Average Concentration															
ID	**Type**	**Approx. Station**	**Run-Off Area inside R/W**	**Run-off Volume inside R/W**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(feet)	**(acres)**	**(cf)**			**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
40010	sinkhole		3.27	37,510			-0.001	0.006	0.003	-6.925	0.241	-5.001	0.320	-0.629	2.672	0.073	-0.046	4.827	-0.303	0.004	-0.006	0.006
40094	sinkhole		0.62	7,078			-0.056	0.022	-0.019	-76.002	-6.095	-65.808	1.317	-11.688	3.475	0.164	-0.506	8.998	-3.325	0.017	-0.058	0.034
40105	sinkhole		5.33	61,139			0.005	0.005	0.005	0.254	0.992	1.435	0.240	0.571	2.864	0.071	0.002	4.861	0.011	0.003	0.000	0.004
40107	sinkhole		10.00	114,708			0.005	0.003	0.004	2.056	0.889	2.685	0.147	0.712	2.048	0.049	0.014	3.401	0.090	0.002	0.001	0.002
40110	sinkhole		8.49	97,390			0.008	0.004	0.006	3.578	1.264	4.318	0.184	1.085	2.727	0.064	0.024	4.494	0.157	0.002	0.002	0.002
40129	sinkhole		5.36	61,426			0.004	0.004	0.004	-0.779	0.794	0.396	0.229	0.349	2.570	0.065	-0.005	4.403	-0.034	0.003	-0.001	0.004
40140	sinkhole		2.85	32,709			-0.002	0.006	0.002	-8.796	0.116	-6.590	0.359	-0.903	2.832	0.079	-0.058	5.175	-0.385	0.005	-0.007	0.007
40164	spring		14.86	170,419			0.009	0.003	0.006	5.471	1.365	5.895	0.138	1.348	2.490	0.056	0.037	4.014	0.239	0.002	0.004	0.001
40204	swallet		1.94	22,253			-0.008	0.009	0.000	-16.621	-0.522	-13.378	0.492	-2.112	3.159	0.096	-0.110	6.049	-0.727	0.006	-0.013	0.011
40217	sinkhole		6.60	75,685			0.005	0.004	0.005	1.021	0.954	1.975	0.202	0.634	2.535	0.062	0.007	4.271	0.045	0.003	0.000	0.003
40286	sinkhole		1.20	13,783			-0.028	0.011	-0.009	-38.276	-2.988	-33.041	0.684	-5.842	1.990	0.089	-0.255	4.940	-1.675	0.009	-0.029	0.017
40414	sinkhole		5.02	57,632			0.001	0.004	0.003	-3.002	0.439	-1.750	0.223	-0.090	2.149	0.056	-0.020	3.777	-0.131	0.003	-0.003	0.004
40429	spring		14.86	170,419			0.009	0.003	0.006	5.471	1.365	5.895	0.138	1.348	2.490	0.056	0.037	4.014	0.239	0.002	0.004	0.001
40509	spring		11.86	135,994			0.005	0.002	0.004	1.949	0.790	2.479	0.126	0.646	1.786	0.042	0.013	2.959	0.085	0.002	0.001	0.002
40532	sinkhole		15.98	183,343			0.009	0.003	0.007	6.109	1.460	6.503	0.138	1.471	2.593	0.058	0.041	4.163	0.267	0.002	0.004	0.001
40623	sinkhole		6.24	71,628			0.004	0.004	0.004	-0.377	0.735	0.631	0.199	0.361	2.283	0.057	-0.002	3.899	-0.016	0.003	-0.001	0.003
40624	sinkhole		4.49	51,488			0.001	0.005	0.003	-3.360	0.491	-1.958	0.250	-0.100	2.405	0.063	-0.022	4.228	-0.147	0.003	-0.003	0.005
41027	sinkhole		8.18	93,831			0.006	0.004	0.005	2.513	1.086	3.282	0.179	0.871	2.504	0.060	0.017	4.158	0.110	0.002	0.002	0.002
41188	spring		1.59	18,263			-0.020	0.009	-0.006	-27.745	-2.041	-23.793	0.527	-4.166	1.813	0.074	-0.184	4.210	-1.214	0.007	-0.021	0.013
41202	spring		23.56	270,274			0.006	0.002	0.004	3.951	0.954	4.218	0.092	0.957	1.706	0.038	0.027	2.742	0.173	0.001	0.003	0.001
41437	sinkhole		20.28	232,585			0.005	0.002	0.004	3.202	0.849	3.512	0.094	0.816	1.605	0.037	0.022	2.600	0.140	0.001	0.002	0.001
41465	sinkhole		29.78	341,620			0.005	0.001	0.003	2.912	0.715	3.124	0.071	0.711	1.292	0.029	0.020	2.079	0.127	0.001	0.002	0.001
41608	sinkhole		0.51	5,830			-0.071	0.026	-0.024	-94.071	-7.736	-81.693	1.582	-14.571	3.733	0.189	-0.626	10.170	-4.116	0.020	-0.072	0.041
41756	spring		8.18	93,831			0.006	0.004	0.005	2.513	1.086	3.282	0.179	0.871	2.504	0.060	0.017	4.158	0.110	0.002	0.002	0.002
41757	spring		6.00	68,825			0.005	0.004	0.005	0.226	0.881	1.274	0.213	0.507	2.544	0.063	0.002	4.318	0.010	0.003	0.000	0.003
41758	spring		4.91	56,322			0.003	0.005	0.004	-1.679	0.710	-0.398	0.242	0.204	2.577	0.066	-0.011	4.452	-0.073	0.003	-0.002	0.004
41760	spring		9.27	106,334			0.007	0.003	0.006	3.253	1.153	3.932	0.168	0.988	2.491	0.058	0.022	4.106	0.142	0.002	0.002	0.002
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #2: 2 Year - 24 Hour Rain Event using Initial Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	**Type**	**Karst Drainage Basin**	**Run-Off Volume in Basin**	**Run-Off Volume in Basin**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(acres)	**(cf)**	**(Liters)**			**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**
40010	sinkhole	0.02	69	1,949			0.000	0.000	0.000	0.937						0.008			0.012	0.000	0.000	0.000
40094	sinkhole	4.29	14,763	418,031			0.067	0.018	0.096	200.907						1.705			2.516	0.001	0.008	0.000
40105	sinkhole	0.02	69	1,949			0.000	0.000	0.000	0.937						0.008			0.012	0.000	0.000	0.000
40107	sinkhole	0.06	206	5,847			0.001	0.000	0.001	2.810						0.024			0.035	0.000	0.000	0.000
40110	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
40129	sinkhole	0.06	206	5,847			0.001	0.000	0.001	2.810						0.024			0.035	0.000	0.000	0.000
40140	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
40164	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40204	swallet	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40217	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
40286	sinkhole	0.2	688	19,489			0.003	0.001	0.004	9.366						0.079			0.117	0.000	0.000	0.000
40414	sinkhole	4.01	13,799	390,746			0.063	0.017	0.089	187.794						1.594			2.352	0.001	0.007	0.000
40429	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40509	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40532	sinkhole	0.18	619	17,540			0.003	0.001	0.004	8.430						0.072			0.106	0.000	0.000	0.000
40623	sinkhole	0.02	69	1,949			0.000	0.000	0.000	0.937						0.008			0.012	0.000	0.000	0.000
40624	sinkhole	0.22	757	21,437			0.003	0.001	0.005	10.303						0.087			0.129	0.000	0.000	0.000
41027	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
41188	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41202	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41437	sinkhole	3.53	12,148	343,974			0.055	0.015	0.079	165.315						1.403			2.070	0.001	0.006	0.000
41465	sinkhole	0.12	413	11,693			0.002	0.001	0.003	5.620						0.048			0.070	0.000	0.000	0.000
41608	sinkhole	0.22	757	21,437			0.003	0.001	0.005	10.303						0.087			0.129	0.000	0.000	0.000
41756	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41757	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41758	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41760	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000

INPUTS

C =	0.3		Runoff coefficient
R =	0.948	in	Total runoff

Mean Runoff Concentrations for Urban Open Land Use

218	mg/L	TSS
1.85	mg/L	TN
2.73	mg/L	Fe
0.00158	mg/L	Cd
0.00851	mg/L	Cr
0.0197	mg/L	Copper
0.0728	mg/L	Lead
0.0005	mg/L	Hg
0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #3: 5 Year - 24 Hour Rain Event using Initial Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Highway)															
ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole	[illegible]	0.06	0	81	70	0.000	0.014	0.008	-14.509	0.880	-10.009	0.766	-1.113	6.710	0.181	-0.095	12.004	-0.635	0.010	-0.012	0.015
40094	sinkhole	[illegible]	0.01	0	13	11	-0.024	0.010	-0.008	-33.282	-2.640	-28.782	0.584	-5.102	1.607	0.074	-0.221	4.084	-1.456	0.007	-0.025	0.015
40105	sinkhole	[illegible]	0.11	0	149	128	0.023	0.018	0.023	4.067	4.363	8.567	0.946	2.834	11.761	0.288	0.030	19.841	0.178	0.012	0.001	0.014
40107	sinkhole	[illegible]	0.15	0	203	174	0.042	0.022	0.035	18.928	7.149	23.428	1.090	5.992	15.801	0.373	0.129	26.110	0.828	0.014	0.012	0.014
40110	sinkhole	[illegible]	0.17	0	230	198	0.052	0.023	0.042	26.527	8.574	31.027	1.163	7.607	17.867	0.416	0.180	29.316	1.161	0.015	0.018	0.014
40129	sinkhole	[illegible]	0.10	0	133	114	0.018	0.017	0.020	-0.211	3.560	4.289	0.904	1.925	10.598	0.263	0.001	18.036	-0.009	0.012	-0.002	0.014
40140	sinkhole	[illegible]	0.05	0	74	64	-0.003	0.013	0.006	-16.395	0.526	-11.895	0.748	-1.514	6.198	0.171	-0.108	11.209	-0.717	0.010	-0.013	0.015
40164	spring	[illegible]	0.28	0	374	321	0.103	0.033	0.075	65.931	15.962	70.431	1.545	15.980	28.580	0.641	0.445	45.939	2.884	0.020	0.046	0.013
40204	swallet	[illegible]	0.04	0	54	46	-0.010	0.012	0.001	-21.939	-0.514	-17.439	0.694	-2.692	4.690	0.139	-0.145	8.869	-0.960	0.009	-0.017	0.015
40217	sinkhole	[illegible]	0.12	0	164	141	0.029	0.019	0.027	8.233	5.144	12.733	0.986	3.719	12.893	0.312	0.058	21.598	0.360	0.013	0.004	0.014
40286	sinkhole	[illegible]	0.01	0	15	13	-0.024	0.010	-0.007	-32.578	-2.508	-28.078	0.591	-4.953	1.798	0.078	-0.217	4.381	-1.425	0.008	-0.025	0.015
40414	sinkhole	[illegible]	0.08	0	102	88	0.007	0.015	0.012	-8.655	1.977	-4.155	0.823	0.131	8.302	0.215	-0.056	14.474	-0.379	0.011	-0.008	0.014
40429	spring	[illegible]	0.28	0	374	321	0.103	0.033	0.075	65.931	15.962	70.431	1.545	15.980	28.580	0.641	0.445	45.939	2.884	0.020	0.046	0.013
40509	spring	[illegible]	0.16	0	210	180	0.045	0.022	0.037	20.898	7.518	25.398	1.109	6.411	16.337	0.384	0.143	26.941	0.914	0.014	0.013	0.014
40532	sinkhole	[illegible]	0.31	0	420	361	0.119	0.035	0.085	78.596	18.337	83.096	1.668	18.672	32.023	0.714	0.530	51.283	3.439	0.021	0.055	0.013
40623	sinkhole	[illegible]	0.10	0	138	119	0.020	0.018	0.021	1.196	3.824	5.696	0.918	2.224	10.980	0.271	0.010	18.630	0.052	0.012	-0.001	0.014
40624	sinkhole	[illegible]	0.08	0	102	88	0.007	0.015	0.012	-8.655	1.977	-4.155	0.823	0.131	8.302	0.215	-0.056	14.474	-0.379	0.011	-0.008	0.014
41027	sinkhole	[illegible]	0.15	0	203	174	0.042	0.022	0.035	18.928	7.149	23.428	1.090	5.992	15.801	0.373	0.129	26.110	0.828	0.014	0.012	0.014
41188	spring	[illegible]	0.02	0	20	18	-0.022	0.010	-0.006	-31.171	-2.245	-26.671	0.605	-4.654	2.180	0.086	-0.207	4.975	-1.364	0.008	-0.024	0.015
41202	spring	[illegible]	0.30	0	407	350	0.114	0.035	0.082	75.078	17.677	79.578	1.634	17.924	31.067	0.694	0.507	49.798	3.285	0.021	0.052	0.013
41437	sinkhole	[illegible]	0.24	0	328	281	0.086	0.030	0.064	53.265	13.587	57.765	1.423	13.289	25.136	0.569	0.360	40.596	2.330	0.018	0.037	0.013
41465	sinkhole	[illegible]	0.29	0	389	334	0.108	0.034	0.078	70.152	16.754	74.652	1.586	16.877	29.728	0.666	0.474	47.721	3.069	0.020	0.049	0.013
41608	sinkhole	[illegible]	0.01	0	10	9	-0.025	0.009	-0.009	-33.985	-2.772	-29.485	0.577	-5.252	1.415	0.070	-0.226	3.787	-1.487	0.007	-0.026	0.015
41756	spring	[illegible]	0.15	0	203	174	0.042	0.022	0.035	18.928	7.149	23.428	1.090	5.992	15.801	0.373	0.129	26.110	0.828	0.014	0.012	0.014
41757	spring	[illegible]	0.11	0	149	128	0.023	0.018	0.023	4.067	4.363	8.567	0.946	2.834	11.761	0.288	0.030	19.841	0.178	0.012	0.001	0.014
41758	spring	[illegible]	0.09	0	122	104	0.014	0.017	0.017	-3.363	2.969	1.137	0.874	1.255	9.741	0.245	-0.020	16.706	-0.147	0.011	-0.004	0.014
41760	spring	[illegible]	0.17	0	230	197	0.052	0.023	0.042	26.358	8.542	30.858	1.162	7.571	17.821	0.415	0.179	29.245	1.153	0.015	0.017	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	3.92	in	Volume of rainfall for 2 year-24 hour (NOAA)
Rain Duration =	24	hr	Duration of rainfall for 2 year-24 hour (NOAA)
r =	0.163	in/hr	Run off rate

Exhibit #3: 5 Year - 24 Hour Rain Event using Initial Criteria

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

			Run-Off Area	Run-off Volume			*Average Concentration*															
ID	**Type**	**Approx. Station**	**inside R/W**	**inside R/W**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(feet)	**(acres)**	**(cf)**			**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
40010	sinkhole	[illegible]	3.27	46,531			0.000	0.005	0.003	-5.000	0.303	-3.449	0.264	-0.384	2.313	0.063	-0.033	4.137	-0.219	0.003	-0.004	0.005
40094	sinkhole		0.62	8,781			-0.045	0.018	-0.015	-60.780	-4.822	-52.562	1.067	-9.318	2.934	0.135	-0.404	7.459	-2.659	0.014	-0.047	0.027
40105	sinkhole		5.33	75,844			0.005	0.004	0.005	0.860	0.922	1.811	0.200	0.599	2.487	0.061	0.006	4.195	0.038	0.003	0.000	0.003
40107	sinkhole		10.00	142,296			0.005	0.002	0.004	2.133	0.806	2.640	0.123	0.675	1.781	0.042	0.015	2.942	0.093	0.002	0.001	0.002
40110	sinkhole		8.49	120,812			0.007	0.003	0.006	3.521	1.138	4.118	0.154	1.010	2.372	0.055	0.024	3.891	0.154	0.002	0.002	0.002
40129	sinkhole		5.36	76,200			0.004	0.004	0.004	-0.044	0.749	0.903	0.190	0.405	2.230	0.055	0.000	3.796	-0.002	0.002	0.000	0.003
40140	sinkhole		2.85	40,575			-0.001	0.005	0.002	-6.479	0.208	-4.701	0.295	-0.598	2.449	0.067	-0.043	4.430	-0.283	0.004	-0.005	0.006
40164	spring		14.86	211,406			0.008	0.002	0.006	5.001	1.211	5.342	0.117	1.212	2.168	0.049	0.034	3.485	0.219	0.002	0.003	0.001
40204	swallet		1.94	27,605			-0.006	0.007	0.001	-12.744	-0.298	-10.130	0.403	-1.564	2.725	0.081	-0.084	5.152	-0.558	0.005	-0.010	0.009
40217	sinkhole		6.60	93,887			0.005	0.003	0.005	1.406	0.879	2.175	0.168	0.635	2.202	0.053	0.010	3.689	0.062	0.002	0.001	0.002
40286	sinkhole		1.20	17,097			-0.022	0.009	-0.007	-30.555	-2.353	-26.335	0.554	-4.645	1.686	0.073	-0.203	4.109	-1.337	0.007	-0.023	0.014
40414	sinkhole		5.02	71,493			0.002	0.003	0.003	-1.941	0.443	-0.932	0.185	0.029	1.862	0.048	-0.013	3.246	-0.085	0.002	-0.002	0.003
40429	spring		14.86	211,406			0.008	0.002	0.006	5.001	1.211	5.342	0.117	1.212	2.168	0.049	0.034	3.485	0.219	0.002	0.003	0.001
40509	spring		11.86	168,702			0.004	0.002	0.004	1.986	0.715	2.414	0.105	0.609	1.553	0.036	0.014	2.561	0.087	0.001	0.001	0.001
40532	sinkhole		15.98	227,438			0.008	0.003	0.006	5.541	1.293	5.859	0.118	1.316	2.258	0.050	0.037	3.616	0.242	0.002	0.004	0.001
40623	sinkhole		6.24	88,855			0.004	0.003	0.004	0.216	0.690	1.028	0.166	0.401	1.982	0.049	0.002	3.362	0.009	0.002	0.000	0.003
40624	sinkhole		4.49	63,871			0.002	0.004	0.003	-2.173	0.496	-1.043	0.207	0.033	2.084	0.054	-0.014	3.634	-0.095	0.003	-0.002	0.004
41027	sinkhole		8.18	116,398			0.006	0.003	0.005	2.608	0.985	3.228	0.150	0.826	2.177	0.051	0.018	3.597	0.114	0.002	0.002	0.002
41188	spring		1.59	22,655			-0.015	0.007	-0.004	-22.063	-1.589	-18.878	0.428	-3.294	1.543	0.061	-0.147	3.521	-0.965	0.005	-0.017	0.011
41202	spring		23.56	335,277			0.005	0.002	0.004	3.591	0.845	3.806	0.078	0.857	1.486	0.033	0.024	2.382	0.157	0.001	0.003	0.001
41437	sinkhole		20.28	288,523			0.005	0.002	0.004	2.960	0.755	3.211	0.079	0.739	1.397	0.032	0.020	2.256	0.130	0.001	0.002	0.001
41465	sinkhole		29.78	423,782			0.004	0.001	0.003	2.655	0.634	2.825	0.060	0.639	1.125	0.025	0.018	1.806	0.116	0.001	0.002	0.000
41608	sinkhole		0.51	7,232			-0.056	0.021	-0.019	-75.360	-6.147	-65.381	1.280	-11.646	3.138	0.155	-0.501	8.398	-3.297	0.016	-0.058	0.033
41756	spring		8.18	116,398			0.006	0.003	0.005	2.608	0.985	3.228	0.150	0.826	2.177	0.051	0.018	3.597	0.114	0.002	0.002	0.002
41757	spring		6.00	85,378			0.004	0.003	0.004	0.764	0.819	1.609	0.178	0.532	2.209	0.054	0.006	3.727	0.033	0.002	0.000	0.003
41758	spring		4.91	69,867			0.003	0.004	0.004	-0.772	0.682	0.261	0.201	0.288	2.236	0.056	-0.005	3.834	-0.034	0.003	-0.001	0.003
41760	spring	[illegible]	9.27	131,908			0.006	0.003	0.005	3.204	1.038	3.751	0.141	0.920	2.166	0.050	0.022	3.555	0.140	0.002	0.002	0.002
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #3: 5 Year - 24 Hour Rain Event using Initial Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	Type	Karst Drainage Basin	Run-Off Volume in Basin	Run-Off Volume in Basin			Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(acres)	(cf)	(Liters)			(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole	0.02	85	2,418			0.000	0.000	0.001	1.162						0.010			0.015	0.000	0.000	0.000
40094	sinkhole	4.29	18,313	518,570			0.083	0.023	0.119	249.226						2.115			3.121	0.002	0.010	0.001
40105	sinkhole	0.02	85	2,418			0.000	0.000	0.001	1.162						0.010			0.015	0.000	0.000	0.000
40107	sinkhole	0.06	256	7,253			0.001	0.000	0.002	3.486						0.030			0.044	0.000	0.000	0.000
40110	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
40129	sinkhole	0.06	256	7,253			0.001	0.000	0.002	3.486						0.030			0.044	0.000	0.000	0.000
40140	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
40164	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40204	swallet	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40217	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
40286	sinkhole	0.2	854	24,176			0.004	0.001	0.006	11.619						0.099			0.146	0.000	0.000	0.000
40414	sinkhole	4.01	17,118	484,723			0.078	0.021	0.111	232.959						1.977			2.917	0.002	0.009	0.001
40429	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40509	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40532	sinkhole	0.18	768	21,758			0.003	0.001	0.005	10.457						0.089			0.131	0.000	0.000	0.000
40623	sinkhole	0.02	85	2,418			0.000	0.000	0.001	1.162						0.010			0.015	0.000	0.000	0.000
40624	sinkhole	0.22	939	26,593			0.004	0.001	0.006	12.781						0.108			0.160	0.000	0.000	0.000
41027	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
41188	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41202	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41437	sinkhole	3.53	15,069	426,702			0.068	0.019	0.098	205.074						1.740			2.568	0.001	0.008	0.000
41465	sinkhole	0.12	512	14,505			0.002	0.001	0.003	6.971						0.059			0.087	0.000	0.000	0.000
41608	sinkhole	0.22	939	26,593			0.004	0.001	0.006	12.781						0.108			0.160	0.000	0.000	0.000
41756	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41757	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41758	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41760	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000

INPUTS

C =	0.3		Runoff coefficient
R =	1.176	in	Total runoff

Mean Runoff Concentrations for Urban Open Land Use

218	mg/L	TSS
1.85	mg/L	TN
2.73	mg/L	Fe
0.00158	mg/L	Cd
0.00851	mg/L	Cr
0.0197	mg/L	Copper
0.0728	mg/L	Lead
0.0005	mg/L	Hg
0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #4: 50 Year - 10 Minute Rain Event using Initial Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Highway)															
ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.06	0	81	81	0.004	0.015	0.011	-10.854	1.565	-6.354	0.801	-0.337	7.704	0.202	-0.071	13.546	-0.475	0.010	-0.009	0.015
40094	sinkhole		0.01	0	13	13	-0.024	0.010	-0.008	-32.705	-2.532	-28.205	0.590	-4.980	1.763	0.077	-0.217	4.328	-1.431	0.008	-0.025	0.015
40105	sinkhole		0.11	0	149	149	0.032	0.020	0.029	10.767	5.619	15.267	1.011	4.258	13.582	0.326	0.075	22.667	0.471	0.013	0.006	0.014
40107	sinkhole		0.15	0	203	203	0.054	0.024	0.043	28.065	8.862	32.565	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
40110	sinkhole		0.17	0	230	230	0.065	0.026	0.051	36.910	10.521	41.410	1.264	9.813	20.690	0.476	0.250	33.696	1.615	0.016	0.025	0.014
40129	sinkhole		0.10	0	133	133	0.026	0.019	0.025	5.788	4.685	10.288	0.963	3.200	12.229	0.298	0.041	20.567	0.253	0.012	0.003	0.014
40140	sinkhole		0.05	0	74	74	0.001	0.014	0.009	-13.049	1.153	-8.549	0.780	-0.803	7.107	0.190	-0.085	12.620	-0.571	0.010	-0.011	0.015
40164	spring		0.28	0	374	374	0.124	0.036	0.089	82.773	19.120	87.273	1.708	19.559	33.159	0.738	0.558	53.045	3.621	0.022	0.058	0.013
40204	swallet		0.04	0	54	54	-0.007	0.013	0.003	-19.503	-0.057	-15.003	0.718	-2.174	5.353	0.153	-0.129	9.897	-0.853	0.009	-0.016	0.015
40217	sinkhole		0.12	0	164	164	0.038	0.021	0.033	15.616	6.528	20.116	1.058	5.288	14.901	0.354	0.107	24.713	0.683	0.014	0.010	0.014
40286	sinkhole		0.01	0	15	15	-0.023	0.010	-0.007	-31.886	-2.379	-27.386	0.598	-4.806	1.986	0.082	-0.212	4.673	-1.395	0.008	-0.024	0.015
40414	sinkhole		0.08	0	102	102	0.013	0.016	0.016	-4.040	2.842	0.460	0.867	1.111	9.557	0.241	-0.025	16.421	-0.177	0.011	-0.004	0.014
40429	spring		0.28	0	374	374	0.124	0.036	0.089	82.773	19.120	87.273	1.708	19.559	33.159	0.738	0.558	53.045	3.621	0.022	0.058	0.013
40509	spring		0.16	0	210	210	0.057	0.024	0.045	30.358	9.292	34.858	1.201	8.421	18.909	0.438	0.206	30.932	1.328	0.015	0.020	0.014
40532	sinkhole		0.31	0	420	420	0.143	0.040	0.101	97.515	21.884	102.015	1.851	22.692	37.167	0.822	0.657	59.264	4.266	0.024	0.069	0.013
40623	sinkhole		0.10	0	138	138	0.028	0.019	0.026	7.426	4.992	11.926	0.978	3.548	12.674	0.307	0.052	21.258	0.325	0.013	0.004	0.014
40624	sinkhole		0.08	0	102	102	0.013	0.016	0.016	-4.040	2.842	0.460	0.867	1.111	9.557	0.241	-0.025	16.421	-0.177	0.011	-0.004	0.014
41027	sinkhole		0.15	0	203	203	0.054	0.024	0.043	28.065	8.862	32.565	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
41188	spring		0.02	0	20	20	-0.021	0.010	-0.006	-30.248	-2.072	-25.748	0.613	-4.458	2.431	0.091	-0.201	5.364	-1.323	0.008	-0.023	0.015
41202	spring		0.30	0	407	407	0.138	0.039	0.098	93.420	21.116	97.920	1.812	21.822	36.054	0.799	0.630	57.537	4.087	0.023	0.066	0.013
41437	sinkhole		0.24	0	328	328	0.105	0.033	0.076	68.032	16.356	72.532	1.566	16.427	29.151	0.654	0.459	46.826	2.976	0.020	0.047	0.013
41465	sinkhole		0.29	0	389	389	0.130	0.038	0.093	87.687	20.041	92.187	1.756	20.604	34.495	0.766	0.591	55.118	3.836	0.023	0.061	0.013
41608	sinkhole		0.01	0	10	10	-0.025	0.010	-0.008	-33.524	-2.686	-29.024	0.582	-5.154	1.541	0.073	-0.223	3.982	-1.467	0.007	-0.026	0.015
41756	spring		0.15	0	203	203	0.054	0.024	0.043	28.065	8.862	32.565	1.178	7.934	18.285	0.425	0.191	29.965	1.228	0.015	0.019	0.014
41757	spring		0.11	0	149	149	0.032	0.020	0.029	10.767	5.619	15.267	1.011	4.258	13.582	0.326	0.075	22.667	0.471	0.013	0.006	0.014
41758	spring		0.09	0	122	122	0.021	0.018	0.021	2.119	3.997	6.619	0.927	2.420	11.231	0.277	0.016	19.019	0.093	0.012	0.000	0.014
41760	spring		0.17	0	230	230	0.065	0.026	0.050	36.713	10.484	41.213	1.262	9.772	20.636	0.474	0.249	33.613	1.606	0.016	0.025	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	1.20	in	Volume of rainfall for 50 year-10 minute (NOAA)
Rain Duration =	0.167	hr	Duration of rainfall for 50 year-10 Minute (NOAA)
r =	7.200	in/hr	Run off rate

Exhibit #4: 50 Year - 10 Minute Rain Event using Initial Criteria

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Average Concentration															
ID	**Type**	**Approx. Station**	**Run-Off Area inside R/W**	**Run-off Volume inside R/W**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(feet)	**(acres)**	**(cf)**			**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
40010	sinkhole		3.27	14,256			0.005	0.017	0.012	-12.209	1.760	-7.147	0.901	-0.379	8.666	0.228	-0.079	15.237	-0.534	0.012	-0.011	0.016
40094	sinkhole		0.62	2,688			-0.142	0.058	-0.045	-195.107	-15.106	-168.262	3.518	-29.708	10.519	0.462	-1.297	25.817	-8.536	0.045	-0.149	0.089
40105	sinkhole		5.33	23,232			0.022	0.014	0.020	7.432	3.878	10.538	0.698	2.939	9.375	0.225	0.051	15.646	0.325	0.009	0.004	0.010
40107	sinkhole		10.00	43,560			0.020	0.009	0.016	10.331	3.262	11.988	0.434	2.921	6.731	0.156	0.070	11.031	0.452	0.006	0.007	0.005
40110	sinkhole		8.49	36,983			0.028	0.011	0.022	16.004	4.562	17.955	0.548	4.255	8.971	0.206	0.109	14.610	0.700	0.007	0.011	0.006
40129	sinkhole		5.36	23,326			0.018	0.013	0.017	3.979	3.221	7.072	0.662	2.200	8.407	0.205	0.028	14.139	0.174	0.008	0.002	0.010
40140	sinkhole		2.85	12,421			0.002	0.018	0.011	-16.847	1.489	-11.037	1.007	-1.037	9.176	0.245	-0.110	16.293	-0.737	0.013	-0.014	0.019
40164	spring		14.86	64,716			0.031	0.009	0.022	20.510	4.738	21.625	0.423	4.847	8.216	0.183	0.138	13.144	0.897	0.005	0.014	0.003
40204	swallet		1.94	8,448			-0.013	0.024	0.007	-37.020	-0.108	-28.478	1.362	-4.127	10.160	0.290	-0.244	18.787	-1.620	0.017	-0.030	0.028
40217	sinkhole		6.60	28,741			0.021	0.012	0.018	8.713	3.642	11.223	0.590	2.951	8.314	0.197	0.060	13.788	0.381	0.008	0.005	0.008
40286	sinkhole		1.20	5,234			-0.070	0.030	-0.021	-97.693	-7.288	-83.906	1.831	-14.724	6.085	0.252	-0.649	14.317	-4.274	0.023	-0.075	0.046
40414	sinkhole		5.02	21,886			0.010	0.012	0.012	-2.960	2.083	0.337	0.636	0.814	7.002	0.177	-0.018	12.031	-0.130	0.008	-0.003	0.011
40429	spring		14.86	64,716			0.031	0.009	0.022	20.510	4.738	21.625	0.423	4.847	8.216	0.183	0.138	13.144	0.897	0.005	0.014	0.003
40509	spring		11.86	51,643			0.018	0.008	0.014	9.426	2.885	10.824	0.373	2.615	5.871	0.136	0.064	9.605	0.412	0.005	0.006	0.004
40532	sinkhole		15.98	69,624			0.033	0.009	0.023	22.460	5.040	23.496	0.426	5.226	8.560	0.189	0.151	13.650	0.983	0.005	0.016	0.003
40623	sinkhole		6.24	27,201			0.016	0.011	0.015	4.378	2.943	7.031	0.577	2.092	7.472	0.181	0.031	12.532	0.192	0.007	0.002	0.008
40624	sinkhole		4.49	19,552			0.011	0.013	0.013	-3.313	2.331	0.377	0.711	0.912	7.838	0.198	-0.020	13.467	-0.145	0.009	-0.004	0.012
41027	sinkhole		8.18	35,640			0.024	0.011	0.019	12.627	3.987	14.652	0.530	3.570	8.227	0.191	0.086	13.482	0.552	0.007	0.008	0.006
41188	spring		1.59	6,935			-0.048	0.024	-0.013	-69.940	-4.790	-59.535	1.418	-10.307	5.622	0.211	-0.465	12.403	-3.060	0.018	-0.054	0.034
41202	spring		23.56	102,636			0.022	0.006	0.015	14.596	3.299	15.299	0.283	3.409	5.633	0.125	0.098	8.989	0.639	0.004	0.010	0.002
41437	sinkhole		20.28	88,324			0.019	0.006	0.014	12.352	2.970	13.169	0.284	2.982	5.293	0.119	0.083	8.502	0.540	0.004	0.009	0.002
41465	sinkhole		29.78	129,729			0.016	0.005	0.011	10.839	2.477	11.395	0.217	2.547	4.264	0.095	0.073	6.813	0.474	0.003	0.008	0.002
41608	sinkhole		0.51	2,214			-0.180	0.069	-0.060	-242.832	-19.454	-210.236	4.214	-37.332	11.160	0.527	-1.615	28.844	-10.624	0.054	-0.186	0.108
41756	spring		8.18	35,640			0.024	0.011	0.019	12.627	3.987	14.652	0.530	3.570	8.227	0.191	0.086	13.482	0.552	0.007	0.008	0.006
41757	spring		6.00	26,136			0.020	0.012	0.018	6.606	3.447	9.367	0.620	2.613	8.333	0.200	0.046	13.908	0.289	0.008	0.004	0.009
41758	spring		4.91	21,384			0.016	0.013	0.016	1.589	2.998	4.963	0.695	1.815	8.422	0.207	0.012	14.262	0.070	0.009	0.000	0.011
41760	spring		9.27	40,392			0.026	0.010	0.020	14.575	4.162	16.362	0.501	3.879	8.193	0.188	0.099	13.345	0.638	0.006	0.010	0.005
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #4: 50 Year - 10 Minute Rain Event using Initial Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Initial Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	**Type**	**Karst Drainage Basin**	**Run-Off Volume in Basin**	**Run-Off Volume in Basin**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(acres)	**(cf)**	**(Liters)**			**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**
40010	sinkhole	0.02	26	740			0.000	0.000	0.000	0.356						0.003			0.004	0.000	0.000	0.000
40094	sinkhole	4.29	5,606	158,746			0.025	0.007	0.036	76.294						0.647			0.955	0.001	0.003	0.000
40105	sinkhole	0.02	26	740			0.000	0.000	0.000	0.356						0.003			0.004	0.000	0.000	0.000
40107	sinkhole	0.06	78	2,220			0.000	0.000	0.001	1.067						0.009			0.013	0.000	0.000	0.000
40110	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
40129	sinkhole	0.06	78	2,220			0.000	0.000	0.001	1.067						0.009			0.013	0.000	0.000	0.000
40140	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
40164	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40204	swallet	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40217	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
40286	sinkhole	0.2	261	7,401			0.001	0.000	0.002	3.557						0.030			0.045	0.000	0.000	0.000
40414	sinkhole	4.01	5,240	148,385			0.024	0.006	0.034	71.314						0.605			0.893	0.001	0.003	0.000
40429	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40509	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
40532	sinkhole	0.18	235	6,661			0.001	0.000	0.002	3.201						0.027			0.040	0.000	0.000	0.000
40623	sinkhole	0.02	26	740			0.000	0.000	0.000	0.356						0.003			0.004	0.000	0.000	0.000
40624	sinkhole	0.22	287	8,141			0.001	0.000	0.002	3.912						0.033			0.049	0.000	0.000	0.000
41027	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
41188	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41202	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41437	sinkhole	3.53	4,613	130,623			0.021	0.006	0.030	62.778						0.533			0.786	0.000	0.002	0.000
41465	sinkhole	0.12	157	4,440			0.001	0.000	0.001	2.134						0.018			0.027	0.000	0.000	0.000
41608	sinkhole	0.22	287	8,141			0.001	0.000	0.002	3.912						0.033			0.049	0.000	0.000	0.000
41756	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41757	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41758	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000
41760	spring	n/a	n/a	n/a			0.000	0.000	0.000	0.000						0.000			0.000	0.000	0.000	0.000

INPUTS

C =	0.3		Runoff coefficient
R =	0.360	in	Total runoff

Mean Runoff Concentrations for Urban Open Land Use

218	mg/L	TSS
1.85	mg/L	TN
2.73	mg/L	Fe
0.00158	mg/L	Cd
0.00851	mg/L	Cr
0.0197	mg/L	Copper
0.0728	mg/L	Lead
0.0005	mg/L	Hg
0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #5: 1 Year - 1 Hour Rain Event using Low Cost Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	*Mass Load per Rain Event (Highway)* Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.23	0	316	316	0.101	0.032	0.073	64.346	15.665	68.846	1.530	15.644	28.149	0.632	0.435	45.271	2.815	0.020	0.045	0.013
40097	sinkhole		0.27	0	360	360	0.118	0.035	0.085	78.269	18.275	82.769	1.665	18.602	31.934	0.712	0.528	51.145	3.424	0.021	0.055	0.013
40130	sinkhole		0.04	0	51	51	-0.008	0.013	0.003	-20.420	-0.229	-15.920	0.709	-2.369	5.103	0.148	-0.135	9.510	-0.893	0.009	-0.016	0.015
40132	sinkhole		0.02	0	26	26	-0.019	0.011	-0.004	-28.610	-1.764	-24.110	0.629	-4.110	2.877	0.101	-0.190	6.055	-1.252	0.008	-0.022	0.015
40171	sinkhole		0.03	0	44	44	-0.011	0.012	0.001	-22.795	-0.674	-18.295	0.686	-2.874	4.458	0.134	-0.151	8.508	-0.997	0.009	-0.018	0.015
40183	sinkhole		0.13	0	169	169	0.040	0.021	0.034	17.254	6.835	21.754	1.074	5.636	15.346	0.363	0.118	25.404	0.755	0.014	0.011	0.014
40204	swallet		0.14	0	189	189	0.049	0.023	0.040	23.806	8.064	28.306	1.137	7.029	17.127	0.401	0.162	28.168	1.041	0.015	0.016	0.014
40215	sinkhole		0.27	0	369	369	0.122	0.036	0.087	81.135	18.813	85.635	1.692	19.211	32.714	0.728	0.547	52.354	3.550	0.022	0.057	0.013
40217	sinkhole		0.24	0	320	320	0.102	0.032	0.074	65.575	15.895	70.075	1.542	15.905	28.483	0.639	0.443	45.789	2.869	0.020	0.046	0.013
40414	sinkhole		0.06	0	77	77	0.002	0.014	0.010	-12.230	1.307	-7.730	0.788	-0.629	7.330	0.195	-0.080	12.965	-0.535	0.010	-0.010	0.015
40509	spring		0.59	0	800	800	0.299	0.068	0.203	219.136	44.688	223.636	3.029	48.536	70.233	1.518	1.475	110.573	9.587	0.039	0.156	0.010
40532	sinkhole		0.27	0	369	369	0.122	0.036	0.087	81.135	18.813	85.635	1.692	19.211	32.714	0.728	0.547	52.354	3.550	0.022	0.057	0.013
40620	sinkhole		0.68	0	921	921	0.349	0.077	0.235	258.039	51.982	262.539	3.406	56.803	80.809	1.740	1.736	126.985	11.289	0.044	0.184	0.010
40621	sinkhole		0.49	0	665	665	0.244	0.058	0.167	176.139	36.626	180.639	2.613	39.400	58.543	1.272	1.186	92.434	7.706	0.034	0.125	0.011
40908	spring		0.50	0	678	678	0.249	0.059	0.170	180.234	37.394	184.734	2.653	40.270	59.656	1.295	1.213	94.161	7.885	0.034	0.128	0.011
41027	sinkhole		0.30	0	401	401	0.135	0.038	0.096	91.455	20.748	95.955	1.792	21.404	35.519	0.787	0.617	56.707	4.001	0.023	0.064	0.013
41200	spring		0.29	0	394	394	0.133	0.038	0.094	89.325	20.349	93.825	1.772	20.952	34.940	0.775	0.602	55.809	3.908	0.023	0.063	0.013
41437	sinkhole		0.17	0	225	225	0.063	0.025	0.049	35.272	10.213	39.772	1.248	9.465	20.244	0.466	0.239	33.005	1.543	0.016	0.024	0.014
41466	sinkhole		0.18	0	246	246	0.072	0.027	0.055	41.824	11.442	46.324	1.312	10.858	22.026	0.504	0.283	35.769	1.830	0.017	0.029	0.014
41744	spring		0.11	0	152	152	0.033	0.020	0.030	11.930	5.837	16.430	1.022	4.505	13.899	0.333	0.082	23.158	0.522	0.013	0.007	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	1.21	in	Volume of rainfall for 1 year-1 hour (NOAA)
Rain Duration =	1	hr	Duration of rainfall for 1 year-1 hour (NOAA)
r =	1.210	in/hr	Run off rate

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Run-Off Area inside R/W	Run-off Volume inside R/W			*Average Concentration* Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(acres)	(cf)			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
40010	sinkhole		10.16	44,644			0.036	0.012	0.026	23.113	5.627	24.729	0.550	5.619	10.111	0.227	0.156	16.261	1.011	0.007	0.016	0.005
40097	sinkhole		12.24	53,744			0.035	0.011	0.025	23.353	5.453	24.696	0.497	5.550	9.528	0.212	0.158	15.260	1.022	0.006	0.016	0.004
40130	sinkhole		1.38	6,040			-0.021	0.033	0.007	-54.212	-0.607	-42.265	1.881	-6.290	13.548	0.392	-0.358	25.248	-2.372	0.024	-0.043	0.039
40132	sinkhole		0.68	2,997			-0.099	0.057	-0.022	-153.072	-9.440	-128.996	3.367	-21.988	15.391	0.540	-1.016	32.397	-6.697	0.043	-0.118	0.079
40171	sinkhole		1.70	7,487			-0.024	0.026	0.001	-48.824	-1.444	-39.185	1.469	-6.156	9.547	0.287	-0.323	18.223	-2.136	0.019	-0.038	0.032
40183	sinkhole		5.70	25,047			0.026	0.014	0.022	11.046	4.376	13.927	0.687	3.609	9.825	0.232	0.076	16.264	0.483	0.009	0.007	0.009
40204	swallet		6.18	27,166			0.029	0.013	0.023	14.052	4.760	16.709	0.671	4.149	10.110	0.236	0.096	16.628	0.615	0.009	0.009	0.008
40215	sinkhole		13.75	60,388			0.032	0.010	0.023	21.545	4.996	22.740	0.449	5.101	8.687	0.193	0.145	13.902	0.943	0.006	0.015	0.003
40217	sinkhole		11.89	52,240			0.031	0.010	0.023	20.129	4.879	21.510	0.473	4.882	8.743	0.196	0.136	14.056	0.881	0.006	0.014	0.004
40414	sinkhole		3.00	13,163			0.003	0.018	0.012	-14.899	1.592	-9.417	0.960	-0.766	8.930	0.237	-0.097	15.795	-0.652	0.012	-0.013	0.018
40509	spring		31.93	140,246			0.034	0.008	0.023	25.056	5.110	25.571	0.346	5.550	8.030	0.174	0.169	12.643	1.096	0.004	0.018	0.001
40532	sinkhole		10.47	45,997			0.043	0.013	0.030	28.286	6.559	29.855	0.590	6.698	11.405	0.254	0.191	18.252	1.238	0.008	0.020	0.004
40620	sinkhole		7.56	33,225			0.168	0.037	0.113	124.538	25.088	126.710	1.644	27.415	39.001	0.840	0.838	61.287	5.449	0.021	0.089	0.005
40621	sinkhole		6.64	29,177			0.134	0.032	0.092	96.806	20.130	99.279	1.436	21.654	32.175	0.699	0.652	50.802	4.235	0.018	0.069	0.006
40908	spring		21.69	95,277			0.042	0.010	0.029	30.335	6.294	31.092	0.446	6.778	10.041	0.218	0.204	15.848	1.327	0.006	0.022	0.002
41027	sinkhole		13.45	59,074			0.037	0.010	0.026	24.826	5.632	26.047	0.487	5.810	9.642	0.214	0.167	15.393	1.086	0.006	0.017	0.003
41200	spring		19.28	84,694			0.025	0.007	0.018	16.913	3.853	17.765	0.335	3.967	6.616	0.147	0.114	10.567	0.740	0.004	0.012	0.002
41437	sinkhole		14.27	62,662			0.016	0.007	0.013	9.026	2.614	10.178	0.319	2.422	5.181	0.119	0.061	8.446	0.395	0.004	0.006	0.004
41466	sinkhole		15.03	66,000			0.017	0.007	0.013	10.162	2.780	11.255	0.319	2.638	5.352	0.122	0.069	8.691	0.445	0.004	0.007	0.003
41744	spring		4.58	20,097			0.027	0.016	0.024	9.519	4.657	13.110	0.816	3.595	11.090	0.265	0.066	18.478	0.416	0.010	0.006	0.011
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #5: 1 Year - 1 Hour Rain Event using Low Cost Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	Type	Karst Drainage Basin	Run-Off Volume in Basin	Run-Off Volume in Basin			Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(acres)	(cf)	(Liters)			(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole	0.02	26	746			0.000	0.000	0.000	0.359						0.003			0.004	0.000	0.000	0.000
40097	sinkhole	0.26	343	9,701			0.002	0.000	0.002	4.662						0.040			0.058	0.000	0.000	0.000
40130	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
40132	sinkhole	0.68	896	25,372			0.004	0.001	0.006	12.194						0.103			0.153	0.000	0.000	0.000
40171	sinkhole	0.18	237	6,716			0.001	0.000	0.002	3.228						0.027			0.040	0.000	0.000	0.000
40183	sinkhole	0.76	1,001	28,357			0.005	0.001	0.006	13.629						0.116			0.171	0.000	0.001	0.000
40204	swallet	21.12	27,830	788,030			0.126	0.034	0.180	378.730						3.214			4.743	0.003	0.015	0.001
40215	sinkhole	0.32	422	11,940			0.002	0.001	0.003	5.738						0.049			0.072	0.000	0.000	0.000
40217	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
40414	sinkhole	4.01	5,284	149,621			0.024	0.006	0.034	71.908						0.610			0.901	0.001	0.003	0.000
40509	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
40532	sinkhole	0.18	237	6,716			0.001	0.000	0.002	3.228						0.027			0.040	0.000	0.000	0.000
40620	sinkhole	0.16	211	5,970			0.001	0.000	0.001	2.869						0.024			0.036	0.000	0.000	0.000
40621	sinkhole	0.12	158	4,477			0.001	0.000	0.001	2.152						0.018			0.027	0.000	0.000	0.000
40908	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41027	sinkhole	0.04	53	1,492			0.000	0.000	0.000	0.717						0.006			0.009	0.000	0.000	0.000
41200	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41437	sinkhole	3.53	4,651	131,711			0.021	0.006	0.030	63.301						0.537			0.793	0.000	0.002	0.000
41466	sinkhole	0.22	290	8,209			0.001	0.000	0.002	3.945						0.033			0.049	0.000	0.000	0.000
41744	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a

INPUTS

C =	0.3		Runoff coefficient	
R =	0.363	in	Total runoff	
Mean Runoff Concentrations for Urban Open Land Use	218	mg/L	TSS	Values listed in red exceed the lowest of the Water Quality Standards found in IAC.
	1.85	mg/L	TN	
	2.73	mg/L	Fe	
	0.00158	mg/L	Cd	
	0.00851	mg/L	Cr	
	0.0197	mg/L	Copper	
	0.0728	mg/L	Lead	
	0.0005	mg/L	Hg	
	0.1037	mg/L	Zinc	

Exhibit #6: 2 Year - 24 Hour Rain Event using Low Cost Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	*Mass Load per Rain Event (Highway)*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole	[illegible]	0.23	0	316	251	0.074	0.027	0.056	43.512	11.759	48.012	1.328	11.216	22.485	0.513	0.295	36.482	1.904	0.017	0.030	0.014
40097	sinkhole		0.27	0	360	286	0.088	0.030	0.065	54.568	13.831	59.068	1.435	13.566	25.491	0.577	0.369	41.146	2.387	0.018	0.038	0.013
40130	sinkhole		0.04	0	51	41	-0.012	0.012	0.000	-23.794	-0.861	-19.294	0.676	-3.086	4.186	0.128	-0.158	8.087	-1.041	0.009	-0.019	0.015
40132	sinkhole		0.02	0	26	20	-0.021	0.010	-0.006	-30.297	-2.081	-25.797	0.613	-4.468	2.418	0.091	-0.201	5.343	-1.325	0.008	-0.023	0.015
40171	sinkhole		0.03	0	44	35	-0.015	0.011	-0.002	-25.680	-1.215	-21.180	0.658	-3.487	3.673	0.118	-0.170	7.291	-1.123	0.008	-0.020	0.015
40183	sinkhole		0.13	0	169	134	0.026	0.019	0.025	6.120	4.748	10.620	0.966	3.271	12.319	0.299	0.043	20.707	0.268	0.012	0.003	0.014
40204	swallet		0.14	0	189	150	0.033	0.020	0.029	11.322	5.723	15.822	1.016	4.376	13.733	0.329	0.078	22.902	0.495	0.013	0.007	0.014
40215	sinkhole		0.27	0	369	293	0.091	0.030	0.067	56.844	14.258	61.344	1.457	14.049	26.109	0.590	0.384	42.106	2.487	0.019	0.039	0.013
40217	sinkhole		0.24	0	320	254	0.075	0.028	0.057	44.488	11.941	48.988	1.337	11.424	22.750	0.519	0.301	36.893	1.946	0.017	0.030	0.014
40414	sinkhole		0.06	0	77	61	-0.004	0.013	0.005	-17.291	0.358	-12.791	0.739	-1.704	5.954	0.166	-0.114	10.830	-0.756	0.009	-0.014	0.015
40509	spring		0.59	0	800	635	0.231	0.056	0.159	166.420	34.804	170.920	2.519	37.334	55.900	1.216	1.120	88.333	7.281	0.032	0.118	0.011
40532	sinkhole		0.27	0	369	293	0.091	0.030	0.067	56.844	14.258	61.344	1.457	14.049	26.109	0.590	0.384	42.106	2.487	0.019	0.039	0.013
40620	sinkhole		0.68	0	921	732	0.271	0.063	0.184	197.309	40.595	201.809	2.818	43.898	64.298	1.393	1.328	101.365	8.632	0.036	0.140	0.011
40621	sinkhole		0.49	0	665	528	0.188	0.048	0.130	132.279	28.402	136.779	2.188	30.079	46.618	1.021	0.891	73.930	5.787	0.028	0.094	0.012
40908	spring		0.50	0	678	539	0.192	0.049	0.133	135.530	29.012	140.030	2.219	30.770	47.502	1.040	0.913	75.302	5.929	0.029	0.096	0.012
41027	sinkhole		0.30	0	401	318	0.101	0.032	0.074	65.038	15.795	69.538	1.537	15.790	28.337	0.636	0.439	45.563	2.845	0.020	0.045	0.013
41200	spring		0.29	0	394	313	0.099	0.032	0.073	63.347	15.478	67.847	1.520	15.431	27.877	0.627	0.428	44.849	2.771	0.020	0.044	0.013
41437	sinkhole		0.17	0	225	179	0.044	0.022	0.037	20.427	7.430	24.927	1.104	6.311	16.209	0.381	0.139	26.743	0.894	0.014	0.013	0.014
41466	sinkhole		0.18	0	246	195	0.051	0.023	0.041	25.629	8.405	30.129	1.155	7.416	17.623	0.411	0.174	28.937	1.121	0.015	0.017	0.014
41744	spring	[illegible]	0.11	0	152	121	0.021	0.018	0.021	1.893	3.955	6.393	0.925	2.372	11.170	0.275	0.015	18.924	0.083	0.012	0.000	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	3.16	in	Volume of rainfall for 2 year-24 hour (NOAA)
Rain Duration =	24	hr	Duration of rainfall for 2 year-24 hour (NOAA)
r =	0.132	in/hr	Run off rate

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Run-Off Area inside R/W	Run-off Volume inside R/W			*Average Concentration*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(acres)	(cf)			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
40010	sinkhole	[illegible]	10.16	116,590			0.010	0.004	0.008	5.985	1.617	6.604	0.183	1.543	3.093	0.071	0.041	5.018	0.262	0.002	0.004	0.002
40097	sinkhole		12.24	140,357			0.010	0.003	0.007	6.234	1.580	6.748	0.164	1.550	2.912	0.066	0.042	4.701	0.273	0.002	0.004	0.002
40130	sinkhole		1.38	15,774			-0.013	0.012	0.000	-24.188	-0.876	-19.613	0.687	-3.137	4.255	0.131	-0.160	8.221	-1.058	0.009	-0.019	0.015
40132	sinkhole		0.68	7,827			-0.042	0.021	-0.011	-62.069	-4.263	-52.850	1.256	-9.154	4.954	0.187	-0.412	10.947	-2.716	0.016	-0.048	0.030
40171	sinkhole		1.70	19,553			-0.012	0.009	-0.001	-21.061	-0.996	-17.370	0.539	-2.860	3.013	0.096	-0.140	5.980	-0.921	0.007	-0.016	0.012
40183	sinkhole		5.70	65,412			0.006	0.005	0.006	1.500	1.164	2.603	0.237	0.802	3.020	0.073	0.011	5.076	0.066	0.003	0.001	0.003
40204	swallet		6.18	70,945			0.007	0.004	0.007	2.559	1.294	3.576	0.230	0.989	3.104	0.074	0.018	5.176	0.112	0.003	0.001	0.003
40215	sinkhole		13.75	157,707			0.009	0.003	0.007	5.780	1.450	6.237	0.148	1.429	2.655	0.060	0.039	4.281	0.253	0.002	0.004	0.001
40217	sinkhole		11.89	136,427			0.009	0.003	0.007	5.229	1.404	5.758	0.157	1.343	2.674	0.061	0.035	4.336	0.229	0.002	0.004	0.002
40414	sinkhole		3.00	34,376			-0.002	0.006	0.002	-8.066	0.167	-5.967	0.345	-0.795	2.777	0.077	-0.053	5.052	-0.353	0.004	-0.007	0.007
40509	spring		31.93	366,261			0.010	0.002	0.007	7.286	1.524	7.483	0.110	1.635	2.447	0.053	0.049	3.867	0.319	0.001	0.005	0.000
40532	sinkhole		10.47	120,123			0.012	0.004	0.009	7.588	1.903	8.189	0.195	1.875	3.485	0.079	0.051	5.621	0.332	0.002	0.005	0.002
40620	sinkhole		7.56	86,770			0.050	0.012	0.034	36.464	7.502	37.296	0.521	8.113	11.883	0.257	0.245	18.733	1.595	0.007	0.026	0.002
40621	sinkhole		6.64	76,198			0.039	0.010	0.027	27.838	5.977	28.785	0.460	6.330	9.811	0.215	0.188	15.558	1.218	0.006	0.020	0.003
40908	spring		21.69	248,822			0.012	0.003	0.009	8.734	1.870	9.024	0.143	1.983	3.061	0.067	0.059	4.853	0.382	0.002	0.006	0.001
41027	sinkhole		13.45	154,275			0.011	0.003	0.008	6.760	1.642	7.228	0.160	1.641	2.945	0.066	0.046	4.736	0.296	0.002	0.005	0.001
41200	spring		19.28	221,184			0.007	0.002	0.005	4.593	1.122	4.919	0.110	1.119	2.021	0.045	0.031	3.252	0.201	0.001	0.003	0.001
41437	sinkhole		14.27	163,647			0.004	0.002	0.004	2.002	0.728	2.443	0.108	0.618	1.588	0.037	0.014	2.620	0.088	0.001	0.001	0.001
41466	sinkhole		15.03	172,362			0.005	0.002	0.004	2.384	0.782	2.803	0.107	0.690	1.640	0.038	0.016	2.692	0.104	0.001	0.002	0.001
41744	spring	[illegible]	4.58	52,485			0.006	0.005	0.007	0.578	1.208	1.953	0.283	0.725	3.413	0.084	0.005	5.782	0.025	0.004	0.000	0.004
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #6: 2 Year - 24 Hour Rain Event using Low Cost Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	**Type**	**Karst Drainage Basin**	**Run-Off Volume in Basin**	**Run-Off Volume in Basin**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(acres)	**(cf)**	**(Liters)**			**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**
40010	sinkhole	0.02	69	1,949			0.000	0.000	0.000	0.937						0.008			0.012	0.000	0.000	0.000
40097	sinkhole	0.26	895	25,335			0.004	0.001	0.006	12.176						0.103			0.152	0.000	0.000	0.000
40130	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
40132	sinkhole	0.68	2,340	66,261			0.011	0.003	0.015	31.845						0.270			0.399	0.000	0.001	0.000
40171	sinkhole	0.18	619	17,540			0.003	0.001	0.004	8.430						0.072			0.106	0.000	0.000	0.000
40183	sinkhole	0.76	2,615	74,057			0.012	0.003	0.017	35.592						0.302			0.446	0.000	0.001	0.000
40204	swallet	21.12	72,679	2,057,996			0.330	0.089	0.470	989.079						8.394			12.386	0.007	0.039	0.002
40215	sinkhole	0.32	1,101	31,182			0.005	0.001	0.007	14.986						0.127			0.188	0.000	0.001	0.000
40217	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
40414	sinkhole	4.01	13,799	390,746			0.063	0.017	0.089	187.794						1.594			2.352	0.001	0.007	0.000
40509	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
40532	sinkhole	0.18	619	17,540			0.003	0.001	0.004	8.430						0.072			0.106	0.000	0.000	0.000
40620	sinkhole	0.16	551	15,591			0.003	0.001	0.004	7.493						0.064			0.094	0.000	0.000	0.000
40621	sinkhole	0.12	413	11,693			0.002	0.001	0.003	5.620						0.048			0.070	0.000	0.000	0.000
40908	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41027	sinkhole	0.04	138	3,898			0.001	0.000	0.001	1.873						0.016			0.023	0.000	0.000	0.000
41200	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41437	sinkhole	3.53	12,148	343,974			0.055	0.015	0.079	165.315						1.403			2.070	0.001	0.006	0.000
41466	sinkhole	0.22	757	21,437			0.003	0.001	0.005	10.303						0.087			0.129	0.000	0.000	0.000
41744	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a

INPUTS

C =	0.3		Runoff coefficient
R =	0.948	in	Total runoff

Mean Runoff Concentrations for Urban Open Land Use

218	mg/L	TSS
1.85	mg/L	TN
2.73	mg/L	Fe
0.00158	mg/L	Cd
0.00851	mg/L	Cr
0.0197	mg/L	Copper
0.0728	mg/L	Lead
0.0005	mg/L	Hg
0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #7: 5 Year - 24 Hour Rain Event using Low Cost Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	*Mass Load per Rain Event (Highway)*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.23	0	316	272	0.082	0.029	0.062	50.099	12.994	54.599	1.392	12.616	24.276	0.551	0.339	39.260	2.192	0.018	0.034	0.013
40097	sinkhole		0.27	0	360	309	0.098	0.032	0.071	62.061	15.236	66.561	1.508	15.158	27.528	0.619	0.419	44.307	2.715	0.019	0.043	0.013
40130	sinkhole		0.04	0	51	44	-0.011	0.012	0.001	-22.727	-0.661	-18.227	0.686	-2.860	4.476	0.134	-0.150	8.537	-0.994	0.009	-0.018	0.015
40132	sinkhole		0.02	0	26	22	-0.020	0.010	-0.005	-29.764	-1.981	-25.264	0.618	-4.355	2.563	0.094	-0.198	5.568	-1.302	0.008	-0.023	0.015
40171	sinkhole		0.03	0	44	38	-0.014	0.012	-0.001	-24.768	-1.044	-20.268	0.667	-3.293	3.921	0.123	-0.164	7.676	-1.084	0.009	-0.019	0.015
40183	sinkhole		0.13	0	169	145	0.031	0.020	0.028	9.640	5.407	14.140	1.000	4.018	13.276	0.320	0.067	22.192	0.422	0.013	0.005	0.014
40204	swallet		0.14	0	189	163	0.038	0.021	0.032	15.269	6.463	19.769	1.054	5.215	14.806	0.352	0.105	24.567	0.668	0.014	0.009	0.014
40215	sinkhole		0.27	0	369	317	0.101	0.032	0.074	64.523	15.698	69.023	1.532	15.681	28.197	0.633	0.436	45.346	2.823	0.020	0.045	0.013
40217	sinkhole		0.24	0	320	275	0.084	0.029	0.062	51.154	13.191	55.654	1.402	12.840	24.563	0.557	0.346	39.706	2.238	0.018	0.035	0.013
40414	sinkhole		0.06	0	77	66	-0.002	0.014	0.007	-15.691	0.658	-11.191	0.754	-1.364	6.389	0.175	-0.103	11.505	-0.686	0.010	-0.013	0.015
40509	spring		0.59	0	800	687	0.253	0.060	0.172	183.086	37.929	187.586	2.680	40.876	60.431	1.311	1.232	95.364	8.010	0.034	0.130	0.011
40532	sinkhole		0.27	0	369	317	0.101	0.032	0.074	64.523	15.698	69.023	1.532	15.681	28.197	0.633	0.436	45.346	2.823	0.020	0.045	0.013
40620	sinkhole		0.68	0	921	792	0.296	0.067	0.200	216.508	44.195	221.008	3.004	47.978	69.518	1.503	1.457	109.464	9.472	0.039	0.154	0.010
40621	sinkhole		0.49	0	665	572	0.205	0.051	0.142	146.145	31.002	150.645	2.322	33.026	50.388	1.100	0.984	79.780	6.394	0.030	0.103	0.012
40908	spring		0.50	0	678	583	0.210	0.052	0.145	149.663	31.662	154.163	2.356	33.773	51.345	1.120	1.008	81.264	6.548	0.030	0.106	0.012
41027	sinkhole		0.30	0	401	344	0.112	0.034	0.081	73.389	17.360	77.889	1.617	17.565	30.608	0.684	0.495	49.086	3.211	0.021	0.051	0.013
41200	spring		0.29	0	394	339	0.110	0.034	0.079	71.560	17.017	76.060	1.600	17.176	30.110	0.674	0.483	48.314	3.131	0.021	0.050	0.013
41437	sinkhole		0.17	0	225	193	0.050	0.023	0.041	25.120	8.310	29.620	1.150	7.308	17.484	0.408	0.171	28.722	1.099	0.015	0.017	0.014
41466	sinkhole		0.18	0	246	211	0.058	0.024	0.045	30.749	9.365	35.249	1.204	8.504	19.015	0.440	0.209	31.097	1.345	0.015	0.021	0.014
41744	spring	---- --	0.11	0	152	131	0.025	0.018	0.024	5.066	4.550	9.566	0.956	3.047	12.032	0.293	0.036	20.262	0.222	0.012	0.002	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	3.92	in	Volume of rainfall for 5 year-24 hour (NOAA)
Rain Duration =	24	hr	Duration of rainfall for 5 year-24 hour (NOAA)
r =	0.163	in/hr	Run off rate

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Run-Off Area inside R/W	Run-off Volume inside R/W			*Average Concentration*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(acres)	(cf)			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
40010	sinkhole	1357+20	10.16	144,630			0.009	0.003	0.007	5.555	1.441	6.054	0.154	1.399	2.692	0.061	0.038	4.353	0.243	0.002	0.004	0.001
40097	sinkhole	1481+20	12.24	174,114			0.009	0.003	0.007	5.716	1.403	6.130	0.139	1.396	2.535	0.057	0.039	4.081	0.250	0.002	0.004	0.001
40130	sinkhole	1445+00	1.38	19,568			-0.009	0.010	0.001	-18.624	-0.542	-14.937	0.562	-2.343	3.668	0.110	-0.123	6.996	-0.815	0.007	-0.015	0.012
40132	sinkhole	1448+00	0.68	9,710			-0.033	0.017	-0.008	-49.154	-3.271	-41.723	1.021	-7.192	4.233	0.156	-0.327	9.196	-2.151	0.013	-0.038	0.025
40171	sinkhole	1241+50	1.70	24,255			-0.009	0.008	-0.001	-16.375	-0.690	-13.400	0.441	-2.177	2.592	0.081	-0.109	5.075	-0.716	0.006	-0.013	0.010
40183	sinkhole	1188+50	5.70	81,144			0.006	0.004	0.005	1.905	1.069	2.794	0.198	0.794	2.624	0.063	0.013	4.386	0.083	0.003	0.001	0.003
40204	swallet	1230+40	6.18	88,007			0.007	0.004	0.006	2.782	1.178	3.602	0.192	0.950	2.698	0.064	0.019	4.476	0.122	0.002	0.002	0.003
40215	sinkhole	1180+70	13.75	195,636			0.008	0.003	0.006	5.289	1.287	5.658	0.126	1.285	2.311	0.052	0.036	3.717	0.231	0.002	0.004	0.001
40217	sinkhole	1182+60	11.89	169,239			0.008	0.003	0.006	4.847	1.250	5.273	0.133	1.217	2.327	0.053	0.033	3.762	0.212	0.002	0.003	0.001
40414	sinkhole	1097+00	3.00	42,644			-0.001	0.005	0.002	-5.900	0.247	-4.208	0.284	-0.513	2.403	0.066	-0.039	4.326	-0.258	0.004	-0.005	0.005
40509	spring	1072+80	31.93	454,350			0.009	0.002	0.006	6.462	1.339	6.621	0.095	1.443	2.133	0.046	0.043	3.366	0.283	0.001	0.005	0.000
40532	sinkhole	1432+60	10.47	149,014			0.011	0.003	0.008	6.943	1.689	7.428	0.165	1.687	3.034	0.068	0.047	4.880	0.304	0.002	0.005	0.001
40620	sinkhole	1430+50	7.56	107,639			0.044	0.010	0.030	32.255	6.584	32.925	0.448	7.148	10.357	0.224	0.217	16.308	1.411	0.006	0.023	0.002
40621	sinkhole	1420+50	6.64	94,524			0.035	0.009	0.024	24.793	5.259	25.556	0.394	5.603	8.548	0.187	0.167	13.534	1.085	0.005	0.018	0.002
40908	spring	1390+00	21.69	308,666			0.011	0.003	0.008	7.775	1.645	8.009	0.122	1.755	2.667	0.058	0.052	4.222	0.340	0.002	0.006	0.001
41027	sinkhole	1296+80	13.45	191,380			0.009	0.003	0.007	6.149	1.455	6.526	0.136	1.472	2.565	0.057	0.042	4.113	0.269	0.002	0.004	0.001
41200	spring	0455+60	19.28	274,380			0.006	0.002	0.005	4.182	0.995	4.445	0.093	1.004	1.760	0.039	0.028	2.824	0.183	0.001	0.003	0.001
41437	sinkhole	1534+20	14.27	203,006			0.004	0.002	0.003	1.984	0.656	2.340	0.091	0.577	1.381	0.032	0.014	2.269	0.087	0.001	0.001	0.001
41466	sinkhole	1533+40	15.03	213,817			0.004	0.002	0.003	2.306	0.702	2.644	0.090	0.638	1.426	0.033	0.016	2.332	0.101	0.001	0.002	0.001
41744	spring	1360+90	4.58	65,108			0.006	0.005	0.006	1.248	1.121	2.356	0.235	0.750	2.964	0.072	0.009	4.991	0.055	0.003	0.001	0.004
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #7: 5 Year - 24 Hour Rain Event using Low Cost Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	**Type**	**Karst Drainage Basin**	**Run-Off Volume in Basin**	**Run-Off Volume in Basin**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(acres)	**(cf)**	**(Liters)**			**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**
40010	sinkhole	0.02	85	2,418			0.000	0.000	0.001	1.162						0.010			0.015	0.000	0.000	0.000
40097	sinkhole	0.26	1,110	31,428			0.005	0.001	0.007	15.105						0.128			0.189	0.000	0.001	0.000
40130	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
40132	sinkhole	0.68	2,903	82,197			0.013	0.004	0.019	39.504						0.335			0.495	0.000	0.002	0.000
40171	sinkhole	0.18	768	21,758			0.003	0.001	0.005	10.457						0.089			0.131	0.000	0.000	0.000
40183	sinkhole	0.76	3,244	91,868			0.015	0.004	0.021	44.152						0.375			0.553	0.000	0.002	0.000
40204	swallet	21.12	90,159	2,552,958			0.410	0.111	0.584	1226.959						10.412			15.365	0.009	0.048	0.003
40215	sinkhole	0.32	1,366	38,681			0.006	0.002	0.009	18.590						0.158			0.233	0.000	0.001	0.000
40217	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
40414	sinkhole	4.01	17,118	484,723			0.078	0.021	0.111	232.959						1.977			2.917	0.002	0.009	0.001
40509	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
40532	sinkhole	0.18	768	21,758			0.003	0.001	0.005	10.457						0.089			0.131	0.000	0.000	0.000
40620	sinkhole	0.16	683	19,341			0.003	0.001	0.004	9.295						0.079			0.116	0.000	0.000	0.000
40621	sinkhole	0.12	512	14,505			0.002	0.001	0.003	6.971						0.059			0.087	0.000	0.000	0.000
40908	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41027	sinkhole	0.04	171	4,835			0.001	0.000	0.001	2.324						0.020			0.029	0.000	0.000	0.000
41200	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41437	sinkhole	3.53	15,069	426,702			0.068	0.019	0.098	205.074						1.740			2.568	0.001	0.008	0.000
41466	sinkhole	0.22	939	26,593			0.004	0.001	0.006	12.781						0.108			0.160	0.000	0.000	0.000
41744	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a

INPUTS

C =	0.3		Runoff coefficient
R =	1.176	in	Total runoff
	218	mg/L	TSS
	1.85	mg/L	TN
	2.73	mg/L	Fe
	0.00158	mg/L	Cd
	0.00851	mg/L	Cr
	0.0197	mg/L	Copper
	0.0728	mg/L	Lead
	0.0005	mg/L	Hg
	0.1037	mg/L	Zinc

Mean Runoff Concentrations for Urban Open Land Use

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

Exhibit #8: 50 Year - 10 Minute Rain Event using Low Cost Criteria

Table #1: Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Length of R/W in Drainage Area	Initial TS Load before Event (Po)	TS Load after Event (P)	TS Load at Discharge (Pd)	*Mass Load per Rain Event (Highway)*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(mi)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
40010	sinkhole		0.23	0	316	316	0.101	0.032	0.073	64.346	15.665	68.846	1.530	15.644	28.149	0.632	0.435	45.271	2.815	0.020	0.045	0.013
40097	sinkhole		0.27	0	360	360	0.118	0.035	0.085	78.269	18.275	82.769	1.665	18.602	31.934	0.712	0.528	51.145	3.424	0.021	0.055	0.013
40130	sinkhole		0.04	0	51	51	-0.008	0.013	0.003	-20.420	-0.229	-15.920	0.709	-2.369	5.103	0.148	-0.135	9.510	-0.893	0.009	-0.016	0.015
40132	sinkhole		0.02	0	26	26	-0.019	0.011	-0.004	-28.610	-1.764	-24.110	0.629	-4.110	2.877	0.101	-0.190	6.055	-1.252	0.008	-0.022	0.015
40171	sinkhole		0.03	0	44	44	-0.011	0.012	0.001	-22.795	-0.674	-18.295	0.686	-2.874	4.458	0.134	-0.151	8.508	-0.997	0.009	-0.018	0.015
40183	sinkhole		0.13	0	169	169	0.040	0.021	0.034	17.254	6.835	21.754	1.074	5.636	15.346	0.363	0.118	25.404	0.755	0.014	0.011	0.014
40204	swallet		0.14	0	189	189	0.049	0.023	0.040	23.806	8.064	28.306	1.137	7.029	17.127	0.401	0.162	28.168	1.042	0.015	0.016	0.014
40215	sinkhole		0.27	0	369	369	0.122	0.036	0.087	81.135	18.813	85.635	1.693	19.211	32.714	0.728	0.547	52.354	3.550	0.022	0.057	0.013
40217	sinkhole		0.24	0	320	320	0.102	0.032	0.074	65.575	15.895	70.075	1.542	15.905	28.483	0.639	0.443	45.789	2.869	0.020	0.046	0.013
40414	sinkhole		0.06	0	77	77	0.002	0.014	0.010	-12.230	1.307	-7.730	0.788	-0.629	7.330	0.195	-0.080	12.965	-0.535	0.010	-0.010	0.015
40509	spring		0.59	0	800	800	0.299	0.068	0.203	219.136	44.688	223.636	3.029	48.536	70.233	1.518	1.475	110.573	9.587	0.039	0.156	0.010
40532	sinkhole		0.27	0	369	369	0.122	0.036	0.087	81.135	18.813	85.635	1.693	19.211	32.714	0.728	0.547	52.354	3.550	0.022	0.057	0.013
40620	sinkhole		0.68	0	921	921	0.349	0.077	0.235	258.039	51.982	262.539	3.406	56.803	80.809	1.740	1.736	126.985	11.289	0.044	0.184	0.010
40621	sinkhole		0.49	0	665	665	0.244	0.058	0.167	176.139	36.626	180.639	2.613	39.400	58.543	1.272	1.186	92.434	7.706	0.034	0.125	0.011
40908	spring		0.50	0	678	678	0.249	0.059	0.170	180.234	37.394	184.734	2.653	40.270	59.656	1.295	1.213	94.161	7.885	0.034	0.128	0.011
41027	sinkhole		0.30	0	401	401	0.135	0.038	0.096	91.455	20.748	95.955	1.792	21.404	35.519	0.787	0.617	56.708	4.001	0.023	0.064	0.013
41200	spring		0.29	0	394	394	0.133	0.038	0.094	89.325	20.349	93.825	1.772	20.952	34.940	0.775	0.602	55.809	3.908	0.023	0.063	0.013
41437	sinkhole		0.17	0	225	225	0.063	0.025	0.049	35.272	10.213	39.772	1.248	9.465	20.244	0.466	0.239	33.005	1.543	0.016	0.024	0.014
41466	sinkhole		0.18	0	246	246	0.072	0.027	0.055	41.824	11.442	46.324	1.312	10.858	22.026	0.504	0.283	35.769	1.830	0.017	0.029	0.014
41744	spring		0.11	0	152	152	0.033	0.020	0.030	11.930	5.837	16.430	1.022	4.505	13.899	0.333	0.082	23.158	0.522	0.013	0.007	0.014

INPUTS			
T =	20	days	Days between events, 20 days is maximum
ADT =	30000	veh/day	ADT in design year
K (1) =	67.6	lb/mi-day	Pollutant accumulation rate
K (2) =	12		Wash-off coeffcicient for rural cross section
Rain Volume =	1.20	in	Volume of rainfall for 50 year-10 Minute (NOAA)
Rain Duration =	0.167	hr	Duration of rainfall for 50 year-10 minute (NOAA)
r =	7.200	in/hr	Run off rate

Table #2: Average Pollutant Concentration of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

ID	Type	Approx. Station	Run-Off Area inside R/W	Run-off Volume inside R/W			*Average Concentration*															
							Lead	Copper	Zinc	TSS	VSS	TVS	TKN	TOC	COD	TN	TPO4	CL-	Fe	Cd	Cr	Hg
		(feet)	(acres)	(cf)			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
40010	sinkhole		10.16	44,275			0.036	0.012	0.027	23.305	5.674	24.935	0.554	5.666	10.195	0.229	0.157	16.397	1.020	0.007	0.016	0.005
40097	sinkhole		12.24	53,300			0.036	0.011	0.026	23.548	5.498	24.902	0.501	5.597	9.608	0.214	0.159	15.387	1.030	0.006	0.016	0.004
40130	sinkhole		1.38	5,990			-0.021	0.034	0.007	-54.663	-0.612	-42.617	1.897	-6.342	13.661	0.395	-0.361	25.459	-2.392	0.024	-0.043	0.039
40132	sinkhole		0.68	2,972			-0.100	0.058	-0.022	-154.347	-9.519	-130.071	3.395	-22.171	15.519	0.544	-1.025	32.667	-6.753	0.043	-0.119	0.080
40171	sinkhole		1.70	7,425			-0.024	0.026	0.001	-49.231	-1.456	-39.512	1.481	-6.207	9.627	0.290	-0.326	18.375	-2.154	0.019	-0.039	0.032
40183	sinkhole		5.70	24,840			0.026	0.014	0.022	11.138	4.412	14.043	0.693	3.639	9.907	0.234	0.076	16.400	0.487	0.009	0.007	0.009
40204	swallet		6.18	26,941			0.029	0.014	0.024	14.170	4.800	16.848	0.677	4.184	10.194	0.238	0.097	16.766	0.620	0.009	0.009	0.008
40215	sinkhole		13.75	59,889			0.033	0.010	0.023	21.725	5.037	22.930	0.453	5.144	8.759	0.195	0.147	14.018	0.950	0.006	0.015	0.003
40217	sinkhole		11.89	51,808			0.032	0.010	0.023	20.297	4.920	21.690	0.477	4.923	8.816	0.198	0.137	14.173	0.888	0.006	0.014	0.004
40414	sinkhole		3.00	13,054			0.003	0.018	0.012	-15.023	1.605	-9.496	0.968	-0.773	9.004	0.239	-0.098	15.927	-0.657	0.012	-0.013	0.018
40509	spring		31.93	139,087			0.034	0.008	0.023	25.265	5.152	25.784	0.349	5.596	8.097	0.175	0.170	12.748	1.105	0.004	0.018	0.001
40532	sinkhole		10.47	45,617			0.043	0.013	0.031	28.522	6.613	30.104	0.595	6.753	11.500	0.256	0.192	18.404	1.248	0.008	0.020	0.005
40620	sinkhole		7.56	32,951			0.170	0.037	0.114	125.576	25.297	127.766	1.658	27.644	39.326	0.847	0.845	61.798	5.494	0.021	0.090	0.005
40621	sinkhole		6.64	28,936			0.135	0.032	0.092	97.613	20.297	100.107	1.448	21.834	32.443	0.705	0.657	51.225	4.271	0.019	0.069	0.006
40908	spring		21.69	94,490			0.042	0.010	0.029	30.587	6.346	31.351	0.450	6.834	10.124	0.220	0.206	15.980	1.338	0.006	0.022	0.002
41027	sinkhole		13.45	58,586			0.037	0.011	0.026	25.032	5.679	26.264	0.491	5.859	9.722	0.216	0.169	15.522	1.095	0.006	0.018	0.003
41200	spring		19.28	83,994			0.025	0.007	0.018	17.054	3.885	17.913	0.338	4.000	6.671	0.148	0.115	10.655	0.746	0.004	0.012	0.002
41437	sinkhole		14.27	62,145			0.016	0.007	0.013	9.101	2.635	10.263	0.322	2.442	5.224	0.120	0.062	8.517	0.398	0.004	0.006	0.004
41466	sinkhole		15.03	65,454			0.018	0.007	0.013	10.246	2.803	11.349	0.321	2.660	5.396	0.123	0.069	8.763	0.448	0.004	0.007	0.003
41744	spring		4.58	19,931			0.027	0.016	0.024	9.599	4.696	13.219	0.822	3.625	11.182	0.268	0.066	18.632	0.420	0.011	0.006	0.011
Accute Aquatic Criterion, AAC (Table 2, 327 IAC 2-1-6)							**0.262**	**0.042**	**0.254**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**860**	**n/a**	**0.011**	**3.679**	**n/a**
Chronic Aquatic Criterion, CAC (Table 2, 327 IAC 2-1-6)							**0.01**	**0.026**	**0.23**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**230**	**n/a**	**0.0023**	**0.438**	**n/a**
Point of Water Intake Human Health (Table 1, 327 IAC 2-1-6)							**0.05**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.01**	**n/a**	**n/a**	**n/a**	**0.01**	**170**	**0.00014**

Values in red exceed one of the water quailty standards

Exhibit #8: 50 Year - 10 Minute Rain Event using Low Cost Criteria

Table #3: Background (Pre-Construction) Pollutant Mass Loading of Karst Features Inside Proposed R/W and Outside Construction Limits - Low Cost Criteria for Refined Preferred Alternative #2

							Mass Load per Rain Event (Background)															
ID	**Type**	**Karst Drainage Basin**	**Run-Off Volume in Basin**	**Run-Off Volume in Basin**			**Lead**	**Copper**	**Zinc**	**TSS**	**VSS**	**TVS**	**TKN**	**TOC**	**COD**	**TN**	**TPO4**	**CL-**	**Fe**	**Cd**	**Cr**	**Hg**
		(acres)	**(cf)**	**(Liters)**			**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**	**(lb)**
40010	sinkhole	0.02	26	740			0.000	0.000	0.000	0.356						0.003			0.004	0.000	0.000	0.000
40097	sinkhole	0.26	340	9,621			0.002	0.000	0.002	4.624						0.039			0.058	0.000	0.000	0.000
40130	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
40132	sinkhole	0.68	889	25,162			0.004	0.001	0.006	12.093						0.103			0.151	0.000	0.000	0.000
40171	sinkhole	0.18	235	6,661			0.001	0.000	0.002	3.201						0.027			0.040	0.000	0.000	0.000
40183	sinkhole	0.76	993	28,123			0.005	0.001	0.006	13.516						0.115			0.169	0.000	0.001	0.000
40204	swallet	21.12	27,600	781,518			0.125	0.034	0.179	375.600						3.187			4.704	0.003	0.015	0.001
40215	sinkhole	0.32	418	11,841			0.002	0.001	0.003	5.691						0.048			0.071	0.000	0.000	0.000
40217	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
40414	sinkhole	4.01	5,240	148,385			0.024	0.006	0.034	71.314						0.605			0.893	0.001	0.003	0.000
40509	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
40532	sinkhole	0.18	235	6,661			0.001	0.000	0.002	3.201						0.027			0.040	0.000	0.000	0.000
40620	sinkhole	0.16	209	5,921			0.001	0.000	0.001	2.845						0.024			0.036	0.000	0.000	0.000
40621	sinkhole	0.12	157	4,440			0.001	0.000	0.001	2.134						0.018			0.027	0.000	0.000	0.000
40908	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41027	sinkhole	0.04	52	1,480			0.000	0.000	0.000	0.711						0.006			0.009	0.000	0.000	0.000
41200	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a
41437	sinkhole	3.53	4,613	130,623			0.021	0.006	0.030	62.778						0.533			0.786	0.000	0.002	0.000
41466	sinkhole	0.22	287	8,141			0.001	0.000	0.002	3.912						0.033			0.049	0.000	0.000	0.000
41744	spring	n/a	n/a	n/a			n/a	n/a	n/a	n/a						n/a			n/a	n/a	n/a	n/a

INPUTS

C =	0.3		Runoff coefficient
R =	0.360	in	Total runoff
Mean Runoff Concentrations for Urban Open Land Use	218	mg/L	TSS
	1.85	mg/L	TN
	2.73	mg/L	Fe
	0.00158	mg/L	Cd
	0.00851	mg/L	Cr
	0.0197	mg/L	Copper
	0.0728	mg/L	Lead
	0.0005	mg/L	Hg
	0.1037	mg/L	Zinc

Values listed in red exceed the lowest of the Water Quality Standards found in IAC.

FHWA HIGHWAY RUNOFF WATER QUALITY TRAINING COURSE

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

Estimated Time for Section:

The CONTENT of this Section

This section introduces impact prediction techniques developed by FHWA and others to assess highway runoff water quality impacts. Several specific procedures will be introduced either by lecture or by case study problems. Specific methods include estimating the highway runoff impact, maintenance practice impacts, groundwater impacts, and aquatic system impacts. Also, a brief overview of water quality models which have been developed to assess the impact of nonpoint pollution on watersheds relative to highway runoff will be provided.

The GOAL of this Section

Participants will become familiar with predicting quality changes in water quality parameters associated with highway runoff water quality.

The PURPOSE of this Section

To introduce participants to different qualitative and quantita- tive techniques for predicting highway runoff water quality impacts.

Listing of Sessions — Time

Session 8.1	Impact Procedures and Data Requirements
Session 8.2	Introduction to Highway Runoff Pollutant Characteristics Predictive Procedures
Session 8.3	Prediction of Pollutant Loadings and Runoff Concentrations on Highway Surfaces - Case Study
Session 8.4	Prediction of Loading Impacts of Highway Runoff - Case Study
Session 8.5	Prediction of Maintenance Impacts
Session 8.6	Prediction of Groundwater Impacts
Session 8.7	Aquatic System Impacts
Session 8.8	Introduction to Water Quality Models for Predicting Water Quality Impacts

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.1: IMPACT PROCEDURES AND DATA REQUIREMENTS

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be introduced to a procedure for the assessment of effects of stormwater runoff from operating highways on receiving waters.
- Be introduced to a general procedure for evaluating potential impacts of highway maintenance practices on water quality.
- Know what data may be required to assess impacts of highway stormwater runoff on quality.

SESSION OVERVIEW:

This session introduces general procedures for assessing potential water quality impacts of highway stormwater runoff and maintenance practices. The specific methods will be introduced in later sessions. An overview of data required to assess water quality impacts of highway stormwater runoff is also presented.

I. INTRODUCTION

Data requirements to assess the need to conduct impact analysis or the potential effects of highway operations on surface water quality are identified in Table 8.1.1. This check list may be supplemented by site-specific data requirements.

II. ASSESSMENT OF HIGHWAY STORMWATER RUNOFF IMPACTS

Determining the need to assess the impact of highway stormwater runoff and the level of analysis depends on a number of factors. Selected factors include:

- The amount of traffic anticipated or currently traveling on the highway.
- The proximity of the highway site to receiving waters and their designated uses (e.g., drinking water, recreation, etc).
- Local and state requirements for control of nonpoint and stormwater point sources.
- Climatic factors, such as frequency and intensity of rainfall.
- The ratio of impervious surface to total watershed area upstream of project site.
- Local controversy.

Figure 8.1.1, illustrates a procedure for assessment of effects of stormwater runoff from operating highways on receiving waters. The first step in the procedure involves determining the anticipated impacts and/or the degree of controversy involved. Possible criteria useful in making the determination are:

- Traffic volumes in excess of 30,000 ADT.
- The highway site located near receiving stream where low dilutive capacities exist.
- Direct discharge of highway runoff to poorly flushed areas of lakes, wetlands, or coastal embayments.

If the decision is made to conduct an analysis, then either a seasonal/annual pollutant loading analysis or an event analysis should be made.

Table 8.1.1. Data for assessing water quality impacts of highway stormwater runoff.

Highway Design Features
- Length
- Number of lanes and lane widths
- Type of access
- Access ramps or intersecting roads
- Paving material
- Type of section(s) involved (at grade, cut, fill)
- Slopes (longitudinal and side)
- Median characteristics (width, paving, barrier type)
- Shoulder characteristics (width, paving, barrier type)
- Characteristics of area outside the shoulders but within the right-of-way (dimensions, topography, vegetation)
- Total impervious surface area

Operating Conditions
- Design average daily traffic (ADT)
- Projected vehicle composition
- Expected daily, weekly and seasonal traffic patterns
- Anticipated average speeds and braking characteristics
- Summary of applicable accident and spill data (from records on similar highways

Drainage System Characteristics (to the extent available during environmental assessment)
- Channel types (closed conduit, paved open channel, bare open channel, vegetated open channel, unchanneled overland flow, etc.)
- Channel dimensions and slopes
- Soils and vegetation characteristics in flow path
- Discharge points
- Collection systems (type, dimensions and spacings of drop boxes, etc.)
- Design flow rates

Hydrologic Characteristics
- Average annual precipitation (rain and snow) and monthly distribution of precipitation
- Receiving water and ground water data --
  - Streams (base flow, annual average flow, peak flow, flood plain maps)
  - Lakes and reservoirs (surface area, mean depth, water residence time)
  - Wetlands (surface area)
  - Groundwater (locations of aquifers, recharge characteristics)
- Summary of available data on point and nonpoint source flows in the watershed

Water Quality and Aquatic Biological Data

- Summary of available receiving water and groundwater monitoring data (water quality; microflora; microfauna, aquatic plants, benthic macroinvertebrates; fish populations, migrations and spawning areas)
- Sensitive or unique habitats
- Threatened and endangered species
- Summary of available data on effluent quality of sources in the watershed
- Beneficial use classification
- Established water quality criteria

Surrounding Land Use Characteristics
- Total watershed area
- Percentage of total area in each land use category (organized as in Tables 3 and 4)

Projected Highway Maintenance Characteristics
- Sanding application (quantity, frequency, particle size description)
- Deicing agent application (type, quantity, frequency, additives used)
- Pesticide application (type, quantity, frequency, toxicity)
- Roadway maintenance (sweeping, washing)
- Right-of-way maintenance (mowing, ditch cleaning, fertilizing, irrigation)

Description of Special Features
- Construction on woodwaste fill
- Detention basins
- Oil and grease traps
- Other mitigative features

Source: Horner et al., 1982

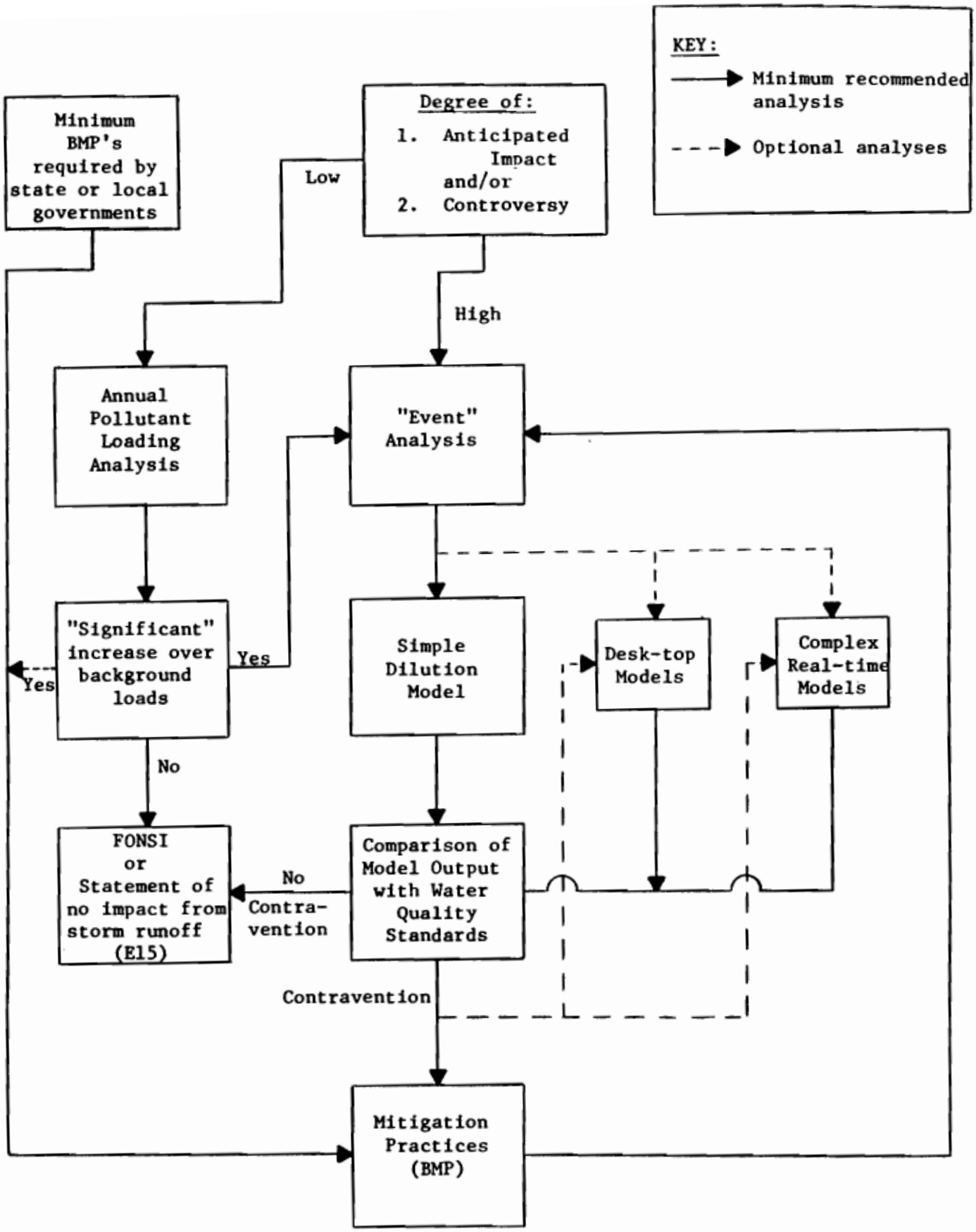


Figure 8.1.1. Simplified procedure for determining levels of analysis required to assess affects of stormwater runoff from operating highways on receiving streams.

Source: Dupuis and Kobriger, 1985.

A. SEASONAL/ANNUAL ANALYSIS

The seasonal/annual analysis determines the highway pollutant loadings relative to other loadings in the watershed. This seasonal/annual pollutant loading analysis may include either a simple determination of loadings (in pounds/yr), or the increase in stream pollutant concentration, using seasonal/annual highway pollutant input and mean flow conditions as a first cut on whether potential water quality problems may occur.

B. EVENT ANALYSIS

If the seasonal/annual analysis indicates the potential for more elaborate analysis, an event analysis may require using predictive model procedures or a simple dilution procedure. The assumption implied in dilution models are conservative, and if they show a standards exceedance, violations are not likely to appear under more exacting conditions.

If a more complex modeling effort is required, several models have been developed that provide the necessary level of analysis. In the majority of cases, these complex, real-time dynamic models would not need to be used.

Which ever approach is used, the results are compared with state water quality standards or, if standards have not been established, then the results may be compared with water quality criteria, to determine if mitigation is required.

Because of the variety of pollutants in highway stormwater runoff and the limited knowledge of the chemical, biological and physical impacts, any results may be subject to a considerable amount of uncertainty. The approaches presented in this section of the training course are intended to provide reasonable estimates of impacts based on the available information to date, and to provide highway agencies with the qualitative and quantitative procedures to make prudent planning decisions regarding highway stormwater runoff and water quality.

III. ASSESSMENT OF MAINTENANCE IMPACTS

Assessment of highway maintenance practice impacts is generally dependent on the extent and magnitude of the activity and its proximity to receiving waters. Session 2.1 provided an overview of when maintenance activity impacts should be assessed. Maintenance activities with potential impacts on water quality that need to be addressed are identified in Figure 8.1.2 with a general impact assessment method or procedure. This method is based on methods which are described in

Sessions 8.5 and 8.7. As with many procedures, it contains some subjective aspects relative to determining potentially significant impacts. It is intended to quantify, to the extent possible, selected maintenance impacts relative to the resource value of the stream, and to evaluate when mitigation measures are warranted. Specific aspects of this general method will be described in later sessions.

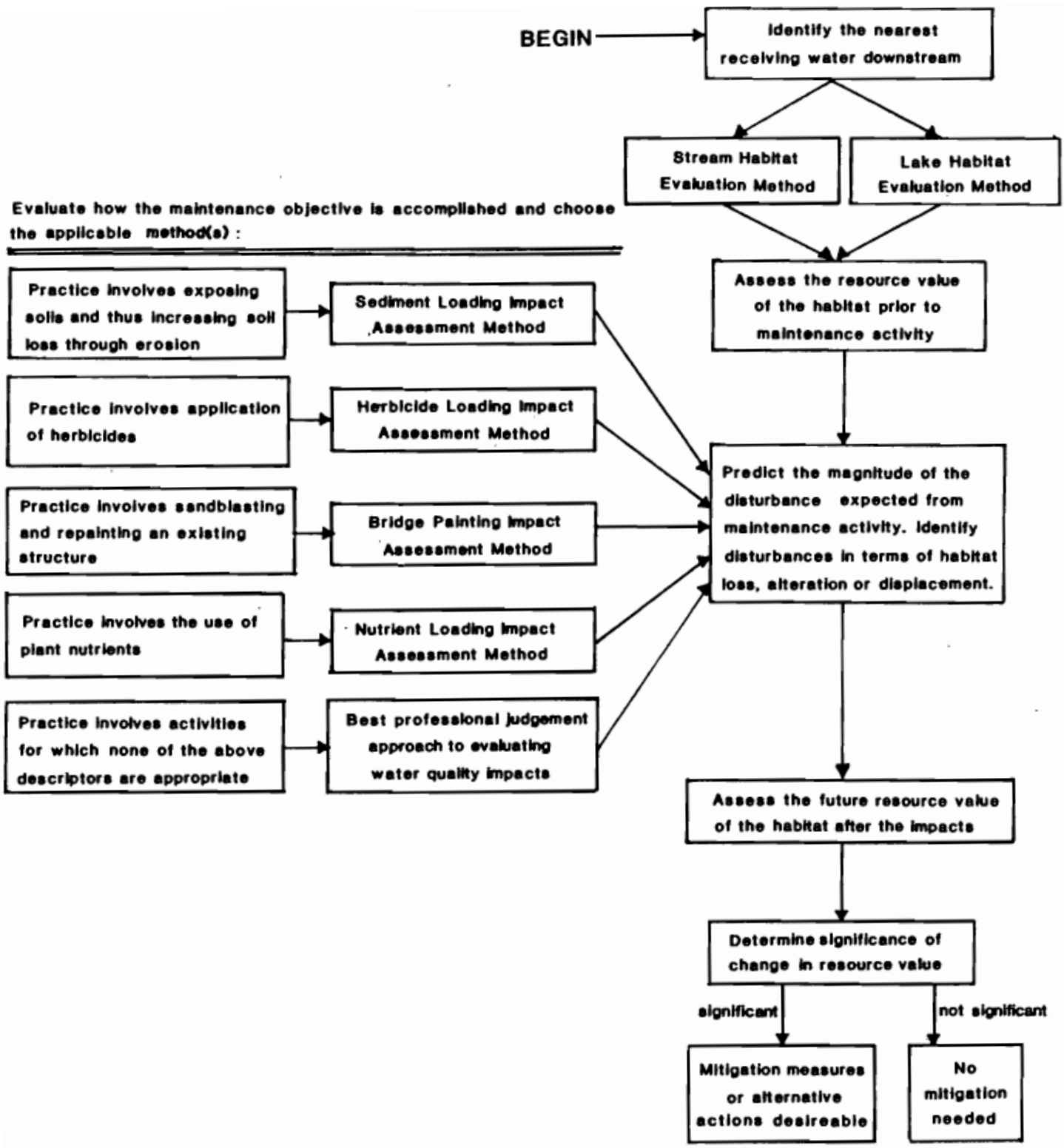


Figure 8.1.2. General impact assessment method for evaluating potential impacts to water quality from highway maintenance practices.

Source: Kramme et al., 1985

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.2: INTRODUCTION TO HIGHWAY RUNOFF POLLUTANT CHARACTERISTICS PREDICTIVE PROCEDURES

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will:

- Be familiar with the sections of FHWA's Predictive Procedure for Determining Pollutant Characteristics in Highway Runoff.
- Be familiar with other prediction methods developed to estimate highway runoff pollutant characteristics.
- Be knowledgeable about the limitations of the methods presented.

SESSION OVERVIEW:

A lecture will introduce the components of FHWA's Predictive Procedure not previously presented. Also, a brief overview of alternative methods will be examined to determine how they differ from FHWA's Procedure. The limitation of each method will also be discussed.

I. FHWA PREDICTIVE PROCEDURE

A. INTRODUCTION

Previous sessions presented selected components of FHWA's procedure on rainfall evaluation and highway runoff evaluation. An overview of the entire manual procedure and a detailed description of the procedure's remaining component follows. The model procedure is computerized both for mainframe and for personal computer.

The development of the procedure is based upon the monitoring program conducted in 1976 and 1977 at sites in Milwaukee, Wisconsin; Harrisburg, Pennsylvania; Nashville, Tennessee; and Denver, Colorado. Complete details of the monitoring programs can be found in Kobriger et al. (1981c).

B. PURPOSE

The predictive procedure offers highway designers and other interested parties a simplified tool to estimate the quantity and quality of storm generated highway runoff. It consists of a series of equations which can be solved manually or by computer. The procedure is composed of four components corresponding to the following functions:

- Rainfall runoff
- Pollutant build-up
- Pollutant wash-off
- Constituent loadings

The predictive procedure can be used for Environmental Impact Statements (EIS) or to determine the loadings for pollutant discharge effects of various design storms at a particular site. The predictive procedure is not meant to be an all-inclusive model which predicts hydrographs and concentrations versus time, but rather an easy-to-use method of determining the total volume of runoff and total pounds of a pollutant discharged from a highway area. The highway area under consideration is defined as the paved roadway and total nonpaved area which contribute to a particular discharge point.

In addition to EIS applications, the procedure evaluates existing highway systems. Thus, the effects of increased traffic, changes in the curb or barrier configuration, or modifications to the nonpaved area can be determined as they relate to the total pollutant loading. Design storm analyses can be conducted on an existing highway drainage area using the predictive procedure. The pollutant loadings, as predicted for these storms, can then be used to evaluate different water quality impacts through mass balance or modeling analyses. In this manner, the pounds of a pollutant discharged from a highway drainage area can be compared to other pollutant sources within the watershed.

C. GENERAL OVERVIEW

In order to use this method, the following information is required:

- Rain event data including date, total rainfall, estimated rainfall duration, and number of dry days between rainfall events
- Average Daily Traffic (ADT)
- Length of highway expressed as miles
- Drainage area above the point of discharge expressed as acres
- Estimated initial pollution levels expressed as pounds
- Total solids accumulation rate (optional, since the rate may be estimated based on ADT)

All of the above information is readily available to the highway engineer and water quality scientist.

Figure 8.2.1 provides an overview of the FHWA procedure.

1. Pollutant Accumulation Equation

The pollutant accumulation equation of the predictive model is as follows:

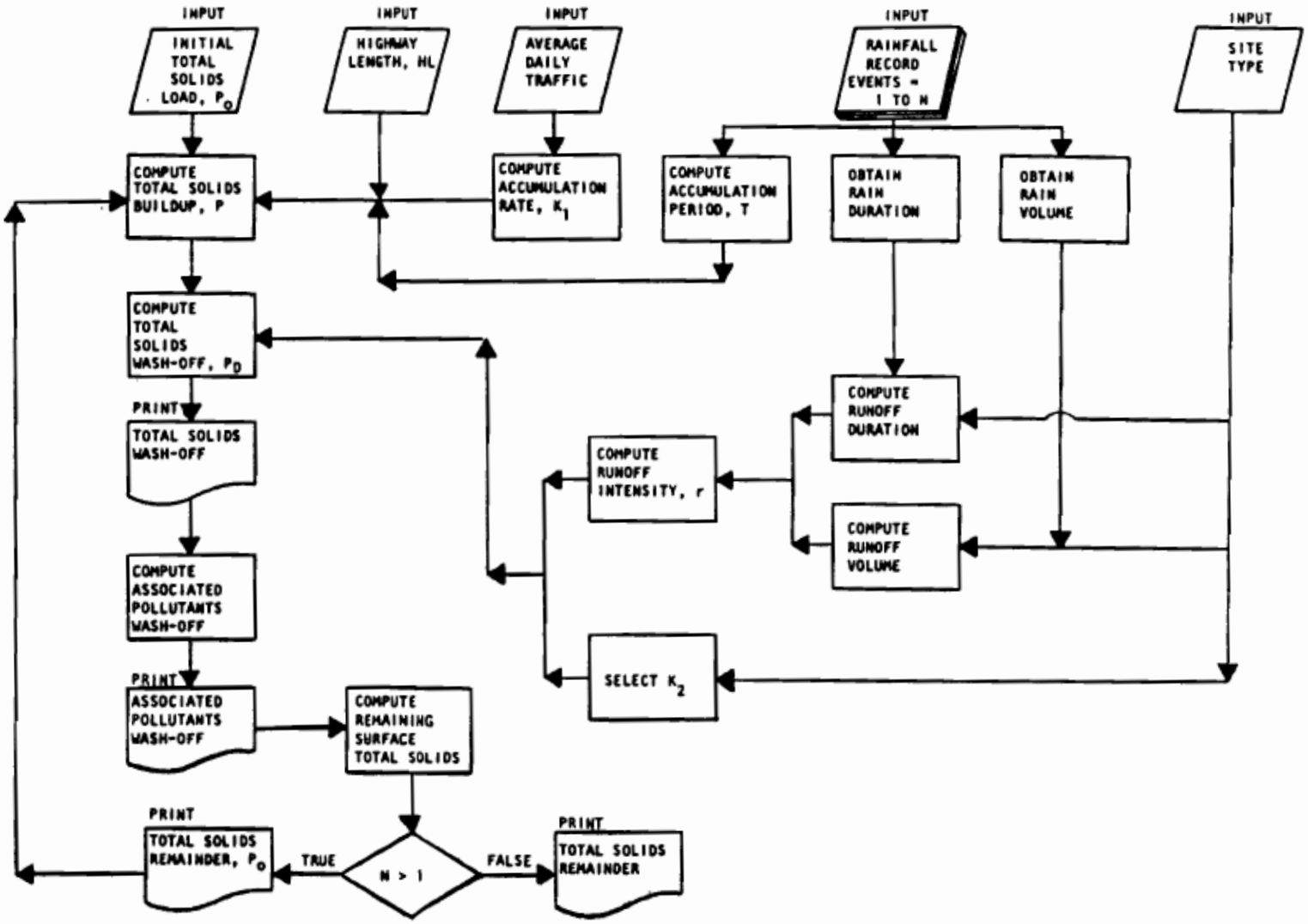
$$P = P_o + (K_1 * HL * T) \quad \text{.....(2)}$$

Where:
P = pollutant level after build-up, lb (kg)
P_o = initial surface pollutant load, lb (kg)
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
T = time of accumulation, days (20 day maximum)
HL = highway length, mi (km)

This model predicts the highway surface pollutant load (P) which accumulates during a selected time period (T) at a specified rate (K_1). Surface pollutants accumulate on the surface of all-paved sites (e.g., elevated bridge sections) and on the paved and unpaved surfaces of highway sections which have right-of-way areas (e.g. gravel shoulders, grassy areas, etc.). For purposes of the predictive model, pollutant load refers to that fraction of the total highway load available for wash-off.

The monitoring data from this study were "end-of-the-pipe" wash-off data, which are not a direct measure of pollutant build-up. Therefore, monitoring data could not be used to establish whether pollutant build-up

Figure 8.2.1 Predictive flow diagram



Source: Gupta, M.K. et al., 1981c

on highways is linear, exponential, or another mathematical function. The pollutant accumulation equation assumes that pollutants build up linearly during the accumulation period. This equation is similar to that used in Storage, Treatment, Overflow, Runoff Model (STORM) from Abbott (1976), which is based on a linear pollutant build-up relationship developed from a study on urban runoff in Chicago.

The surface pollutant accumulation variable K_1 is the rate at which the carrier pollutant, total solids, accumulates in pounds per mile per day (kg/km/day). A carrier pollutant exhibits the highest degree of association with all other pollutants being considered. In many mathematical models, the predicted quantity of carrier pollutant is used to estimate the quantity of all other pollutants being modeled. This method eliminates the need for each pollutant to be predicted separately by the model, greatly reducing the number of calculations required. Total solids were chosen as the carrier pollutant for the predictive model developed in this study, because they showed the highest correlation with the other monitored quality parameters when regression analyses were performed. The term total solids (TS) refers to total suspended solids (TSS) plus total dissolved solids (TDS). Under the new nomenclature of Standard Methods, total solids as used in this study, are defined as total residue.

K_1 was developed from monitored data, and is expressed as pounds per mile - day (kg/km-day). The unit miles refers to the actual length of highway section in the contributing drainage area. This is in contrast to curb mile or lane mile, which is a multiple of the highway length. K_1 is site specific, and its value may be based upon actual monitoring data, if it exists, or estimated from average daily traffic. K_1 estimation based on average daily traffic is discussed at the end of this section.

The initial surface pollutant load (P_o) is the pounds of pollutants on the surface at the beginning of the accumulation period. The accumulation period can be intervals within an actual rainfall record, intervals within a series of design storms, or the period prior to a single design storm event.

If an accumulation period follows a large storm event, the initial surface pollutant load will be considered zero (P_o=0). The definition of a large storm is based upon that used in the Stormwater Management Model (SWMM) for the rate of pollutant removal during a storm event. For purposes of the predictive procedure, a large storm event is defined as one with greater than one inch (2.54 cm) of total rainfall, and having at least one hour in which the average intensity is 0.5 inches per hour (1.27 cm/hr). For such a storm, SWMM estimates that approximately 90 percent of the surface pollutants available for wash-off have been removed.

For succeeding rainfall events in a continuous rainfall record, P_o is the surface pollutant load remaining after wash-off from the previous rainfall event. For rainfall records which do not follow a large storm event or for design storms, the initial surface pollutant load must be estimated using a site specific K_1 value, site length, and a specified period of build-up or estimate. An analysis of monitored wash-off data and rainfall records during the subject study suggests that dry periods greater than 20 days over-estimate the surface load; therefore, any dry periods exceeding 20 days are assumed to equal 20. The initial surface pollutant load for a site with a K_1 of 80, and a site length of 5 miles would be:

$$80 \frac{\text{lbs}}{\text{mi-day}} * 5 \text{ mi.} * 20 \text{ days} = 8{,}000 \text{ lbs } (3{,}629 \text{ kg})$$

Any rainfall less than 0.05 inches (0.13 cm) is considered a trace of rain not producing runoff of sufficient volume and rate to effect pollutant wash-off. Figure 8.2.2. indicates the relationship between pollutant build-up and rainfall intensity and volume.

The minimum runoff duration that can be used in calculating average runoff intensity is 0.5 hours. Short duration flows, less than 0.5 hours, are often the result of small storms producing less than 0.1 inches (.25 cm) of flow. Using the high average runoff rates calculated from such storms gives more weight to the pollutant wash-off ability of a small storm that occurs. For this reason, all storms used in the predictive procedure were considered to have a duration of at least 0.5 hours, eliminating overestimates of total solids wash-off for short duration storms. For example, a storm producing 0.05 inches (.12 cm) of runoff in 0.17 hours (10 minutes) would have an average runoff rate calculated using an adjusted runoff duration of 0.5 inch/hr as follows:

$$\begin{aligned}\text{Average runoff rate} &= 0.05 \text{ inch of flow} \div 0.5 \text{ hours} \\ &= 0.10 \text{ inch/hr } (0.25 \text{ cm/hr})\end{aligned}$$

Otherwise, the average rate calculated from the actual runoff duration (0.17 hr) would be 0.29 inch/hr (0.73 cm/hr) and would cause a large overprediction of pollutant wash-off.

2. K_1 Variable

The total solids accumulation rate (K_1) varies from location to location. Selected K_1 previously reported in the literature are indicated in Table 8.2.1.

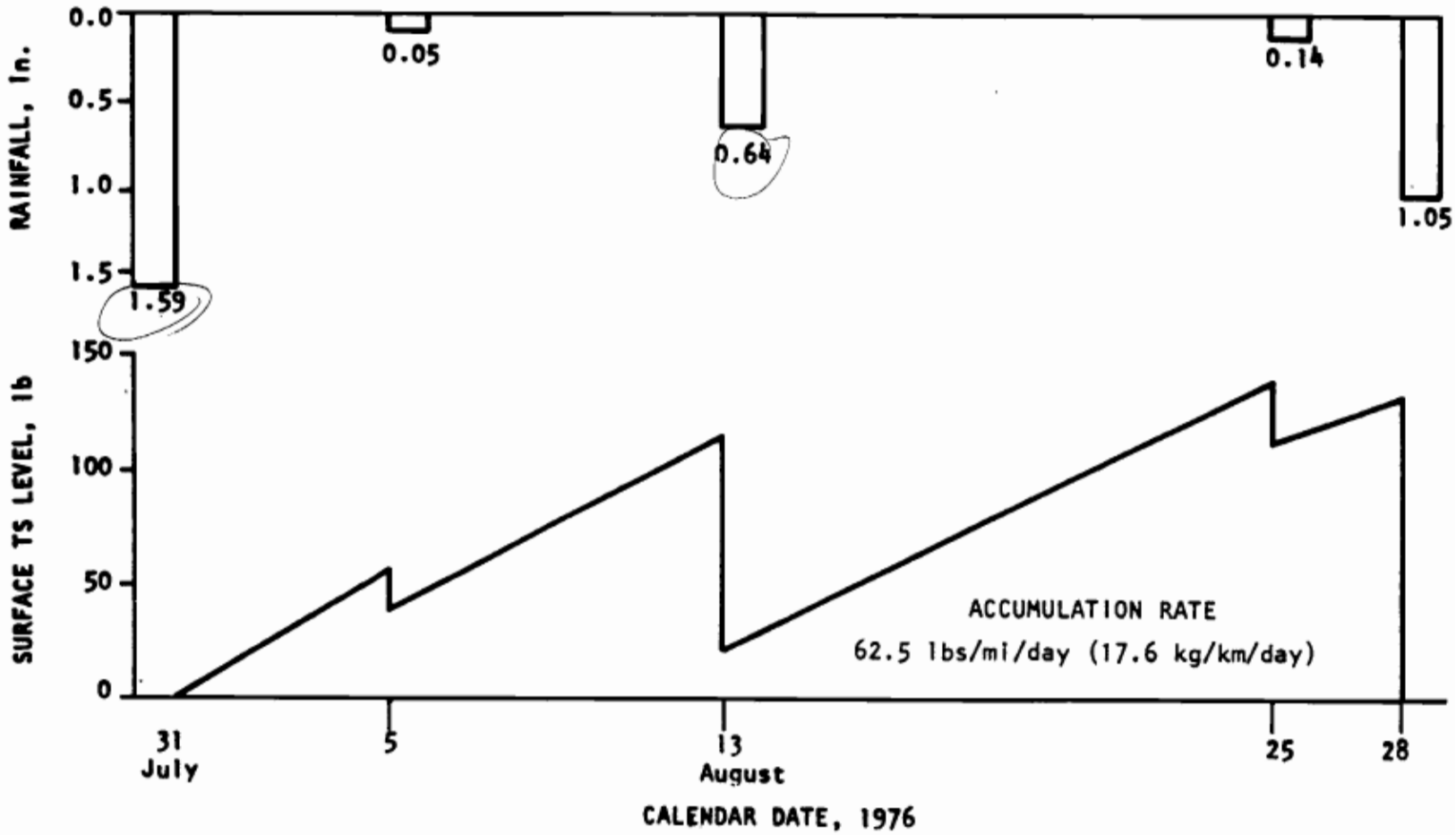


Figure 8.2.2. **Surface total solids level, Milwaukee - Hwy I-794.**

Table 8.2.1. Published K_1 values

Total solids accumulation rate, lb/mi-day	Location	Solids collection Techniques	Reference
1,580	Chicago City Sts.	Sweeping	American Public Works Association, 1969
1,180	11 U.S. City Sts.	Combined sweeping and flushing	Sartor, J.D. and G.B. Boyd, 1972
10.4	Seattle Highway	Runoff analysis	Sylvester, R.O. and F.B. DeWalle, 1972
382	Washington, D.C.	Vacuuming and	Shaheen, D.G., 1975
69.4	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973
26.6	Seattle Highway	Runoff analysis	Municipality of Metropolitan Seattle, 1973a
236.9	Milwaukee (non-winter)	Mass balance for TS 250	Kobriger, N.P., 1984

metric units: lb x 0.454 = kg
mi x 1.609 = km

The total solids accumulation rate was correlated with ADT for the sites included in the monitoring study (Figure 8.2.3). As a result, it is possible to calculate the appropriate solids build-up rate using the following equation, when site specific rates are not available:

$$K_1 = (ADT^{0.89})\ 0.007$$

3. Wash-Off Coefficient (K_2)

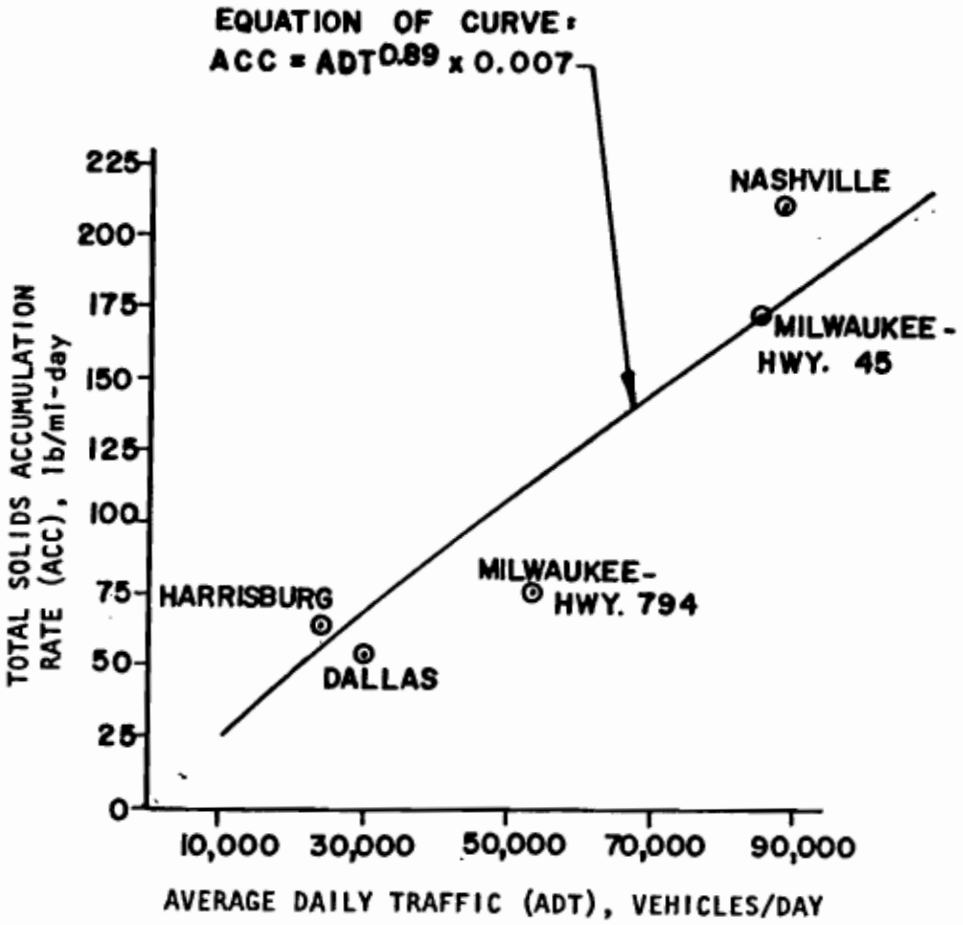
The coefficient K_2 is used in the predictive procedure to remove a portion of the carrier pollutant from the surface of the drainage area. The general wash-off equation in the Corps of Engineer STORM model and U.S. EPA Stormwater Management Model (Huber, 1975) is used as part of this procedure.

$$P_D = P\ (1-e^{-K_2 r})$$

Where: P_D = pounds (kilograms) of pollutant discharged
P = surface load at start of the runoff event.
K_2 = wash-off coefficient
r = average runoff rate, in./hr. (cm/hr)

For purposes of the predictive procedure, a single K_2 value is required for each of the three site categories. Based upon the comparison of individual K_2 values with actual monitoring data, a K_2 value of 6.5 represents sites which contain some curb or barrier, structured drainage, and grassy right-of-way (Type II). A value of 12 represents a rural, flush shouldered site (Type III) which uses grassy

Figure 8.2.3. Selected total solids accumulation rates versus average daily traffic



Source: Kobriger, N.P. et al., 1981

ditch conveyance for the surface runoff. A K_2 value of 5.0, selected for the Type I site, will be used for elevated bridge decks which are completely paved.

The Type III site requires the highest K_2 value in order to wash-off larger amounts of the pollutant load per runoff volume than other sites. This site type's flush shoulder and the nonpaved drainage conditions probably account for the high, since the grassy areas adjacent to the roadway require more pollutant wash-off per event to remove the pollutant load. The Type I site has the lowest K_2 value, indicating that pollutant wash-off is easier from a site that is all paved than a site with both paved and unpaved areas (Type II and III).

4. Constituent Loadings

The final component of the predictive procedure transforms the pounds of total solids washed off into pounds of lead, COD, suspended solids, or any other of the 16 quality constituents available in the model. The prediction of heavy metals, nutrients, solids and other parameters for individual storm events rely upon linear regression equations for predicting each parameter as a function of the total solids load for each site (Tables 8.2.2 and 8.2.3).

For example, the determination of the COD load for the Milwaukee I-794 site is as follows:

$$COD\ (lb) = 0.202\ TS + 5.47$$

where: TS = total solids in pounds

The asterisk in Tables 8.2.2 and 8.2.3 next to equations indicates significance at the 95 percent confidence limits (1). This indicates that one can be 95 percent confident that the sample was not selected from a population for which no correlation exists (i.e., that the correlation coefficient R is equal to zero). An equation may still provide good estimates even if the variables in that equation do not show a significant correlation at the 95 percent confidence level (Gupta et al., 1981c). An equation developed using regression techniques is the best fit of the data being analyzed.

The predictive procedure uses a separate constituent equation for each general site type. Individual equations account for differences between site drainage and solids retention characteristics.

D. PREDICTIVE PROCEDURE RESULTS

Table 8.2.4. summarizes the application results of the procedure to the five monitoring sites, plus a sixth site not included in the development of the procedure.

Table 8.2.2 Constituent equations developed for Type I and Type III sites.

Parameter		Type I Milwaukee I-794	Type III Harrisburg I-40
SS	=	0.53TS - 3.2*	0.32TS - 36.8*
VSS	=	0.191TS + 0.2*	0.061TS-3.3*
TVS	=	0.221TS + 13.3	0.32TS - 32.3*
TKN	=	3.3×10^{-3} TS + 0.16	3.1×10^{-3}TS+ 0.55*
BOD	=	0.023TS + 1.5*	N/A
TOC	=	0.057TS + 0.80*	0.068TS - 5.85*
COD	=	0.202TS + 5.47*	0.087TS + 0.65*
TN	=	1.37×10^{-3} TS + 0.12	1.83×10^{-3} TS+0.054*
TPO_4	=	1.0×10^{-3} TS + 3.0×10^{-4}	2.15×10^{-3}TS - 0.245
Cl^-	=	0.034TS + 2.59	0.135TS + 2.6*
Pb	=	5.6×10^{-3}TS - 0.024	4.1×10^{-4}TS - 0.029*
Zn	=	8.4×10^{-4}TS + 0.014	2.67×10^{-4}TS-0.011*
Fe	=	0.015TS + 0.59	0.014TS - 1.61*
Cu	=	2.9×10^{-4}TS+7.3×10^{-4}	7.4×10^{-5}TS+8.78×10^{-3}*
Cd	=	1.4×10^{-4}TS-1.4×10^{-3}	4.0×10^{-5}TS+0.007
Cr	=	1.6×10^{-4}TS+1.2×10^{-3}	2.3×10^{-4}TS-0.028
Hg	=	-7.6×10^{-7}TS+8.8×10^{-4}	-5.8×10^{-6}TS+0.015*

Note: TS = total solids (lb)
* - Variables correlate at the 95 percent confidence level.
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.3 **Constituent equations developed for Type II sites.**

Parameter	Equation
SS	$0.63TS - 188$
VSS	$0.152TS + 13.5$
TVS	$0.263TS + 243$
TKN	$5.46 \times 10^{-3}TS + 1.28$
BOD	$3.0 \times 10^{-2}TS + 28.3$
TOC	$5.6 \times 10^{-2}TS + 25.2$
COD	$0.193TS + 275.3$
TN	$1.3 \times 10^{-3}TS + 0.713$
TPO_4	$2.25 \times 10^{-3}TS - 0.32$
Cl	$0.042TS + 87$
Pb	$1.02 \times 10^{-3}TS + 0.04$
Zn	$5.84 \times 10^{-4}TS + 0.103$
Fe	$1.96 \times 10^{-2}TS - 5.0$
Ni	N/A
Cu	$3.16 \times 10^{-4}TS + 0.064$
Cd	$4.16 \times 10^{-5}TS + 0.021$
Cr	$4.3 \times 10^{-5}TS + 0.036$
Hg	$2.44 \times 10^{-6}TS + 1.006 \times 10^{-6}$

Note: TS = total solids (lb)
metric units: lb x 0.454 = kg

Source: Gupta, M.K. et al., 1981c

Table 8.2.4. Summary of Model Versus Actual Monitored Non-Winter Total Pollutant Loads Used to Develop the Predictive Procedures (except the Dallas Site)

Site Location	Total Solids, lb	Suspended Solids, lb	TPO_4, lb	COD, lb	Lead, lb[1]	Iron, lb
Milwaukee I-794						
Actual	1,862	570	1.03	271	5.17	22.94
Predicted	1,640	658	0.86	245	4.55	20.66
Predicted vs. Actual %	-11.9	+15.4	-16.5	-9.6	-12.0	-10.0
Milwaukee Hwy 45						
Actual	55,024	29,123	34.76	6,863	53.6	929.75
Predicted	63,478	36,665	137.11	17,205	65.47	1,115.14
Predicted vs. Actual %	+15.4	+25.9	+294.4	+150.7	+22.2	+24.2
Nashville I-40						
Actual	20,273	10,692	65.81	3,909	24.76	268.06
Predicted	23,325	11,369	30.62	6,294	24.53	367.97
Predicted vs. Actual %	+15.1	+6.3	-53.5	+61.0	-1.0	+37.3
Harrisburg I-81						
Actual	3,655	767	6.43	212	1.40	31.97
Predicted	3,689	835	5.64	170	1.22	36.59
Predicted vs. Actual %	+1.0	+8.9	-12.3	-19.8	-12.9	+14.5
Denver I-25						
Actual	11,016	7,263	13.66	4,338	11.99	252.43
Predicted	15,118	7,189	27.67	7,029	16.04	231.97
Predicted vs. Actual %	+37.2	-1.0	+117.2	+62.0	+33.8	-8.1
Dallas I-45						
Actual	468	204	NA	345	1.18	5.60
Predicted	626	307	NA	169	3.32	14.10
Predicted vs. Actual %	+33.8	+50.5	-	-51.0	+181.4	+151.8

[1]Caution must be used when interpreting the pollutant loadings of lead predicted by the model. The reduction in lead in gasoline has resulted in an estimated 50% reduction in lead loadings since the predictive procedure equation was developed.

As can be seen, the predicted versus the actual monitored data are within one order of magnitude for all values. Total solids and suspended solids in particular, are fairly close, although greater variation exists for other constituents. When predicted versus actual loadings on an event basis are compared, greater variation exists. Thus, the model is best suited for monthly or non-winter period evaluations.

The model is undergoing further evaluation and validation by FHWA in a study initiated in September, 1984, titled Design Procedures to Estimate Pollutant Loadings from Higher Stormwater Runoff. The study is to be completed in FY 1986.

E. MODEL LIMITATIONS

The predictive procedure is a tool for evaluating the effects of increased traffic, changes in the highway configuration, or other design aspects, on the loading of solids or other constituents to the receiving water.

Because of the complex interaction of rainfall, runoff and traffic on a highway, the prediction model has certain limitations. Users of the procedure are encouraged to further study the Predictive Procedures to ensure a full understanding of the components of the model and aid in the interpretation of the results (Kobriger, 1981c).

Specific limitations of the procedure are as follows:

- Geographic locations with low intensity, frequent rainfalls, e.g., Washington state, should not use this procedure. Research (Horner et al., 1982) demonstrates situations where ADT is not a valid variable to estimate pollutant accumulation on the roadway surface. This method will not be acceptable for use in California and states with similar climatic conditions.

- The procedure should be limited to non-winter periods. As such, the results will reflect only a portion of the total loadings that can be expected from a roadway. As shown in a more recent study (Kobriger, 1984), winter pollutant accumulation can be significant, although the dispersion is more complex and highly variable.

- The predictive procedure is better suited to continuous simulation using daily rainfall records covering periods of at least one month, since it is unable to predict surface loads prior to individual events.

- The model assumes the highway area to be uniformly characterized by the three site types that are listed. Significant variations in a site may have widely varying results.

- The predicted pounds of total solids washed off during a rainfall event are dependent upon the model prediction of the surface load at the start of the storm. If the surface load is underestimated, the pounds discharged will be low.

- The use of average runoff rate to remove surface pollutants is the quickest and easiest method. Peak runoff intensities during the runoff hydrograph may be more accurate, but are too complex for this procedure.

- Long dry periods and overlapping storms present predictive problems in determining the pre-storm surface load.

- Construction activities are difficult to simulate unless monitoring data is available to determine K_1 values.

II. FHWA PROCEDURE FOE ESTIMATING POLLUTANT LOADS

1. Determine the pollutant accumulation rate for the project site being evaluated if site specific or other accumulation values are being used:

$$K_1 = (ADT^{0.89}) * 0.007$$

where: K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
ADT = average daily traffic, vehicles/day

Example: If the site has an ADT of 30,000 vehicles per day, the K_1 value that results would be:

$$K_1 = (30{,}000^{0.89}) * 0.007$$
$$= 67.6 \text{ lb/mi-day } (19.1 \text{ kg/km-day})$$

2. a. Using K_1, determine the pounds of total solids on the surface of the project site at the start of the storm event:

$$P = P_o + (K_1 * HL * T)$$

where: P_o = initial surface pollutant load, lb
P = pollutant level after build-up, lb
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
HL = highway length, mi(km)
T = time of accumulation, days (20 days maximum)

The variable P_o is a function of the amount (load) of pollutants estimated to be left on the surface after the last rainfall event. If more than one event is being evaluated, e.g., monthly or seasonal loadings are being determined, the results of P_o are carried through the calculations on an iterative basis by subtracting the pounds washed off from the previous pollutant load. The build-up rate, K_1, is then used for each dry day to add to P_o until the pollutant load at the start of the next event is determined.

The initial estimation of a P_o is made easier if the first storm to be evaluated follows a storm of average rainfall intensity greater than 0.5 inches (1.27 cm) per hour. This large storm is assumed to wash-off essentially all of the available total solids load on the surface. The succeeding dry days are then used to build up the available surface load to the start of storm conditions. Further descriptions of P_o and K_1 are included in the components description of this report.

Example: If the accumulation period is six days, the highway length is 6.5 miles, K_1 is 67.6 16/mi-day (19.1 kg/km-day) (predicted from the ADT of 30,000 vehicles/day) and P_o is zero (assume accumulation period started with a large storm). The pollutant level after build-up (P) would be:

$$
\begin{aligned}
P &= P_o + (K_1 * HL * T) \\
&= 0.0 + (67.6 \text{ lb/mi-day} * 6.5 \text{ miles} * 6 \text{ days}) \\
&= 0.0 + (2{,}636.4 \text{ lbs}) \\
&= 2{,}636.4 \text{ lbs } (1{,}196 \text{ kg}) \text{ of total solids available at the start of event number one.}
\end{aligned}
$$

b. If a large rainfall event does not occur at the beginning of the initial accumulation period of the month or period being evaluated, P_o must be estimated. One method is to evaluate local climatic data to determine the average number of dry days between rainfall events. P_o can then be estimated using the average number of dry days, K_1 and highway length.

Another approach would be to estimate the pollutant load for the first event in the period, and determine the number of dry days since the last rain event prior to the start of the event period actually being evaluated. Note: The event used to establish the accumulation period for the first event in the period or month of concern must be rainfall, not snowfall, otherwise use the first approach. Assume that $P_o = 0$. Then count the number of dry days to determine the load available for the first event for the period. This will slightly underestimate the pollutant load on the highway's surface if this previous event was less than 0.5 in./hr., since it will not account for the load left on the surface. This applies to the first approach as well.

Example (1st approach): If a large storm did not precede the initial accumulation period, and if the average number of dry days between storms was determined to be four, the estimate of P_o would be calculated as follows:

$$P_o = K_1 * HL * T$$
$$= 67.6 * 6.5 * 4$$
$$= 1{,}758 \text{ lb } (797 \text{ kg})$$

3. Calculate load wash-off using the average runoff rate (r) using the following formula:

$$P_D = P(1-e^{-K_2 r})$$

where: P_D = pollutant load discharged (total solids), lb (kg)
P = pollutant load at the storm start, lb (kg)
K_2 = wash-off coefficient r = average runoff rate - inch/hr (cm/hr)

K_2 is selected based upon site characteristics as follows:

K_2 =	Type 1	Type 2	Type 3
	5.0	6.5	12.0

Example: Assuming the site is Type II, the pounds of total solids removed would be determined as follows (P = 2,636 lbs; r = .019 in./hr, assumed here; K_2 = 6.5)

$$P_D = P(1-e^{-K_2 r})$$
$$= 2{,}636\ (1-e^{-(6.5)(0.019)})$$
$$= 306 \text{ lb of total solids discharged } (139 \text{ kg})$$

4. Calculate the surface load remaining after the storm from the above example.

$$P_o = P - P_D$$
$$= 2{,}636 \text{ lb} - 306 \text{ lbs}$$
$$= 2{,}330 \text{ lb of total solids remaining } (1{,}057 \text{ kg})$$

Thus, P_o for the next event is 2,330 lb (1,057 kg). This amount is then added to P (pollutant load after build-up that is available for washoff by next rainfall event.)

5. To calculate loadings, use the equations in Tables 8.2.2 and 8.2.3 for each pollutant of interest for each site type. The results will be expressed as pounds of pollutants discharged at the highway site for each event.

Example: From the previous example, it was determined that 306 lbs of total solids were washed off from the site. To calculate the amount of the pounds Zn washed off:

$$Zn = 5.84 * 10^{-4}TS + 0.103$$
$$= 5.84 * 10^{-4}(306) + 0.103$$
$$= .28 \text{ lbs of Zn}$$

6. Determine the average concentration of Zn in the highway runoff using the following formula (7.48 is a conversion factor to convert volume to gallons):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

Example: From the previous step, the loading of Zn was determined to be .28 lbs. Thus, the average concentration in the runoff would be (Assume Q_{cf} = 7,000):

$$P_{conc} = (P_{Zn} * 454{,}000)/(Q_{cf} * 7.48 * 3.785)$$

$$= \frac{.28 \text{ lbs} * 454{,}000 \text{ mg/lbs}}{7{,}000 \text{ cf} * 7.48 * 3.785 \text{ liters/gallon}}$$

$$= \frac{127{,}120 \text{ mg}}{198{,}182 \text{ liters}}$$

$$= .641 \text{ mg/liter of Zn in highway runoff.}$$

7. Repeat the above calculations to obtain the total solids wash-off for each event and pollutants.

III. CALIFORNIA METHOD FOR ESTIMATING

A. INTRODUCTION

Caltrans has developed a different procedure for estimating highway runoff quality (Howell et al., 1982; Kerri et al., 1985). Its method reflects the findings of studies for sites located in California:

- The number of dry days between storm events and the corresponding cumulative traffic volume before the storm were found to be not statistically significant for estimating constituent loads.

- Equations used to estimate the cumulative loads of the following pollutants were found to be statistically significant at the .05 level, on a storm event basis when:

- Correlated with vehicles during the storm: COD, Filterable Residue (Dissolved Solids), Lead (T), TKN, ZN(T).

- Correlated with total residue: COD, Nonfilterable Residue (Suspended Solids), ZN(T).

- No statistically significant correlations at the .05 level of significance were found with any of the independent variables examined: boron, cadmium, nitrate nitrogen, ammonia nitrogen, total phosphorus, dissolved orthophosphate, oil and grease. Thus, these pollutants cannot be estimated using the Caltrans procedure.

- The method is considered suitable on an event basis.

- The regression equations developed in this research can be used for calculating constituent loads from the paved travelled way and shoulder area. In order to assess the effects of the constituent load on nearby receiving waters - the load must be routed through the drainage system and ultimately to the receiving water - runoff from other sources may be encountered and must be included - highway runoff dilution factors in terms of the receiving water source must be accounted for.

B. PROCEDURE FOR USING THE REGRESSION EQUATIONS

In using the Caltran procedure the following assumptions are made:

- The vehicle fleet and fuels used are relatively the same as the years of actual data collection (1979 through 1981) to build the regression equations.

- The highway is in an urban setting.

- The drainage area of the roadway surface is between 2.00 and 3.00 acres, as this was the smallest area from which data were collected to build the equations. (HL * HW of pavement = 72<3 acres).

- The median, traveled lanes, and shoulders are 100 percent paved.

- The procedure should be used with highways having ADT exceeding 30,000 vehicles, and only when a sensitive receptor, e.g. stream, lake etc., is located adjacent to the facility.

- Runoff from the assumed drainage area is conveyed via open channels to a single point of discharge. (Runoff quantity and quality from the unpaved area adjacent to the paved area was excluded from the research.)

- The storm chosen is an annual one-day rainfall event (two-year return interval) versus actual continuous events evaluation required by FHWA procedure.

- A 24-hour storm is chosen as the storm duration, since a storm lasting 24 hours will be sufficient to wash-off the gutter load and will allow both the AM and PM peak traffic to travel through the site and contribute to the runoff load. A 24-hour storm is used because the future traffic prediction is a 24-hour value.

- A runoff coefficient of 0.90 is used to compute the cumulative runoff volume because the drainage area is completely paved.

1. Using the projected average daily traffic (ADT), compute constituent loads using the linear regression equations below which were evaluated and found to be acceptable.

Eq.1	Pb	= 14.3 + 0.00189 (ADT)
Eq.2	Zn	= 14.3 + 0.00060 (ADT)
Eq.3	FR	= 5360 + 0.140 (ADT)
Eq.4	COD	= 3590 + 0.221 (ADT)
Eq.5	TKN	= 150 + 0.00342 (ADT)

Where: Pb, Zn, FR, COD, and TKN are the cumulative loads in grams for lead, zinc, filterable residue, chemical oxygen demand, and total Kjeldahl nitrogen, respectively, the intercepts represent initial dry loads in grams, while the slopes represent the washoff of a constituent in grams per ADT during storm.

2. To forecast an annual load, divide the depth (amount) of the total annual rainfall (2-year return interval, 365-day value) for the station by the 1-day depth. The result is the theoretical number of 1-day events per year. Multiply each of the daily loads by the number of 1-day events to arrive at an annual load.

3. The flow weighted concentration is computed by dividing the daily event load determined in Step 1 (above) by the 1-day cumulative runoff volume.

4. The following linear regression equations are used to calculate nonfilterable residue loads:

Eq.6	Zn	= 11.5 + 0.00064 (TR)
Eq.7	COD	= 3600 + 0.214 (TR)
Eq.8	NR	= -760 + 0.65 (TR)

Where: TR is total residue in grams, Zn, COD, and NR are the cumulative loads in grams for zinc, chemical oxygen demand, and nonfilterable residue, respectively. The intercepts represent the initial dry loads in grams, while the slopes represent the fraction of constituent found in the total residue load washed from the pavement during the storm. Because total residue is an independent variable for which no easy future value can be obtained, the following procedure should be executed. Substitute values of the total zinc load computed from Equation 2 and the chemical oxygen demand load computed from Equation 4 in Equations 6 and 7 and compute two values of total residue. Then use the average value of total residue to compute the nonfilterable residue load using Equation 8. Compute the flow-weighted concentration as in Step 3 (above).

5. The final step is to check the computed loads and flow-weighted concentrations to make sure that the computed values are bound by the field observations. Table 8.2.5. shows the limits of the observed concentrations and loads.

Table 8.2.5. Limits of observed concentrations and loads of single events from monitored events in California.

Constituent	Concentration (mg/l)		Load (grams)	
	Low	High	Low	High
Total lead	0.17	4.10	4.0	304
Total zinc	0.10	1.80	2.0	84
Filterable residue	16	461	428	50,167
Chemical oxygen demand	23	724	382	26,344
Total kjeldahl nitrogen	0.1	14.0	34	1,070
Nonfilterable residue	18	2,660	143	55,259

Source: Howard et al., 1982

6. Final water quality assessment must be made using the values of loads and concentrations in a receiving water analysis.

C. EXAMPLE PROBLEM USING CALTRAN PROCEDURE

The following example problem is taken directly from Howell (1982) and is reproduced here to demonstrate the use of the Caltran model.

Problem: An urban freeway has been proposed for year 2005 and will have the following dimensions:

46 feet of paved median	=	46 ft
Two 10-foot wide shoulders	=	20 ft
Four 12-foot wide lanes	=	48 ft
		114 ft width

The ADT for year 2005 is 56,800 vehicles. The project will cross a river used for recreation and fishing. Trout (*Salmo gairdneri*) inhabit the river. Average annual rainfall for the site is 22 inches.

Make the following assumptions:

- The paved width of 114 ft and each 750 ft of freeway length will be drained to a single discharge point.
- Runoff coefficient is 0.90; thus, .90 * rainfall volume = runoff volume.
- A 24-hour storm delivers 2.06 inches of continuous rainfall.
- The vehicle fleet (and fuel used) will be the same in 2005 as it was in 1980. The vehicles are operating normally, i.e., at speeds of 55 miles per hour with no accidents or spills.

Given the above data and assumptions compute:

- The area of the assumed catchment.
- The cumulative volume of runoff (in liters).
- The loads and flow-weighted concentrations of the constituents: lead (Pb), Zinc (Zn), filterable residue (FR), chemical oxygen demand (COD), and total Kjeldahl nitrogen (TKN), and nonfilterable residue, using equations 1 through 5.

1. Area = length (ft) * width (ft) $\left(\frac{1 \text{ acre}}{43{,}560 \text{ ft}^2}\right)$ = acres

$$= 750 * 114 * \frac{1}{43{,}560} = 1.96 \text{ acres}$$

(1.96 acres approaches the lower limit of 2.0 acres, the smallest area from which data were collected to build the equations).

2. Cumulative Runoff Volume = runoff coefficient * rainfall volume

   = [0.90] * [2.06 in] * [1.96 ac] * [3630 ft^3/ac-in] [28.32 $1/ft^3$]

   = 373,564 call 373,500 liters

3. First, compute the load in grams using the appropriate regression equation, then compute the flow-weighted concentration (conc.) in milligrams per liter:

$$\text{conc.(mg/l)} = \frac{\text{Load (grams)}}{\text{cumulative runoff volume (liters)}} * \frac{\text{1000 milligrams}}{\text{1 gram}}$$

Eq.1	Pb	=	14.3 + 0.00189 (56,800)	
		=	121.65	122 grams
	conc.	=	121.65/373,500 * 1,000	
		=	0.326	0.33 mg/l
Eq.2	Zn	=	14.3 + 0.00060 (56,800)	
		=	48.38	48 grams
	conc.	=	48.38/373,500 * 1,000	
		=	0.129	0.13 mg/l
Eq.3	FR	=	5,360 + 0.140 (56,800)	
		=	13,312	13,300 grams
	conc.	=	13,312/373,500 * 1,000	
		=	35.64	35.6 mg/l
Eq.4	COD	=	3,590 + 0.221 (56,800)	
		=	16,142	16,150 grams
	conc.	=	16,142/373,500 * 1,000	
		=	43.22	43.2 mg/l
Eq.5	TKN	=	150 + 0.00342 (56,800)	
		=	344.26	344 grams
	conc.	=	344.26/373,500 * 1,000	
		=	0.922	0.92 mg/l

Using the forecasted values of zinc (48 grams) and chemical oxygen demand (16,150 grams), an average value of total residue (TR) can be calculated using equations 6 and 7.

Eq.6 Zn = 11.5 + 0.000640 (TR)

Eq.7 COD = 3600 + 0.214 (TR)

Solve for total residue (TR):
Using (6) TR = 57,031 grams
Using (7) TR = 58,645 grams
Sum = 115,676 grams
Avg = 57,838 57,840 grams

Using Equation 8 and the average value of 57,840 grams for total residue (TR), solve for nonfilterable residue (NR):

Eq.8 NR = -760 + 0.65 (57,840)
= 36,836 grams 36,840 grams
conc. = 36,836/373,500 * 1000
= 98.62 98.6 mg/l

4. Check

The computed values within Table 8.2.5 to see if they are within the limits of the values recorded.

The results must be compared to established water quality criteria, and if any excessive values are found, mitigating measures (or transportation alternatives) may be needed.

IV. WASHINGTON STATE DEPARTMENT OF TRANSPORTATION PROCEDURE FOR WATER QUALITY IMPACTS

A. INTRODUCTION

The State of Washington has developed a procedure (Horner and March, 1982) to assess highway stormwater water quality, in-stream water quality and aquatic ecological impacts of operation highways. The procedure is based on a model (Chui et al., 1982) developed as part of an ongoing multi-year study, sponsored by the Washington Department of Transportation (WSDOT) and conducted by the Department of Civil Engineering of the University of Washington.

This model to estimate cumulative pollutant loadings is applicable when soils, climate, and land use are similar to those at the monitored highway sites used to develop the model. Thus, Oregon, Northern California, and Southern Idaho as well as Washington State, may find the model suitable for assessing the impact of highway stormwater runoff. The impact assessment component of the WSDOT procedure has been incorporated into the FHWA procedure (Session 8.4).

The model for estimating loadings differs in that it relies on vehicles during the storm (VDS) as the primarily independent variable to

estimate pollutant loads. Washington State experiences low intensity, long duration rainfall events unique to this portion of the country. This contrasts with other locations in the country where relatively intense but brief precipitation events occur. As has been shown in the State of Washington, the migration and transport of highway pollutants are more of a function of the kinetic energy provided by moving vehicles than by rainfall (Chui et al., 1982).

The model expresses cumulative runoff pollutant loadings as functions of highway geometry, drainage configuration, and, vehicles during the storm expressed as follows:

Eq.1 $TSS = (K)\ (VDS)\ (C)$

Eq.2 Pollutant loading i = (Kp_i) (TSS Loading)

where:
- TSS = loading of total suspended solids from runoff (lb/highway-mi)
- K = loading constant (lb/1000 VDS/highway-mi)
- VDS = vehicles during the storm (in thousands)
- C = runoff coefficient (ratio of runoff volume to precipitation volume)
- Kp_i = ratio of pollutant i to TSS

The model, in addition to its geographic considerations, is limited in suitability for long-term (monthly or annually) versus individual event projections. This is similar to FHWA's Predictive Procedure (Kobriger, 1981). Loadings in a given locale are highly variable on an event basis, but more constant in a longer time frame when normalized for traffic and using a runoff coefficient.

B. WSDOT ANNUAL POLLUTANT LOADING ASSESSMENT PROCEDURE

The following procedure is taken directly from Horner and Mar (1982) and represents only one portion of the procedure. If based on the initial annual analysis described in the procedure, a monthly evaluation is required and presented here as an example of another possible approach, given the restrictions previously described. It also illustrates the variations between highway sites.

1. Estimate the hr/yr during which the roadway is expected to be wet as equal to the hr/yr of recorded precipitation. The reported hr/yr of recorded precipitation ($\leq$0.01 inch) represents the mean of a number of years of data (1948-1964). Trace quantities are eliminated from consideration, since they generally do not produce runoff. The tabulated data are recommended as an estimate of the hr/yr of wet roadway, recognizing that two counteracting factors are operating: (1) the highway remains wet for some time after precipitation stops; however (2) precipitation does not necessary fall throughout a recorded hour.

2. Estimate the total annual vehicles passing during storms (VDS/yr) as follows:

$$\text{VDS/yr} = \text{ADT} \quad \frac{\text{wet hr/yr}}{\text{24 hr/day}}$$

where: ADT = projected average daily traffic on highway lanes draining to receiving water.

3. Estimate annual highway runoff TSS loading according to:

$$\text{TSS (lb/highway - mi/yr)} = (K) \quad \frac{\text{VDS/yr}}{1000} \; (C)$$

where: K = 6.4 lb TSS/highway-mi/1000 VDS for western Washington
K = 26 lb TSS/highway-mi/1000 VDS for eastern Washington
C = runoff coefficient for the site

The loading constants given apply to new highways and existing highways where traffic increase is anticipated. On existing highways the constants apply whether or not additional lanes are constructed, up to a maximum of four lanes in a single direction, representing the cases contributing to the data base (Little, 1982). With greater widths, pollutants deposited on innermost lanes may be transported less effectively into shoulder drainage, such that K would tend to decrease; however, there was no sampling to test this hypothesis.

Note: If the lanes in one direction only drain to the receiving water, adjust ADT accordingly.

4. Express total annual highway loading (L_H) by multiplying by number of highway-mi.

5. If a mitigation device such as a detention basin is provided, reduce the TSS loading according to the solids removal capability of the device. If highway runoff is discharged to receiving water via a vegetated drainage course, multiply the estimated TSS loading by the appropriate fraction as follows in Table 8.2.6 (after Wang, 1981). Interpolate as necessary.

6. Estimate annual highway loadings of other pollutants from:

$$\text{Loading (lb/yr)} = (K_p) \text{ (TSS Loading)}$$

where: K_p = ratio of pollutant P to TSS (Table 8.2.7.)
TSS Loading previously estimated

Table 8.2.6. Solids removal ability of vegetated drainage course.

Length of Vegetated Drainage Course (ft)	Fraction of Pollutant Remaining
≤30	1
31- 60	0.50
61- 90	0.40
91-120	0.30
121-150	0.26
151-180	0.23
≥180	0.20

Use the modified TSS loading in further calculations.

Source: Wang, 1981

Table 8.2.7 K_p (Pollutant:TSS Ratios) for Various Contaminants in Highway Runoff.

Pollutant	Abbreviation	K_p
Chemical Oxygen Demand	COD	$K_{COD} = 0.4$
Lead (Western Washington)	Pb	$K_{Pb} = 1.5 \times 10^{-4} + (8.7 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Pb} = 5.3 \times 10^{-4} + (2.8 \times 10^{-9})(ADT)$ (Note 1)
Zinc (Western Washington)	Zn	$K_{Zn} = 1.4 \times 10^{-4} + (3.0 \times 10^{-8})(ADT)$
(Eastern Washington)		$K_{Zn} = 2.0 \times 10^{-4} + (3.2 \times 10^{-7})(ADT)$
Copper	Cu	$K_{Cu} = 7.9 \times 10^{-5} + (2.7 \times 10^{-9})(ADT)$
Nitrate + Nitrite-Nitrogen	NO_3+NO_2-N	$K_N = 2.0 \times 10^{-3}$
Total Kjeldahl Nitrogen (Western Washington)	TKN	$K_{TKN} = 2.7 \times 10^{-3}$
(Eastern Washington)		$K_{TKN} = 1.2 \times 10^{-3}$
Total Phosphorus	TP	$K_{TP} = 2.1 \times 10^{-3}$

Note: (1) Base predicted lead loading on the lead concentration in gasoline at the time in proportion to that during the years of research. During those years, the concentration was 0.13 grams/liter. That concentration is scheduled to be reduced under U.S. Environmental Protection Agency regulations, and that agency can provide information on adherence to the schedule. For estimation purposes, it should be assumed that the proportion of vehicles using leaded gasoline remains constant.

SESSION QUESTIONS:

1. Based on the different procedures, what are the major differences bewteen the predictive procedures presented?

2. What limitations restrict the use of the procedures presented?

3. In what ways may the most applicable procedure presented here be adopted to use in a particular state?

SECTION 8: PREDICTION OF WATER QUALITY IMPACTS

SESSION 8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

Estimated Time for Completion:

OBJECTIVES: Upon completion of this session, participants will be able to:

- Calculate pollutant loadings from other land uses within a watershed, using the simplified method presented.
- Assess the loading impacts from the highway, relative to loadings from other land uses within the watershed.
- Recognize the problems of the method presented, and be introduced to other approaches that might be used when more sensitive analysis is required.

SESSION OVERVIEW:

One approach to assess the potential impacts of pollutant loadings from highways surfaces compares the area loadings from other land uses within the watershed to those loadings estimated from the highway right-of-way.

This session introduces a simplified procedure for conducting an impact analysis. Case Study 8.4 will be distributed and participants will complete the required analysis.

Participants will review questions at the end of the session and discuss the findings and other approaches used when more sensitive analysis is required.

8.4: PREDICTION OF LOADING IMPACTS OF HIGHWAY RUNOFF - CASE STUDY

I. DETERMINATION OF BACKGROUND LOADINGS FOR THE DRAINAGE AREA

The following procedure is adapted from Horner and Mar (1982). This simplified procedure may be used for non-winter periods to determine background loadings for a watershed area, based on typical area pollutant loadings and typical runoff concentrations data for selected land uses reported in the literature. The actual loadings and runoff concentrations vary for each location, based on site characteristics (e.g., rural or urban), soil types, and other factors, and the results should be interpreted with caution. The procedure provides a relative indication of highway loads to background loadings, and may determine whether a more detailed evaluation using more complicated procedures is required. The steps of the procedure are:

1. If the receiving water is a stream and if a comprehensive water quality record exists for the stream, proceed to Step 2. Otherwise, go to Step 3.

2. Estimate the mean monthly loading of each pollutant transported by the stream, prior to the presence of the highway (L_s, lb/mo) according to:

$$L_s = 1{,}965\ Q_s C_s$$

where: Q_s and C_s are average quantities for the month in question.

where: Q_s = average stream discharge (cfs)
C_s = average pollutant concentration (mg/l)

The loadings for each month should be aggregated for the period, if the measured flow data are available.

Q_s may be the discharge rate determined for a specific drainage area; however, then C_s must be a flow weighted average for the same flow rate.

If the stream is gaged, obtain Q_s in the U.S. Geological Survey Water Resources Data provided for the most recent water year. If the stream is not gaged, estimate Q_s from the record of a nearby stream with similar watershed characteristics, as follows:

$$Q_s = Q_s^{\ 1} \frac{A_w}{A_w^{\ 1}}$$

where: Q_s = average discharge in runoff receiving stream (cfs)

$Q_s^{\,1}$ = average discharge in stream of record (cfs)

A_w = runoff receiving stream watershed area (any area units)

$A_w^{\,1}$ = stream of record watershed area (any area units)

3. Determine the areas (in acres) in Central Business District, Other Commercial, Industrial, Single-Family Residential, Multiple-Family Residential, Cropland, Pasture, and Forested and Open Land used in the watershed draining to the highway runoff discharge point located farthest downstream. If it is projected by the planning agency for the location that development will modify land uses substantially in coming years, conduct the analysis for both present and ultimate land uses.

4. Determine annual area loading (lb/acre/yr) of each contaminant for each land use in the receiving water basin from local data, if they exist, or Table 8.4.1. (Note storm runoff pollutant loadings for specific land use categories.) Where a range is given, use the lower value if a conservative estimate of highway contribution to total loading is desired; otherwise, use the midpoint of the range. If pollutant loading rates are not available for a specific pollutant, then go to Step 7.

5. Approximate the proportion of each annual area loading delivered during the month or period in question according to:

   lb/acre/mo (period)=[(hr ppt during month (period)/annual hr ppt) (lb/acre/yr)] or lb/acre/mo = []

6. Multiply loadings in lb/acre/mo by the respective acres to obtain loadings for the month (period) in question for each land use (L_{Li}). Then sum over all land uses for each pollutant (summation L_{Li}). Record results on Worksheet 8.4.a.

7. From Table 8.4.1a, determine the runoff coefficient for each land use in the watershed, above the discharge point for the project.

8. Multiply the runoff coefficient for each land use by the total seasonal rainfall for the site to obtain the runoff in inches.

9. Convert the runoff in inches to runoff volume by the following equation:

$$Q_{cf} = \frac{R \quad * \quad acres}{12 \quad * \quad 43{,}560}$$

R = runoff in inches
Q_{cf} = runoff in cubic feet

10. Convert Q_{cf} to liters by multiplying by 28.31625.

$$R_L = Q_{cf} * 28.31625$$

R_L = Runoff in liters

11. Determine total lbs. of pollutant by using the following equation and Table 8.4.2. Record results on Worksheet 8.4.b:

$$P_{pD} = R_L * P_{conc} * 2.2046 * 10^{-6}$$

where: P_{pD} = total pollutant loading
R_L = runoff volume expressed as liters
P_{conc} = pollutant concentration

12. If the receiving water is a stream, proceed to Step 13. If the receiving water is a lake or wetland, go to Step 15.

13. Estimate point source loadings (L_p) of each pollutant as follows:

$$L_p \text{ (lb/mo)} = 1{,}965\ Q_p C_p$$

where: Q_p and C_p are monthly quantities for the month in question

Q_p = point source effluent flow rate (cfs) (average over year if not continuous). Obtain flow from discharge monitoring report as required by NPDES permit or develop industry typical flow.

C_p = average point source effluent pollutant concentration (mg/l). Obtain from monitoring records or from industry typical discharge concentrations available from U.S. EPA Development Document Series for the specific point source category.

14. Estimate total stream loadings prior to highway presence as:

$$L_s = \text{summation } L_{Li} + L_p$$

Table 8.4.1. Storm runoff pollutant loadings for specific land use categories.

Land	Loading (lb/acre/yr)							
	TSS	COD	Pb	Zn	Cu	NO_3+NO_2	TKN	TP
Central Business District	964	955	6.3	2.7	1.9	4.0	13	2.5
Other Commercial	750	906	2.7	2.9	N/A	0.6	13	2.4
Industrial	50	56	1.8-6.3	3.1-11	0.3-1.0	0.4	2-13	0.8-3.6
Single-Family Residential	15	25	0.1	0.2	0.03	0.3	1-5	0.2-1.3
Multiple-Family Residential	390	297	0.6	0.3	0.3	3.4	3-4	1.2-1.4
Cropland	402	N/A	0.004-0.005	0.03-0.07	0.01-0.05	7.0	1.5	0.3
Pasture	306	N/A	0.003-0.013	0.02-0.15	0.02-0.04	0.3	0.6	0.06
Forested	76	N/A	0.01-0.03	0.01-0.03	0.02-0.03	0.5	2.6	0.08
Open	6	1.8	N/A	N/A	N/A	0.3	1.5	0.06

NOTES:

1. Means given where available; otherwise ranges are reported.

2. N/A -- Not available. (If specific pollutant loadings are not indicated here, then, determine loadings based on mean concentration values.

SOURCE: Horner, R.R. et al., 1982.

Table 8.4.1a Values of runoff coefficients (C) for use in the runoff volume estimation.

Type of surface	Runoff coefficient (C)[a]
Rural Areas	
Concrete or sheet asphalt pavement	0.8-0.9
Asphalt macadam pavement	0.6-0.8
Gravel roadways or shoulders	0.4-0.6
Bare earth	0.2-0.9
Steep grassed areas (2:1)	0.5-0.7
Turf meadows	0.1-0.4
Forested areas	0.1-0.3
Cultivated fields	0.2-0.4
Urban Areas	
Flat residential, with about 30 percent of area impervious	0.40
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep built up area, with about 70 percent of area impervious	0.80
Flat commercial, with about 90 percent of area impervious	0.80

Source: Searcy, 1973.

[a] For flat slopes or permeable soil, use the lower values. For steep slopes or impermeable soil, use the higher values.

Table 8.4.2. Mean urban runoff concentrations by land use (NURP) (U.S. EPA, 1983)

Pollutant	Units	Residential	Commercial	Industrial	Mixed	Open
TSS	mg/l	206.0	160.0	143.0	297.0	218.0
BOD	mg/l	12.0	12.4	9.5	12.4	2.0
TN	mg/l	3.64	2.45	2.32	2.51	1.85
TP	mg/l	0.465	0.493	0.539	0.489	0.188
FCB (winter only)	cells/100 ml	7,099.0	7,099.0	7,099.0	7,099.0	7,099.0
S/S/F	cells/ 100 ml	31,995.0	31,995.0	31,995.0	31,995.0	31,995.0
O&G[a]	mg/l	3.89	13.13	7.1	6.23	.0
Fe	mg/l	2.73	2.73	2.73	2.73	2.73
As	ug/l	4.25	4.25	4.25	4.25	4.25
Cd	ug/l	1.58	1.58	1.58	1.58	1.58
Cr	ug/l	8.51	8.51	8.51	8.51	8.51
Cu	ug/l	19.7	19.7	19.7	19.7	19.7
Pb	ug/l	72.8	72.8	72.8	72.8	72.8
Hg	ug/l	0.5	0.5	0.5	0.5	0.5
Zn	ug/l	103.7	103.7	103.7	103.7	103.7
PCBs	ug/l	2.96	2.96	2.96	2.96	2.96
CHPs	ug/l	9.07	9.07	9.07	9.07	9.07

[a]Data taken from Stenstrom et al., 1984.

15. Express the impact on stream pollutant loadings in terms of the estimated increase due to P_d highway runoff as a percentage of the original stream loadings (L_s). If the estimated increase exceeds 10 percent for any pollutant, then mitigation may be required. If the stream eventually discharges to a lake or wetland, also evaluate the impact on the body of water according to the next Steps 16 and 17.

16. If the immediate or eventual receiving water is a lake or wetland, estimate total loadings for the month in question prior to the highway presence (L_{La}) as equal to summation L_{Li} plus any point source loading (1,965 Q_pC_p).

17. If the immediate or eventual receiving water is a lake, conduct a special analysis to assess the potential impact of phosphorus loading on trophic state as follows:

    a. Convert P_d and L_{La} to kg/mo by dividing by 2.2 lb/kg.

    b. Estimate annual loadings from the monthly or seasonal loadings found previously by proportion (for both P_d and summation L_{Li} + L_B):

$$\text{kg/yr} = \frac{\text{annual hr precipitation}}{\text{hr precipitation during the month}} \text{ (kg/mo)}$$

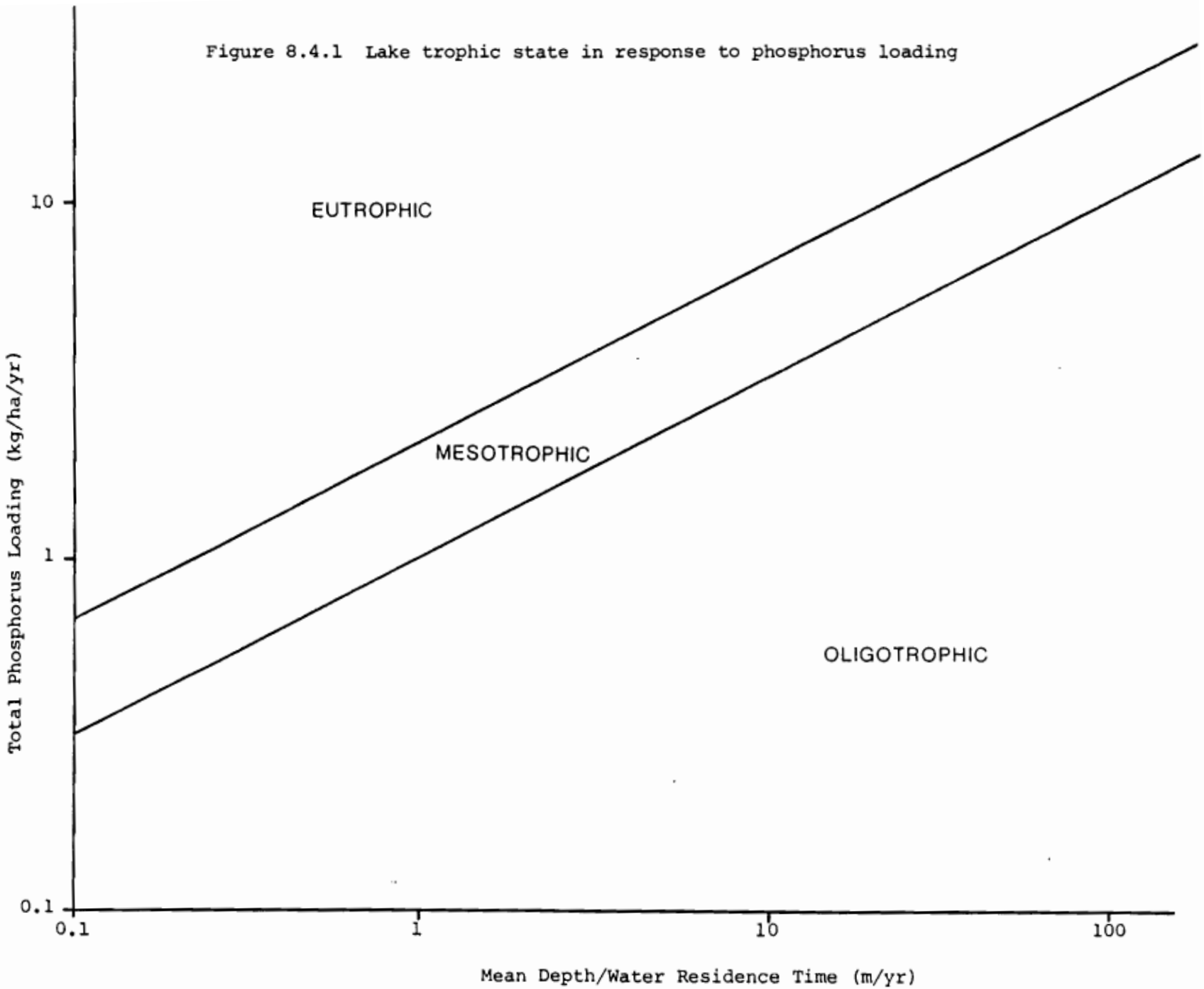
    c. Find the contributions of the highway and all other sources to the lake area total phosphorus (TP) loading (kg/ha/yr) by dividing L_H and L_{La}, respectively, by the lake surface area (A_{La}, ha). [Note: 1 hectare (ha) = 2.47 acres.]

    d. Divide lake mean depth (m) by water residence time (yr), where water residence time = lake volume (any volume units)/outflow rate (any consistent volume/yr units).

    e. Locate the lake on Figure 8.4.1, the trophic state graph (Vollenweider and Dillon, 1974), by using L_{La}/A_{La} as ordinate and the result of the previous step as abscissa.

18. If the highway loading addition does not move the status point near or into a higher trophic category, declare minimal impact on lake eutrophication and analyze impacts associated with maintenance or special problem areas. If a substantial impact on trophic state appears likely, mitigation should be further considered.

Figure 8.4.1 Lake trophic state in response to phosphorus loading



Source: Vollenweider and Dillon, 1974