

HYDROLOGIC & HYDRAULIC REPORT
FOR

**SR 7 OVER BEAR CREEK
BRIDGE REPLACEMENT**

JEFFERSON COUNTY, INDIANA
7.0 MILES NORTH OF SR 250

Des. No. 1006242

Prepared By



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January 2014

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**HYDRAULIC RECOMMENDATIONS
 For SR 7 Jefferson County over Bear Creek**

Site Parameters	
Drainage Area (Acres)	1,114
Q100 Discharge (cfs)	703
Q100 Elevation (ft.)	769.81

Existing Slab Structure

19.7' Clear Span

Backwater at Q ₁₀₀	1.11 ft
Velocity at Q ₁₀₀	8.25 ft/s
Q ₁₀₀ Headwater Elevation	770.87 ft
Gross Waterway Area Opening Below Q ₁₀₀ Elevation	90.29 ft ²
Road Overflow Area	0.00 ft ²
Minimum Low Structure	772.88 ft
Skew	0°

Proposed Slab Structure

20' Clear Span

Surcharge at Q ₁₀₀	0.01 ft
Backwater at Q ₁₀₀	1.07 ft
Velocity at Q ₁₀₀	8.11 ft/s
Q ₁₀₀ Headwater Elevation	770.88 ft
Gross Waterway Area Opening Below Q ₁₀₀ Elevation	91.51 ft ²
Road Overflow Area	0.00 ft ²
Minimum Low Structure	772.88 ft
Skew	11°

Notes:

1. The existing structure creates a backwater of 1.11 ft in Cross Section 394. The proposed structure creates a backwater of 1.07 ft in Cross Section 394.
2. Roadway Overflow does not occur with the existing or proposed structure.
3. The proposed clear span is measured perpendicular to the flow of Bear Creek and has a skew of 11° with SR 7.
4. Ordinary high water (OHW) elevation determined to be approximately 766.62 feet per topographic survey. Channel clearing cannot occur below 1 ft above ordinary high water or within 2 ft of the flowline elevation.

Proposed Scour Analysis Summary

20' Clear Span

	Q ₁₀₀	Q ₅₀₀
Discharge	703 cfs	1022 cfs
Q ₁₀₀ Maximum Velocity	8.87 ft/s	12.35 ft/s
Q ₁₀₀ Contraction Scour Depth	4.91 ft	9.36 ft
Q ₁₀₀ Pier Scour Depth	-	-
Q ₁₀₀ Total Scour Depth	4.91 ft	9.36 ft
Q ₁₀₀ Low Scour Elevation	759.66 ft	755.21 ft
Low Scour Elevation based on the flow line elevation of 764.57 ft		

INTRODUCTION

The purpose and need of this project is to replace the existing structure located on State Road 7 approximately 7.0 miles north of State Road 250 in Jefferson County, Indiana. The project location can be seen below as Figure 1 – Project Location. A more detailed project map can be seen as Exhibit 1.

This technical report presents the hydrologic and hydraulic analysis for the existing and proposed crossing of SR 7 over Bear Creek. The existing crossing consists of an approximate 19.7-foot Single Span Bridge that has an overall rating of 2 per the Engineering Assessment Report dated March 22nd, 2012. The existing structure creates a backwater greater than 1.00 foot. The proposed structure will be required to decrease the backwater as the existing backwater is greater than 1.00 foot. The proposed structure will be an in-kind replacement with a span of 20-feet, aligned on skew with Bear Creek. Economic analysis will need to be performed in order to determine whether a slab structure or a three-sided culvert is more economical. This will be performed as part of the Stage 1 Plan submittal. A bridge number is currently being obtained for the proposed structure. Design procedure is in accordance with INDOT Design Manual (IDM) 2013.



Figure 1 – Project Location

The project is a bridge replacement funded and approved by INDOT. The project does not lie within corporate boundaries of a consolidated city or an incorporated town. The project is located in a rural area in which the flood protection grade of each residential property impacted by the project is higher than the regulatory flood elevation under the project condition. Due to these parameters and the size of the contributing drainage area, an IDNR Construction in a floodway permit is not required

Field surveys were performed by Janssen & Spaans Engineering, Inc. in August 2013 and January 2014. Topography was developed from the survey and used in development of a HEC-RAS model. The vertical datum of the topographic survey is NAVD 88. The historic high water mark was located and found to be approximately 768.80 feet. The ordinary high water was determined to be approximately 766.62 feet. The historic and ordinary high water elevations were observed and surveyed upstream of the existing structure. Field reconnaissance indicated that was no evidence of excessive scour at the structure or along the streambed. The field survey was supplemented with the Vernon, Indiana USGS Quad Map (N3852.5–W8530/7.5) for delineation of the contributing drainage area and development of the HEC-RAS model.

HISTORIC DATA

No historical data could be found for this project. The Jefferson County, Indiana and Incorporated Areas Flood Insurance Study (FIS) indicated that Bear Creek had not been studied with detailed or approximate methods. The Indiana Hydrology and Hydraulics Model Library was also consulted and found that no studies were available for the project area. The current published FEMA Flood Insurance Rate Map (FIRM) for the project site is Map No. 1801040002A (Effective date is October 1, 1992). A copy of the FIRM panel is provided as Exhibit 5. Coordination with the Seymour District Highway Department was performed on January 21st, 2014 to discuss historic flooding and maintenance issues for the existing structure. There is no evidence of roadway overtopping at this structure.

HYDROLOGY

The design storm frequency for the SR 7 crossing was determined based upon Figure 203-2C of the IDM and future AADT for the road which is classified as a minor arterial. The future AADT forecast for SR 7 is 4,600 vehicles per day (vpd) which warrants a roadway serviceability annual exceedance probability (EP) of 1% (100-year event). This classification warrants a roadway serviceability freeboard of 1 foot. As the proposed structure is considered a bridge, it is required to provide a minimum of 2.00' feet of structure freeboard where practical. Scour calculations were also conducted in accordance with IDM 203-3.03(03), for the 1% and 0.2% annual EP.

USGS's STREAMSTATS was used for the initial drainage-area delineation. HYMAPS-OWL was also consulted for verification of drainage area and used in determination of soil groups and curve number. The contributing drainage area is approximately 1.74 square miles or 1,114 acres. The drainage area is shown on the USGS quad maps as Exhibit 2 and on an aerial map as Exhibit 3. STREAMSTATS output can be seen in Appendix A1. HYMAPS-OWL is included as Appendix A2.

Using HYMAPS-OWL and aerial imagery a weighted curve number was computed for the contributing drainage area. Curve numbers are in accordance with Figure 202-2F of the IDM. The contributing land use consisted of a mixture of row crops, pasture/rangeland, woods, water, and residential areas with a majority of the area being row crops. The hydrologic soil groups consisted of mostly soil type "C" with sporadic areas of soil type "D". The combination of land uses and hydrologic soil groups was used to determine the curve number. A weighted curve number of 80 was computed based upon the contributing drainage area and above noted parameters. As the surrounding land is comprised of rural farmland and forests, the future land use will not be taken into account as the existing land use is stable and non-fluctuating. Calculations for the curve number are included in Appendix A4.

Time of concentration was calculated with a computer spreadsheet using TR-55 methodology. Figure 202-2A of the IDM was filled out with the spreadsheet results and is included as Appendix A4. Values chosen based upon sheet flow, shallow concentrated

flow, and channel flow are in accordance with TR-55 and IDM guidance. The longest flow path within the drainage area is approximately 15,365 ft. The estimated travel time within the travel area was evaluated using TR-55 methodology as outlined in IDM. The overall time of concentration was determined to be approximately 253 minutes or 4.209 hours. The time of concentration checklist is included in Appendix E.

Section 202-3.02 and Figure 202-3A – Selection of Discharge-Computation Method of the IDM were referenced for selection of the hydrologic method. There is no IDNR Coordinated Discharge Curve for Bear Creek. As the drainage area is larger than 200 acres, TR-20 was chosen as the hydrologic method. This analysis was performed using HydroCAD. A synthetic storm was generated using the 50% probability Huff Distribution per the Indiana LTAP Stormwater Drainage Manual, 2008. The project is closest to Indianapolis, thus the Indianapolis Station was chosen along with the 1st, 2nd, and 3rd quartile groups. The first quartile was applied to the 100-year, 1-hour, 2-hour, 3-hour, and 6-hour storm durations. The second quartile was applied to the 100-year, 12-hour storm duration. The third quartile was applied to the 100-year, 24-hour storm duration. Precipitation depth in inches was determined using the PF Data Server. Rainfall data is included as Appendix A3. These six storms were modeled in HydroCAD, along with the rainfall, curve number and time of concentration in order to determine the peak discharge. A peak discharge of 703 cfs was estimated to occur during the 100-year, 6-hour storm. Refer to Appendix A5 for HydroCAD output.

Table -1 – Summary of Peak Discharges from Various Storm Events

Storm Event	100-YR Peak Discharge (cfs)
1-hour	366
2-hour	523
3-hour	588
6-hour	703
12-hour	619
24-hour	479

HYDRAULIC MODELING

The field survey performed by Janssen & Spaans Engineering, Inc. indicated the existing structure is an approximate 19.7-foot slab structure, which is classified as a bridge. The existing structure was modeled using US Army Corps of Engineers' HEC-RAS version 4.1.0. Check-RAS was also ran on all HEC-RAS models. Check-RAS output is included as Appendix B4.

Cross sections incorporated into the HEC-RAS model were determined using field survey as well as USGS Quad Maps. In cross sections where field survey was not extensive enough to fully model the Bear Creek floodplain, the Vernon, Indiana Quad Map was utilized and cross sections were extended up to 780' to contain the largest storm events. Six cross-sections were used in the existing HEC-RAS model, including three cross sections upstream of the existing structure and three cross-sections downstream. Normal depth was used as the downstream reach boundary condition and was determined using results of the field survey.

Ineffective flows were calculated for the existing and proposed structures in accordance with the HEC-RAS User's Manual. Downstream of the existing and proposed structures ineffective flows were placed at a 2:1 expansion ratio while upstream ineffective flows were placed at a 1:1 contraction ration. Ineffective flow limits were also placed at cross section 397 in order to define areas of the cross section that will contain water not actively being conveyed.

The existing structure generated a backwater of 1.11 feet based on the modeling performed. The IDM 203.202(02) states that when the existing backwater is less than 1 foot, the proposed backwater for the proposed structure shall not be greater than the existing backwater. The proposed structure will be a replacement of the existing structure with an effective span of 20-feet with a proposed backwater of 1.07 feet.

The roadway-serviceability freeboard for the proposed structure, as stated in Figure 203-2C, shall be greater than 1 foot for a two-lane Facility with AADT greater than 3000 vpd. The proposed bridge meets this requirement with a freeboard of 5.05 feet.

The proposed structure should maintain at least 2.00 feet of structural freeboard when possible to allow for the flow of ice and debris, as stated in the IDM 202-3.03(1). The proposed structure provides a structural freeboard of 3.07 ft.

Class 1 Riprap will be used for the scour protection due to the outlet velocity, which is less than 10 ft./sec but greater than 6.5 ft/sec, in accordance with IDM Figure 203-2S.

SAMPLE

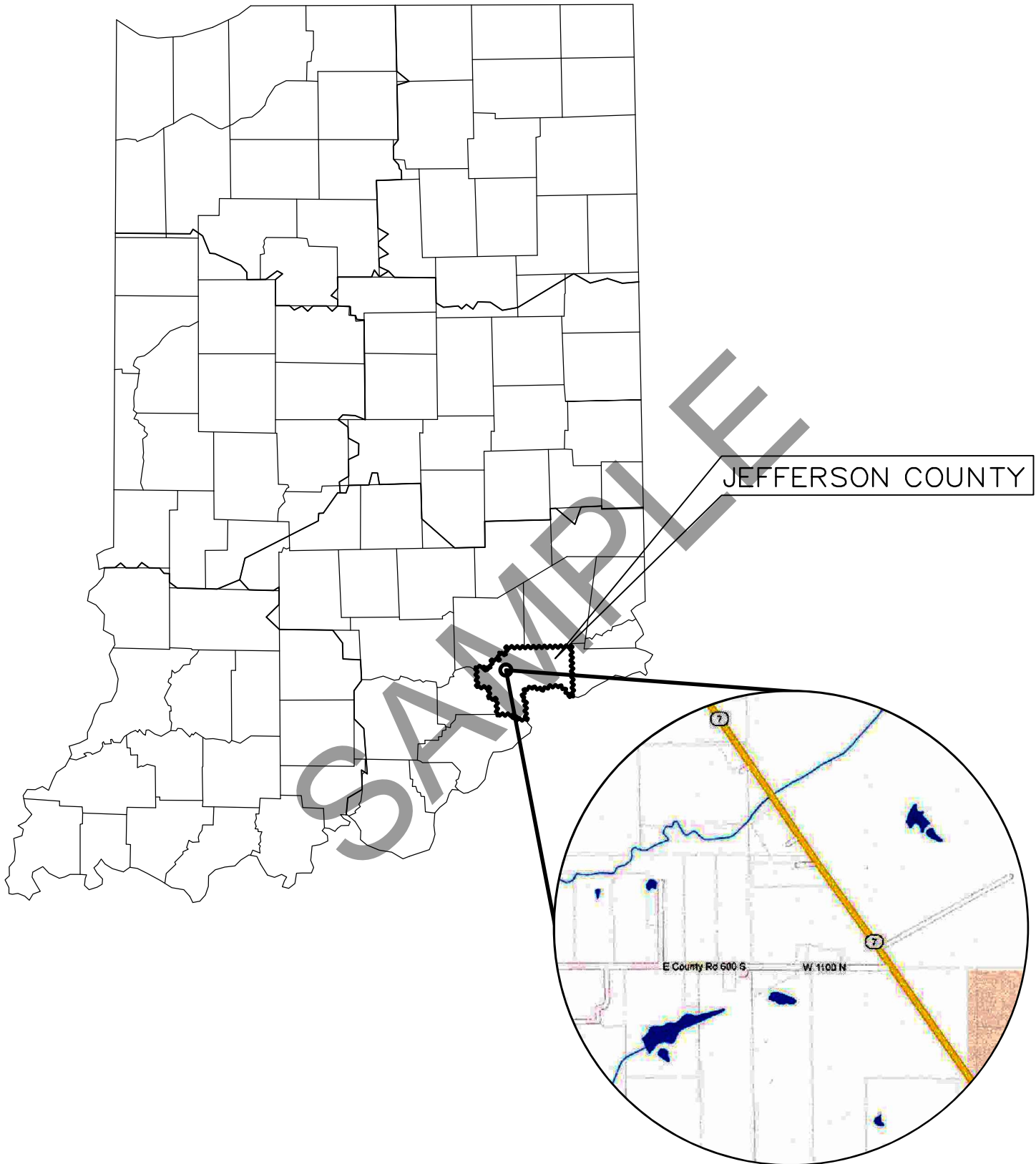
CONCLUSION

Based on the results in this study it can be concluded that:

- The existing structure is an approximate 19.7-foot slab structure. The proposed structure will be an In Kind Replacement, with an effective opening of 20-feet. The type of structure, whether a slab structure or an oversized box culvert, is to be determined after economic analysis required at Stage 1. The proposed structure will be constructed on skew with the roadway, in-line with Bear Creek. The skew is approximately 11 degrees.
- The existing structure creates a backwater of 1.11 feet. The proposed structure creates a backwater of 1.07 feet. The existing flow distribution is maintained as near as practical and does not alter the flow distribution in the floodplain. Proposed velocities through the structure will not damage the highway facility or increase damages to adjacent property.
- Standard INDOT riprap and scour abatement details will be implemented for the proposed structure. The scour velocity falls within the Class I Riprap erosion protection method. Standard INDOT scour countermeasures are implemented.
- The appropriate level of traffic service as defined by INDOT is employed.
- Minimal disruptions of ecosystems and floodplain characteristics are considered in the hydraulic review. A comprehensive environmental study will be conducted to determine the potential impacts that this project may have on the surrounding natural, cultural, and social environment in accordance with the National Environmental Policy Act and INDOT's Office of Environmental Services.

Exhibit 1: Project Location Map

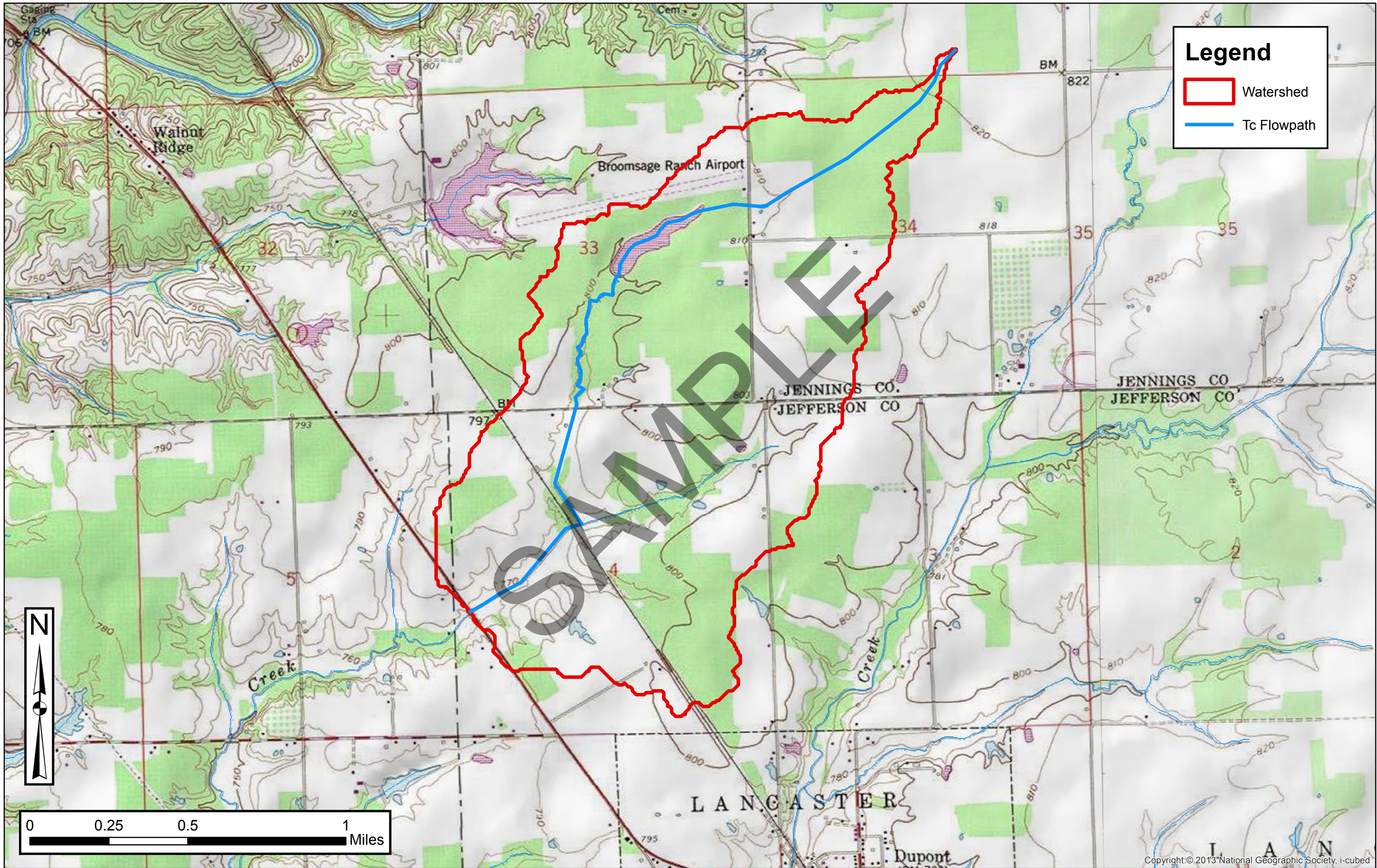
SAMPLE



PROJECT LOCATION SHOWN BY 

**Exhibit 2: Topographic Map with
Watershed**

SAMPLE



Legend

- Watershed
- Tc Flowpath

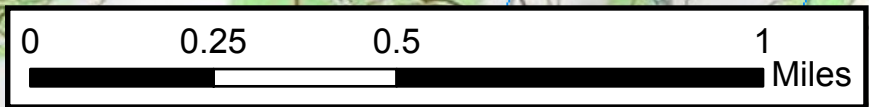
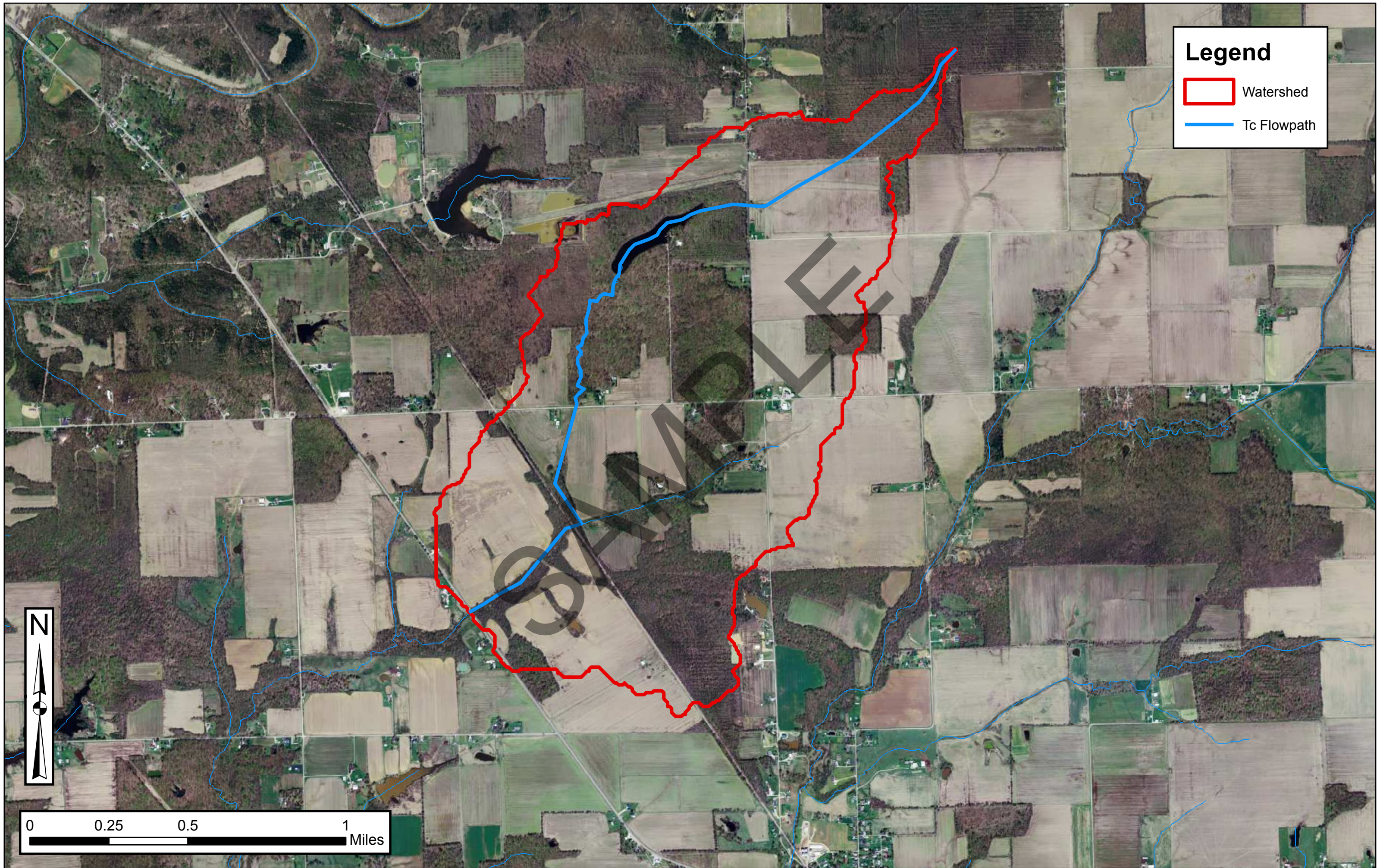


Exhibit 3: Aerial Map with Watershed

SAMPLE



Legend

- Watershed
- Tc Flowpath

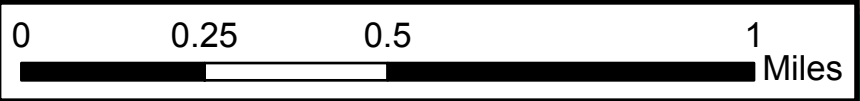
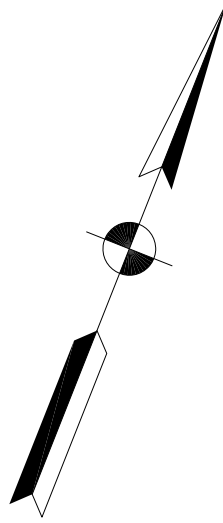
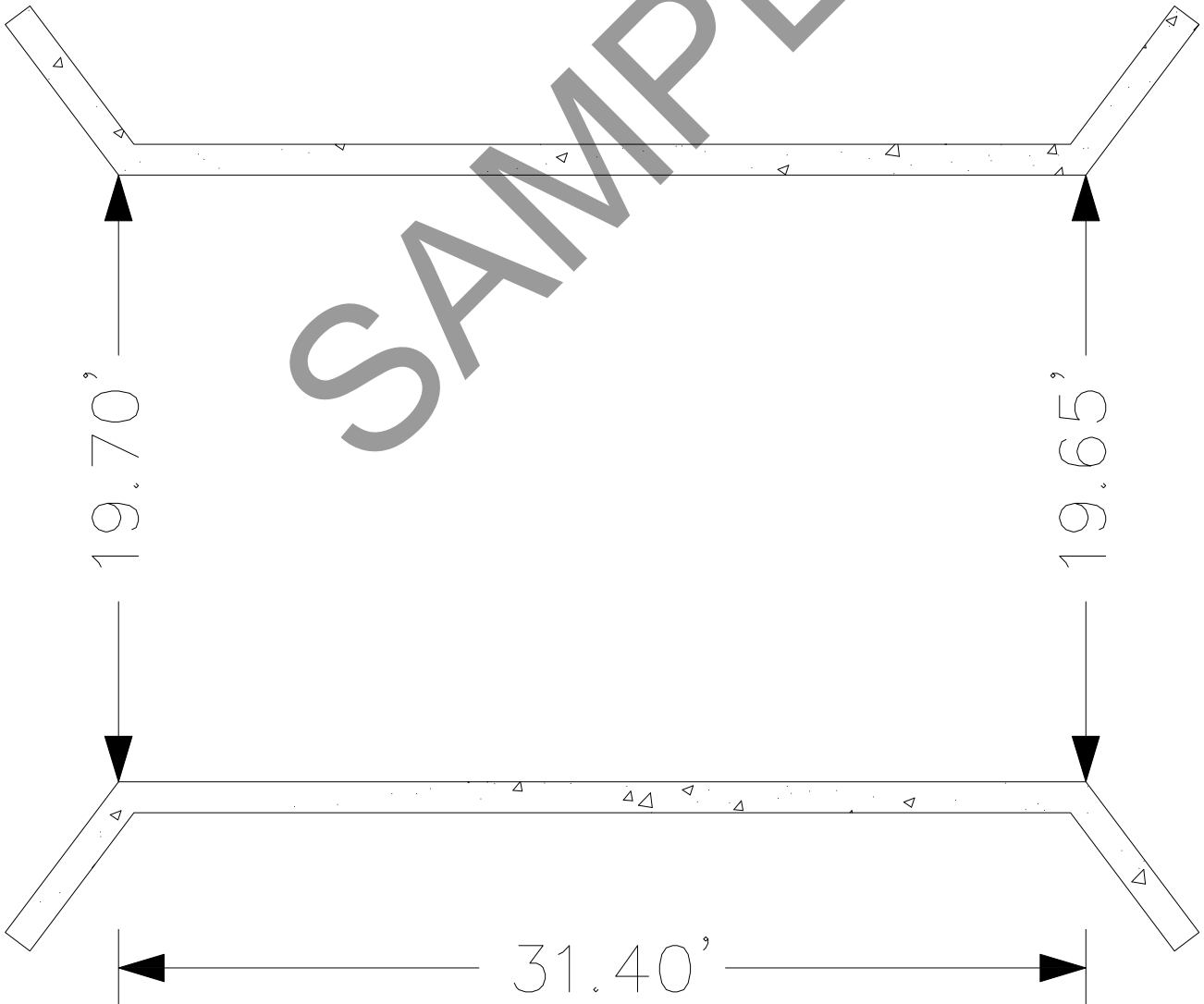


Exhibit 4: Existing Bridge Sketches

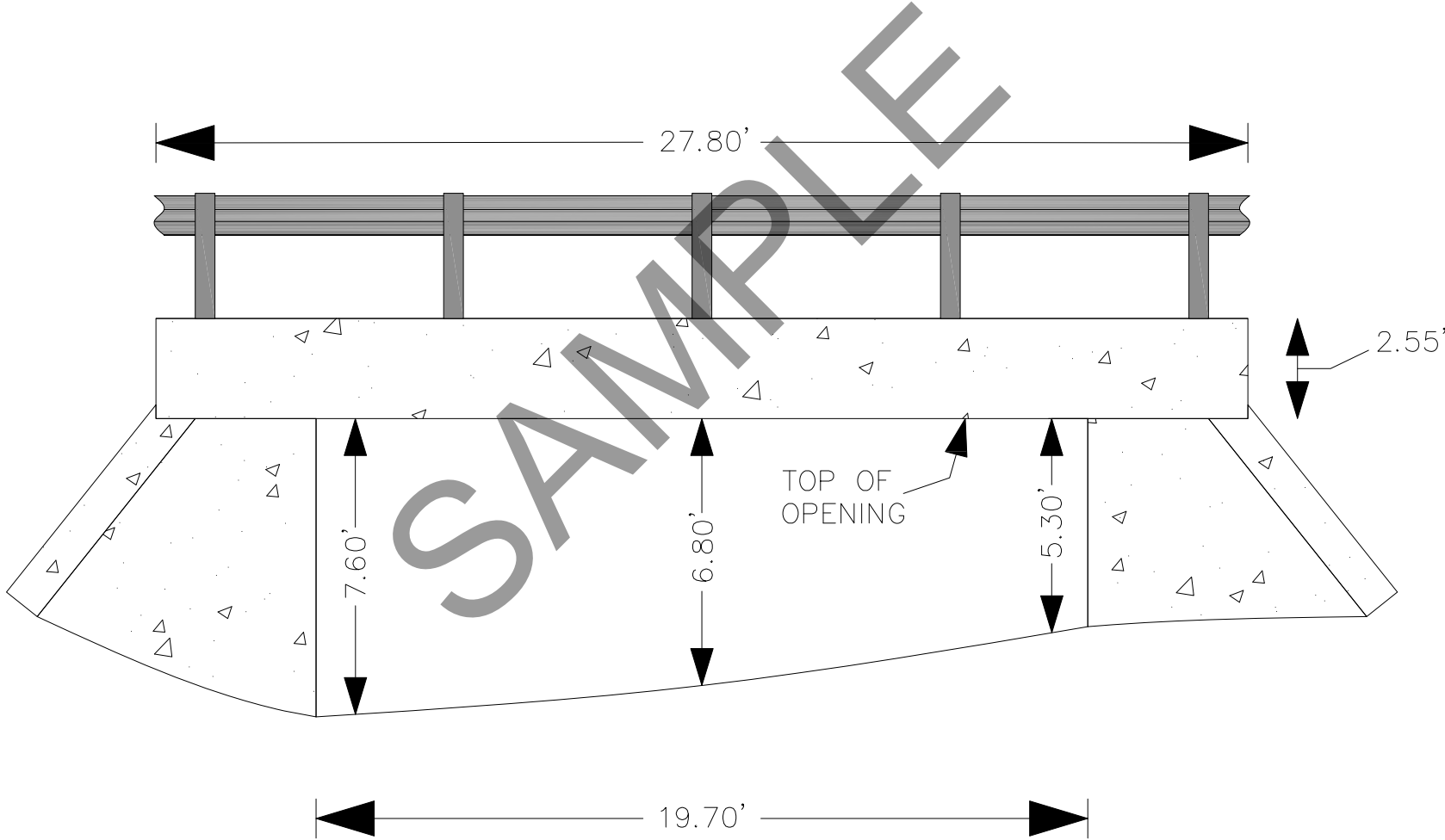
SAMPLE



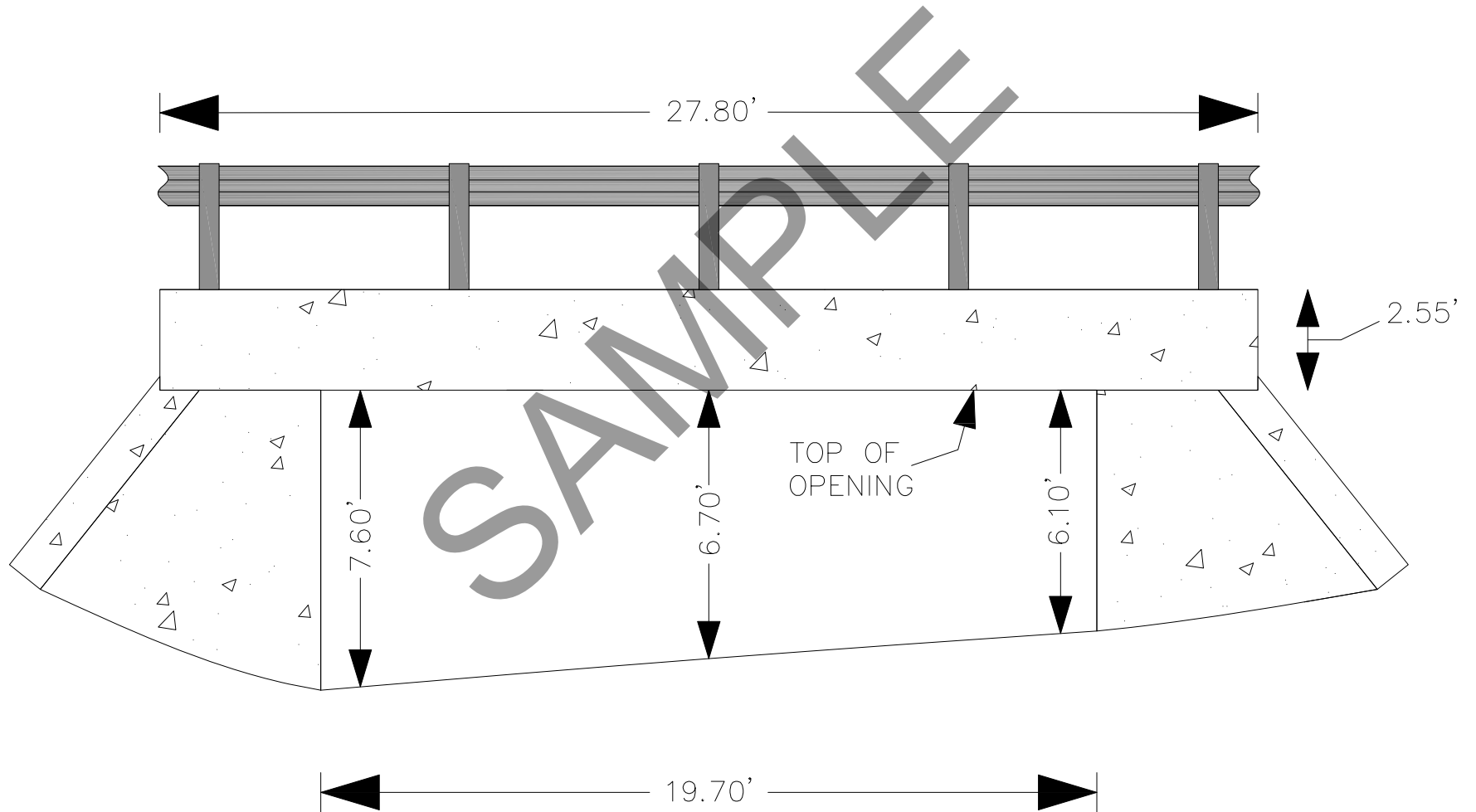
TOP VIEW



LOOKING EAST @ WEST FACE

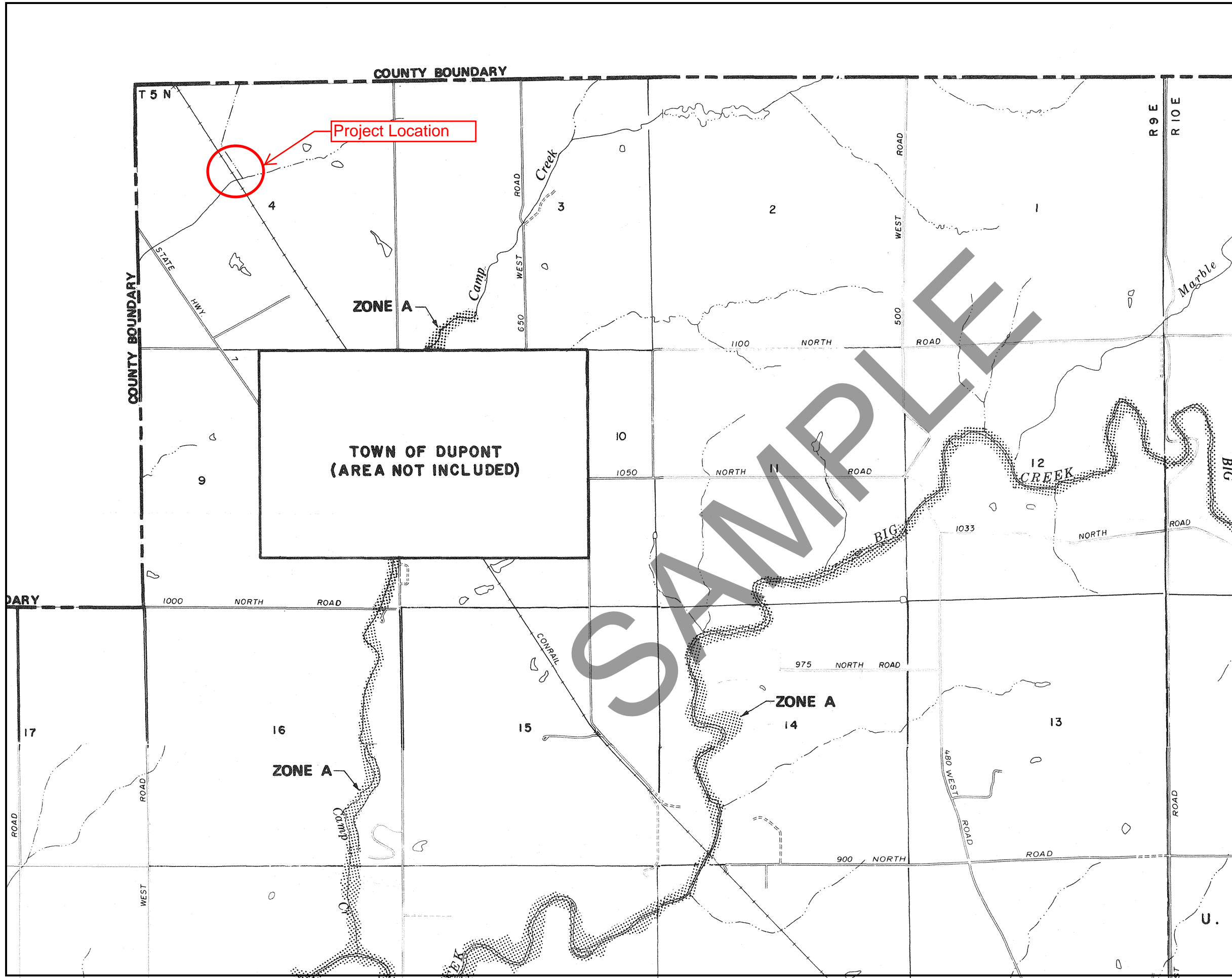
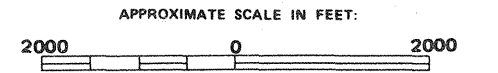


LOOKING WEST @ EAST FACE



**Exhibit 5: FEMA Flood Insurance Rate
Map**

SAMPLE



FLOOD HAZARD BOUNDARY MAP

**JEFFERSON COUNTY
INDIANA
UNINC. AREAS**

PAGE 2 OF 7
(SEE MAP INDEX FOR PAGES NOT PRINTED)

MAP REVISED:
APRIL 7, 1978

CONVERTED BY LETTER
EFFECTIVE 10/1/92

COMMUNITY—PANEL NUMBER
180104 0002 A

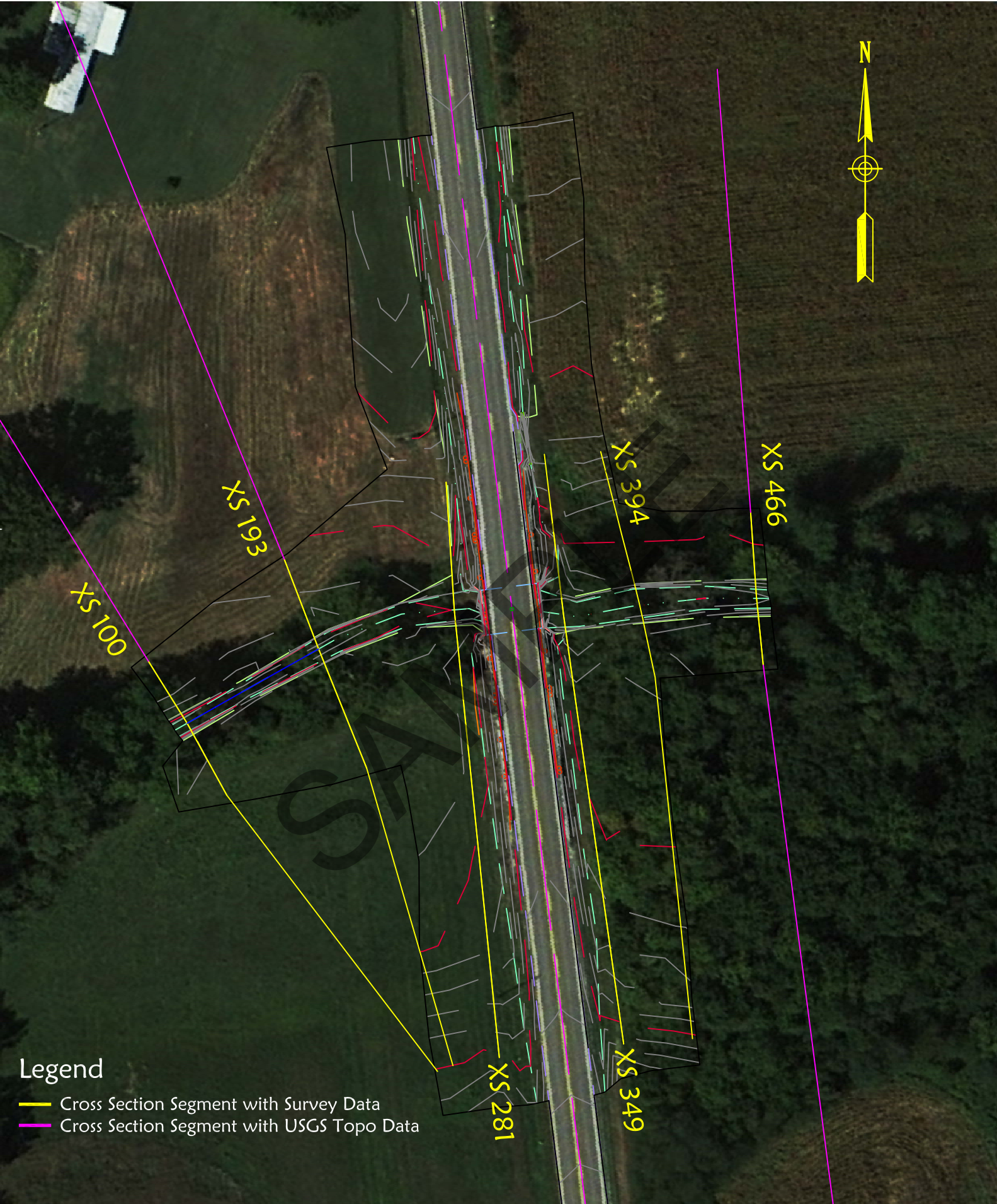


**U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION**

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Exhibit 6: HEC-RAS Cross Sections

SAMPLE



Legend

- Cross Section Segment with Survey Data
- Cross Section Segment with USGS Topo Data

**Appendix A: Hydrologic Calculations
& Supporting Data**

SAMPLE

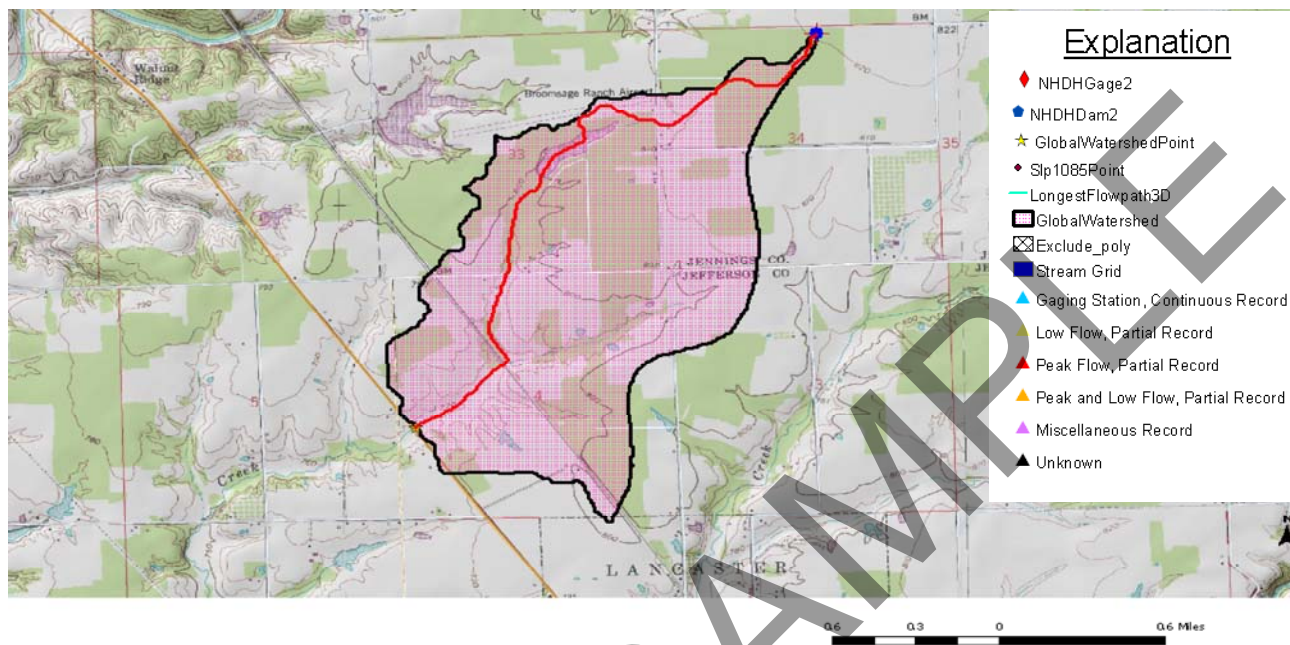
**Appendix A1: USGS Stream Stats
Output**

SAMPLE

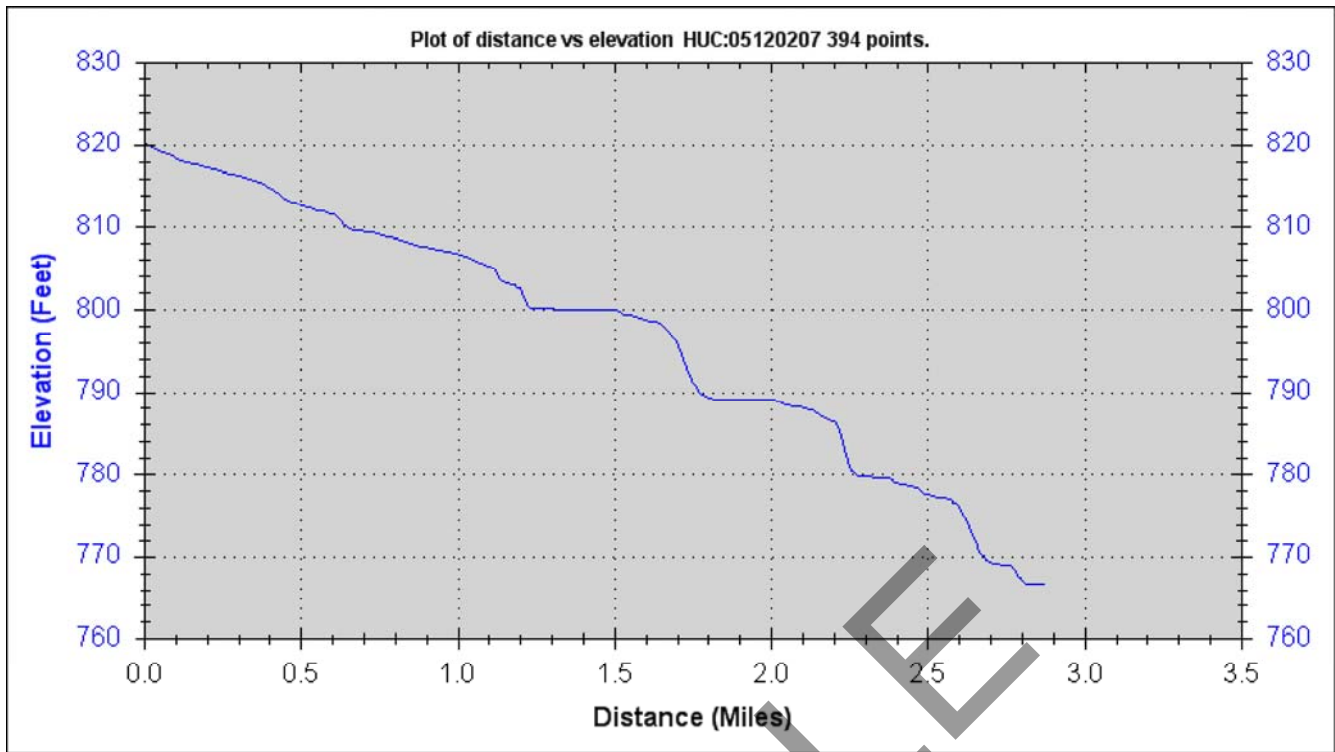


StreamStats Print Page

SR 7 over Bear Creek



1/20/2014 10:01:13 AM



Save2Excel

S	Z	X	Y	UserPoint
0	820.348	629204.97	4309714.96	False
0.01	820.086	629194.97	4309704.96	False
0.02	819.889	629184.97	4309694.96	False
0.03	819.692	629174.97	4309684.96	False
0.03	819.561	629174.97	4309674.96	False
0.04	819.463	629174.97	4309664.96	False
0.05	819.364	629174.97	4309654.96	False
0.05	819.266	629174.97	4309644.96	False
0.06	819.167	629164.97	4309634.96	False
0.07	819.069	629164.97	4309624.96	False
0.08	818.97	629154.97	4309614.96	False
0.08	818.872	629154.97	4309604.96	False
0.09	818.675	629144.97	4309594.96	False



Indiana StreamStats

Streamstats Ungaged Site Report

Date: Tue Jan 7 2014 08:17:31 Mountain Standard Time

Site Location: Indiana

NAD27 Latitude: 38.9028 (38 54 10)

NAD27 Longitude: -85.5371 (-85 32 14)

NAD83 Latitude: 38.9029 (38 54 10)

NAD83 Longitude: -85.5371 (-85 32 13)

Drainage Area: 1.591 mi²

Peak Flow Basin Characteristics			
Region number=1007			
100% Region 3 Peak Flow (1.59 mi ²)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Contributing Drainage Area (square miles)	1.59	0.07	284
Stream Slope 10 and 85 Method (feet per mi)	17.6	3.8	253

Peak Flow Streamflow Statistics					
Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK10	372	21	8.9	238	580
PK25	468	20	14	303	723
PK50	543	20	16	348	849
PK100	615	20	18	387	978
PK200	698	22	18	423	1150
PK500	810	25	18	466	1410

Appendix A2: HYMAPS-OWL Output

SAMPLE

Watershed Spatial Data Summary

Apparent outlet point coordinate (NAD83 UTM Zone 16, meter): X = 626880, Y = 4307046 [[More information about the outlet point \(precipitation and elevation\)](#)]

Watershed longest flow length: 10168 ft		
Watershed average slope: 1 percent		
Watershed Area (acres)	1114.4	
Land use	Soil group	Area(acres)
Water	C	5.9
Water	D	7.6
Commercial	C	1.7
Agriculture	C	554.2
Agriculture	D	0.9
HD-Residential	C	19
LD-Residential	C	26.6
Grass/Pasture	C	12.8
Grass/Pasture	D	0
Forest	C	483.1
Forest	D	2.2
Others	Undefined	0
Total Area		1114.4

**Appendix A3: NOAA Atlas 14 – Point
Precipitation Frequency Estimates**

SAMPLE



NOAA Atlas 14, Volume 2, Version 3
 Location name: Dupont, Indiana, US*
 Coordinates: 38.9030, -85.5369
 Elevation: 769ft*
 * source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.382 (0.348-0.422)	0.455 (0.414-0.503)	0.540 (0.491-0.598)	0.608 (0.551-0.671)	0.694 (0.625-0.766)	0.762 (0.682-0.839)	0.826 (0.735-0.912)	0.894 (0.788-0.988)	0.984 (0.855-1.09)	1.05 (0.904-1.17)
10-min	0.594 (0.541-0.655)	0.710 (0.647-0.785)	0.840 (0.764-0.929)	0.938 (0.851-1.04)	1.06 (0.956-1.17)	1.15 (1.03-1.27)	1.24 (1.11-1.37)	1.33 (1.18-1.48)	1.45 (1.26-1.61)	1.53 (1.32-1.71)
15-min	0.728 (0.663-0.803)	0.868 (0.791-0.960)	1.03 (0.938-1.14)	1.16 (1.05-1.28)	1.31 (1.18-1.45)	1.43 (1.28-1.57)	1.55 (1.38-1.71)	1.66 (1.46-1.84)	1.81 (1.57-2.01)	1.91 (1.65-2.14)
30-min	0.963 (0.877-1.06)	1.16 (1.06-1.29)	1.41 (1.28-1.56)	1.60 (1.45-1.77)	1.85 (1.67-2.04)	2.04 (1.83-2.25)	2.23 (1.99-2.46)	2.42 (2.14-2.68)	2.67 (2.32-2.97)	2.87 (2.47-3.20)
60-min	1.18 (1.07-1.30)	1.43 (1.30-1.58)	1.77 (1.61-1.96)	2.04 (1.85-2.25)	2.40 (2.16-2.65)	2.69 (2.41-2.97)	2.98 (2.65-3.29)	3.29 (2.90-3.63)	3.70 (3.22-4.11)	4.03 (3.46-4.50)
2-hr	1.39 (1.26-1.55)	1.68 (1.53-1.87)	2.10 (1.90-2.34)	2.44 (2.20-2.71)	2.91 (2.61-3.23)	3.29 (2.93-3.65)	3.70 (3.26-4.11)	4.12 (3.60-4.60)	4.73 (4.07-5.30)	5.22 (4.43-5.89)
3-hr	1.49 (1.35-1.66)	1.80 (1.63-2.01)	2.25 (2.04-2.51)	2.62 (2.36-2.92)	3.14 (2.81-3.49)	3.57 (3.17-3.97)	4.03 (3.54-4.48)	4.52 (3.93-5.04)	5.23 (4.46-5.85)	5.81 (4.88-6.53)
6-hr	1.80 (1.64-2.03)	2.18 (1.98-2.45)	2.73 (2.47-3.07)	3.18 (2.86-3.57)	3.82 (3.41-4.28)	4.35 (3.85-4.88)	4.92 (4.30-5.53)	5.54 (4.78-6.24)	6.42 (5.45-7.26)	7.16 (5.99-8.14)
12-hr	2.16 (1.96-2.41)	2.60 (2.36-2.89)	3.22 (2.92-3.59)	3.72 (3.36-4.15)	4.43 (3.97-4.93)	5.01 (4.46-5.58)	5.63 (4.95-6.26)	6.28 (5.46-7.01)	7.20 (6.18-8.08)	7.96 (6.74-8.97)
24-hr	2.54 (2.36-2.76)	3.05 (2.84-3.32)	3.79 (3.51-4.12)	4.39 (4.05-4.76)	5.23 (4.81-5.67)	5.93 (5.42-6.42)	6.66 (6.05-7.23)	7.45 (6.71-8.09)	8.57 (7.62-9.34)	9.48 (8.33-10.4)
2-day	3.03 (2.81-3.30)	3.63 (3.36-3.95)	4.46 (4.12-4.86)	5.13 (4.73-5.57)	6.05 (5.56-6.58)	6.80 (6.21-7.40)	7.58 (6.88-8.25)	8.39 (7.56-9.15)	9.52 (8.49-10.4)	10.4 (9.21-11.5)
3-day	3.24 (3.02-3.50)	3.88 (3.61-4.19)	4.74 (4.40-5.12)	5.44 (5.04-5.87)	6.40 (5.91-6.91)	7.18 (6.60-7.75)	7.99 (7.30-8.64)	8.83 (8.01-9.57)	9.99 (8.98-10.9)	10.9 (9.73-12.0)
4-day	3.45 (3.22-3.70)	4.12 (3.85-4.43)	5.02 (4.69-5.38)	5.75 (5.35-6.16)	6.75 (6.26-7.24)	7.56 (6.98-8.11)	8.40 (7.72-9.03)	9.27 (8.47-9.99)	10.5 (9.47-11.4)	11.4 (10.3-12.4)
7-day	4.11 (3.85-4.39)	4.89 (4.58-5.24)	5.91 (5.53-6.32)	6.71 (6.27-7.18)	7.80 (7.26-8.36)	8.67 (8.05-9.29)	9.56 (8.83-10.3)	10.5 (9.61-11.3)	11.7 (10.6-12.6)	12.6 (11.4-13.7)
10-day	4.67 (4.37-5.00)	5.55 (5.20-5.95)	6.68 (6.24-7.16)	7.56 (7.05-8.10)	8.76 (8.14-9.39)	9.70 (8.99-10.4)	10.7 (9.83-11.4)	11.6 (10.7-12.5)	12.9 (11.8-13.9)	13.9 (12.6-15.1)
20-day	6.37 (6.00-6.77)	7.54 (7.11-8.02)	8.92 (8.39-9.48)	9.97 (9.37-10.6)	11.4 (10.7-12.1)	12.5 (11.6-13.3)	13.5 (12.6-14.4)	14.6 (13.5-15.6)	16.0 (14.7-17.1)	17.0 (15.6-18.3)
30-day	7.88 (7.45-8.33)	9.28 (8.77-9.82)	10.8 (10.2-11.5)	12.0 (11.3-12.7)	13.6 (12.8-14.4)	14.8 (13.9-15.7)	16.0 (15.0-17.0)	17.2 (16.0-18.3)	18.7 (17.3-20.0)	19.9 (18.3-21.3)
45-day	9.92 (9.41-10.5)	11.7 (11.0-12.3)	13.4 (12.7-14.2)	14.8 (14.0-15.6)	16.6 (15.7-17.5)	17.9 (16.9-18.9)	19.2 (18.0-20.3)	20.4 (19.1-21.6)	22.0 (20.5-23.4)	23.2 (21.5-24.7)
60-day	11.8 (11.2-12.4)	13.8 (13.1-14.5)	15.8 (15.1-16.6)	17.4 (16.5-18.3)	19.4 (18.4-20.3)	20.8 (19.7-21.9)	22.2 (21.0-23.4)	23.6 (22.2-24.9)	25.2 (23.6-26.7)	26.4 (24.7-28.1)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

Appendix A4: TR-55 & CN Output

SAMPLE

TIME OF CONCENTRATION

Sheet Flow, applies to Tc only

		1	2
1	Surface Description, see Figure 202-2B	Dense Woods	
2	Manning's Roughness Coefficient, n, see Figure 202-2B	0.800	
	Max. Flow Elevation (ft)	821	
	Min. Flow Elevation (ft)	820	
3	Flow length, L (total L<=100ft.)	100.0	
4	Two-yr 24hr Rainfall, P2 (in.) (Using NOAA Atlas 14)	3.05	
5	Land Slope, S (ft/ft)	0.00	
6	$T_t = 0.007 (nL)^{0.8} / [P2^{0.5} * S^{0.4}]$ (hr.)	1.227	

Subtotal: 1.227 hr.

Shallow Concentration Flow

		1	2
7	Surface description, paved or unpaved	Unpaved	Unpaved
	Max. Flow Elevation (ft)	820	813
	Min Flow Elevation (ft)	813	810
8	Flow length, L (ft)	2560.0	915.0
9	Watercourse slope, S (ft/ft)	0.0029	0.0034
10	Average velocity, V (ft/s), see Figure 202-2D	1.0	1.0
11	$T_t = L/(3600 V)$ (hr)	0.711	0.254

Subtotal: 0.965 hr.

Channel Flow

Note: Channel cross section approximated using a trapezoidal section.

	1	2	3
Base, B (ft)	10	15	20
Depth, d (ft)	2	2	2
Side Slope, z	2	2	2

12	Cross-sectional flow area, a	28.00	38.00	48.00
13	Wetted perimeter, (ft) $P_w = b + 2d * (z^2 + 1)^{0.5}$	18.94	23.94	28.94
14	Hydraulic radius, (ft) $r = a/P_w$	1.48	1.59	1.66
	Max. Flow Elevation (ft)	810	794	789
	Min Flow Elevation (ft)	794	789	767
15	Channel slope, S (ft/ft)	0.003	0.004	0.004
16	Manning's roughness coeff., n, see Figure 202-2C	0.100	0.050	0.040
17	$V = (1.49 r^{2/3} s^{1/2})/n$ (ft/s)	1.04	2.61	3.45
18	Flow length, L (ft)	5580	1095	5115
19	$T_t = L/(3600 V)$ (hr.)	1.488	0.116	0.412

Subtotal: 2.017 hr.

20 Add Tt in lines 6, 11, and 19 to get watershed or subarea Tc or Tt= 4.209 hr.

or

253 min.

CN Spreadsheet / Drainage Area

Land Use	A		B		C		D		Area by Use (acres)	Average CN	Weighted CN
	Area (ac)	CN	Area (ac)	CN	Area (ac)	CN	Area (ac)	CN			
Runoff Curve Numbers for Rural Area from Figure 202-2F of IDM 2013											
Row Crops	0.00	67	0.00	76	554.20	83	0.90	86	555.1	83.00	41.36
Pasture or RangeLand	0.00	49	0.00	69	12.80	79	0.00	84	12.8	79.00	0.91
Meadow		30		58		71		78	0.0	0.00	0.00
Brush or Brush-Weed Mixture		35		56		70		77	0.0	0.00	0.00
Woods or Forest	0.00	43	0.00	65	483.10	76	2.20	82	485.3	76.03	33.12
Woods and Grass, Orchard		36		60		73		79	0.0	0.00	0.00
Water	0.00	100	0.00	100	5.90	100	7.60	100	13.5	100.00	1.21
Runoff Curve Numbers for Urban Area from Figure 202-2F of IDM 2013											
Open Space: Lawn or Golf Course		49		69		79		84	0.00	0.00	0.00
Fair condition (<75% cover)		39		61		74		80	0.00	0.00	0.00
Good condition (>75% cover)											
Street and Roads		83		89		92		93	0.00	0.00	0.00
Paved, open ditches, entire right of way		76		85		89		91	0.00	0.00	0.00
Gravel, open ditches, entire right of way		72		82		87		89	0.00	0.00	0.00
Earth, open ditches, entire right of way											
Impervious		98		98		98		98	0.00	0.00	0.00
Urban Area											
Commercial or Business, 85% impervious	0.00	89	0.00	92	1.70	94	0.00	95	1.70	94.00	0.14
Industrial, 72% impervious		81		88		91		93	0.00	0.00	0.00
Residential Area											
1/8 acre, apartments, 65% impervious		77		85		90		92	0.00	0.00	0.00
1/4 acre, 38% impervious		61		75		83		87	0.00	0.00	0.00
1/3 acre, 30% impervious		57		72		81		86	0.00	0.00	0.00
1/2 acre, 30% impervious		54		70		80		85	0.00	0.00	0.00
1 acre, 20% impervious	0.00	51	0.00	68	19.00	79	0.00	84	19.00	79.00	1.35
2 acres, 12% impervious	0.00	46	0.00	65	26.60	77	0.00	82	26.60	77.00	1.84
Developing Urban Area		57		73		82		86	0.00	0.00	0.00
Water											
		100		100		100		100		0.00	
TOTAL Area									1114	acre	
TOTAL Area									1.741	sq. mi.	
Weighted CN											79.93
											Use CN = 80

Appendix A5: HydroCAD Output

SAMPLE

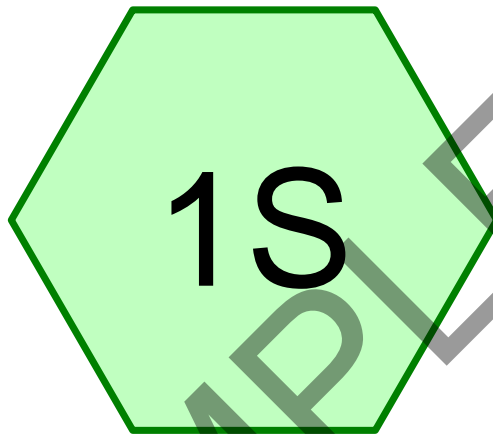
Table 2.1.5
50% Huff Curve Ordinates (Purdue et al., 1992)

% Storm Time	Indianapolis				Evansville				Fort Wayne				South Bend			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	20.00	6.50	5.26	6.67	22.82	6.28	5.13	6.92	20.00	6.67	6.00	7.14	20.00	7.50	7.00	8.26
20	40.80	18.13	11.55	14.25	44.69	17.33	11.11	14.04	41.11	17.14	12.23	14.23	40.00	18.57	13.33	16.35
30	54.95	35.85	17.06	20.00	57.11	33.33	16.67	20.51	54.83	34.17	18.86	20.00	51.67	34.00	20.00	22.73
40	62.50	52.94	24.24	26.09	65.33	53.09	25.44	27.06	62.00	52.18	26.15	25.71	60.89	51.43	27.50	28.50
50	68.75	67.86	37.78	33.33	71.43	69.57	37.93	34.21	68.42	66.67	38.46	33.33	67.35	66.67	39.13	34.04
60	76.67	76.52	58.33	40.00	78.15	78.57	57.39	40.91	75.00	76.36	57.23	38.00	75.00	75.17	58.46	40.20
70	83.05	83.81	78.03	50.00	84.66	85.60	77.44	50.79	81.62	84.29	76.11	48.50	80.83	82.32	75.98	50.00
80	89.70	90.67	88.68	68.57	90.00	91.72	88.54	69.70	87.50	90.00	87.69	68.24	86.67	88.89	86.79	67.50
90	95.00	95.89	95.29	88.37	95.36	96.50	95.88	89.36	93.75	95.56	95.08	87.88	92.89	94.78	94.17	87.50
100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

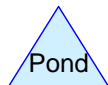
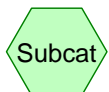
Table 2.1.6
60% Huff Curve Ordinates (Purdue et al., 1992)

% Storm Time	Indianapolis				Evansville				Fort Wayne				South Bend			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	17.50	5.22	4.18	5.45	19.15	5.07	4.00	5.22	17.78	5.71	4.67	5.45	17.37	6.09	5.65	6.67
20	37.86	15.56	9.23	11.03	40.51	15.12	9.00	11.11	38.00	14.69	10.42	11.00	36.00	15.94	11.25	13.33
30	50.00	31.25	14.29	17.39	53.13	30.00	13.69	16.94	50.00	30.00	15.89	16.04	48.57	30.53	17.14	20.00
40	58.33	48.39	21.58	22.28	60.86	48.81	22.22	23.00	57.50	48.42	22.44	22.98	56.67	48.00	24.00	25.00
50	65.12	64.13	32.45	28.57	66.95	65.79	33.96	30.77	65.00	63.64	35.00	27.42	65.00	62.50	35.66	29.41
60	71.97	73.33	54.17	36.67	74.36	75.56	53.33	37.23	71.43	73.33	53.08	34.17	71.43	72.44	54.07	37.02
70	80.00	81.13	73.89	47.14	80.91	82.46	74.43	47.27	77.78	81.43	72.86	44.17	77.78	79.29	72.67	47.02
80	86.67	88.82	86.32	65.00	87.50	89.53	86.67	66.00	85.00	88.00	85.71	64.41	84.00	86.67	84.44	64.44
90	93.33	94.74	94.12	86.67	94.00	95.50	94.67	86.00	92.12	94.44	93.85	85.42	90.77	93.55	92.89	85.71
100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Quartiles used in
HydroCAD

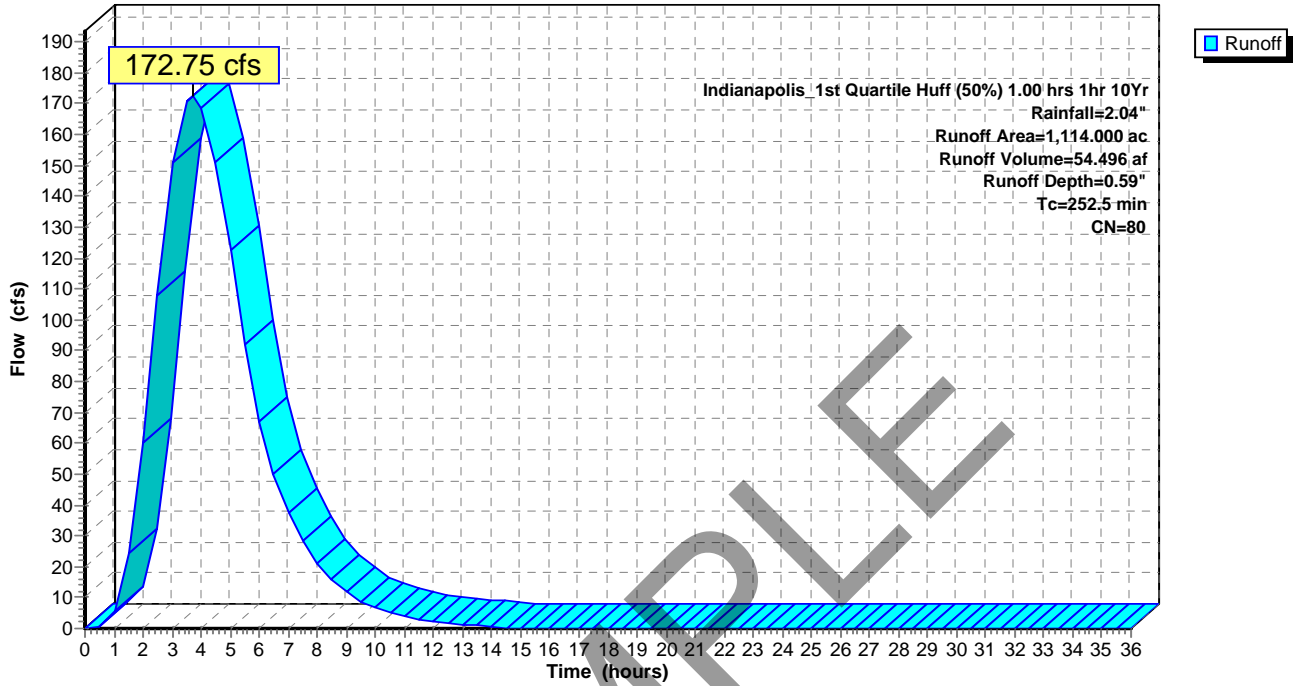


SR 7 over Bear Creek



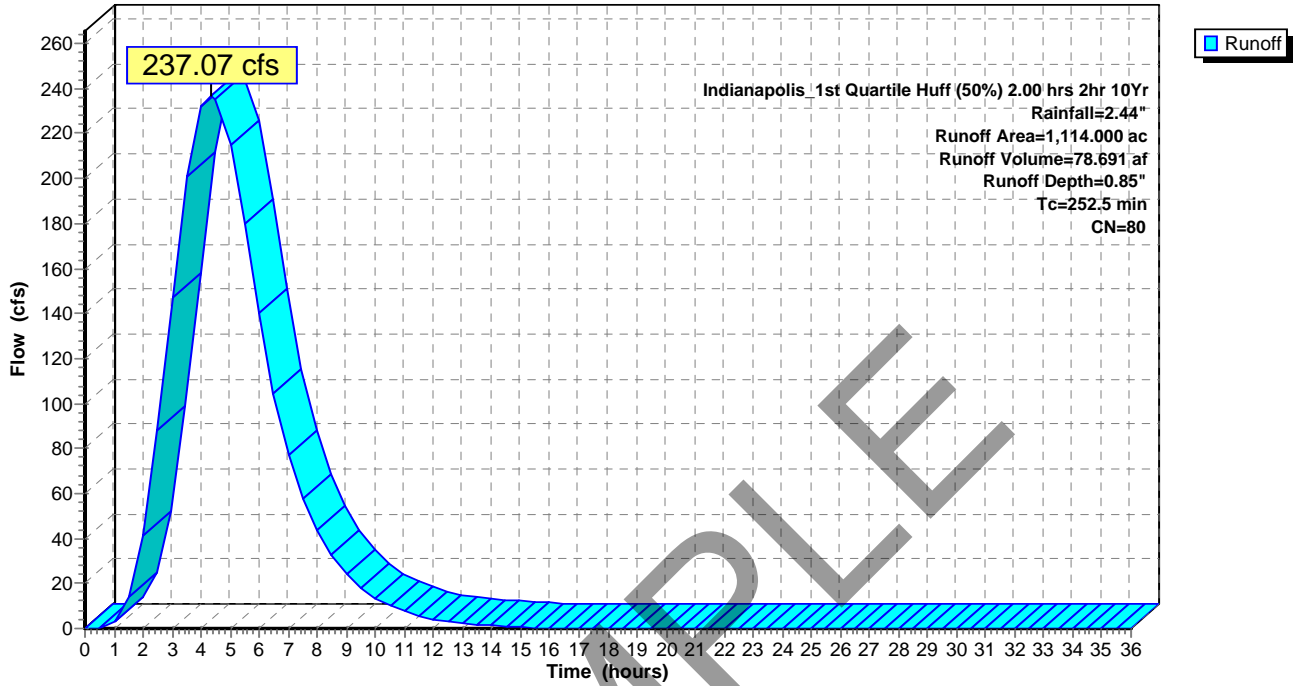
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



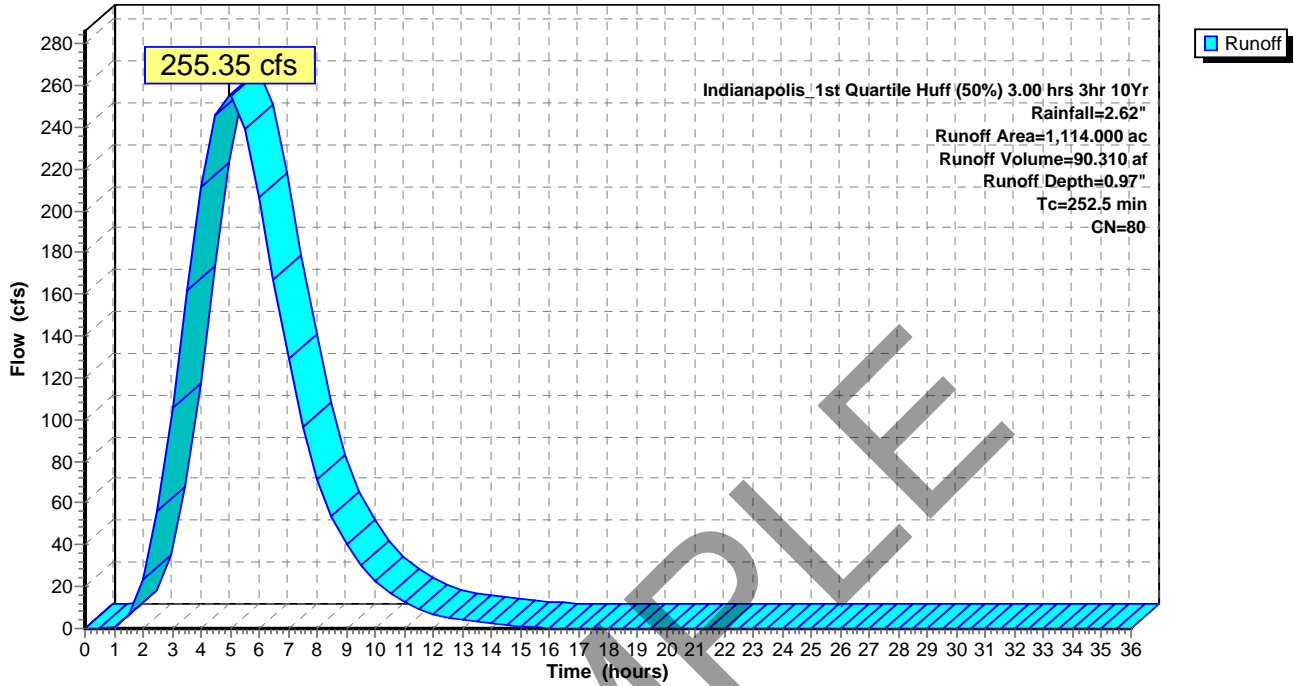
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



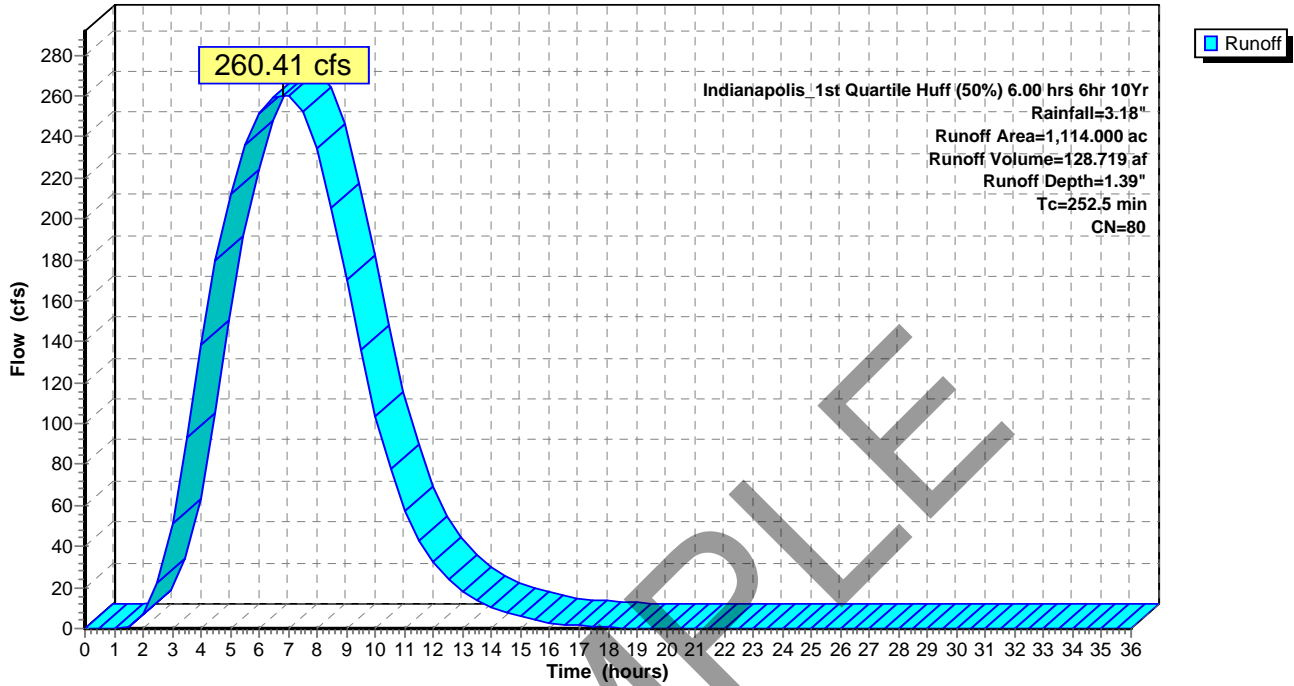
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



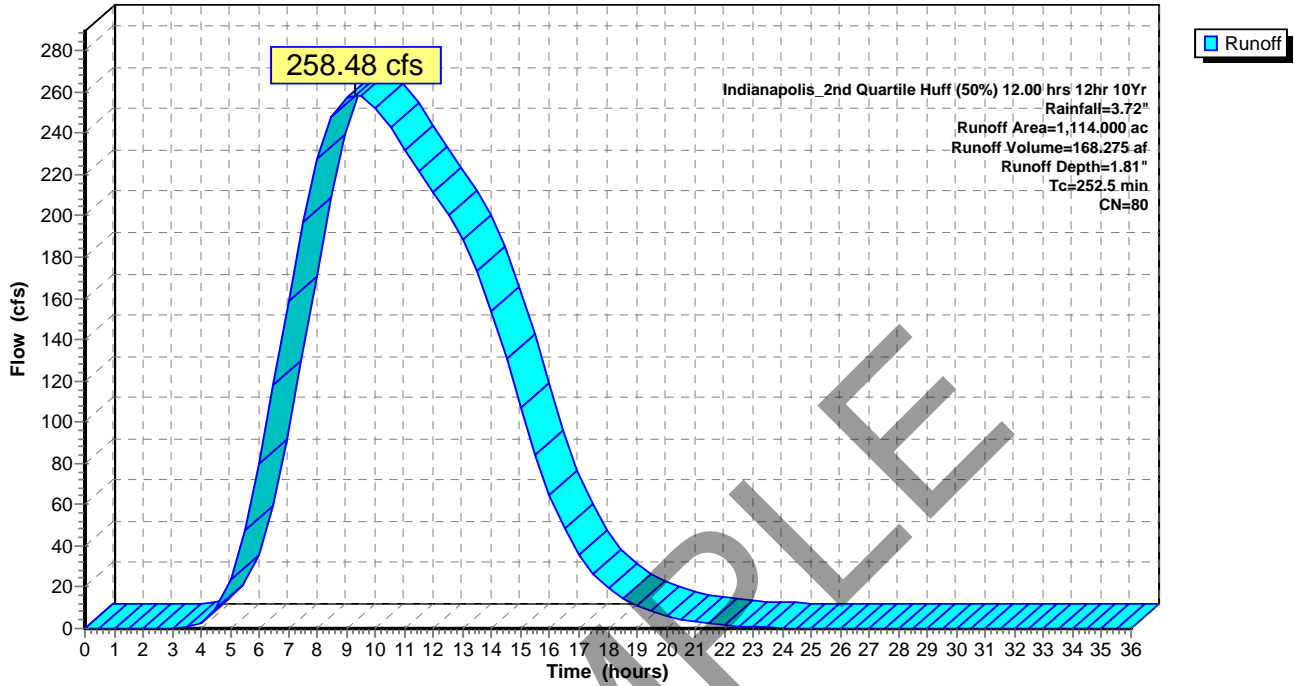
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



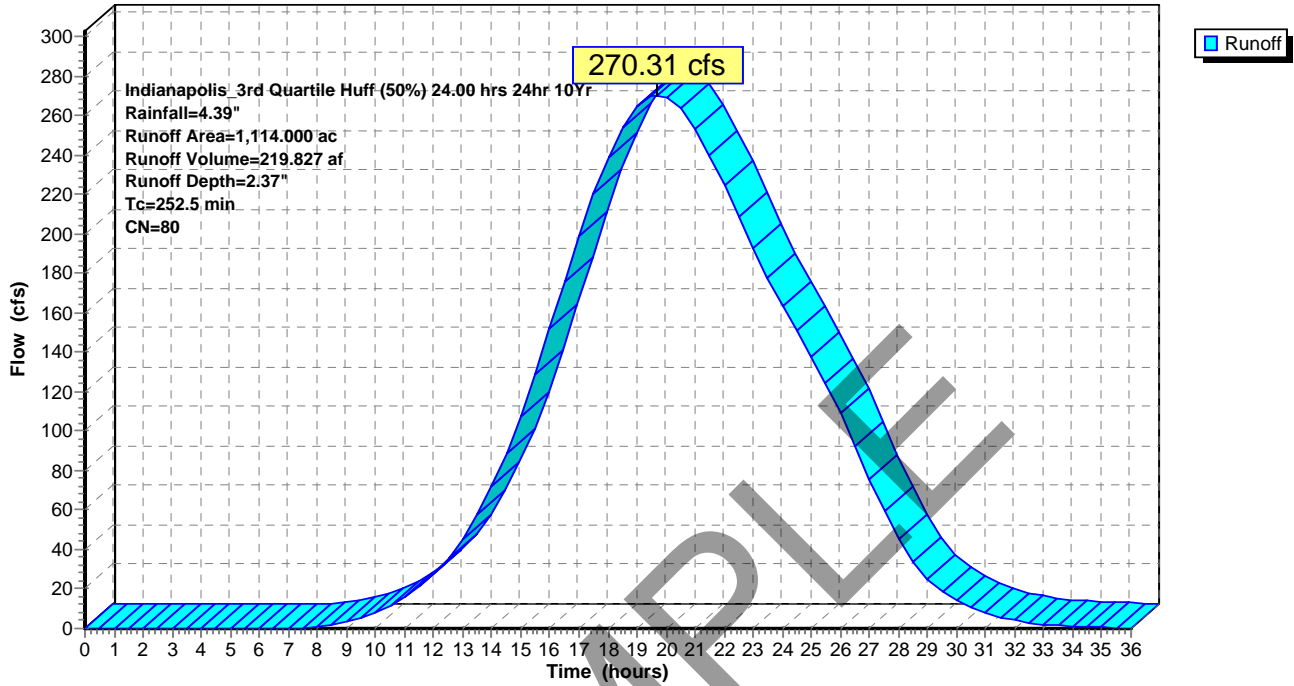
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



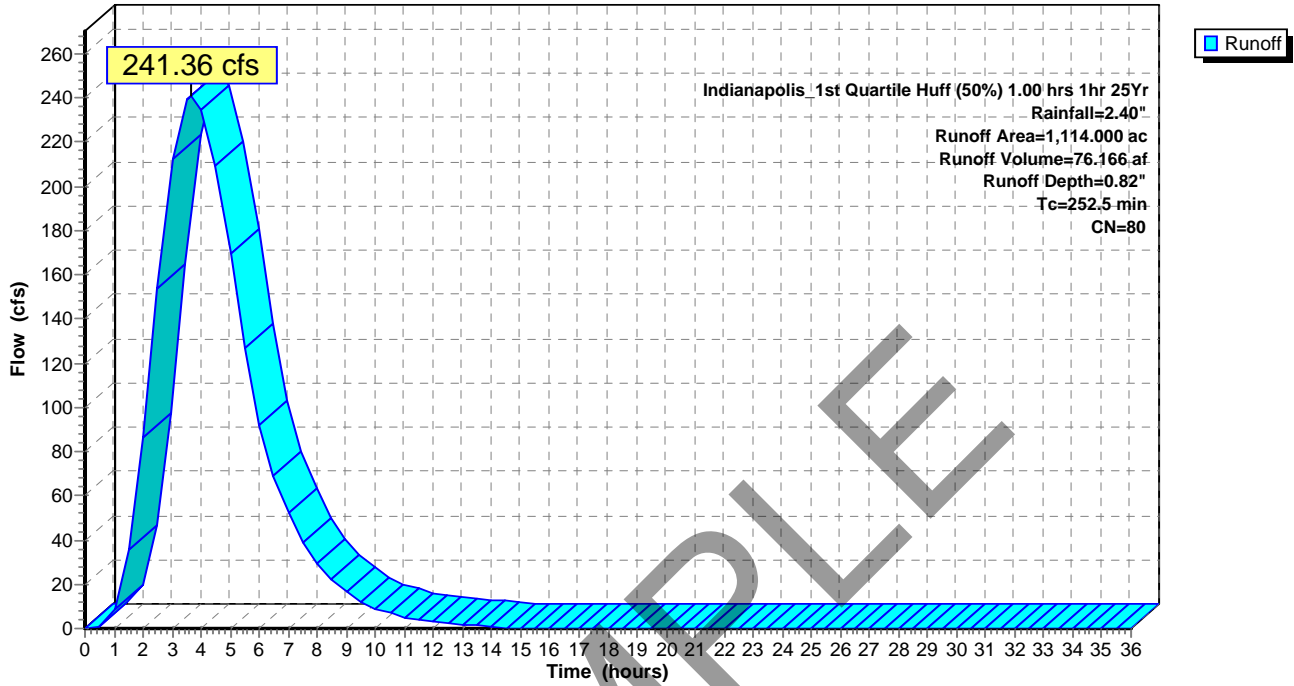
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



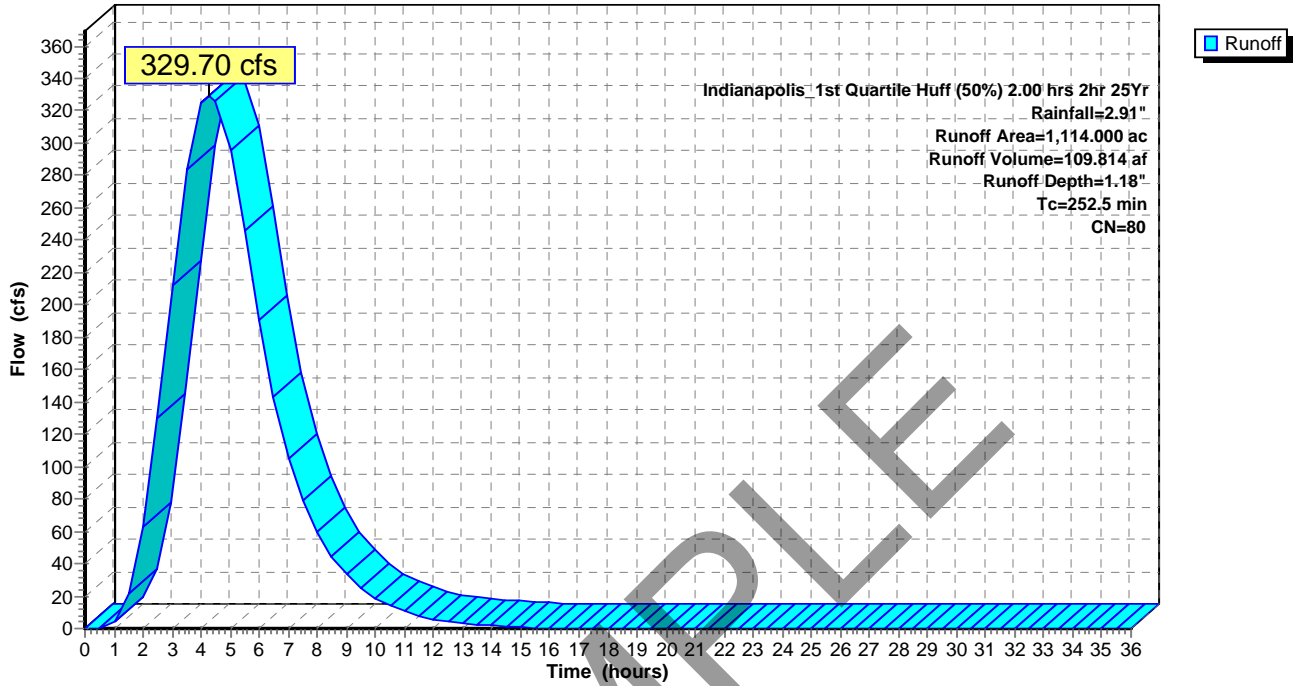
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



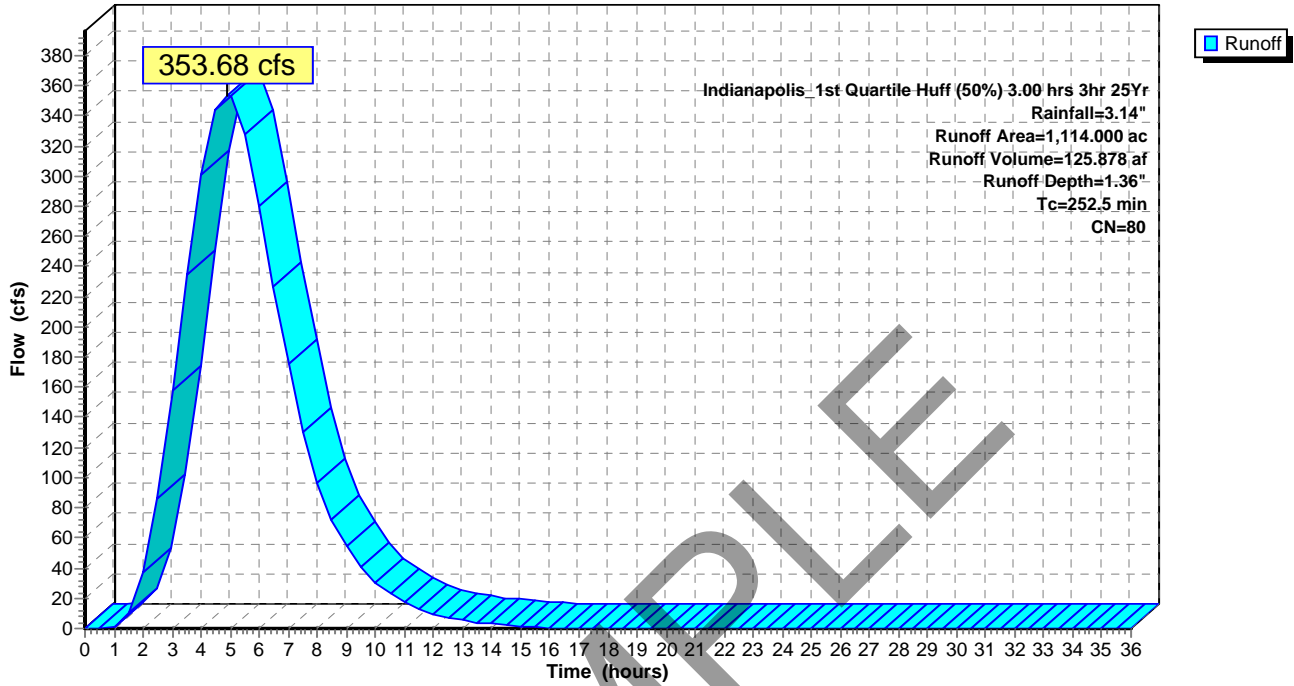
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



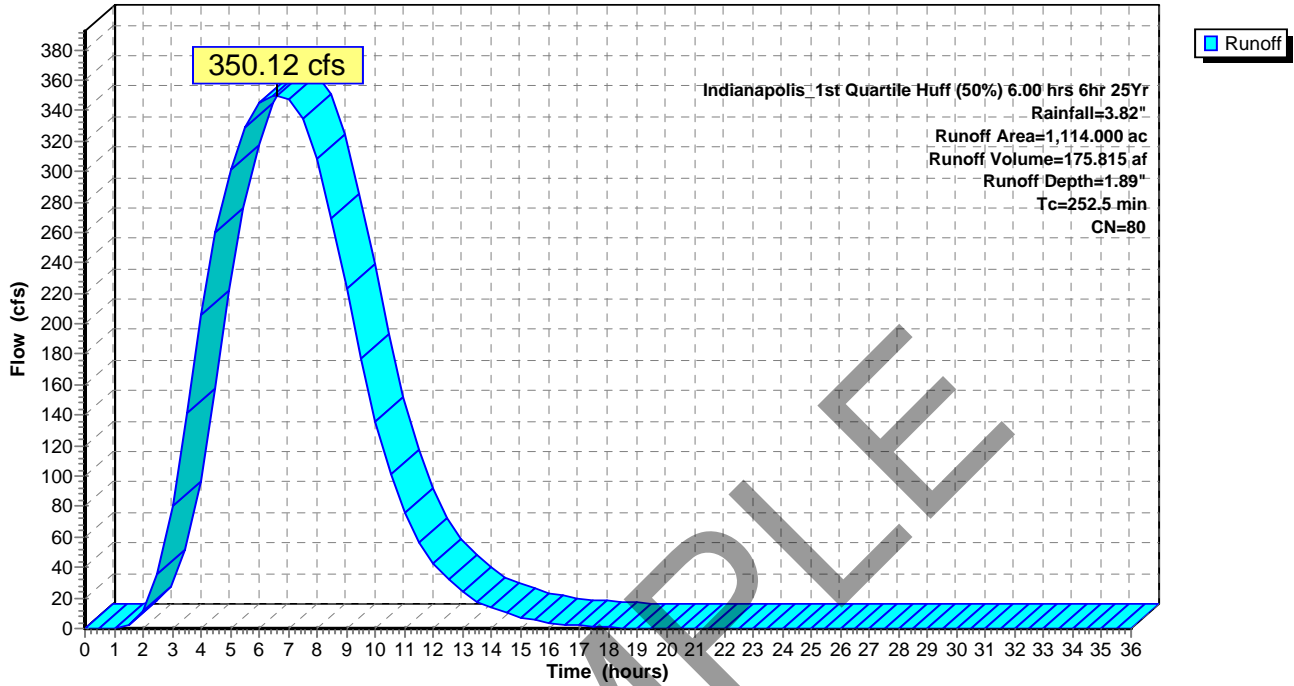
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



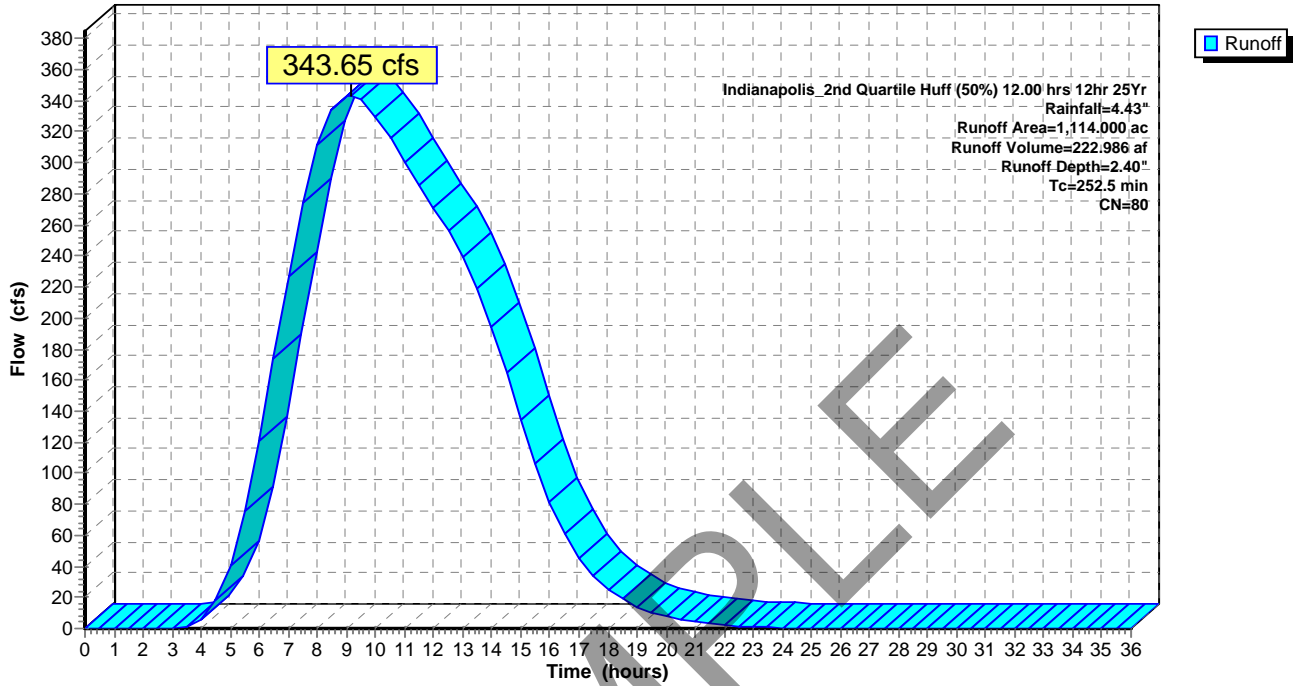
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



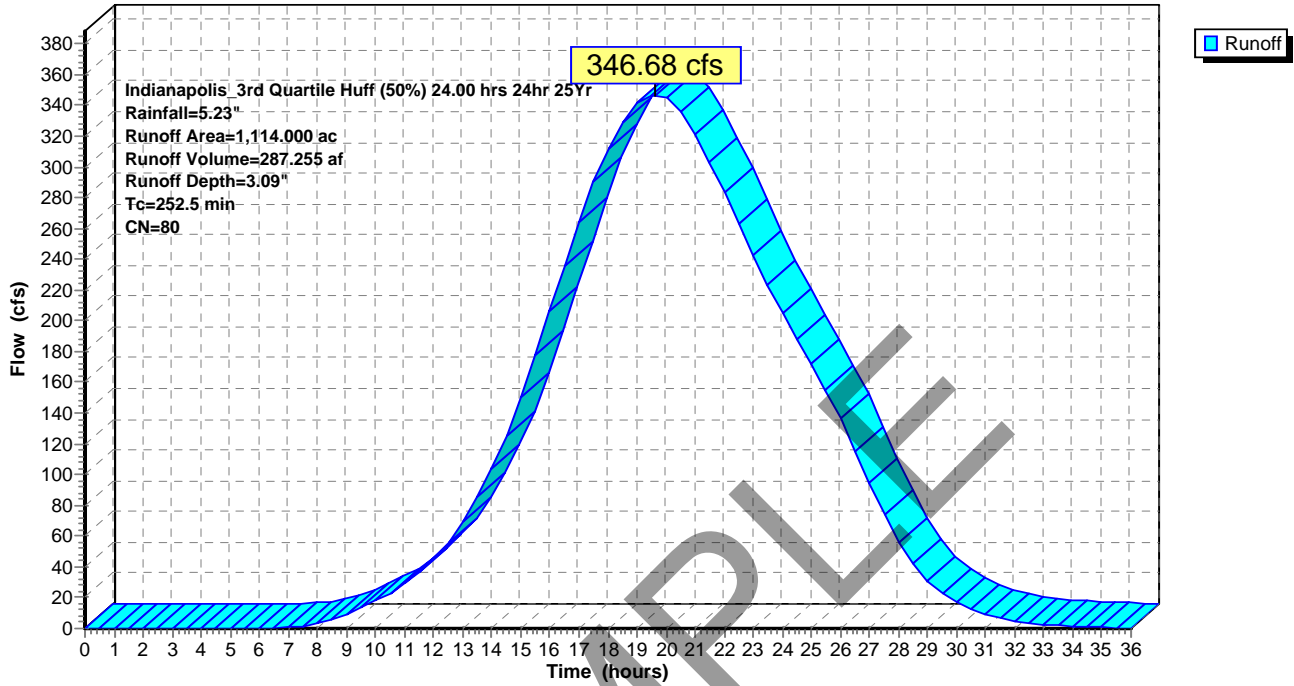
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



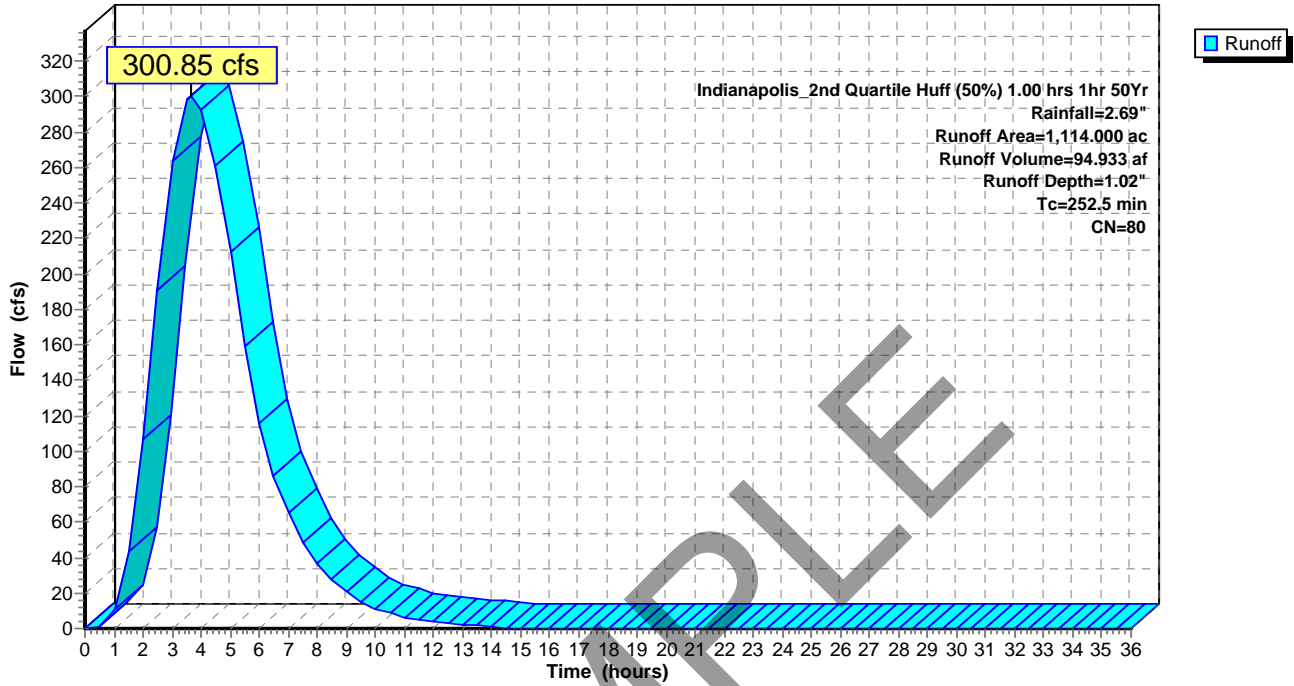
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



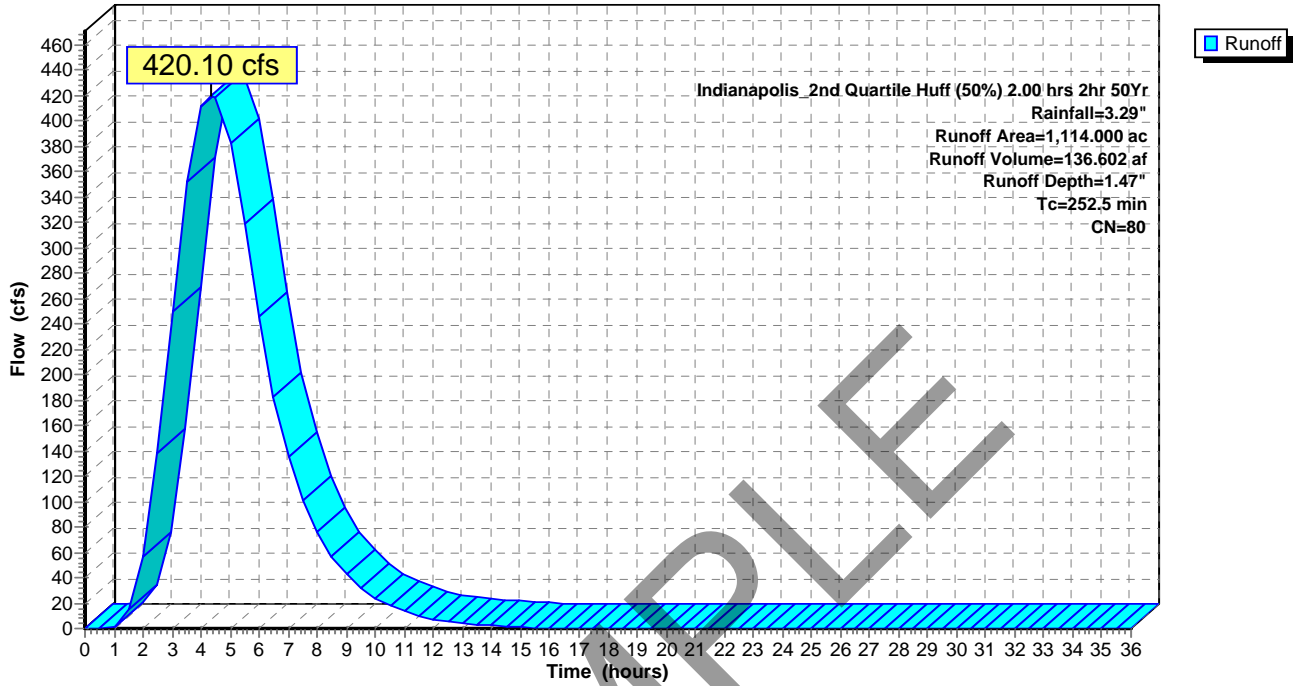
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



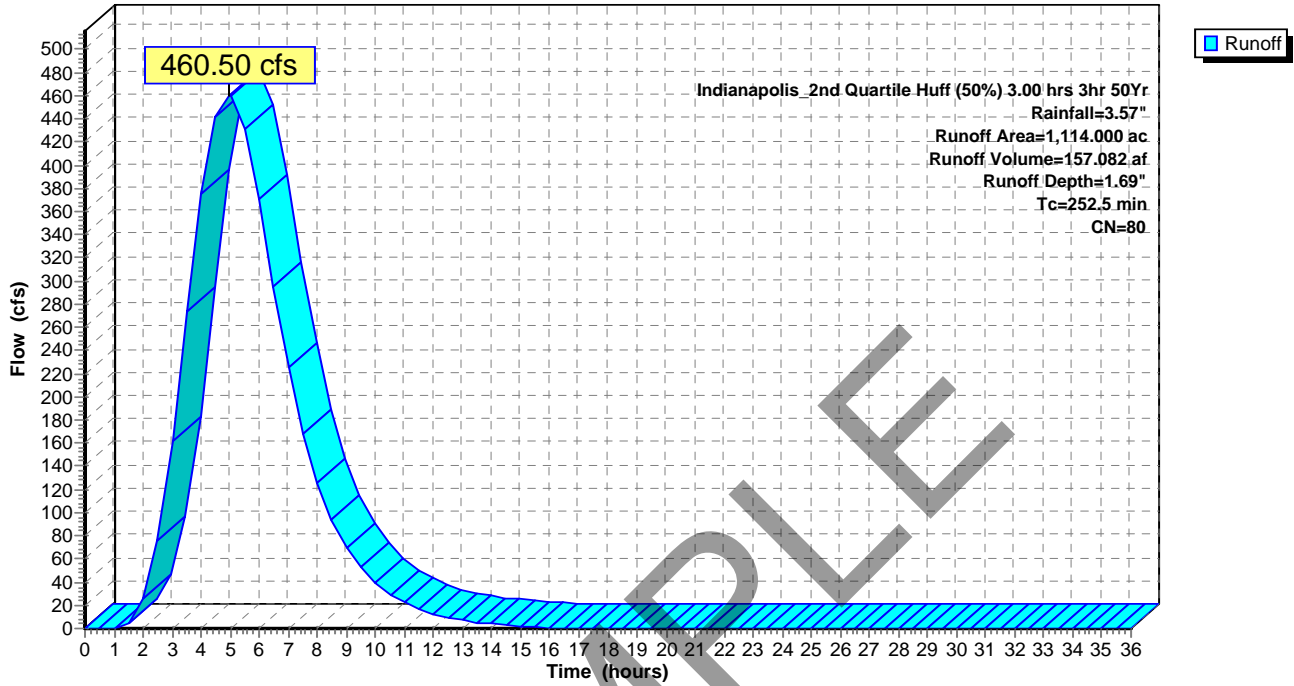
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



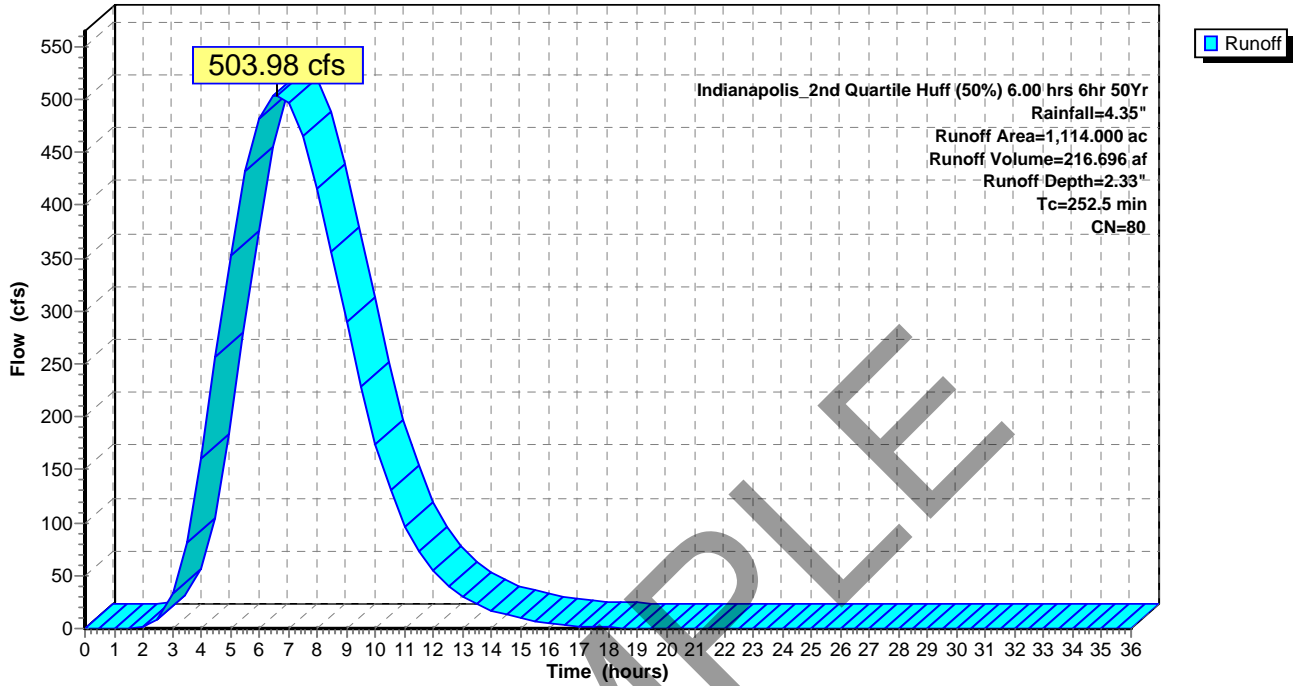
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



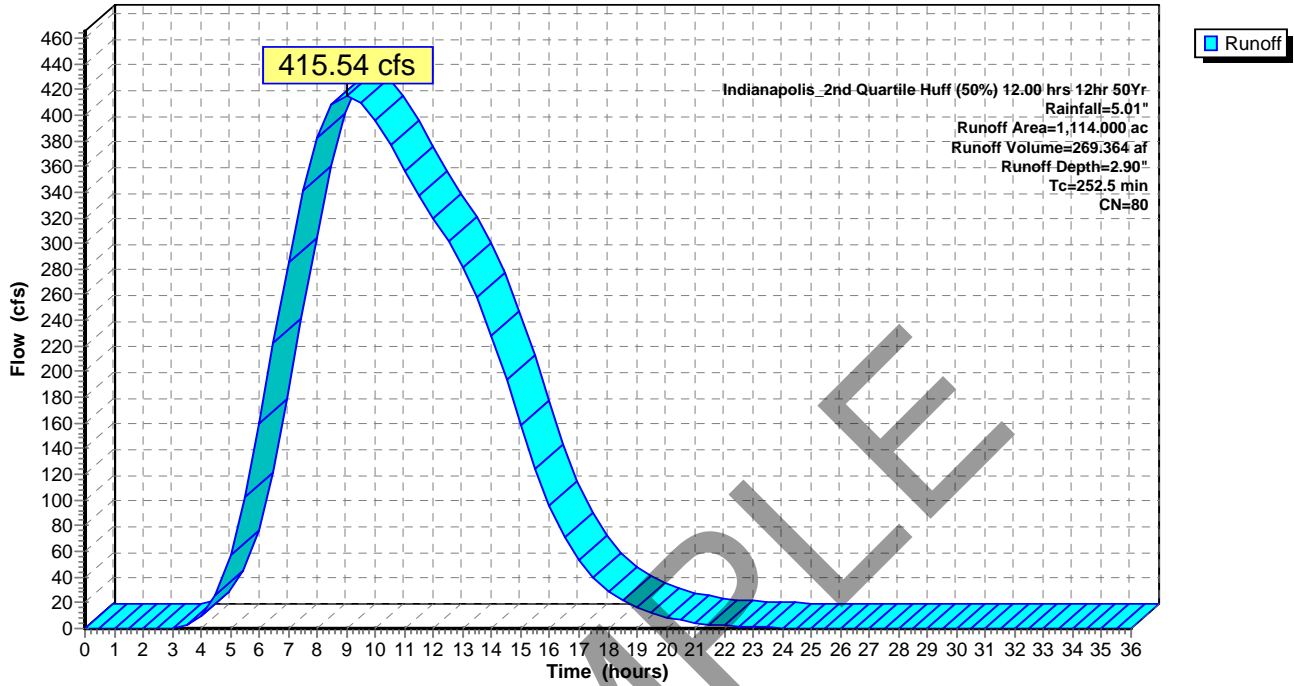
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph

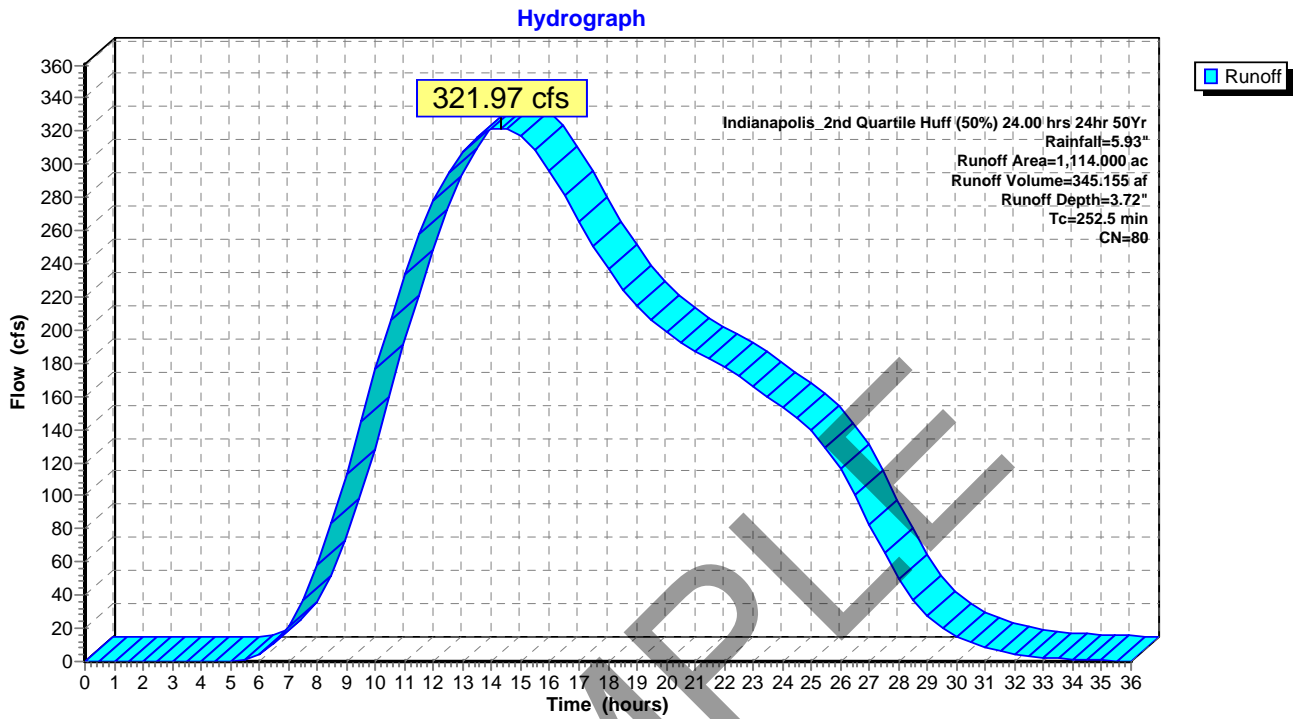


Subcatchment 1S: SR 7 over Bear Creek

Hydrograph

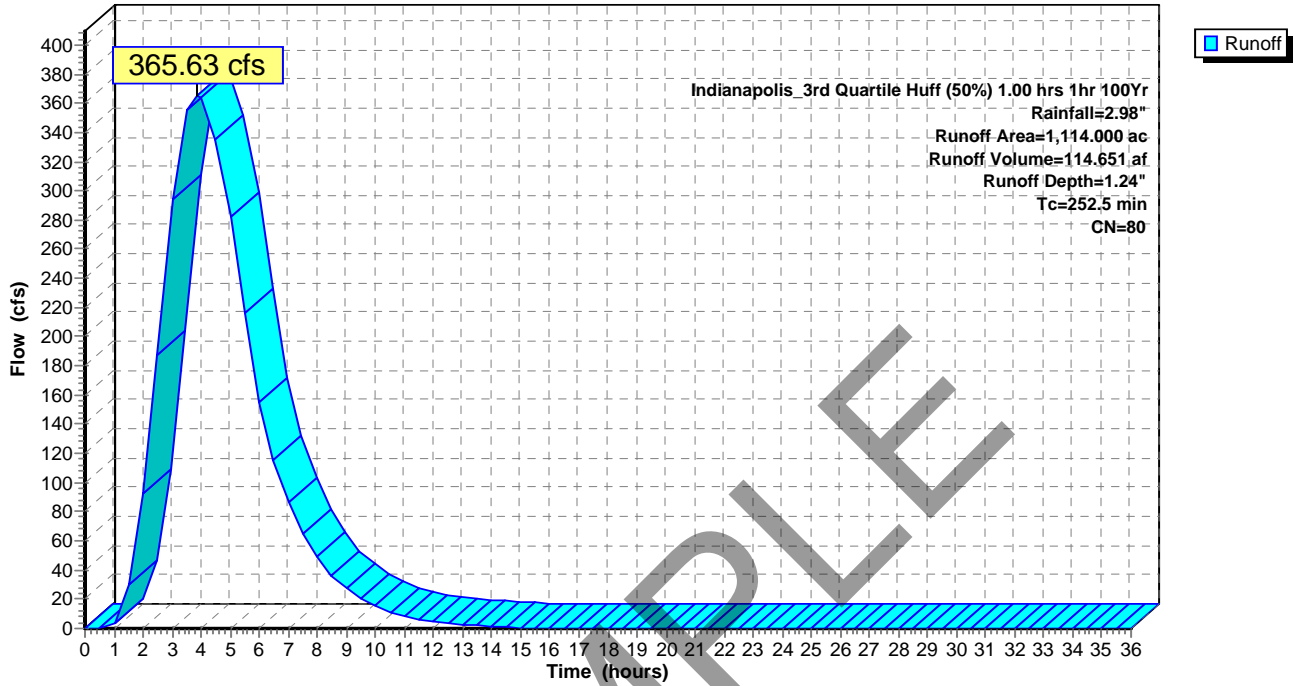


Subcatchment 1S: SR 7 over Bear Creek



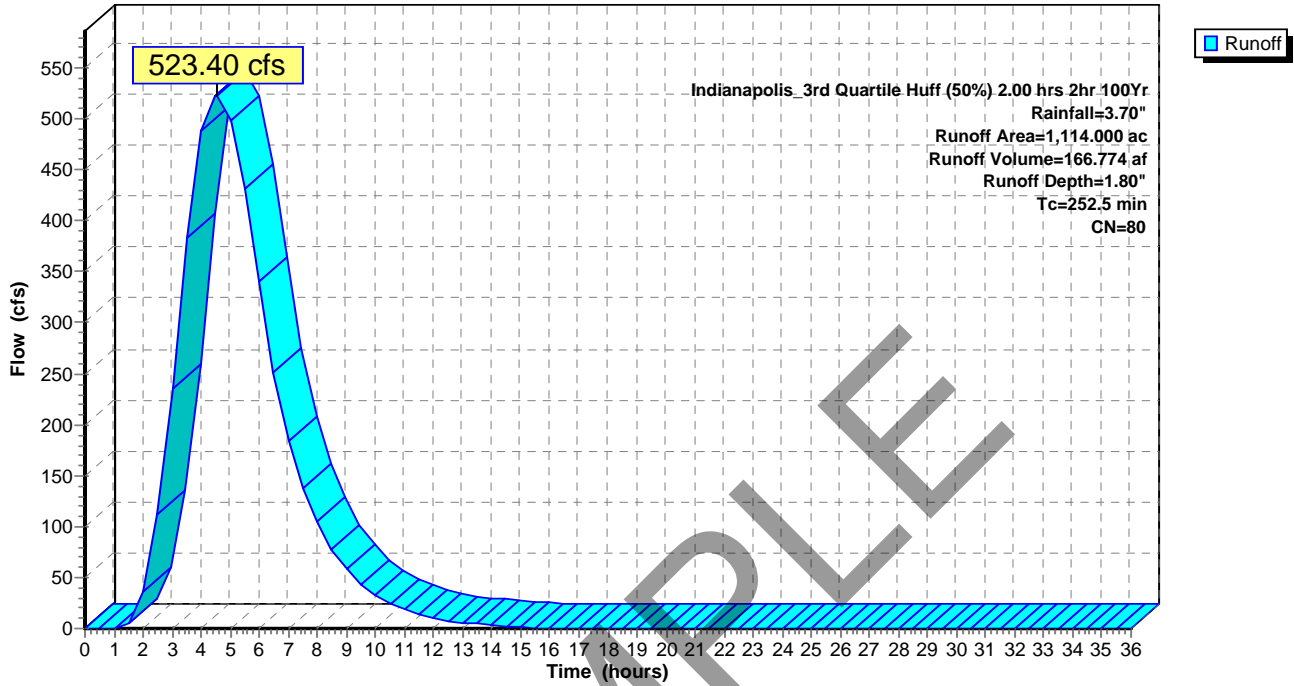
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



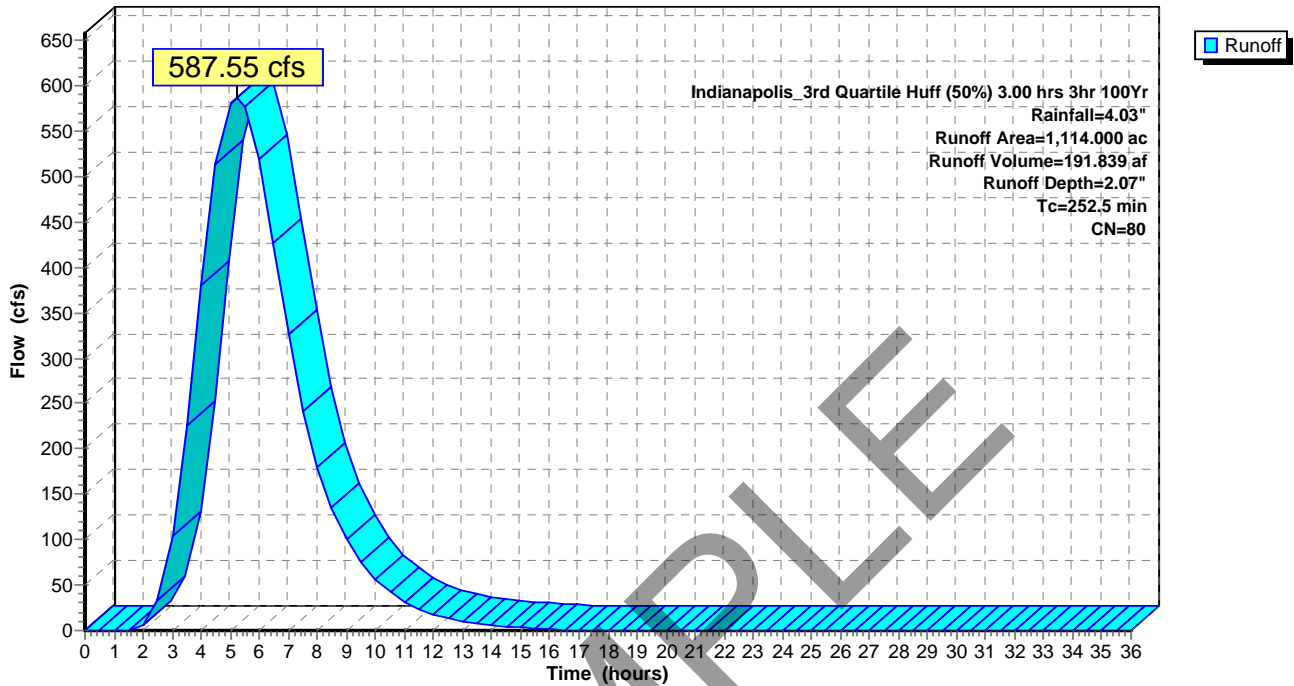
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



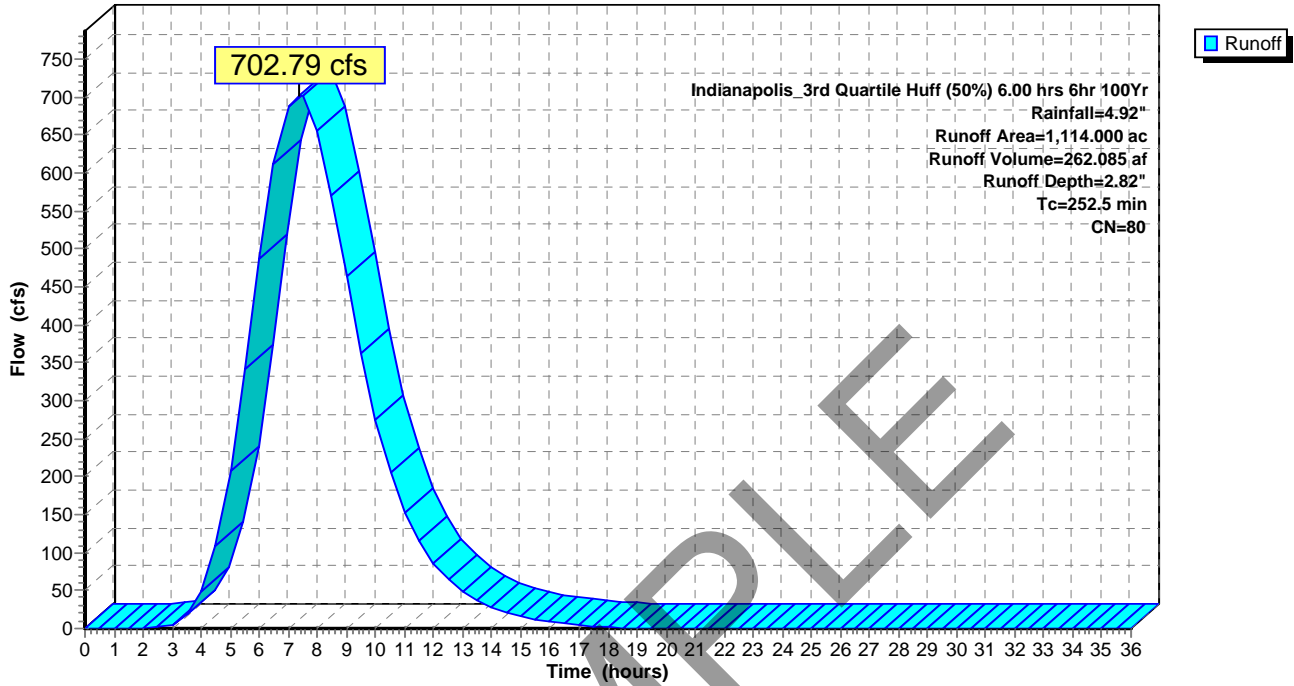
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



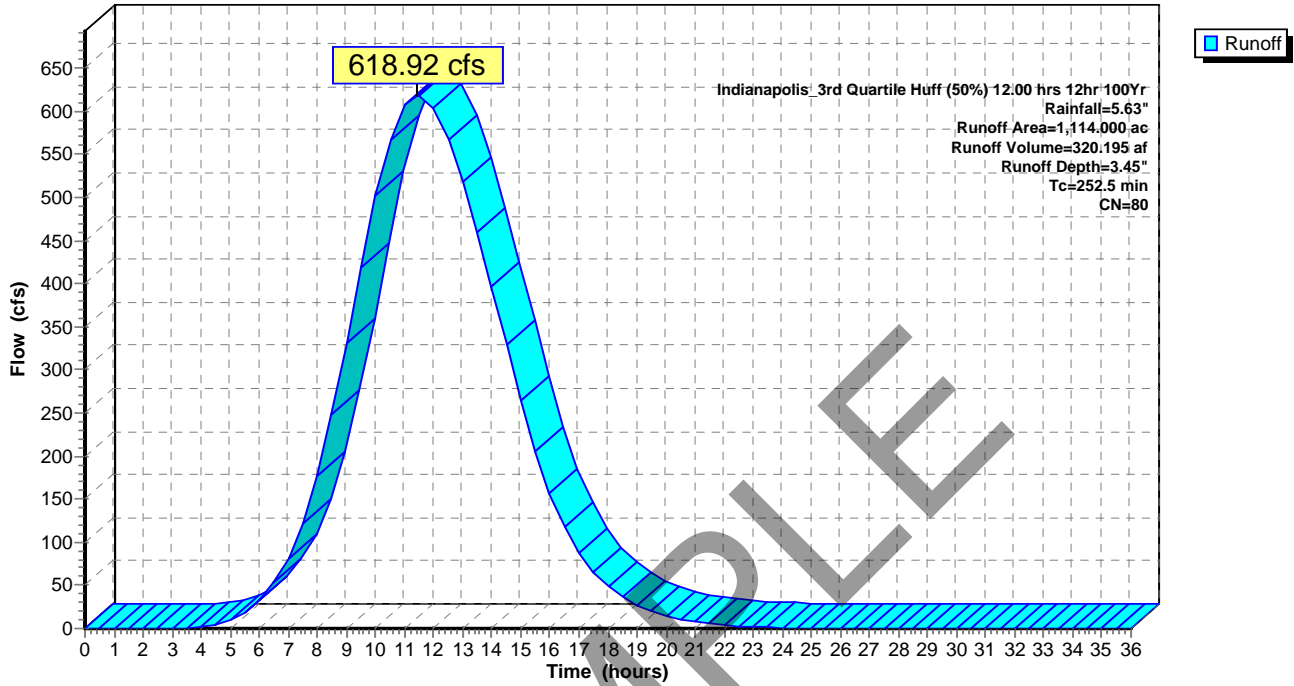
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



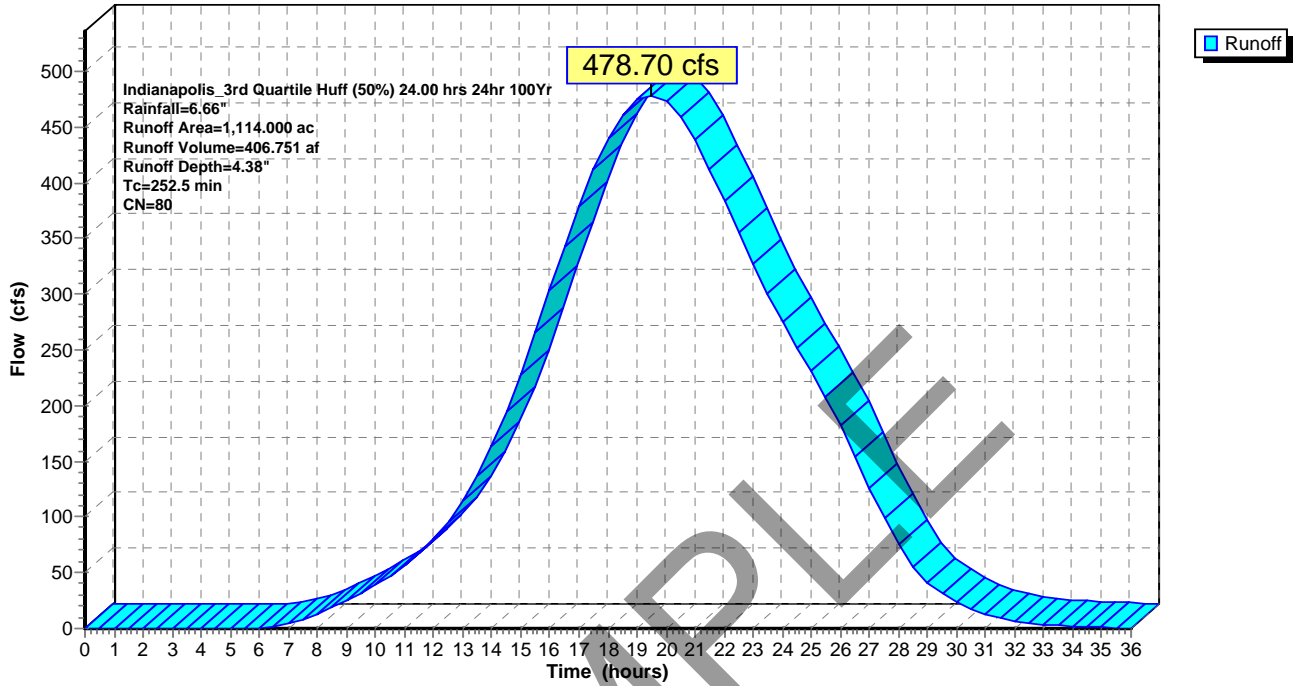
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



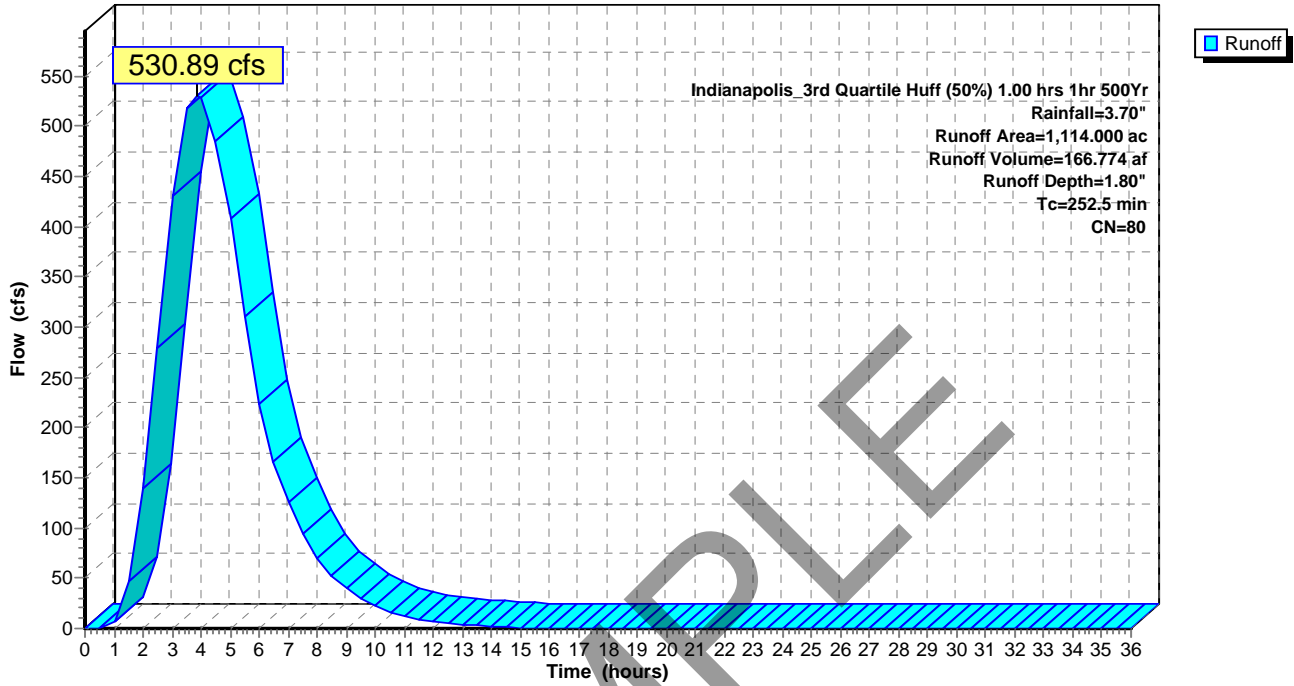
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



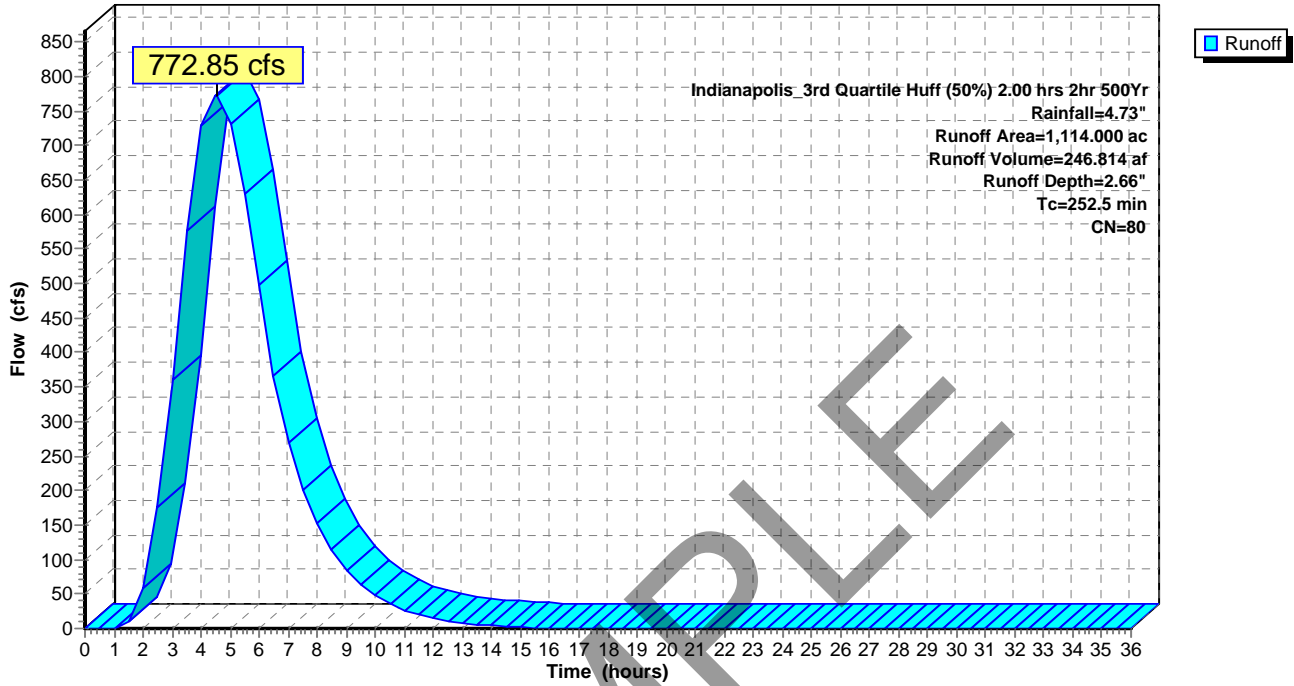
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



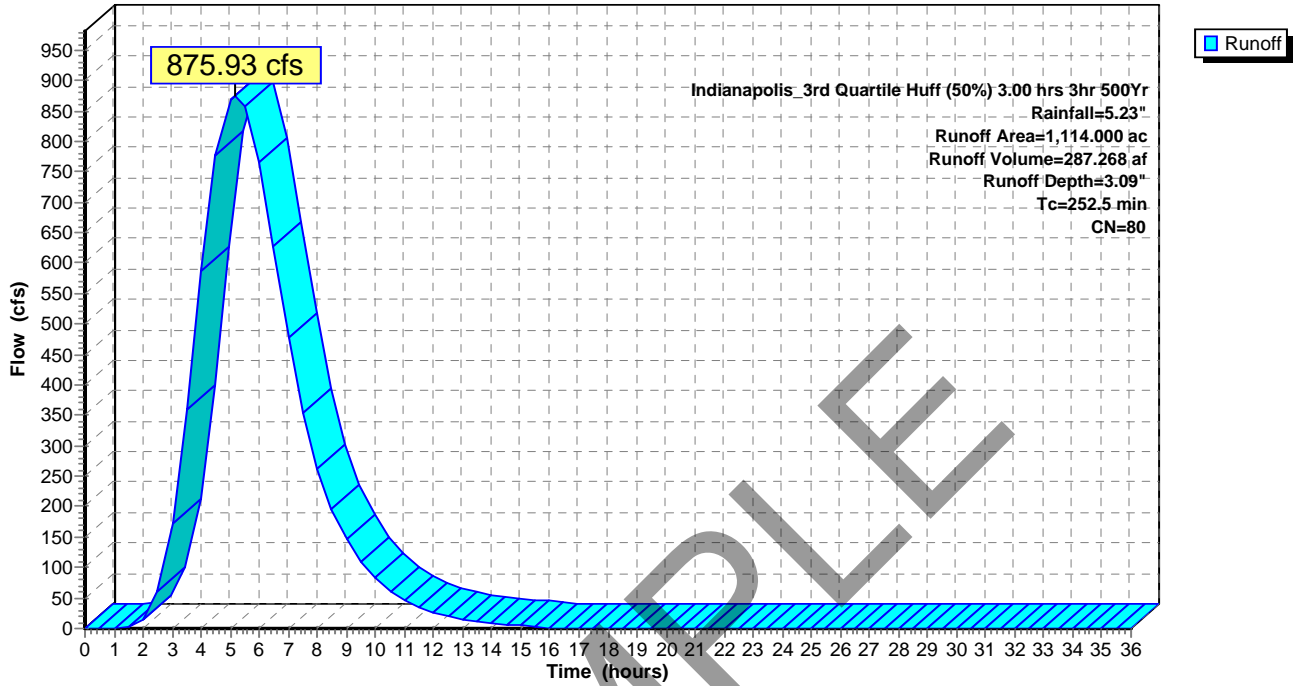
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



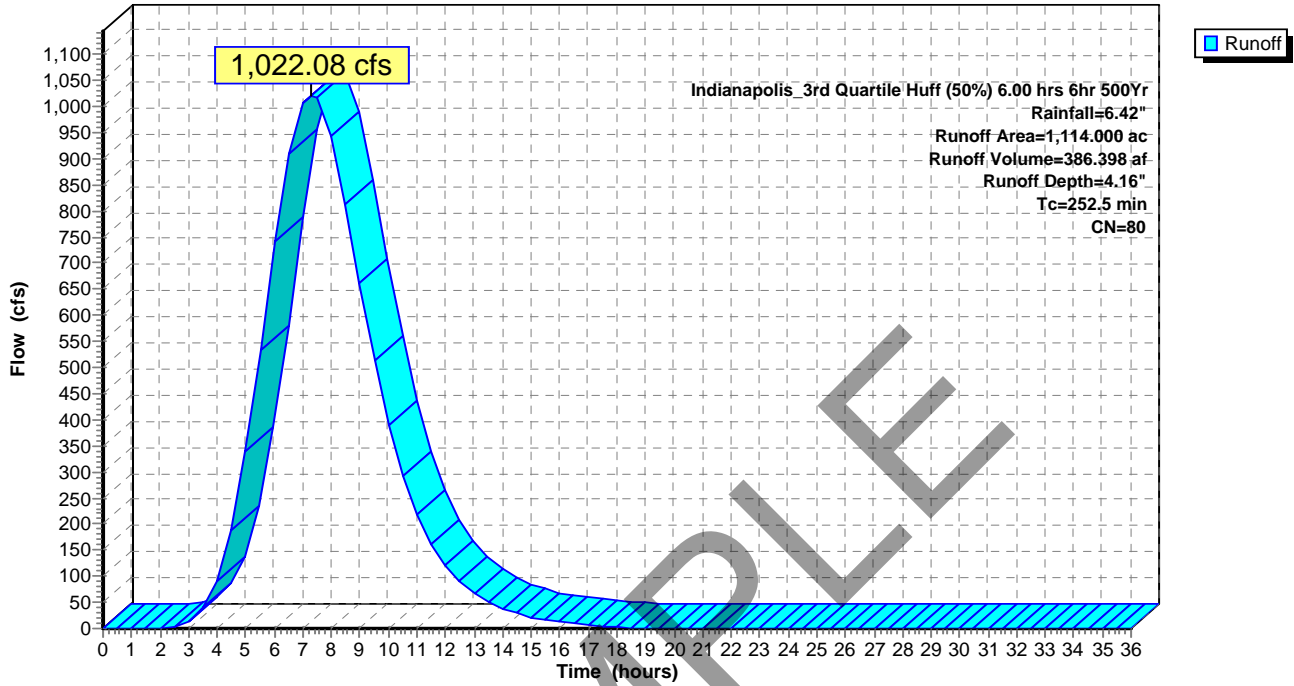
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



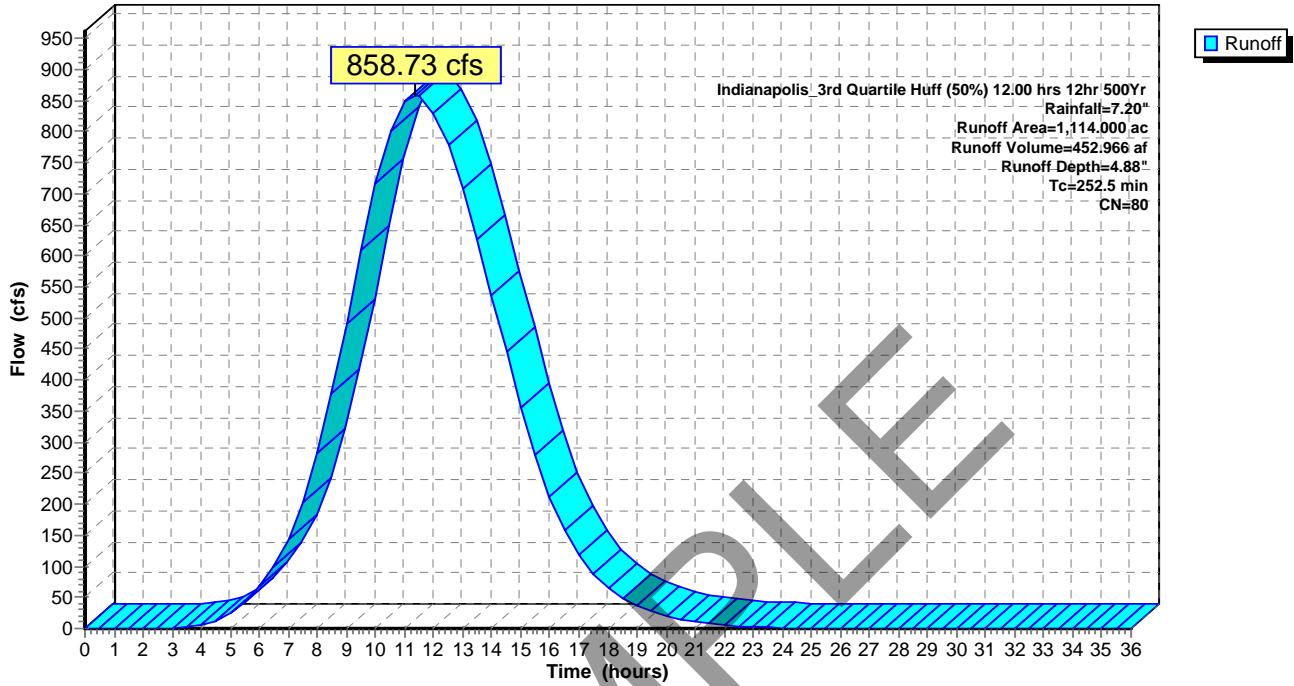
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



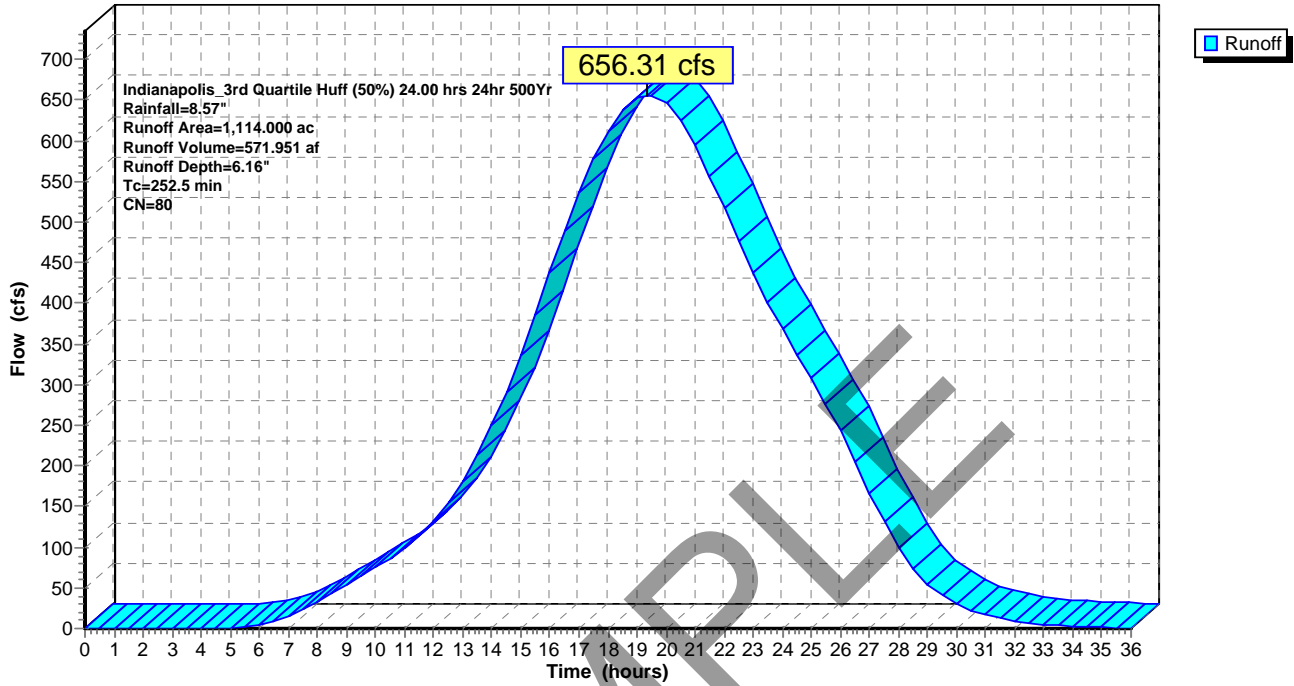
Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



Subcatchment 1S: SR 7 over Bear Creek

Hydrograph



**Appendix B: Hydraulic Calculations &
Supporting Data**

SAMPLE

**Appendix B1: HEC-RAS Natural
Conditions**

SAMPLE

Standard Table 1

HEC-RAS Plan: Natural River: Bear Creek Reach: Main

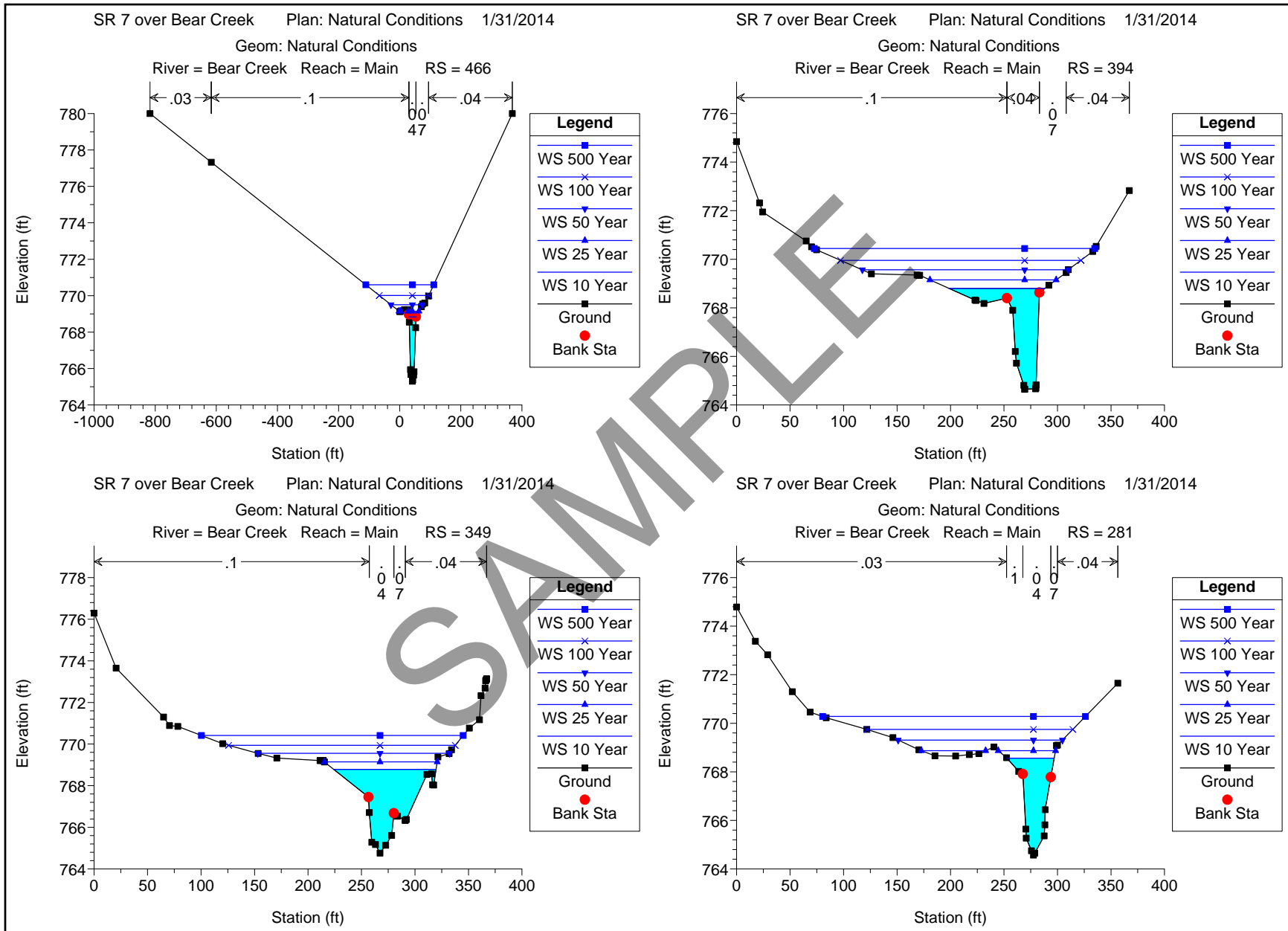
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	10 Year	270.00	765.30	768.84		769.21	0.01	4.87	55.46	22.62	0.55
Main	466	25 Year	353.00	765.30	769.15	768.26	769.64	0.01	5.63	64.33	41.04	0.60
Main	466	50 Year	504.00	765.30	769.50	768.86	770.22	0.01	6.92	92.66	102.58	0.69
Main	466	100 Year	703.00	765.30	770.01	770.01	770.79	0.01	7.54	160.99	162.30	0.70
Main	466	500 Year	1022.00	765.30	770.60	770.60	771.35	0.01	8.01	273.79	222.37	0.69
Main	394	10 Year	270.00	764.64	768.80		768.93	0.00	2.95	110.89	89.54	0.30
Main	394	25 Year	353.00	764.64	769.15		769.31	0.00	3.33	147.33	117.95	0.32
Main	394	50 Year	504.00	764.64	769.56		769.79	0.00	4.01	211.15	192.50	0.37
Main	394	100 Year	703.00	764.64	769.96		770.23	0.00	4.62	292.87	224.67	0.40
Main	394	500 Year	1022.00	764.64	770.44		770.77	0.00	5.33	411.62	262.15	0.44
Main	349	10 Year	270.00	764.76	768.78		768.85	0.00	2.41	158.13	95.67	0.23
Main	349	25 Year	353.00	764.76	769.14		769.23	0.00	2.66	194.32	105.51	0.24
Main	349	50 Year	504.00	764.76	769.56		769.68	0.00	3.30	253.90	179.06	0.28
Main	349	100 Year	703.00	764.76	769.94		770.10	0.00	3.85	329.30	211.72	0.32
Main	349	500 Year	1022.00	764.76	770.41		770.62	0.00	4.56	437.25	244.71	0.36
Main	281	10 Year	270.00	764.57	768.56		768.75	0.00	3.46	83.71	44.20	0.36
Main	281	25 Year	353.00	764.57	768.87		769.10	0.00	3.96	108.51	113.69	0.39
Main	281	50 Year	504.00	764.57	769.31		769.54	0.00	4.24	168.34	153.59	0.39
Main	281	100 Year	703.00	764.57	769.75		769.96	0.00	4.35	243.73	192.44	0.38
Main	281	500 Year	1022.00	764.57	770.28		770.47	0.00	4.43	361.06	245.74	0.36
Main	193	10 Year	270.00	762.87	768.37		768.56	0.00	3.62	94.86	111.86	0.31
Main	193	25 Year	353.00	762.87	768.70		768.90	0.00	3.87	136.63	141.46	0.32
Main	193	50 Year	504.00	762.87	769.16		769.34	0.00	3.98	211.38	177.98	0.31
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	193	500 Year	1022.00	762.87	770.16		770.30	0.00	4.15	422.78	245.72	0.30
Main	100	10 Year	270.00	762.75	768.29	765.95	768.39	0.00	2.64	129.15	109.10	0.26
Main	100	25 Year	353.00	762.75	768.62	766.49	768.72	0.00	2.83	169.15	134.96	0.27
Main	100	50 Year	504.00	762.75	769.06	767.18	769.17	0.00	3.07	237.13	169.24	0.27
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28
Main	100	500 Year	1022.00	762.75	770.04	768.75	770.17	0.00	3.56	439.11	244.17	0.29

Standard Table 2

HEC-RAS Plan: Natural River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Main	466	10 Year	769.21	768.84	0.37	0.20	0.07		270.00		22.62
Main	466	25 Year	769.64	769.15	0.49	0.23	0.10	0.06	352.23	0.71	41.04
Main	466	50 Year	770.22	769.50	0.72	0.29	0.15	8.28	489.17	6.55	102.58
Main	466	100 Year	770.79	770.01	0.78	0.31	0.15	50.29	620.82	31.89	162.30
Main	466	500 Year	771.35	770.60	0.76	0.33	0.13	148.32	767.40	106.27	222.37
Main	394	10 Year	768.93	768.80	0.13	0.06	0.02	7.01	262.92	0.07	89.54
Main	394	25 Year	769.31	769.15	0.16	0.06	0.02	19.83	331.70	1.47	117.95
Main	394	50 Year	769.79	769.56	0.22	0.08	0.03	44.89	450.62	8.49	192.50
Main	394	100 Year	770.23	769.96	0.27	0.09	0.03	103.01	574.41	25.58	224.67
Main	394	500 Year	770.77	770.44	0.33	0.11	0.04	212.61	741.32	68.07	262.15
Main	349	10 Year	768.85	768.78	0.07	0.10	0.01	7.82	195.54	66.64	95.67
Main	349	25 Year	769.23	769.14	0.08	0.11	0.01	15.23	237.98	99.79	105.51
Main	349	50 Year	769.68	769.56	0.12	0.13	0.01	28.19	327.40	148.41	179.06
Main	349	100 Year	770.10	769.94	0.16	0.13	0.01	62.86	418.05	222.08	211.72
Main	349	500 Year	770.62	770.41	0.21	0.14	0.00	136.20	545.30	340.50	244.71
Main	281	10 Year	768.75	768.56	0.18	0.18	0.00	1.85	267.51	0.64	44.20
Main	281	25 Year	769.10	768.87	0.23	0.20	0.01	13.56	337.76	1.67	113.69
Main	281	50 Year	769.54	769.31	0.23	0.19	0.02	89.08	410.52	4.40	153.59
Main	281	100 Year	769.96	769.75	0.21	0.17	0.02	218.90	471.78	12.32	192.44
Main	281	500 Year	770.47	770.28	0.19	0.16	0.01	447.44	541.95	32.62	245.74
Main	193	10 Year	768.56	768.37	0.20	0.15	0.03	10.51	258.24	1.25	111.86
Main	193	25 Year	768.90	768.70	0.20	0.15	0.03	47.84	297.58	7.58	141.46
Main	193	50 Year	769.34	769.16	0.17	0.14	0.02	134.17	337.05	32.77	177.98
Main	193	100 Year	769.77	769.62	0.16	0.14	0.01	251.90	372.85	78.25	208.84
Main	193	500 Year	770.30	770.16	0.15	0.13	0.01	438.67	420.70	162.63	245.72
Main	100	10 Year	768.39	768.29	0.10			34.16	234.83	1.01	109.10
Main	100	25 Year	768.72	768.62	0.10			69.54	277.70	5.76	134.96
Main	100	50 Year	769.17	769.06	0.11			140.14	340.79	23.08	169.24
Main	100	100 Year	769.62	769.51	0.12			237.83	407.85	57.33	203.16
Main	100	500 Year	770.17	770.04	0.12			397.78	495.93	128.29	244.17

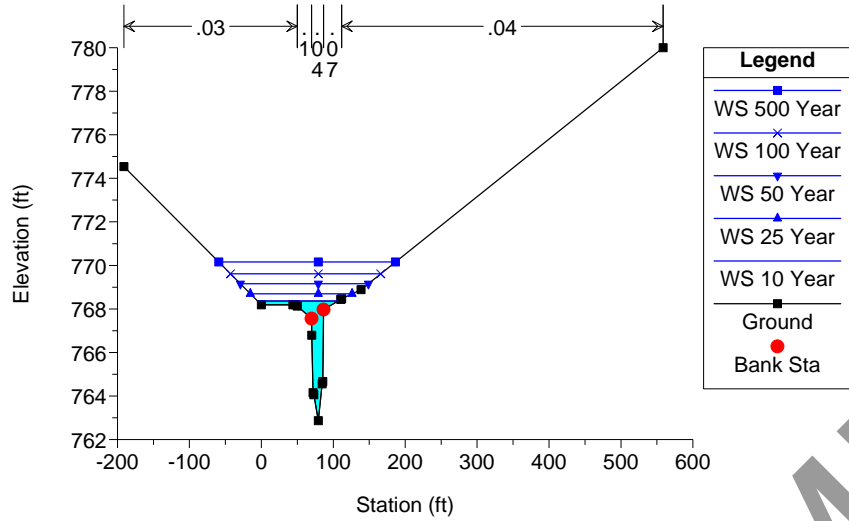
Cross Sections



SR 7 over Bear Creek Plan: Natural Conditions 1/31/2014

Geom: Natural Conditions

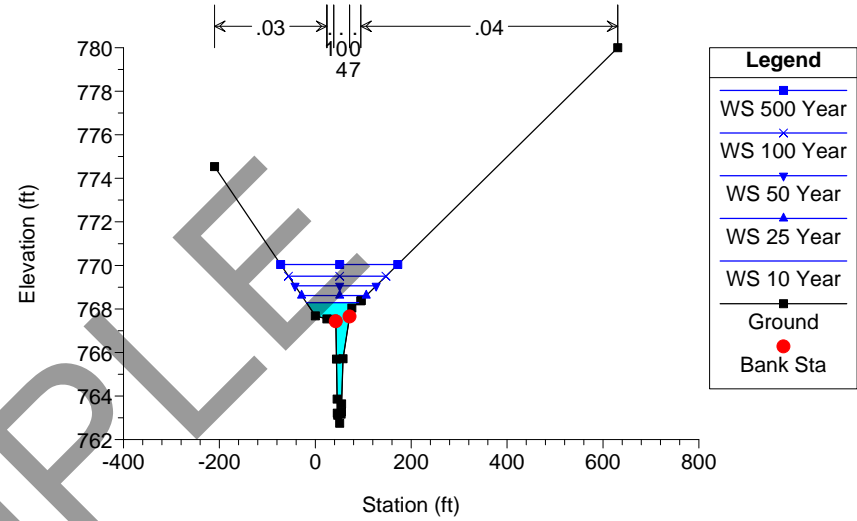
River = Bear Creek Reach = Main RS = 193



SR 7 over Bear Creek Plan: Natural Conditions 1/31/2014

Geom: Natural Conditions

River = Bear Creek Reach = Main RS = 100



**Appendix B2: HEC-RAS Existing
Conditions**

SAMPLE

Standard Table 1

HEC-RAS Plan: Existing Con River: Bear Creek Reach: Main

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	10 Year	270.00	765.30	768.96		769.29	0.00	4.64	58.35	26.40	0.51
Main	466	25 Year	353.00	765.30	769.36	768.26	769.77	0.01	5.17	78.98	87.74	0.53
Main	466	50 Year	504.00	765.30	770.10		770.46	0.00	5.16	175.64	171.29	0.47
Main	466	100 Year	703.00	765.30	771.09		771.28	0.00	4.25	395.83	272.85	0.35
Main	466	500 Year	1022.00	765.30	772.68		772.74	0.00	2.96	958.96	435.67	0.21
Main	394	10 Year	270.00	764.64	768.94	766.74	769.05	0.00	2.78	124.01	100.50	0.28
Main	394	25 Year	353.00	764.64	769.38	767.09	769.51	0.00	3.01	177.13	165.86	0.28
Main	394	50 Year	504.00	764.64	770.13	767.64	770.25	0.00	3.09	286.34	239.08	0.26
Main	394	100 Year	703.00	764.64	771.07	768.58	771.17	0.00	2.96	442.55	289.30	0.23
Main	394	500 Year	1022.00	764.64	772.64	769.52	772.71	0.00	2.65	709.30	345.91	0.18
Main	349	10 Year	270.00	764.76	768.89	766.99	768.98	0.00	2.63	125.76	98.62	0.25
Main	349	25 Year	353.00	764.76	769.33	767.27	769.45	0.00	2.99	145.84	150.43	0.26
Main	349	50 Year	504.00	764.76	770.02	767.69	770.18	0.00	3.53	177.41	218.44	0.29
Main	349	100 Year	703.00	764.76	770.87	768.19	771.08	0.00	4.05	216.45	279.11	0.30
Main	349	500 Year	1022.00	764.76	772.36	768.83	772.62	0.00	4.50	284.63	317.08	0.30
Main	300		Bridge									
Main	281	10 Year	270.00	764.57	768.56	766.93	768.75	0.00	3.46	82.60	44.25	0.36
Main	281	25 Year	353.00	764.57	768.87	767.30	769.13	0.00	4.06	94.36	114.03	0.40
Main	281	50 Year	504.00	764.57	769.27	767.87	769.67	0.00	5.10	110.52	151.17	0.47
Main	281	100 Year	703.00	764.57	769.63	768.50	770.24	0.01	6.39	125.86	181.38	0.56
Main	281	500 Year	1022.00	764.57	769.98	769.35	771.02	0.01	8.42	140.89	215.69	0.71
Main	193	10 Year	270.00	762.87	768.37		768.56	0.00	3.62	94.86	111.86	0.31
Main	193	25 Year	353.00	762.87	768.70		768.90	0.00	3.67	136.62	141.45	0.32
Main	193	50 Year	504.00	762.87	769.16		769.34	0.00	3.98	211.36	177.97	0.31
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	193	500 Year	1022.00	762.87	770.16		770.30	0.00	4.15	422.86	245.74	0.30
Main	100	10 Year	270.00	762.75	768.29	765.95	768.39	0.00	2.64	129.15	109.10	0.26
Main	100	25 Year	353.00	762.75	768.62	766.49	768.72	0.00	2.83	169.15	134.96	0.27
Main	100	50 Year	504.00	762.75	769.06	767.18	769.17	0.00	3.07	237.13	169.24	0.27
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28
Main	100	500 Year	1022.00	762.75	770.04	768.75	770.17	0.00	3.56	439.11	244.17	0.29

Standard Table 2

HEC-RAS Plan: Existing Con River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Main	466	10 Year	769.29	768.96	0.33	0.17	0.07		269.96	0.04	26.40
Main	466	25 Year	769.77	769.36	0.41	0.17	0.08	2.22	348.21	2.57	87.74
Main	466	50 Year	770.46	770.10	0.36	0.13	0.07	41.57	435.17	27.25	171.29
Main	466	100 Year	771.28	771.09	0.19	0.08	0.03	141.59	455.70	105.72	272.85
Main	466	500 Year	772.74	772.68	0.06	0.04	0.00	331.82	425.19	264.99	435.67
Main	394	10 Year	769.05	768.94	0.12	0.06	0.01	10.02	259.66	0.32	100.50
Main	394	25 Year	769.51	769.38	0.13	0.06	0.01	27.96	321.59	3.46	165.86
Main	394	50 Year	770.25	770.13	0.12	0.06	0.01	80.19	400.03	23.78	239.08
Main	394	100 Year	771.17	771.07	0.09	0.05	0.04	152.01	468.50	82.49	289.30
Main	394	500 Year	772.71	772.64	0.07	0.03	0.06	261.27	545.03	215.70	345.91
Main	349	10 Year	768.98	768.89	0.09	0.02	0.04	6.98	219.47	43.55	98.62
Main	349	25 Year	769.45	769.33	0.12	0.02	0.07	12.14	280.50	60.36	150.43
Main	349	50 Year	770.18	770.02	0.16	0.03	0.12	22.87	389.32	91.81	218.44
Main	349	100 Year	771.08	770.87	0.21	0.03	0.19	39.17	529.00	134.82	279.11
Main	349	500 Year	772.62	772.36	0.26	0.03	0.28	69.74	745.29	206.97	317.08
Main	300		Bridge								
Main	281	10 Year	768.75	768.56	0.18	0.18	0.00	1.85	267.51	0.64	44.25
Main	281	25 Year	769.13	768.87	0.25	0.20	0.03	4.44	346.84	1.72	114.03
Main	281	50 Year	769.67	769.27	0.39	0.22	0.11	9.95	489.17	4.87	151.17
Main	281	100 Year	770.24	769.63	0.61	0.24	0.23	17.88	672.29	12.83	181.38
Main	281	500 Year	771.02	769.98	1.04	0.26	0.45	31.04	963.02	27.95	215.69
Main	193	10 Year	768.56	768.37	0.20	0.15	0.03	10.51	258.24	1.25	111.86
Main	193	25 Year	768.90	768.70	0.20	0.15	0.03	47.83	297.59	7.57	141.45
Main	193	50 Year	769.34	769.16	0.17	0.14	0.02	134.16	337.07	32.77	177.97
Main	193	100 Year	769.77	769.62	0.16	0.14	0.01	251.90	372.85	78.25	208.84
Main	193	500 Year	770.30	770.16	0.15	0.13	0.01	438.71	420.64	162.65	245.74
Main	100	10 Year	768.39	768.29	0.10			34.16	234.83	1.01	109.10
Main	100	25 Year	768.72	768.62	0.10			69.54	277.70	5.76	134.96
Main	100	50 Year	769.17	769.06	0.11			140.14	340.79	23.08	169.24
Main	100	100 Year	769.62	769.51	0.12			237.83	407.85	57.33	203.16
Main	100	500 Year	770.17	770.04	0.12			397.78	495.93	128.29	244.17

HEC-RAS Plan: Existing Con River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Frctn Loss (ft)	C & E Loss (ft)	Top Width (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)
Main	394	10 Year	769.052	768.936	766.744	0.057	0.012	100.497	10.017	259.664	0.320	2.784
Main	394	25 Year	769.512	769.384	767.090	0.059	0.005	165.860	27.956	321.587	3.457	3.010
Main	394	50 Year	770.250	770.131	767.638	0.056	0.013	239.083	80.188	400.031	23.781	3.088
Main	394	100 Year	771.165	771.071	768.584	0.047	0.035	289.296	152.011	468.498	82.490	2.964
Main	394	500 Year	772.706	772.640	769.525	0.032	0.057	345.908	261.271	545.032	215.697	2.650
Main	349	10 Year	768.984	768.891	766.992	0.020	0.044	98.624	6.981	219.470	43.549	2.626
Main	349	25 Year	769.448	769.330	767.266	0.023	0.067	150.426	12.141	280.502	60.357	2.985
Main	349	50 Year	770.181	770.019	767.687	0.029	0.117	218.435	22.868	389.318	91.814	3.530
Main	349	100 Year	771.083	770.871	768.190	0.033	0.194	279.108	39.172	529.004	134.824	4.054
Main	349	500 Year	772.616	772.360	768.829	0.031	0.282	317.083	69.740	745.285	206.975	4.496
Main	300	BR U	768.919	768.679	766.994	0.073	0.005	19.700		270.000		3.935
Main	300	BR U	769.357	769.015	767.340	0.093	0.009	19.700		353.000		4.691
Main	300	BR U	770.035	769.482	767.913	0.133	0.022	19.700		504.000		5.969
Main	300	BR U	770.856	769.999	768.598	0.189	0.060	19.700		703.000		7.429
Main	300	BR U	772.304	771.108	769.556	0.254	0.267	19.700		1022.000		8.775
Main	300	BR D	768.841	768.582	767.005	0.056	0.037	19.700		270.000		4.080
Main	300	BR D	769.255	768.883	767.375	0.069	0.060	19.700		353.000		4.897
Main	300	BR D	769.881	769.256	767.956	0.098	0.116	19.700		504.000		6.344
Main	300	BR D	770.604	769.546	768.624	0.142	0.225	19.700		703.000		8.254
Main	300	BR D	771.785	769.699	769.598	0.241	0.522	19.700		1022.000		11.592
Main	281	10 Year	768.747	768.563	766.932	0.183	0.003	44.254	1.851	267.507	0.642	3.461
Main	281	25 Year	769.125	768.874	767.299	0.203	0.026	114.033	4.439	346.837	1.724	4.059
Main	281	50 Year	769.667	769.275	767.870	0.222	0.109	151.167	9.952	489.174	4.875	5.098
Main	281	100 Year	770.237	769.629	768.504	0.240	0.226	181.382	17.681	672.285	12.834	6.387
Main	281	500 Year	771.019	769.977	769.353	0.265	0.448	215.691	31.037	963.016	27.948	8.419
Main	193	10 Year	768.561	768.366		0.145	0.030	111.857	10.511	258.241	1.248	3.624
Main	193	25 Year	768.896	768.697		0.147	0.029	141.453	47.834	297.593	7.574	3.873
Main	193	50 Year	769.336	769.161		0.143	0.020	177.973	134.158	337.075	32.767	3.983
Main	193	100 Year	769.771	769.615		0.137	0.012	208.844	251.900	372.855	78.245	4.041
Main	193	500 Year	770.305	770.159		0.132	0.006	245.739	438.705	420.644	162.651	4.149

SAMPLE

HEC-RAS Plan: Existing Con River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. U.S. (ft)	Min El Prs (ft)	BR Open Area (sq ft)	Prs O WS (ft)	Q Total (cfs)	Min El Weir Flow (ft)	Q Weir (cfs)	Delta EG (ft)
Main	300	10 Year	768.984	773.020	152.515		270.000	774.910		0.237
Main	300	25 Year	769.448	773.020	152.515		353.000	774.910		0.323
Main	300	50 Year	770.181	773.020	152.515		504.000	774.910		0.515
Main	300	100 Year	771.083	773.020	152.515		703.000	774.910		0.846
Main	300	500 Year	772.616	773.020	152.515		1022.000	774.910		1.598

SAMPLE

Plan: Existing Con Bear Creek Main RS: 300 Profile: 10 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	768.98	E.G. Elev (ft)	768.92	768.84
W.S. US. (ft)	768.89	W.S. Elev (ft)	768.68	768.58
Q Total (cfs)	270.00	Crit W.S. (ft)	766.99	767.01
Q Bridge (cfs)	270.00	Max Chl Dpth (ft)	3.92	4.01
Q Weir (cfs)		Vel Total (ft/s)	3.94	4.08
Weir Sta Lft (ft)		Flow Area (sq ft)	68.61	66.17
Weir Sta Rgt (ft)		Froude # Chl	0.35	0.36
Weir Submerg		Specif Force (cu ft)	153.48	150.05
Weir Max Depth (ft)		Hydr Depth (ft)	3.48	3.36
Min El Weir Flow (ft)	774.91	W.P. Total (ft)	19.94	20.46
Min El Prs (ft)	773.02	Conv. Total (cfs)	5810.0	5376.0
Delta EG (ft)	0.24	Top Width (ft)	19.70	19.70
Delta WS (ft)	0.33	Frctn Loss (ft)	0.07	0.06
BR Open Area (sq ft)	152.52	C & E Loss (ft)	0.01	0.04
BR Open Vel (ft/s)	4.08	Shear Total (lb/sq ft)	0.46	0.51
Coef of Q		Power Total (lb/ft s)	0.00	0.00
Br Sel Method	Energy only			

Plan: Existing Con Bear Creek Main RS: 300 Profile: 25 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	769.45	E.G. Elev (ft)	769.36	769.25
W.S. US. (ft)	769.33	W.S. Elev (ft)	769.02	768.88
Q Total (cfs)	353.00	Crit W.S. (ft)	767.34	767.38
Q Bridge (cfs)	353.00	Max Chl Dpth (ft)	4.26	4.31
Q Weir (cfs)		Vel Total (ft/s)	4.69	4.90
Weir Sta Lft (ft)		Flow Area (sq ft)	75.24	72.09
Weir Sta Rgt (ft)		Froude # Chl	0.40	0.42
Weir Submerg		Specif Force (cu ft)	196.12	190.29
Weir Max Depth (ft)		Hydr Depth (ft)	3.82	3.66
Min El Weir Flow (ft)	774.91	W.P. Total (ft)	19.94	20.46
Min El Prs (ft)	773.02	Conv. Total (cfs)	6775.5	6201.6
Delta EG (ft)	0.32	Top Width (ft)	19.70	19.70
Delta WS (ft)	0.46	Frctn Loss (ft)	0.09	0.07
BR Open Area (sq ft)	152.52	C & E Loss (ft)	0.01	0.06
BR Open Vel (ft/s)	4.90	Shear Total (lb/sq ft)	0.64	0.71
Coef of Q		Power Total (lb/ft s)	0.00	0.00
Br Sel Method	Energy only			

Plan: Existing Con Bear Creek Main RS: 300 Profile: 50 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	770.18	E.G. Elev (ft)	770.04	769.88
W.S. US. (ft)	770.02	W.S. Elev (ft)	769.48	769.26
Q Total (cfs)	504.00	Crit W.S. (ft)	767.91	767.96
Q Bridge (cfs)	504.00	Max Chl Dpth (ft)	4.72	4.69
Q Weir (cfs)		Vel Total (ft/s)	5.97	6.34
Weir Sta Lft (ft)		Flow Area (sq ft)	84.43	79.44
Weir Sta Rgt (ft)		Froude # Chl	0.48	0.52
Weir Submerg		Specif Force (cu ft)	275.37	264.19
Weir Max Depth (ft)		Hydr Depth (ft)	4.29	4.03
Min El Weir Flow (ft)	774.91	W.P. Total (ft)	19.94	20.46
Min El Prs (ft)	773.02	Conv. Total (cfs)	8210.1	7291.1
Delta EG (ft)	0.51	Top Width (ft)	19.70	19.70
Delta WS (ft)	0.74	Frctn Loss (ft)	0.13	0.10
BR Open Area (sq ft)	152.52	C & E Loss (ft)	0.02	0.12
BR Open Vel (ft/s)	6.34			

Plan: Existing Con Bear Creek Main RS: 300 Profile: 50 Year (Continued)

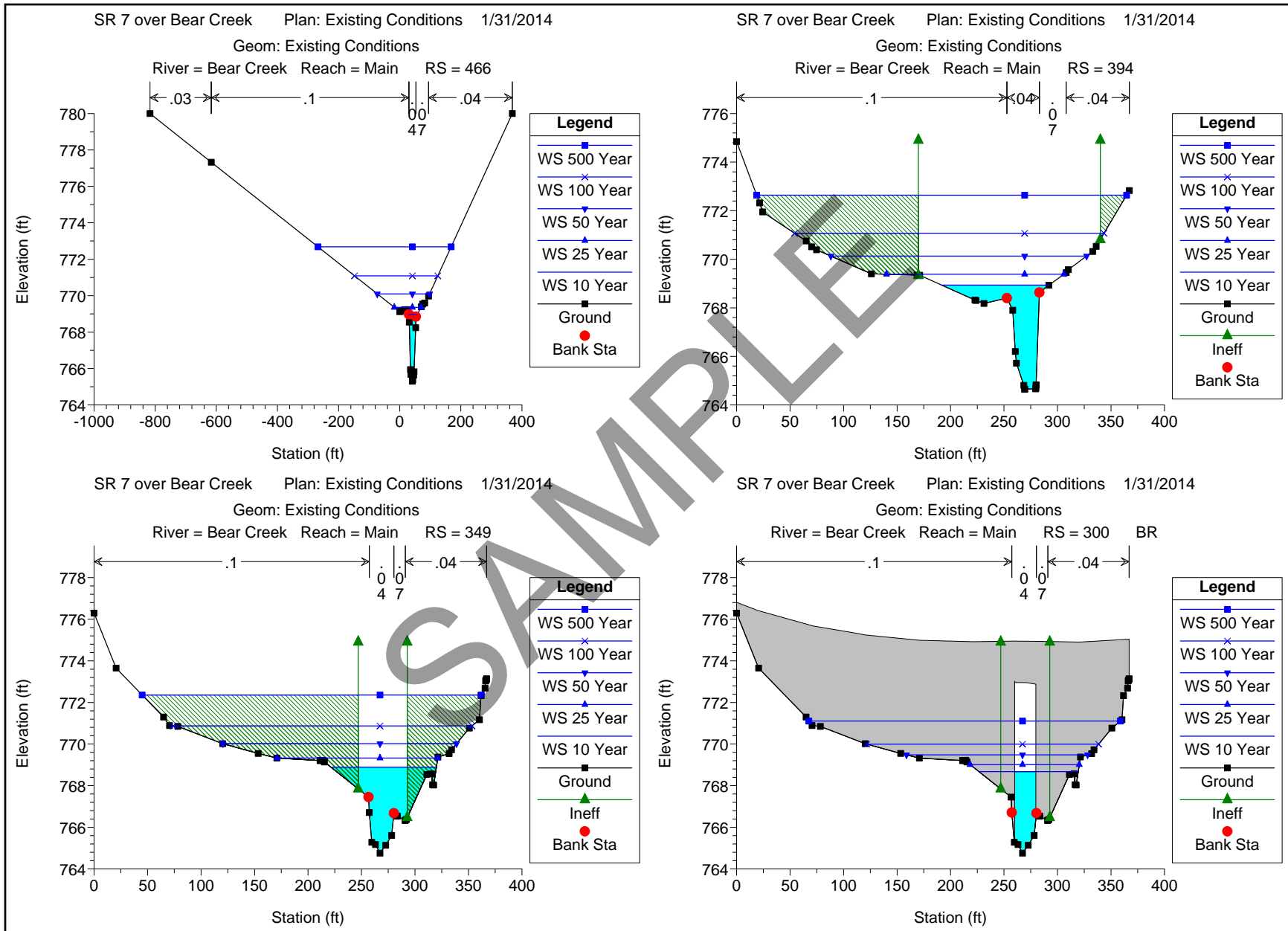
Coef of Q		Shear Total (lb/sq ft)	1.00	1.16
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

Plan: Existing Con Bear Creek Main RS: 300 Profile: 100 Year

E.G. US. (ft)	771.08	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	770.87	E.G. Elev (ft)	770.86	770.60
Q Total (cfs)	703.00	W.S. Elev (ft)	770.00	769.55
Q Bridge (cfs)	703.00	Crit W.S. (ft)	768.60	768.62
Q Weir (cfs)		Max Chl Dpth (ft)	5.24	4.98
Weir Sta Lft (ft)		Vel Total (ft/s)	7.43	8.25
Weir Sta Rgt (ft)		Flow Area (sq ft)	94.63	85.17
Weir Submerg		Froude # Chl	0.57	0.65
Weir Max Depth (ft)		Specif Force (cu ft)	390.47	369.02
Min EI Weir Flow (ft)	774.91	Hydr Depth (ft)	4.80	4.32
Min EI Prs (ft)	773.02	W.P. Total (ft)	19.94	20.46
Delta EG (ft)	0.85	Conv. Total (cfs)	9928.2	8188.0
Delta WS (ft)	1.24	Top Width (ft)	19.70	19.70
BR Open Area (sq ft)	152.52	Frctn Loss (ft)	0.19	0.14
BR Open Vel (ft/s)	8.25	C & E Loss (ft)	0.06	0.23
Coef of Q		Shear Total (lb/sq ft)	1.49	1.92
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

Plan: Existing Con Bear Creek Main RS: 300 Profile: 500 Year

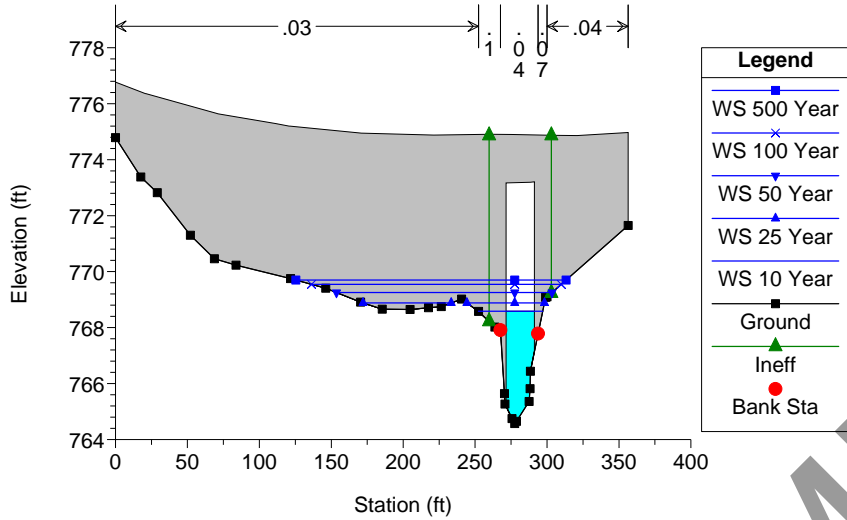
E.G. US. (ft)	772.62	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	772.36	E.G. Elev (ft)	772.30	771.79
Q Total (cfs)	1022.00	W.S. Elev (ft)	771.11	769.70
Q Bridge (cfs)	1022.00	Crit W.S. (ft)	769.56	769.60
Q Weir (cfs)		Max Chl Dpth (ft)	6.35	5.13
Weir Sta Lft (ft)		Vel Total (ft/s)	8.77	11.59
Weir Sta Rgt (ft)		Flow Area (sq ft)	116.47	88.17
Weir Submerg		Froude # Chl	0.61	0.90
Weir Max Depth (ft)		Specif Force (cu ft)	623.79	569.91
Min EI Weir Flow (ft)	774.91	Hydr Depth (ft)	5.91	4.48
Min EI Prs (ft)	773.02	W.P. Total (ft)	19.94	20.46
Delta EG (ft)	1.60	Conv. Total (cfs)	14033.5	8673.9
Delta WS (ft)	2.38	Top Width (ft)	19.70	19.70
BR Open Area (sq ft)	152.52	Frctn Loss (ft)	0.25	0.24
BR Open Vel (ft/s)	11.59	C & E Loss (ft)	0.27	0.52
Coef of Q		Shear Total (lb/sq ft)	1.93	3.74
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00



SR 7 over Bear Creek Plan: Existing Conditions 1/31/2014

Geom: Existing Conditions

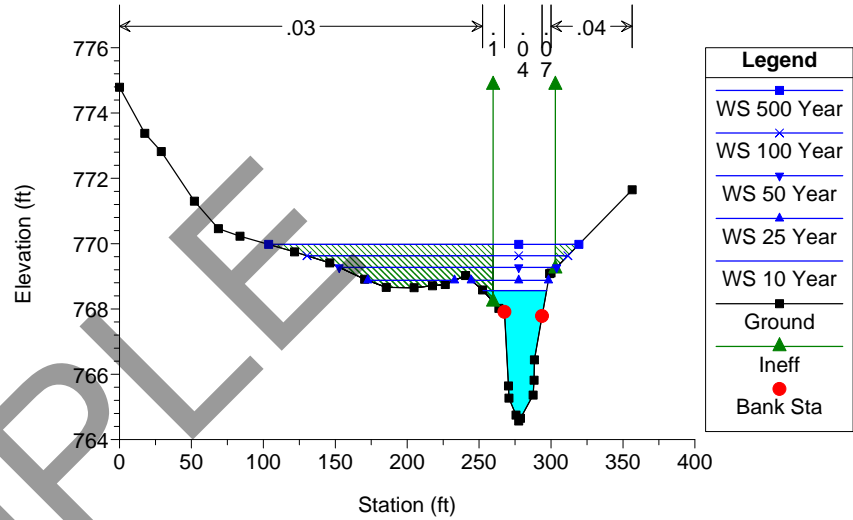
River = Bear Creek Reach = Main RS = 300 BR



SR 7 over Bear Creek Plan: Existing Conditions 1/31/2014

Geom: Existing Conditions

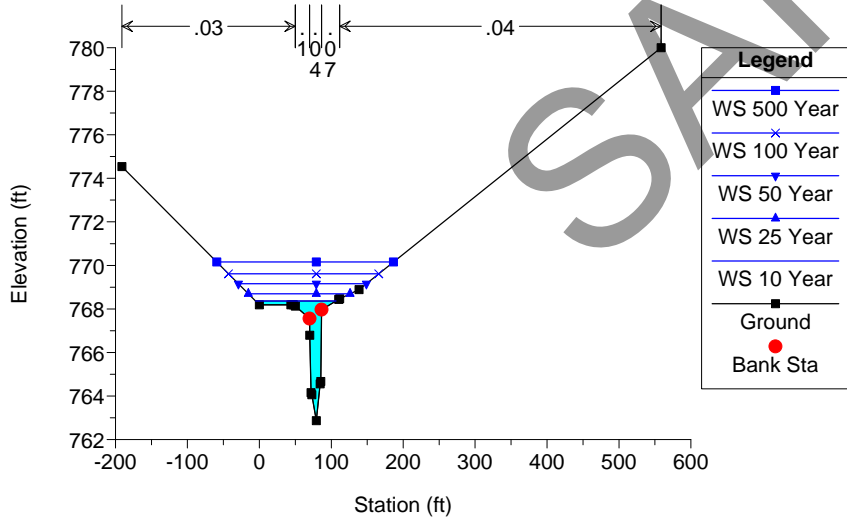
River = Bear Creek Reach = Main RS = 281



SR 7 over Bear Creek Plan: Existing Conditions 1/31/2014

Geom: Existing Conditions

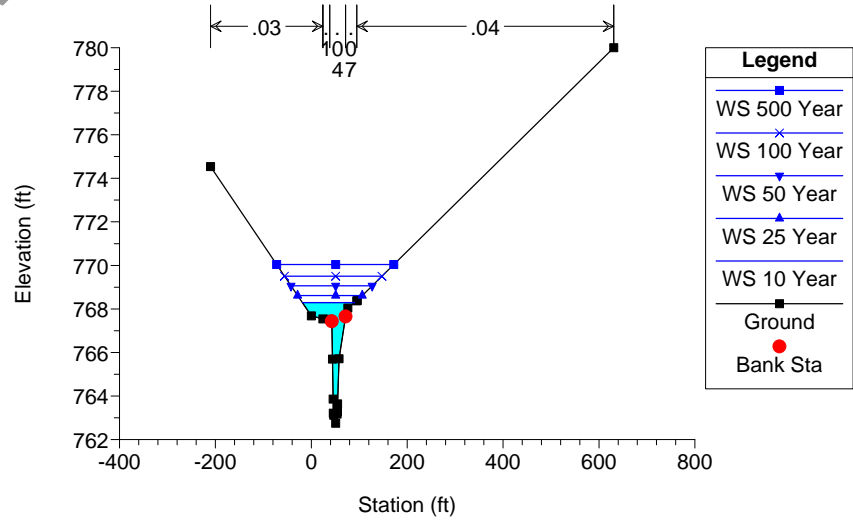
River = Bear Creek Reach = Main RS = 193



SR 7 over Bear Creek Plan: Existing Conditions 1/31/2014

Geom: Existing Conditions

River = Bear Creek Reach = Main RS = 100



**Appendix B3: HEC-RAS Proposed
Conditions**

SAMPLE

Standard Table 1

HEC-RAS Plan: Prop River: Bear Creek Reach: Main

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	10 Year	270.00	765.30	768.95		769.29	0.00	4.65	58.29	26.32	0.51
Main	466	25 Year	353.00	765.30	769.36	768.26	769.77	0.01	5.16	79.27	88.09	0.53
Main	466	50 Year	504.00	765.30	770.08		770.45	0.00	5.21	172.18	169.21	0.48
Main	466	100 Year	703.00	765.30	771.06		771.25	0.00	4.33	386.28	269.24	0.35
Main	466	500 Year	1022.00	765.30	772.60		772.67	0.00	3.06	925.31	427.68	0.22
Main	394	10 Year	270.00	764.64	768.93	766.74	769.05	0.00	2.79	123.73	100.27	0.28
Main	394	25 Year	353.00	764.64	769.39	767.09	769.51	0.00	3.01	177.60	168.88	0.28
Main	394	50 Year	504.00	764.64	770.11	767.64	770.23	0.00	3.11	283.44	237.56	0.27
Main	394	100 Year	703.00	764.64	771.04	768.58	771.13	0.00	3.00	436.66	287.65	0.23
Main	394	500 Year	1022.00	764.64	772.56	769.52	772.63	0.00	2.70	696.01	344.19	0.18
Main	349	10 Year	270.00	764.76	768.90	767.03	768.98	0.00	2.47	130.44	97.00	0.23
Main	349	25 Year	353.00	764.76	769.35	767.32	769.45	0.00	2.79	151.05	149.01	0.25
Main	349	50 Year	504.00	764.76	770.04	767.68	770.17	0.00	3.28	182.89	215.57	0.27
Main	349	100 Year	703.00	764.76	770.88	768.14	771.06	0.00	3.76	221.86	276.16	0.28
Main	349	500 Year	1022.00	764.76	772.33	768.73	772.55	0.00	4.18	288.55	310.35	0.28
Main	300		Bridge									
Main	281	10 Year	270.00	764.57	768.55	766.95	768.75	0.00	3.55	78.52	43.25	0.36
Main	281	25 Year	353.00	764.57	768.87	767.33	769.14	0.00	4.17	88.71	111.58	0.41
Main	281	50 Year	504.00	764.57	769.27	767.90	769.69	0.00	5.27	102.35	147.74	0.49
Main	281	100 Year	703.00	764.57	769.61	768.50	770.27	0.01	6.63	116.58	176.14	0.58
Main	281	500 Year	1022.00	764.57	769.93	769.41	771.08	0.01	8.77	130.58	207.52	0.74
Main	193	10 Year	270.00	762.87	768.37		768.56	0.00	3.62	94.86	111.86	0.31
Main	193	25 Year	353.00	762.87	768.70		768.90	0.00	3.67	136.62	141.45	0.32
Main	193	50 Year	504.00	762.87	769.16		769.34	0.00	3.98	211.35	177.97	0.31
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	193	500 Year	1022.00	762.87	770.16		770.30	0.00	4.15	422.86	245.74	0.30
Main	100	10 Year	270.00	762.75	768.29	765.95	768.39	0.00	2.64	129.15	109.10	0.26
Main	100	25 Year	353.00	762.75	768.62	766.49	768.72	0.00	2.83	169.15	134.96	0.27
Main	100	50 Year	504.00	762.75	769.06	767.18	769.17	0.00	3.07	237.13	169.24	0.27
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28
Main	100	500 Year	1022.00	762.75	770.04	768.75	770.17	0.00	3.56	439.11	244.17	0.29

Standard Table 2

HEC-RAS Plan: Prop River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Main	466	10 Year	769.29	768.95	0.34	0.17	0.07		269.96	0.04	26.32
Main	466	25 Year	769.77	769.36	0.41	0.17	0.08	2.28	348.11	2.61	88.09
Main	466	50 Year	770.45	770.08	0.37	0.14	0.07	40.29	437.48	26.23	169.21
Main	466	100 Year	771.25	771.06	0.20	0.09	0.03	138.96	460.53	103.51	269.24
Main	466	500 Year	772.67	772.60	0.07	0.04	0.00	327.43	433.66	260.91	427.68
Main	394	10 Year	769.05	768.93	0.12	0.05	0.02	9.95	259.73	0.31	100.27
Main	394	25 Year	769.51	769.39	0.13	0.05	0.01	28.11	321.40	3.49	168.88
Main	394	50 Year	770.23	770.11	0.12	0.05	0.01	79.39	401.42	23.19	237.56
Main	394	100 Year	771.13	771.04	0.10	0.05	0.03	151.01	471.40	80.59	287.65
Main	394	500 Year	772.63	772.56	0.07	0.03	0.05	260.03	549.84	212.13	344.19
Main	349	10 Year	768.98	768.90	0.08	0.02	0.05	3.93	203.09	62.98	97.00
Main	349	25 Year	769.45	769.35	0.10	0.02	0.07	6.62	258.18	88.20	149.01
Main	349	50 Year	770.17	770.04	0.14	0.03	0.12	12.07	356.46	135.47	215.57
Main	349	100 Year	771.06	770.88	0.18	0.03	0.20	20.18	482.45	200.37	276.16
Main	349	500 Year	772.55	772.33	0.22	0.03	0.29	35.09	677.18	309.73	310.35
Main	300		Bridge								
Main	281	10 Year	768.75	768.55	0.19	0.19	0.00	0.87	268.50	0.63	43.25
Main	281	25 Year	769.14	768.87	0.27	0.21	0.03	1.92	349.35	1.73	111.58
Main	281	50 Year	769.69	769.27	0.42	0.23	0.12	4.08	495.09	4.82	147.74
Main	281	100 Year	770.27	769.61	0.66	0.25	0.25	7.13	681.90	13.97	176.14
Main	281	500 Year	771.08	769.93	1.14	0.27	0.50	12.07	975.45	34.48	207.52
Main	193	10 Year	768.56	768.37	0.20	0.15	0.03	10.51	258.24	1.25	111.86
Main	193	25 Year	768.90	768.70	0.20	0.15	0.03	47.83	297.59	7.57	141.45
Main	193	50 Year	769.34	769.16	0.17	0.14	0.02	134.15	337.09	32.76	177.97
Main	193	100 Year	769.77	769.62	0.16	0.14	0.01	251.90	372.85	78.25	208.84
Main	193	500 Year	770.30	770.16	0.15	0.13	0.01	438.71	420.64	162.65	245.74
Main	100	10 Year	768.39	768.29	0.10			34.16	234.83	1.01	109.10
Main	100	25 Year	768.72	768.62	0.10			69.54	277.70	5.76	134.96
Main	100	50 Year	769.17	769.06	0.11			140.14	340.79	23.08	169.24
Main	100	100 Year	769.62	769.51	0.12			237.83	407.85	57.33	203.16
Main	100	500 Year	770.17	770.04	0.12			397.78	495.93	128.29	244.17

HEC-RAS Plan: Prop River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Frctn Loss (ft)	C & E Loss (ft)	Top Width (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)
Main	394	10 Year	769.050	768.934	766.744	0.053	0.018	100.273	9.954	259.733	0.313	2.787
Main	394	25 Year	769.515	769.387	767.090	0.055	0.014	168.884	28.108	321.401	3.492	3.005
Main	394	50 Year	770.234	770.113	767.638	0.053	0.005	237.561	79.387	401.423	23.191	3.112
Main	394	100 Year	771.134	771.036	768.584	0.045	0.025	287.655	151.014	471.399	80.587	3.002
Main	394	500 Year	772.631	772.562	769.525	0.032	0.047	344.189	260.032	549.838	212.130	2.704
Main	349	10 Year	768.978	768.898	767.029	0.018	0.046	97.002	3.934	203.089	62.977	2.470
Main	349	25 Year	769.446	769.346	767.320	0.021	0.069	149.011	6.622	258.177	88.201	2.788
Main	349	50 Year	770.175	770.036	767.681	0.026	0.119	215.573	12.067	356.464	135.468	3.280
Main	349	100 Year	771.063	770.882	768.137	0.029	0.195	276.159	20.184	482.446	200.371	3.760
Main	349	500 Year	772.552	772.328	768.727	0.028	0.289	310.352	35.089	677.179	309.732	4.181
Main	300	BR U	768.913	768.679	766.988	0.073	0.006	20.000		270.000		3.887
Main	300	BR U	769.356	769.024	767.337	0.092	0.009	20.000		353.000		4.622
Main	300	BR U	770.030	769.493	767.910	0.131	0.021	20.000		504.000		5.877
Main	300	BR U	770.838	770.006	768.575	0.187	0.056	20.000		703.000		7.323
Main	300	BR U	772.235	771.046	769.521	0.255	0.239	20.000		1022.000		8.750
Main	300	BR D	768.834	768.581	767.003	0.056	0.029	20.000		270.000		4.037
Main	300	BR D	769.255	768.892	767.369	0.069	0.048	20.000		353.000		4.829
Main	300	BR D	769.878	769.272	767.942	0.097	0.091	20.000		504.000		6.247
Main	300	BR D	770.594	769.573	768.615	0.143	0.178	20.000		703.000		8.108
Main	300	BR D	771.742	769.757	769.561	0.241	0.420	20.000		1022.000		11.306
Main	281	10 Year	768.749	768.555	766.949	0.188	0.000	43.245	0.869	268.501	0.629	3.548
Main	281	25 Year	769.138	768.871	767.335	0.208	0.034	111.578	1.925	349.346	1.729	4.168
Main	281	50 Year	769.689	769.265	767.905	0.229	0.124	147.742	4.084	495.092	4.824	5.269
Main	281	100 Year	770.273	769.609	768.505	0.247	0.254	176.139	7.130	681.897	13.973	6.633
Main	281	500 Year	771.080	769.935	769.410	0.273	0.499	207.520	12.071	975.454	34.475	8.773
Main	193	10 Year	768.561	768.366		0.145	0.030	111.857	10.511	258.241	1.248	3.624
Main	193	25 Year	768.896	768.697		0.147	0.029	141.453	47.834	297.593	7.574	3.873
Main	193	50 Year	769.336	769.161		0.143	0.020	177.968	134.151	337.085	32.764	3.984
Main	193	100 Year	769.771	769.615		0.137	0.012	208.844	251.900	372.855	78.245	4.041
Main	193	500 Year	770.305	770.159		0.132	0.006	245.739	438.705	420.644	162.651	4.149

SAMPLE

HEC-RAS Plan: Prop River: Bear Creek Reach: Main

Reach	River Sta	Profile	E.G. U.S. (ft)	Min El Prs (ft)	BR Open Area (sq ft)	Prs O WS (ft)	Q Total (cfs)	Min El Weir Flow (ft)	Q Weir (cfs)	Delta EG (ft)
Main	300	10 Year	768.978	772.950	153.120		270.000	774.910		0.229
Main	300	25 Year	769.446	772.950	153.120		353.000	774.910		0.308
Main	300	50 Year	770.175	772.950	153.120		504.000	774.910		0.486
Main	300	100 Year	771.063	772.950	153.120		703.000	774.910		0.791
Main	300	500 Year	772.552	772.950	153.120		1022.000	774.910		1.473

SAMPLE

Plan: Prop Bear Creek Main RS: 300 Profile: 10 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	768.98	E.G. Elev (ft)	768.91	768.83
W.S. US. (ft)	768.90	W.S. Elev (ft)	768.68	768.58
Q Total (cfs)	270.00	Crit W.S. (ft)	766.99	767.00
Q Bridge (cfs)	270.00	Max Chl Dpth (ft)	3.92	4.01
Q Weir (cfs)		Vel Total (ft/s)	3.89	4.04
Weir Sta Lft (ft)		Flow Area (sq ft)	69.46	66.88
Weir Sta Rgt (ft)		Froude # Chl	0.35	0.36
Weir Submerg		Specif Force (cu ft)	154.32	150.65
Weir Max Depth (ft)		Hydr Depth (ft)	3.47	3.34
Min EI Weir Flow (ft)	774.91	W.P. Total (ft)	20.26	20.76
Min EI Prs (ft)	772.95	Conv. Total (cfs)	5867.8	5418.3
Delta EG (ft)	0.23	Top Width (ft)	20.00	20.00
Delta WS (ft)	0.34	Frctn Loss (ft)	0.07	0.06
BR Open Area (sq ft)	153.12	C & E Loss (ft)	0.01	0.03
BR Open Vel (ft/s)	4.04	Shear Total (lb/sq ft)	0.45	0.50
Coef of Q		Power Total (lb/ft s)	0.00	0.00
Br Sel Method	Energy only			

Plan: Prop Bear Creek Main RS: 300 Profile: 25 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	769.45	E.G. Elev (ft)	769.36	769.25
W.S. US. (ft)	769.35	W.S. Elev (ft)	769.02	768.89
Q Total (cfs)	353.00	Crit W.S. (ft)	767.34	767.37
Q Bridge (cfs)	353.00	Max Chl Dpth (ft)	4.26	4.32
Q Weir (cfs)		Vel Total (ft/s)	4.62	4.83
Weir Sta Lft (ft)		Flow Area (sq ft)	76.37	73.10
Weir Sta Rgt (ft)		Froude # Chl	0.39	0.41
Weir Submerg		Specif Force (cu ft)	197.59	191.51
Weir Max Depth (ft)		Hydr Depth (ft)	3.82	3.65
Min EI Weir Flow (ft)	774.91	W.P. Total (ft)	20.26	20.76
Min EI Prs (ft)	772.95	Conv. Total (cfs)	6872.4	6284.2
Delta EG (ft)	0.31	Top Width (ft)	20.00	20.00
Delta WS (ft)	0.47	Frctn Loss (ft)	0.09	0.07
BR Open Area (sq ft)	153.12	C & E Loss (ft)	0.01	0.05
BR Open Vel (ft/s)	4.83	Shear Total (lb/sq ft)	0.62	0.69
Coef of Q		Power Total (lb/ft s)	0.00	0.00
Br Sel Method	Energy only			

Plan: Prop Bear Creek Main RS: 300 Profile: 50 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	770.17	E.G. Elev (ft)	770.03	769.88
W.S. US. (ft)	770.04	W.S. Elev (ft)	769.49	769.27
Q Total (cfs)	504.00	Crit W.S. (ft)	767.91	767.94
Q Bridge (cfs)	504.00	Max Chl Dpth (ft)	4.73	4.70
Q Weir (cfs)		Vel Total (ft/s)	5.88	6.25
Weir Sta Lft (ft)		Flow Area (sq ft)	85.75	80.68
Weir Sta Rgt (ft)		Froude # Chl	0.48	0.51
Weir Submerg		Specif Force (cu ft)	276.94	265.50
Weir Max Depth (ft)		Hydr Depth (ft)	4.29	4.03
Min EI Weir Flow (ft)	774.91	W.P. Total (ft)	20.26	20.76
Min EI Prs (ft)	772.95	Conv. Total (cfs)	8336.7	7408.1
Delta EG (ft)	0.49	Top Width (ft)	20.00	20.00
Delta WS (ft)	0.77	Frctn Loss (ft)	0.13	0.10
BR Open Area (sq ft)	153.12	C & E Loss (ft)	0.02	0.09
BR Open Vel (ft/s)	6.25			

Plan: Prop Bear Creek Main RS: 300 Profile: 50 Year (Continued)

Coef of Q		Shear Total (lb/sq ft)	0.97	1.12
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

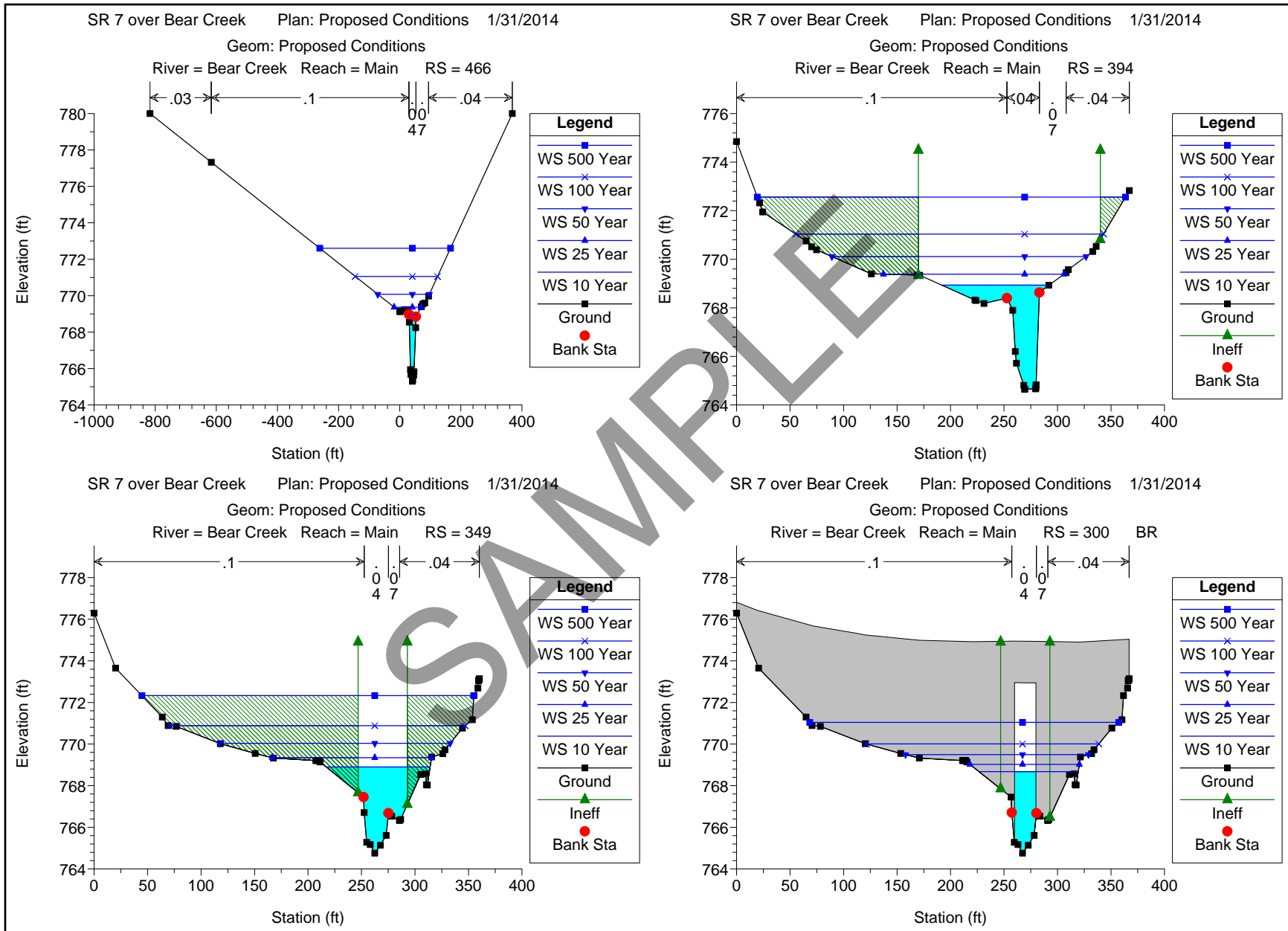
Plan: Prop Bear Creek Main RS: 300 Profile: 100 Year

E.G. US. (ft)	771.06	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	770.88	E.G. Elev (ft)	770.84	770.59
Q Total (cfs)	703.00	W.S. Elev (ft)	770.01	769.57
Q Bridge (cfs)	703.00	Crit W.S. (ft)	768.57	768.62
Q Weir (cfs)		Max Chl Dpth (ft)	5.25	5.00
Weir Sta Lft (ft)		Vel Total (ft/s)	7.32	8.11
Weir Sta Rgt (ft)		Flow Area (sq ft)	96.00	86.71
Weir Submerg		Froude # Chl	0.56	0.64
Weir Max Depth (ft)		Specif Force (cu ft)	391.40	369.95
Min EI Weir Flow (ft)	774.91	Hydr Depth (ft)	4.80	4.34
Min EI Prs (ft)	772.95	W.P. Total (ft)	20.26	20.76
Delta EG (ft)	0.79	Conv. Total (cfs)	10063.1	8353.1
Delta WS (ft)	1.27	Top Width (ft)	20.00	20.00
BR Open Area (sq ft)	153.12	Frctn Loss (ft)	0.19	0.14
BR Open Vel (ft/s)	8.11	C & E Loss (ft)	0.06	0.18
Coef of Q		Shear Total (lb/sq ft)	1.44	1.85
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

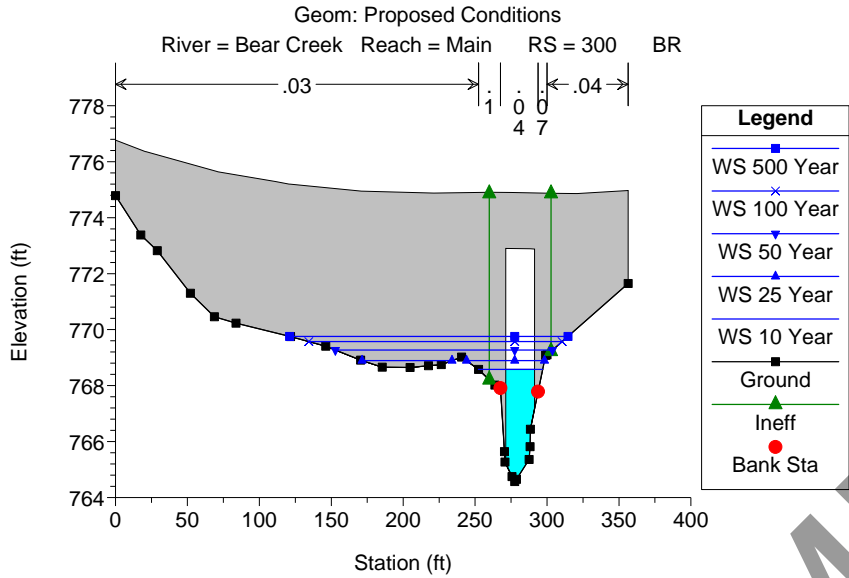
Plan: Prop Bear Creek Main RS: 300 Profile: 500 Year

E.G. US. (ft)	772.55	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	772.33	E.G. Elev (ft)	772.23	771.74
Q Total (cfs)	1022.00	W.S. Elev (ft)	771.05	769.76
Q Bridge (cfs)	1022.00	Crit W.S. (ft)	769.52	769.56
Q Weir (cfs)		Max Chl Dpth (ft)	6.29	5.19
Weir Sta Lft (ft)		Vel Total (ft/s)	8.75	11.31
Weir Sta Rgt (ft)		Flow Area (sq ft)	116.80	90.40
Weir Submerg		Froude # Chl	0.62	0.87
Weir Max Depth (ft)		Specif Force (cu ft)	619.90	568.11
Min EI Weir Flow (ft)	774.91	Hydr Depth (ft)	5.84	4.52
Min EI Prs (ft)	772.95	W.P. Total (ft)	20.26	20.76
Delta EG (ft)	1.47	Conv. Total (cfs)	13953.2	8953.6
Delta WS (ft)	2.39	Top Width (ft)	20.00	20.00
BR Open Area (sq ft)	153.12	Frctn Loss (ft)	0.25	0.24
BR Open Vel (ft/s)	11.31	C & E Loss (ft)	0.24	0.42
Coef of Q		Shear Total (lb/sq ft)	1.93	3.54
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

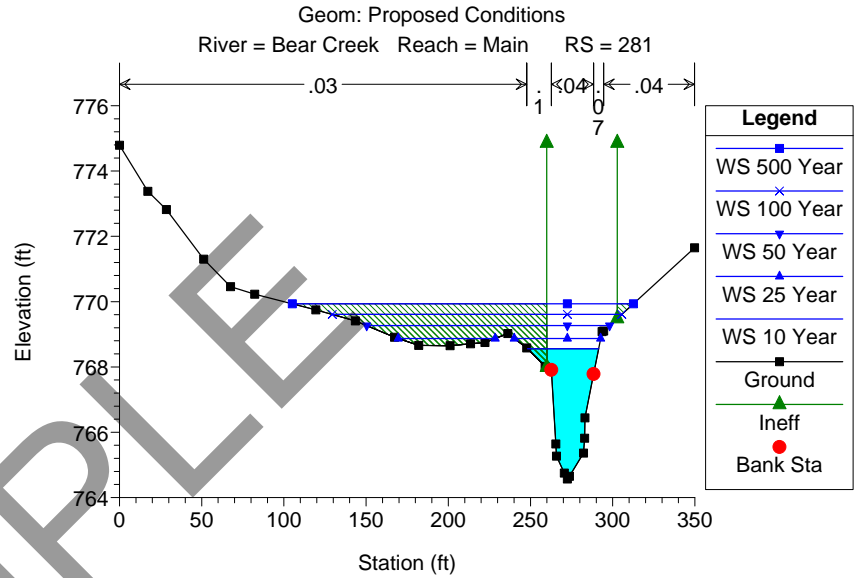
Cross Sections



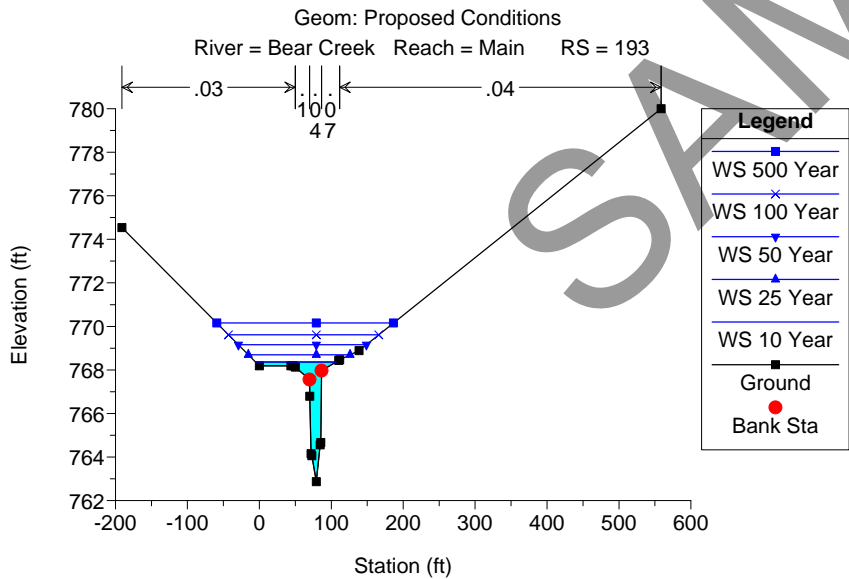
SR 7 over Bear Creek Plan: Proposed Conditions 1/31/2014



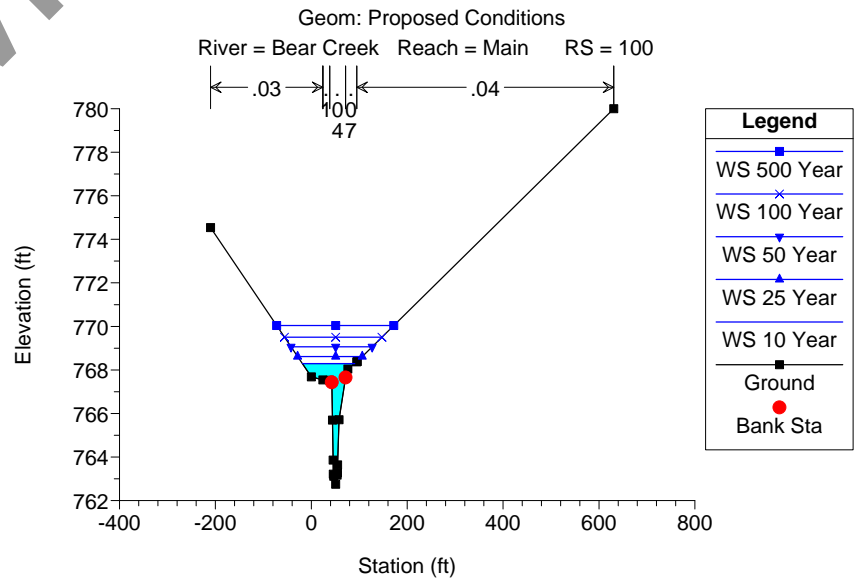
SR 7 over Bear Creek Plan: Proposed Conditions 1/31/2014



SR 7 over Bear Creek Plan: Proposed Conditions 1/31/2014



SR 7 over Bear Creek Plan: Proposed Conditions 1/31/2014



Appendix B4: CHeck-RAS Output

SAMPLE

Natural Conditions

Group By XS Order(ascending)

[XS DC 02](#)

Constant discharge used for the entire profile for 0.2%-annual-chance flood. At least two discharges should be selected; one at the mouth and the other at the middle of the watershed or above the confluence of a tributary. Or provide explanation why only one discharge should be used. Other flood frequencies should also be checked.

SAMPLE

Proposed Conditions

Group By XS Order(ascending)

- [XS DC 02](#) Constant discharge used for the entire profile for 0.2%-annual-chance flood. At least two discharges should be selected; one at the mouth and the other at the middle of the watershed or above the confluence of a tributary. Or provide explanation why only one discharge should be used. Other flood frequencies should also be checked.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 0.2%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 772.55 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 772.55 is less than MxLoCdU of 772.95.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 1%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 771.06 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 771.06 is less than MxLoCdU of 772.95.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 2%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 770.17 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 770.17 is less than MxLoCdU of 772.95.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 4%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 769.45 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 769.45 is less than MxLoCdU of 772.95.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 10%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 768.98 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 768.98 is less than MxLoCdU of 772.95.
- [NT RS 02BDC](#) SECNO: 300
This is the Downstream Bridge Section (BRD). The channel n value of 0.04 for the downstream internal bridge opening section is equal to or larger than the channel n value of 0.04 at Section 2. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 2. The "n" value for Section 2 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of the higher "n" value.
- [NT RS 02BUC](#) SECNO: 300
This is the Upstream Bridge Section (BRU). The channel n value of 0.04 for the upstream internal bridge opening section is equal to or larger than the channel n value of 0.04 at Section 3. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 3. The "n" value for Section 3 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of a higher "n" value.

SAMPLE

Existing Conditions

Group By XS Order(ascending)

- [XS DC 02](#) Constant discharge used for the entire profile for 0.2%-annual-chance flood. At least two discharges should be selected; one at the mouth and the other at the middle of the watershed or above the confluence of a tributary. Or provide explanation why only one discharge should be used. Other flood frequencies should also be checked.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 0.2%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 772.62 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 772.62 is less than MxLoCdU of 773.02.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 1%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 771.08 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 771.08 is less than MxLoCdU of 773.02.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 2%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 770.18 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 770.18 is less than MxLoCdU of 773.02.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 4%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 769.45 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 769.45 is less than MxLoCdU of 773.02.
- [BR LF 01](#) SECNO: 300
This is (Bridge-UP). The selected profile is 10%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 768.98 is less than or equal to MinTopRd of 774.92. 2. EGEL 3 of 768.98 is less than MxLoCdU of 773.02.
- [NT RS 02BDC](#) SECNO: 300
This is the Downstream Bridge Section (BRD). The channel n value of 0.04 for the downstream internal bridge opening section is equal to or larger than the channel n value of 0.04 at Section 2. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 2. The "n" value for Section 2 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of the higher "n" value.
- [NT RS 02BUC](#) SECNO: 300
This is the Upstream Bridge Section (BRU). The channel n value of 0.04 for the upstream internal bridge opening section is equal to or larger than the channel n value of 0.04 at Section 3. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 3. The "n" value for Section 3 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of a higher "n" value.

SAMPLE

**Appendix B5: Hydraulic and Scour
Calculations**

SAMPLE

1. Q₁₀₀ Elevation

Q₁₀₀ Elevation. This elevation is determined for natural conditions at the downstream face of the bridge. If using HEC-RAS, this can be determined by using interpolated sections between the adjacent bridge sections in natural conditions to the downstream bridge face.

HEC-RAS Plan: Natural River: Bear Creek Reach: Main Profile: 100 Year

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	100 Year	703.00	765.30	770.01	770.01	770.79	0.01	7.54	160.99	162.30	0.70
Main	394	100 Year	703.00	764.64	769.96		770.23	0.00	4.62	292.87	224.67	0.40
Main	349	100 Year	703.00	764.76	769.94		770.10	0.00	3.85	329.30	211.72	0.32
Main	281	100 Year	703.00	764.57	769.75		769.96	0.00	4.35	243.73	192.44	0.38
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28

$$Q_{100} \text{ Elevation} = 769.75' - (22.92/67.97) * (769.75' - 769.94') = 769.81'$$

2. Q₁₀₀ Headwater Elevation

HEC-RAS Plan: Prop River: Bear Creek Reach: Main Profile: 100 Year

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	100 Year	703.00	765.30	771.06		771.25	0.00	4.33	386.28	269.24	0.35
Main	394	100 Year	703.00	764.64	771.04	768.58	771.13	0.00	3.00	436.66	287.65	0.23
Main	349	100 Year	703.00	764.76	770.88	768.14	771.06	0.00	3.76	221.86	276.16	0.28
Main	300	Bridge										
Main	281	100 Year	703.00	764.57	769.61	768.50	770.27	0.01	6.63	116.58	176.14	0.58
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28

HEC-RAS Plan: Existing Con River: Bear Creek Reach: Main Profile: 100 Year

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	100 Year	703.00	765.30	771.09		771.28	0.00	4.25	395.83	272.85	0.35
Main	394	100 Year	703.00	764.64	771.07	768.58	771.17	0.00	2.96	442.55	289.30	0.23
Main	349	100 Year	703.00	764.76	770.87	768.19	771.08	0.00	4.05	216.45	279.11	0.30
Main	300	Bridge										
Main	281	100 Year	703.00	764.57	769.63	768.50	770.24	0.01	6.39	125.86	181.38	0.56
Main	193	100 Year	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	100	100 Year	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28

3. Gross Waterway Area Opening Below Q_{100} Elevation

Gross Waterway Area Opening Below Q_{100} Elevation. The required area is determined by using the Q_{100} natural water surface elevation at the downstream bridge face. Since this is to be the gross area, the flow-area output from HEC-RAS, which is net area, should include the piers and adjusted flow-area water-surface elevation to the Q_{100} elevation. The gross waterway area should be taken in a direction parallel to the flow.

Plan: Prop Bear Creek Main RS: 300 Profile: 100 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	771.06			
W.S. US. (ft)	770.88	E.G. Elev (ft)	770.84	770.59
Q Total (cfs)	703.00	W.S. Elev (ft)	770.01	769.57
Q Bridge (cfs)	703.00	Crit W.S. (ft)	768.57	768.62
Q Weir (cfs)		Max Chl Dpth (ft)	5.25	5.00
Weir Sta Lft (ft)		Vel Total (ft/s)	7.32	8.11
Weir Sta Rgt (ft)		Flow Area (sq ft)	96.00	86.71
Weir Submerg		Froude # Chl	0.56	0.64
Weir Max Depth (ft)		Specif Force (cu ft)	391.40	369.95
Min El Weir Flow (ft)	774.91	Hydr Depth (ft)	4.80	4.34
Min El Prs (ft)	772.95	W.P. Total (ft)	20.26	20.76
Delta EG (ft)	0.79	Conv. Total (cfs)	10063.1	8353.1
Delta WS (ft)	1.27	Top Width (ft)	20.00	20.00
BR Open Area (sq ft)	153.12	Frctn Loss (ft)	0.19	0.14
BR Open Vel (ft/s)	8.11	C & E Loss (ft)	0.06	0.18
Coef of Q		Shear Total (lb/sq ft)	1.44	1.85
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

Gross Waterway Area Opening Below Q_{100} Elevation = $86.71' - (769.57' - 769.81') * 20' = 91.51 \text{ ft}^2$

4. Road-Overflow Area

Plan: Prop Bear Creek Main RS: 300 Profile: 100 Year

		Element	Inside BR US	Inside BR DS
E.G. US. (ft)	771.06			
W.S. US. (ft)	770.88	E.G. Elev (ft)	770.84	770.59
Q Total (cfs)	703.00	W.S. Elev (ft)	770.01	769.57
Q Bridge (cfs)	703.00	Crit W.S. (ft)	768.57	768.62
Q Weir (cfs)	0.00	Max Chl Dpth (ft)	5.25	5.00
Weir Sta Lft (ft)		Vel Total (ft/s)	7.32	8.11
Weir Sta Rgt (ft)		Flow Area (sq ft)	96.00	86.71
Weir Submerg		Froude # Chl	0.56	0.64
Weir Max Depth (ft)		Specif Force (cu ft)	391.40	369.95
Min El Weir Flow (ft)	774.91	Hydr Depth (ft)	4.80	4.34
Min El Prs (ft)	772.95	W.P. Total (ft)	20.26	20.76
Delta EG (ft)	0.79	Conv. Total (cfs)	10063.1	8353.1
Delta WS (ft)	1.27	Top Width (ft)	20.00	20.00
BR Open Area (sq ft)	153.12	Frctn Loss (ft)	0.19	0.14
BR Open Vel (ft/s)	8.11	C & E Loss (ft)	0.06	0.18
Coef of Q		Shear Total (lb/sq ft)	1.44	1.85
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

5. Q₁₀₀ Velocity

Plan: Prop Bear Creek Main RS: 300 Profile: 100 Year

E.G. US. (ft)	771.06	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	770.88	E.G. Elev (ft)	770.84	770.59
Q Total (cfs)	703.00	W.S. Elev (ft)	770.01	769.57
Q Bridge (cfs)	703.00	Crit W.S. (ft)	768.57	768.62
Q Weir (cfs)	0.00	Max Chl Dpth (ft)	5.25	5.00
Weir Sta Lft (ft)		Vel Total (ft/s)	7.32	8.11
Weir Sta Rgt (ft)		Flow Area (sq ft)	96.00	86.71
Weir Submerg		Froude # Chl	0.56	0.64
Weir Max Depth (ft)		Specif Force (cu ft)	391.40	369.95
Min EI Weir Flow (ft)	774.91	Hydr Depth (ft)	4.80	4.34
Min EI Prs (ft)	772.95	W.P. Total (ft)	20.26	20.76
Delta EG (ft)	0.79	Conv. Total (cfs)	10063.1	8353.1
Delta WS (ft)	1.27	Top Width (ft)	20.00	20.00
BR Open Area (sq ft)	153.12	Frctn Loss (ft)	0.19	0.14
BR Open Vel (ft/s)	8.11	C & E Loss (ft)	0.06	0.18
Coef of Q		Shear Total (lb/sq ft)	1.44	1.85
Br Sel Method	Energy only	Power Total (lb/ft s)	0.00	0.00

11. Q₁₀₀ Maximum Velocity

Plan: Prop Bear Creek Main RS: 300 BR D Profile: 100 Year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	Chan	270.74	271.79	15.54	1.91	0.44	2.21	4.39	8.14	1.93	15.70
2	Chan	271.79	272.83	38.58	4.68	1.05	5.49	4.47	8.24	1.96	16.17
3	Chan	272.83	273.88	40.19	4.80	1.05	5.72	4.58	8.37	2.01	16.85
4	Chan	273.88	274.93	41.83	4.92	1.05	5.95	4.69	8.51	2.06	17.54
5	Chan	274.93	275.98	43.49	5.03	1.05	6.19	4.80	8.64	2.11	18.24
6	Chan	275.98	277.03	45.10	5.14	1.05	6.42	4.90	8.77	2.16	18.93
7	Chan	277.03	278.08	46.36	5.23	1.05	6.59	4.98	8.87	2.20	19.48
8	Chan	278.08	279.13	45.64	5.17	1.05	6.49	4.93	8.82	2.18	19.20
9	Chan	279.13	280.18	44.38	5.09	1.05	6.31	4.85	8.72	2.14	18.65
10	Chan	280.18	281.22	43.10	5.00	1.05	6.13	4.77	8.62	2.10	18.11
11	Chan	281.22	282.27	41.83	4.91	1.05	5.95	4.68	8.52	2.06	17.58
12	Chan	282.27	283.32	40.58	4.82	1.05	5.77	4.60	8.41	2.03	17.05
13	Chan	283.32	284.37	39.34	4.73	1.05	5.60	4.51	8.31	1.99	16.53
14	Chan	284.37	285.42	38.12	4.65	1.05	5.42	4.43	8.20	1.95	16.02
15	Chan	285.42	286.47	36.91	4.56	1.05	5.25	4.35	8.10	1.92	15.51
16	Chan	286.47	287.52	35.72	4.47	1.05	5.08	4.26	7.99	1.88	15.01
17	Chan	287.52	288.57	21.39	3.94	1.66	3.04	3.76	5.42	1.05	5.69
18	Chan	288.57	289.61	19.14	3.11	1.08	2.72	2.96	6.16	1.27	7.83
19	Chan	289.61	290.66	16.41	2.83	1.08	2.33	2.70	5.79	1.16	6.72
20	Chan	290.66	291.71	9.35	1.71	0.71	1.33	2.49	5.48	1.07	5.85

8. Q₅₀₀ Maximum Velocity

Plan: Prop Bear Creek Main RS: 300 BR D Profile: 500 Year

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)	Shear (lb/sq ft)	Power (lb/ft s)
1	Chan	270.74	271.79	65.14	5.34	1.05	6.37	5.09	12.21	4.12	50.28
2	Chan	271.79	272.83	66.90	5.42	1.05	6.55	5.17	12.35	4.19	51.71
3	Chan	272.83	273.88	65.90	5.37	1.05	6.45	5.12	12.28	4.15	50.98
4	Chan	273.88	274.93	64.14	5.28	1.05	6.28	5.04	12.14	4.08	49.58
5	Chan	274.93	275.98	62.35	5.19	1.05	6.10	4.95	12.00	4.02	48.20
6	Chan	275.98	277.03	60.59	5.11	1.05	5.93	4.87	11.87	3.95	46.84
7	Chan	277.03	278.08	58.84	5.02	1.05	5.76	4.78	11.73	3.88	45.49
8	Chan	278.08	279.13	57.11	4.93	1.05	5.59	4.70	11.59	3.81	44.15
9	Chan	279.13	280.18	55.41	4.84	1.05	5.42	4.61	11.45	3.74	42.83
10	Chan	280.18	281.22	53.72	4.75	1.05	5.26	4.53	11.31	3.67	41.53
11	Chan	281.22	282.27	52.06	4.66	1.05	5.09	4.44	11.17	3.60	40.24
12	Chan	282.27	283.32	31.46	4.14	1.66	3.08	3.95	7.60	2.02	15.39
13	Chan	283.32	284.37	28.74	3.30	1.08	2.81	3.15	8.71	2.48	21.64
14	Chan	284.37	285.42	24.89	3.03	1.08	2.44	2.89	8.22	2.28	18.73
15	Chan	285.42	286.47	14.31	1.83	0.71	1.40	2.67	7.81	2.11	16.46
16	Chan	286.47	287.52	65.14	5.34	1.05	6.37	5.09	12.21	4.12	50.28
17	Chan	287.52	288.57	66.90	5.42	1.05	6.55	5.17	12.35	4.19	51.71
18	Chan	288.57	289.61	65.90	5.37	1.05	6.45	5.12	12.28	4.15	50.98
19	Chan	289.61	290.66	64.14	5.28	1.05	6.28	5.04	12.14	4.08	49.58
20	Chan	290.66	291.71	62.35	5.19	1.05	6.10	4.95	12.00	4.02	48.20

12. Q₁₀₀ Contraction Scour

Contraction Scour

Input Data

	Left	Channel	Right
Average Depth (ft):		5.17	
Approach Velocity (ft/s):		3.00	
Br Average Depth (ft):		4.80	
BR Opening Flow (cfs):		703.00	
BR Top WD (ft):		20.00	
Grain Size D50 (mm):		0.01	
Approach Flow (cfs):		471.40	
Approach Top WD (ft):		30.36	
K1 Coefficient:		0.690	

Results

Scour Depth Ys (ft):	4.91
Critical Velocity (ft/s):	0.47
Equation:	Live

13. Q₅₀₀ Contraction Scour

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):		6.70	
Approach Velocity (ft/s):		2.70	
Br Average Depth (ft):		5.84	
BR Opening Flow (cfs):		1022.00	
BR Top WD (ft):		20.00	
Grain Size D50 (mm):		0.01	
Approach Flow (cfs):		549.84	
Approach Top WD (ft):		30.36	
K1 Coefficient:		0.690	
Results			
Scour Depth Ys (ft):		9.36	
Critical Velocity (ft/s):		0.49	
Equation:		Live	

14. Backwater and Surge Calculations

HEC-RAS River: Bear Creek Reach: Main Profile: 100 Year

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	466	100 Year	Natural	703.00	765.30	770.01	770.01	770.79	0.01	7.54	160.99	162.30	0.70
Main	466	100 Year	Existing Con	703.00	765.30	771.09		771.28	0.00	4.25	395.83	272.85	0.35
Main	466	100 Year	Prop	703.00	765.30	771.06		771.25	0.00	4.33	386.28	269.24	0.35
Main	394	100 Year	Natural	703.00	764.64	769.96		770.23	0.00	4.62	292.87	224.67	0.40
Main	394	100 Year	Existing Con	703.00	764.64	771.07	768.58	771.17	0.00	2.96	442.55	289.30	0.23
Main	394	100 Year	Prop	703.00	764.64	771.04	768.58	771.13	0.00	3.00	436.66	287.65	0.23
Main	349	100 Year	Natural	703.00	764.76	769.94		770.10	0.00	3.85	329.30	211.72	0.32
Main	349	100 Year	Existing Con	703.00	764.76	770.87	768.19	771.08	0.00	4.05	216.45	279.11	0.30
Main	349	100 Year	Prop	703.00	764.76	770.88	768.14	771.06	0.00	3.76	221.86	276.16	0.28
Main	281	100 Year	Natural	703.00	764.57	769.75		769.96	0.00	4.35	243.73	192.44	0.38
Main	281	100 Year	Existing Con	703.00	764.57	769.63	768.50	770.24	0.01	6.39	125.86	181.38	0.56
Main	281	100 Year	Prop	703.00	764.57	769.61	768.50	770.27	0.01	6.63	116.58	176.14	0.58
Main	193	100 Year	Natural	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	193	100 Year	Existing Con	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	193	100 Year	Prop	703.00	762.87	769.62		769.77	0.00	4.04	299.32	208.84	0.30
Main	100	100 Year	Natural	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28
Main	100	100 Year	Existing Con	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28
Main	100	100 Year	Prop	703.00	762.75	769.51	768.21	769.62	0.00	3.29	319.49	203.16	0.28

Existing Backwater = Existing WS - Unconstricted WS

River Station 466 = 771.09' - 770.01' = 1.08'
 River Station 394 = 771.07' - 769.96' = 1.11'
 River Station 349 = 770.87' - 769.94' = 0.93'

Maximum

Proposed Backwater = Proposed WS - Unconstricted WS

River Station 466 = 771.05' - 770.01' = 1.04'
 River Station 394 = 771.03' - 769.96' = 1.07'
 River Station 349 = 770.88' - 769.94' = 0.94'

Maximum

Proposed Surcharge = Proposed WS - Existing WS

River Station 466 = $771.05' - 771.09' = -0.04'$

River Station 394 = $771.03' - 771.07' = -0.04'$

River Station 349 = $770.88' - 770.87' = 0.01'$

← Maximum

SAMPLE

Appendix C: Site Photographs

SAMPLE





1. Standing south of the structure looking north along SR 7.



2. Standing north of the structure looking south along SR 7.



3. Standing at the structure looking west at the creek.



4. Standing at the structure looking east at the creek.



5. Standing downstream of the structure looking west



6. Standing upstream of the structure looking east



7. Standing west of the structure looking at the upstream southern abutment



8. Standing east of the structure looking at the downstream northern abutment

**Appendix D: Pertinent Excerpts from
other Reports/Studies**

SAMPLE



Indiana Department of Transportation
Indianapolis, IN 46204
317-233-1057 Voice
317 232-5478 FAX

5/25/2012 12:00:00 AM

TO: Charles Read
FROM: Beckie Black
Senior Forecast Technician

RE: SR 7 SR 7 North of SR 250 at RP 14 + 95
Jefferson County

DES # 1006242

Below is the traffic forecast developed for the above referenced project:

Segment Name:

2011 AADT 3,840
2012 AADT 3,870
2015 AADT 3,970
2025 AADT 4,280
2030 AADT 4,440
2035 AADT 4,600
2035 DHV 9.8%

Commercial Vehicles
8.70 % AADT
5.56 % DHV

Peak Hour = 5 PM

Directional Distribution = 49.96% Positive Direction

The per year growth rate used for this forecast = 0.82%

For ESAL Projections requests, the volume forecasted is the highest volume in the project area.

It should be recognized by users of this forecast that the base AADT has an accuracy of plus or minus 10%. It is the responsibility of the designer to exercise professional judgment when using this data to influence design decisions.

If you have any questions, please feel free to contact Beckie Black at 317 233-1057.

Large Culvert Inspection Report

Large Culvert # 7-39-14.95 **Sub-District** 655 **Last Inspection Date** 03/22/2012

Location SR 7 North of SR 250 at RP 14+95 **On Skew**

Type I **Description** _____ **Shape** _____

Type II **Description** Concrete Slabtop **Abutment Type** Concrete

Vert Opening 8 **Span** 19.5 **Length** 35 **Cover** 1

GPS Longitude 85° 32' 12.59" **GPS Latitude** 38° 54' 10.8" **Year Built (If Known)** _____

Roadway Related Items

Road Alignment	<u>7</u>	Ditches are scoured and meander.
Pavement/Wearing Surface	<u>7</u>	
Shoulders	<u>6</u>	
Embankment/Side Ditches	<u>5</u>	
Guardrail/Concrete Barrier	<u>6</u>	

Type I Culverts and Pipes

Barrel/Box	_____
Headwalls/Anchors	_____
Wingwalls	_____
Settlement	_____
OVERALL	<input type="checkbox"/>

Type II Structures

Superstructure Items

Concrete Slab	<u>3</u>	The under side is delaminated and rebar exposed in some areas. The added box beam on the west side is cracked and on the east side of the culvert the bottom is completely gone (6" to 8" in width).
Beams/Girders	<u>2</u>	
Coping/Headwall	<u>5</u>	Added the rating to exterior box beams since they had not been rated originally. The box beam on the east has lost the steel strands since
OVERALL	<input type="text" value="2"/>	

Substructure Items

Caps	_____
Abutments	<u>4</u>
Wingwalls	<u>5</u>
Footings	<u>6</u>
Pilings	_____
OVERALL	<input type="text" value="4"/>

Large Culvert Inspection Report

Channel Related Items

Channel Alignment	<u>5</u>	
Bank Erosion	<u>6</u>	
Channel Scour	<u>6</u>	
Drift/Sediment	<u>5</u>	
OVERALL CHANNEL	<table border="1"><tr><td>5</td></tr></table>	5
5		

Unobstructed Flow: _____

Recommendations

In Program Des # 1006242 Ready For Contracts: 04/18/2015

Deficiencies East exterior box beam has failed and the west box beam is failing.
(See Deficiency Report)

Repair by Contract _____

Recommend Replacement Estimated Remaining Life _____

Operations Special Project Special Project Type: _____

Sketch or Additional Comments

This interim inspection was made as recommended by John McCrary.

Inspected By jlm,cw Date Inspected 6/22/2012 OVERALL RATING

2

Engineering Assessment Scoping Meeting Minutes

Small Structure Replacement
Des. No. 1006242

SR 7 over Bear Creek
7.0 mi N of SR 250
Jefferson County

This is a summary of the observations and recommendations made at a scoping field check held at the project site on Thursday, January 24, 2013. The scoping field check was held to review the existing conditions and discuss the scope of work for this engineering assessment. The following individuals were in attendance:

William "Bill" Read	INDOT Seymour District Project Manager
Gary Kreuzjans	INDOT Seymour District Environmental Scoping Engineer
Jason Fee	Janssen & Spaans Engineering, Inc.

The weather was clear, cold and very windy at the time of the site visit. A summary of the items discussed are as follows:

Using a road closure with a detour was discussed as the most likely method for maintenance of traffic. Bill Read suggested that JSE follow up with Hillary Lowther at the Seymour District to get her opinion.

INDOT suggested that a design exception should be considered for shoulder width to reduce from 6 ft. to 4 ft. paved shoulders along the guardrail.

3R standards should be used. It is desirable to maintain the existing horizontal and vertical alignment of SR 7. The vertical profile will need checked for compliance. If the existing condition does not meet current standards, a design exception should be used.

The budget for the project is currently \$377,000.

The existing R/W is not believed to be recorded.

The existing slab structure has been widened with precast box beams. One of the box beams has deteriorated to the point that it has complete section loss in the lower section of the beam. The slab portion of the structure has exposed reinforcing steel, spalling and efflorescence. The opening appears large enough, but the skew of the structure aligns poorly with the channel. The new structure should have more skew than the existing structure. The existing structure appears to be built on footings on rock.

Prepared by:
Jason G. Fee, P.E.
Senior Project Manager

Appendix E: Checklists

SAMPLE

Hydraulics QA Checklist

Route: SR 7 Des No. 1006242

County: Jefferson City or Town:

Description: SR 7 over Bear Creek

Designer: CLH Reviewer: CWR

MAPS

- USGS Quad. Scale Date
- ARC GIS Date
- Flood-Insurance Firm and FHBM
- Soils Map
- Aerial Photos Scale Date

STUDIES BY EXTERNAL AGENCIES

- FEMA Flood-Insurance Studies
- NRCS Watershed Studies
- USGS Gages and Studies
- Interim Floodplain Studies

STUDIES BY INTERNAL SOURCES

- Office Records
- Flood Record (High Water, Newspaper)
Gaging Data

BRIDGE INSPECTION REPORTS

CALIBRATION OF HIGH-WATER DATA

- Discharge and Frequency of H.W. el.
- Influences Responsible for H.W. el. - Check
Maps for Larger Streams Nearby that May
Backwater the Site
- Analyze Hydraulic Performance of
Existing Facility for 100-Year Flood
- Analyze Hydraulic Performance of
Proposed Facility for 100-Year Flood
- Field Reconnaissance Revisions Report

DESIGN APPURTENANCES

- Dissipators, Riprap
- Scour Analysis/Evaluation

TECHNICAL RESOURCES

- Indiana Design Manual, Part II*
- Other _____

DISCHARGE CALCULATIONS

- Drainage Area Delineation
- Drainage Areas of IN Streams
- DNR Discharge Letter
- Rational Formula
- HEC-HMS / TR-20
- NRCS
- Regional Analysis
- Coordinated Discharges of IN Streams
- Log-Pearson Type III Gage Rating

HIGH-WATER ELEVATIONS

- INDOT Survey
- Plans for Existing Structure
- DNR Historic Flood Profiles
- Maintenance Records
- External Sources
- Personal Reconnaissance

ENVIRONMENTAL REPORTS

INDOT

TECHNICAL AIDS

Indiana Design Manual, Part II

INDOT and FHWA Directives

FHWA Publications

COMPUTER PROGRAMS

HY8

HEC-RAS River Analysis System

Log-Pearson Type III Analysis


WSPRO Water-Surface Profile

PFP-HYDRA

HEC-HMS / TR 20

HEC-RAS Scour Analysis

Other _____

Designed by: 

Date: 1/31/14

Reviewed by: 

Date: 1/31/14

SAMPLE

TR-55 TIME-OF-CONCENTRATION WORKSHEET

Route: SR 7 Project No.: 1006242 Location: Jefferson County, IN
 Designer: CLH Date: 1/28/14
 Checked By: CSR Date:

Present Developed

T_c T_t Through subarea

A map, schematic, or flow-segments description is attached.

Sheet Flow, applies to T_c only	Segment ID		
1. Surface description, see Figure 202-2B		Dense Woods	
2. Manning's roughness coeff., n , see Figure 202-2B		0.800	
3. Flow length, L (total $L \leq 100$ ft)		100 ft	ft
4. Two-year 24-h rainfall		3.05 in.	in.
5. Land slope, s		0.00 ft/ft	ft/ft
6. $T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}(s)^{0.4}}$		1.227 h	h

Total T_t in line 6 for both segments = 1.227 h

Shallow Concentrated Flow	Segment ID		
7. Surface description, paved or unpaved		Unpaved	Unpaved
8. Flow length, L		2500 ft	915 ft
9. Watercourse slope, s		0.0029 ft/ft	0.0034 ft/ft
10. Average velocity, V , see Figure 202-2D		1.0 ft/s	1.0 ft/s
11. $T_t = \frac{L}{3600V}$		0.711 h	0.254 h

Total T_t in line 11 for both segments = 0.965 h

Channel Flow	Segment ID			
12. Cross-sectional flow area, a		28 ft ²	38 ft ²	48 ft ²
13. Wetted perimeter, P_w		18.74 ft	23.74 ft	28.74 ft
14. Hydraulic radius, $r = a/P_w$		1.48 ft	1.57 ft	1.66 ft
15. Channel slope, s		0.003 ft/ft	0.004 ft/ft	0.004 ft/ft
16. Manning's roughness coeff., n , see Figure 202-2C		0.100	0.050	0.040
17. $V = \frac{1.49r^{2/3}s^{1/2}}{n}$		1.04 ft/s	2.61 ft/s	3.45 ft/s
18. Flow length, L		5580 ft	1095 ft	5115 ft
19. $T_t = \frac{L}{3600V}$		1.488 h	0.116 h	0.412 h

Total T_t in line 19 for both segments = 2.017 h

20. Add T_t in lines 6, 11, and 19 to get watershed or subarea T_c or $T_t = 4.209$ h

EXAMPLE OF TR-55 TIME OF CONCENTRATION WORKSHEET

Figure 202-2A

Back

QUALITY ASSURANCE FORM

CONSULTANT COMPLETES THIS SECTION

Consultant: Janssen and Spaans Engineering, Inc.

Des. No.: 1006242 Project No.: 1006242

Project Description: Bridge Replacement on SR 7 over Bear Creek in Jefferson County


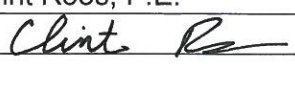
Submittal: Hydraulics

This submittal has been reviewed with regard to consistency, completeness, and overall content prior to submittal by Clint Roos, P.E., Project Manager, on January 31, 2014, telephone number 317-254-9686.

REVIEWER COMPLETES THIS SECTION

The submittal described above has been reviewed for quality in accordance with the Quality Assurance Procedures.

The consultant is responsible for checking all of its work as outlined in *Indiana Design Manual* Section 6-2.0, Quality Assurance Procedures. The table shown below indicates which of the reviewer's personnel has checked which items.

Item	Designer	Reviewer
202-4.0; 203-3.0	Chris Horsley, E.I.T.	Clint Roos, P.E.
		

Remarks: