Selecting Measures for Improvement

Multiple improvement measures have been identified for implementation in order to improve the Pigeon Creek Watershed. The measures are divided into items pertinent to each of the three subwatersheds, as well as a list of improvements practical for all of the subwatersheds. Each measure is presented with information detailing proposed location, historical background (if any), level of expected improvement, impacts created by implementation, construction feasibility, and a recommendation for course of further evaluation. Implementation sites were selected through Steering Committee participation, Public Meeting input, discussion with the Steuben County Surveyor's Office (January 21, 2005), Canoe Survey by V3 and the Steuben SWCD (October 1, 2004), and Windshield Survey by V3 and the Steuben SWCD (Spring 2005). Additional source control measures can be implemented subject to land owner participation.

List of Measures for Improvement:

- Stream Maintenance (Measure #1)
- Development Code Enforcement (2)
- Removal of Illicit Sanitary Connections (3)
- Public Education (4)
- Obtain IDNR Hydrologic and Hydraulic Models (5)
- Voluntary Buyout and Structure Elevation (6)
- Wetland / Habitat Restoration (7)
- Stream and Site BMP Restoration / Retrofitting (8)
- Flood Access Plan (9)
- Kankamp Property (10)
- Bill Deller Road Project (11)
- Sediment Basins (12)
- Rock Vortex Weirs (13)
- Rock Cross Vanes (14)
- Filter Strips (15)
- Monitoring Replacement of CR 150W Culvert (16)
- Shoreline Stabilization (17)
- West Otter Lake Pump Station (18)
- Gravel Pits (19)
- Culvert Modifications (20)
- Arrowhead Lake Outlet (21)

General

Several measures have been identified for implementation throughout the watershed. These measures include:

- Stream Maintenance (1)
- Development Code Enforcement (2)
- Removal of Illicit Sanitary Connections (3)
- Public Education (4)
- Obtain IDNR Hydrologic and Hydraulic Models (5)
- Voluntary Buyout and Structure Elevation (7)
- Wetland / Habitat Restoration (8)
- Stream and Site BMP Restoration / Retrofitting (9)
- Flood Access Plan (10)

Stream Maintenance (1) – The Steuben County Surveyor's Office is currently responsible for the maintenance of Pigeon Creek. Accordingly, the office has conducted annual operations to remove fallen tree limbs from the waterway. This function should be continued, and possibly expanded to include removal of litter and other debris from the channel and adjacent lands. Continued maintenance will improve water quality and prevent flood obstructions. This program, currently funded by the Ditch Tax, will provide a watershed benefit and can be assisted by youth volunteer groups. This measure will specifically improve water quality and reduce flood potential within the watershed through the removal of debris from the watercourse.

Development Code Enforcement (2) – In order to regulate the development of land within the county, the Steuben County Board of Commissioners has enacted the "Steuben County Ordinance for Storm Drainage and Erosion Control". The ordinance requires that all development shall provide flood storage to reduce the post-development 100-year peak discharge from the property to the pre-development 5-year discharge, which should result in a watershed benefit. The ordinance also requires each development to contain an erosion control plan approved by the county. The City of Angola also has a Storm Water Ordinance to control runoff release from developed sites. Each of these ordinances provides a valuable platform for limiting the negative impact of development activities on the watershed, and the county and city each should ensure their respective ordinance is enforced to its fullest degree. In addition, regulators should review additional requirements necessary to provide a watershed benefit in critical areas, such as increased detention requirements in the West Otter Lake watershed and additional water quality standards near Gooseneck and Meserve Lakes for the endangered Cisco fish habitat. This measure will specifically protect water quality, promote no increase in flood potential, and limit erosion as the watershed develops.

Removal of Illicit House Connections (3) – The county health department currently inspects reports of illicit discharges and enforces remediation requirements. This program should be continued and enforced to remove these connections and provide proper treatment of the discharge. In addition, the program should be expanded to survey drain tile connections near Pigeon Creek and its tributaries. A voluntary dye testing campaign is proposed for houses within one mile of water bodies to ensure the home is plumbed correctly. This program will accelerate the identification and removal of illicit connections and will ultimately result in improved water quality in the watershed, including a decrease in concentrations of *E. Coli* and other bacteria. This measure will specifically improve water quality and reduce bacteria levels in the watershed.

Public Education (4) – A substantial watershed benefit can be obtained by educating the public on watershed awareness. Examples of educational activities include: informational booths at local fairs, storm drain stenciling, educational programs at local schools, and local media advertisements. In a survey taken at one of the public meetings, 16 out of 18 residents responded that they would change their habits and practices in order to improve overall water quality. The results of the survey are included in the following section. This measure will specifically improve overall water quality in the watershed.

Survey Question #1: Which of the following activities have a member of your household or your neighbor performed during the past year?

Washed vehicle in driveway or street	9/18 (50%)
Applied Fertilizer to lawn or garden	13/18 (72%)
Applied insecticides/pesticides to lawn or garden	10/18 (56%)
Took pet for walks or allowed to roam free	10/18 (56%)
Used paints, varnished, thinners, sealers, etc interior or exterior	13/16 (72%)
Changed oil or other fluid in vehicle/mower	13/18 (72%)
Drained or backwashed swimming pool	2/18 (11%)
Hosed down house, driveway, sidewalk, patio, etc	7/18 (39%)
Watered or irrigated lawn or garden	13/18 (72%)

Survey Question #2: If someone in your household or your neighbors used pesticides or insecticides, how did you dispose of any leftover material?

Used it all up, nothing left	10/18 (56%)
Pour it on the dirt/ground	1/18 (6%)
Store it for future use	6/18 (33%)
Take it to a hazardous waste event/recycle center	2/18 (11%)

Survey Question #3: How do you or your neighbors normally get rid of/dispose of pet waste while on a walk?

Leave it there	5/18 (28%)
Bury it in the ground	2/18 (11%)
Bag it and put it in the trash	4/18 (22%)

Survey Question #4: How do you or your neighbors dispose of your grass clippings?

Don’t bag clippings	11/18 (61%)
Place them in the trash	1/18 (6%)
Take them to Solid Waste District	1/18 (6%)
Dump them in the woods or field	1/18 (6%)
Put them in a compost pile	8/18 (44%)
Mulch	2/18 (11%)

Survey Question #5: How do you or your neighbors dispose of your leaves?

Dump them in the woods or field	4/18 (22%)
Place them in the trash	1/18 (6%)
City picks them up	1/18 (6%)
Don’t rake leaves	3/18 (17%)
Put them in compost pile	7/18 (39%)
Dump them in ditch or lake	1/18 (6%0
Mulch	2/18 (11%)
Burn	3/18 (17%)

Survey Question #6: How do you or your neighbors get rid of / dispose of oil?

Never have any to dispose of	5/18 (28%)
Take it to facility that burns it for heat	2/18 (11%)
Take it to Solid Waste District	7/18 (39%)
Burn	2/18 (11%)

Survey Question #7: Which of the following do you or your neighbors have?

Septic system w/ leach field	17/18 (94%)
Septic system w/ dry well	1/18 (6%)

Survey Question #8: How often is your tank pumped?

Once a year	4/18 (22%)
Every 3 years	9/18 (50%)
Never	3/18 (17%)
Don't Know	1/18 (6%)

Survey Question #9: Do you know the difference between gray water and sewage?

Yes	14/18 (78%)
No	0/18 (0%)
Don't Know	2/18 (11%)

Survey Question #10: Would you switch from household products you now use to different products if you believed overall water quality would be improved?

Yes	16/18 (89%)
No	1/18 (6%)
Don't Know	1/18 (6%)

Survey Question #11: Would you change your habits and practices you now participate in if you believed overall water quality would be improved?

Yes	16/18 (89%)
No	0/18 (0%)
Don't Know	1/18 (6%)

Obtain IDNR Watershed Hydrologic and Hydraulic Models (5) – The Indiana Department of Natural Resources has developed hydrologic and hydraulic planning models for flood flow on Pigeon Creek. Copies of these models should be obtained by Steuben County for use in planning future flood control projects. This measure will specifically be used to plan projects for future reductions in flood potential.

Voluntary Buyout and Structure Elevation (6) – Often the most effective solutions for floodproofing a structure is to remove it from the floodplain, either by demolition or elevation above the expected high water level. Voluntary buyout programs have proven successful across the country at removing frequently damaged homes from the floodplain. However, the homeowners must be willing to sell their property for the program to be successful. Homes are prioritized by susceptibility to flooding; with structures with the highest flood potential being the first to be bought. When homeowners want to stay on their property, elevating the structure above the flood elevation can be a feasible solution depending on the site topography and structure. Both options provide flood solutions one structure at a time, which will require a substantial period of time to remediate every structure in a large watershed. By removing frequently damaged structures from the floodplain, this program has a positive watershed benefit. This measure will specifically reduce damages due to flooding.

Wetland Restoration / Development (7) – Wetlands provide many ecological benefits to the Pigeon Creek Watershed. Properly functioning wetlands treat runoff, collect sediment, and store flood waters, as well as provide habitat for local wildlife. Several sites within Steuben County have been identified for wetland restoration or development, including:

- John Leach Ditch at Commons Park
- Private property on Waymire Road
- CR 275 S
- CR 150 W by railroad tracks
- SR 375 south of West Otter Lake
- Other sites as identified, especially in the Upper Watershed that is 40% hydric soils.

Site BMP Restoration / Retrofitting (8) – Once site developments are completed, erosion control and other BMP measures begin to lose efficiency if they are not maintained. This measure allows for restoration of existing BMP measures that have outlasted their life cycle, as well as the implementation of new BMP measures where none previously existed. This measure will specifically improve water quality, reduce erosion, and promote no increase in flood potential due to continued development.

Flood Access Plan (9) – Stakeholders have stated concerns with flooded road crossings in the watershed, particularly CR 275S, CR 475S, and Fanning Road. Flooded road crossings can be a hazard, both for the general public as well as emergency vehicles. A Flood Access Plan is suggested to review the potential for road crossings within the watershed to be inundated by flood waters. The plan should identify crossings that need improvement to ensure properties are accessible with minimal detour during heavy

rainfall. Remediation of poor performing road crossings should also be performed under this measure. This measure will specifically reduce damages due to flooding.

Upper Watershed
Measures identified for implementation in the Upper Watershed include:

- Kankamp Property (10)
- Bill Deller Road Project (11)
- Sediment Basins (12)
- Rock Vortex Weirs (13)
- Rock Cross Vanes (14)
- Filter Strips (15)
- Monitoring Replacement of CR 150W Culvert (16)

Kankamp Property (10) – In 2001, Tri-State University students developed a preliminary design for a detention facility along Wood Ditch, which connects the Angola WWTP to Pigeon Creek upstream of Long Lake. The study identified a low-lying area north of Mud Lake that can provide storage for approximately 620 acre-feet of flood water with the construction of an embankment along the downstream bank. The proposed facility will also provide additional treatment for the Angola WWTP effluent and local runoff. The project has been under consideration for ten years, and due to the hydrologic and water quality benefits provided is included in this plan. Sediment removal (dredging) of nearby Mud Lake would also provide a stormwater storage benefit to the watershed. The location of this project is shown in Figure 24. This measure will specifically improve water quality and reduce flood potential downstream of the project.

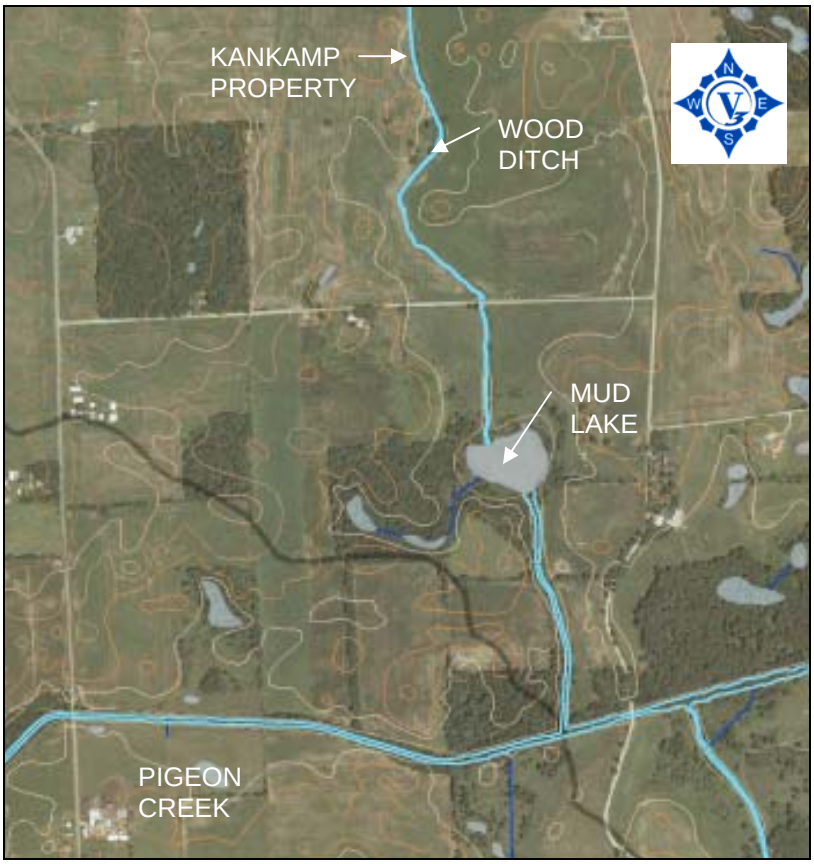

Figure 24: Location of Kankamp Property.

Bill Deller Road Project (11) - The creation of a dam and associated multipurpose water quality, flood storage, recreation, and wildlife facility near the crossing of Bill Deller Road and Pigeon Creek was first mentioned by the SCS in 1967. The proposed facility would provide temporary flood storage for approximately 4.3 inches of runoff for the 48.9 square mile tributary area upstream of the crossing. Perhaps equally as important, the open water facility will also provide a water quality enhancement for the downstream lakes and rivers, as well as a new recreational resource for the watershed. In 1997, the estimated project construction cost with land acquisition was up to $4,600,000.

After the plan was proposed in 1967, the IDNR reviewed the plan and determined that the facility would be ineffective in reducing flood elevations along the watercourse. This is possibly due to the fact that the design sheet for the facility indicates the emergency spillway is set to bypass flow at the 50-year rainfall event. As flood elevations for insurance purposes are set according to the 100-year rainfall event, base flood elevations may not be affected by the proposed facility as detailed in the 1967 plan.

However, the facility also indicates a proposed flood storage capacity of 4.3 inches of runoff. The "Steuben County Ordinance for Storm Drainage and Erosion Control" indicates the rainfall depth for the 100-year, 24-hour rainfall event in Steuben County is 5.03 inches. Using standard engineering practices, the expected runoff volume generated by the tributary agricultural area under 5.03 inches of rainfall should be less than 4.3 inches. In this scenario, the 100-year rainfall event would be contained within the proposed facility, which may in fact provide a benefit for the landowners downstream.

Based on the above inconsistencies, a feasibility analysis should be performed using the IDNR hydrologic and hydraulic models to determine if 1) the original plan will provide a significant reduction in flood elevations using current techniques, and if not, 2) can the original plan be modified to provide a significant reduction in flood elevations downstream along the chain of lakes, and 3) if a smaller version of the original plan can effectively reduce flooding for more frequent events while acknowledging the possibility that flood levels for the 100-yr event may not be reduced (this may be beneficial, as the historical flood stages at Hogback Lake are 6 feet for the 2yr flood, 7 feet for the 10yr flood, and 8.5 feet for the 100 year flood). Each feasible alternative should be extended to include a preliminary construction cost estimate, as well as identification of funding sources for implementation of the project.

The location of this project is shown in Figure 25.

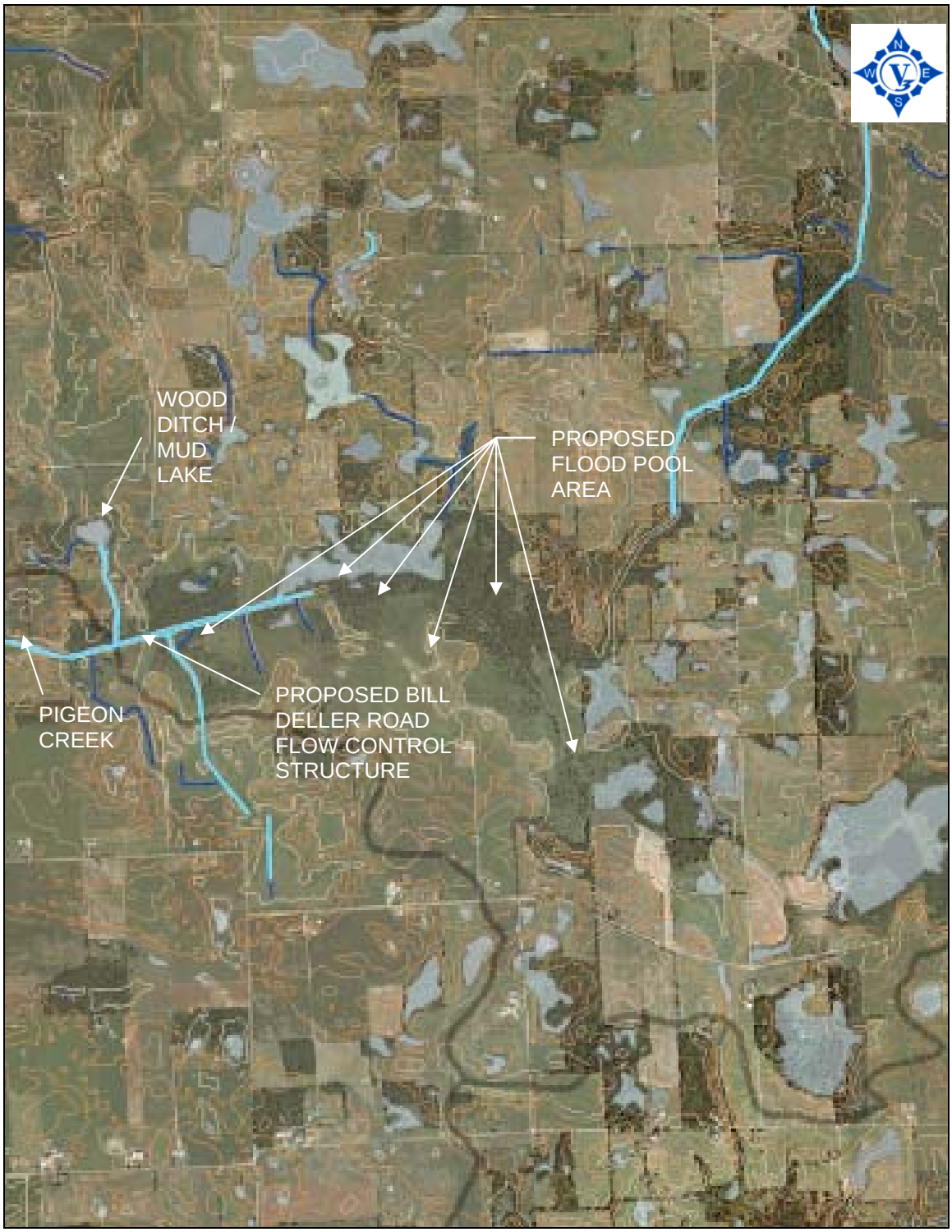

Figure 25: Location of Bill Deller Road Project.

Sediment Basins (12) – Stakeholders have identified sedimentation as a major concern within the watershed. Sediment historically accumulates at various locations in the Upper Watershed and reduces the conveyance capacity of the channel. Proposed improvements consist of the installation of sediment basins at various locations along the channel to collect the sediment before it enters Pigeon Creek. Accessibility for maintaining sediment removal is crucial to the success of selecting these sediment basin locations. For recreational purposes, a boat ramp can be included as part of some sediment basin maintenance access areas. Based on comments received from the stakeholders, the following locations have been identified as potential locations for installation of a sediment basin: Johnson Ditch at Pigeon Creek, Jack Ditch at Pigeon Creek, and Wood Ditch at Pigeon Creek. Locations of potential sediment basins in the Upper Watershed are shown in Figure 26.

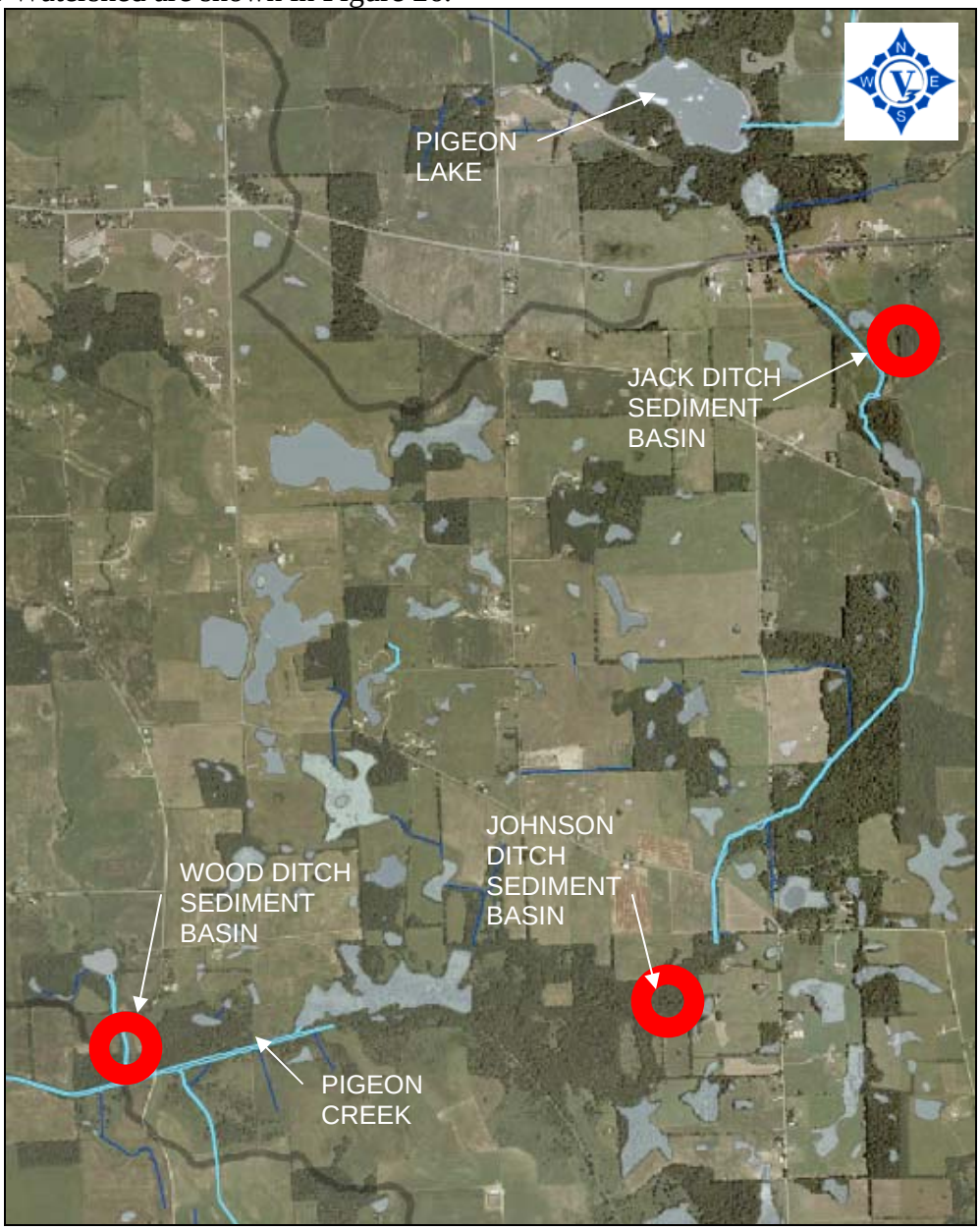

Figure 26: Location of Potential Sediment Basins in the Upper Watershed.

Rock Vortex Weirs (RVW) (13) are in-stream structures designed to provide grade control in smaller streams and create a diversity of flow velocities. An advantage of RVW is that it can accomplish grade control and flow velocity diversity while still maintaining bedload transport and fish passage. The RVW arches upstream with the two arms angling downstream and extending into the streambank up to the bankfull elevation. During baseflow conditions, water flows around and between the weir stones, creating a diversity of flow velocities and depths that allow fish to pass. During higher flows, water rises over the weir stones to form a scour pool below the structure while allowing bed load to pass through. Properly built RVWs should not cause upstream sediment deposition or streambank erosion on the flanks of the weir. As a grade control devise, the RVW can prevent further channel incision, thereby reducing upstream bank erosion (Center for Watershed Protection 2004).

Rock Cross Vanes (RCV) (14) are similar to the RVW but differ in that the rocks barely extend above the stream invert. The RCV consists of a rock sill located perpendicular to the stream flow that is situated at the bottom elevation of the stream channel. The two arms of the sill extend downstream, rising in elevation until they meet the streambank at bankfull height. The low profile of the RCV makes it less vulnerable to scouring and upstream sediment deposition. The RCV is generally used to provide grade control, narrow the baseflow channel and reduce the local bank erosion. RCVs are often located at the top and bottom of meander bends to establish invert elevations for riffle-pool formation (Center for Watershed Protection 2004).

Locations of potential rock vortex weirs and cross vanes in the Upper Watershed are shown in Figure 27.

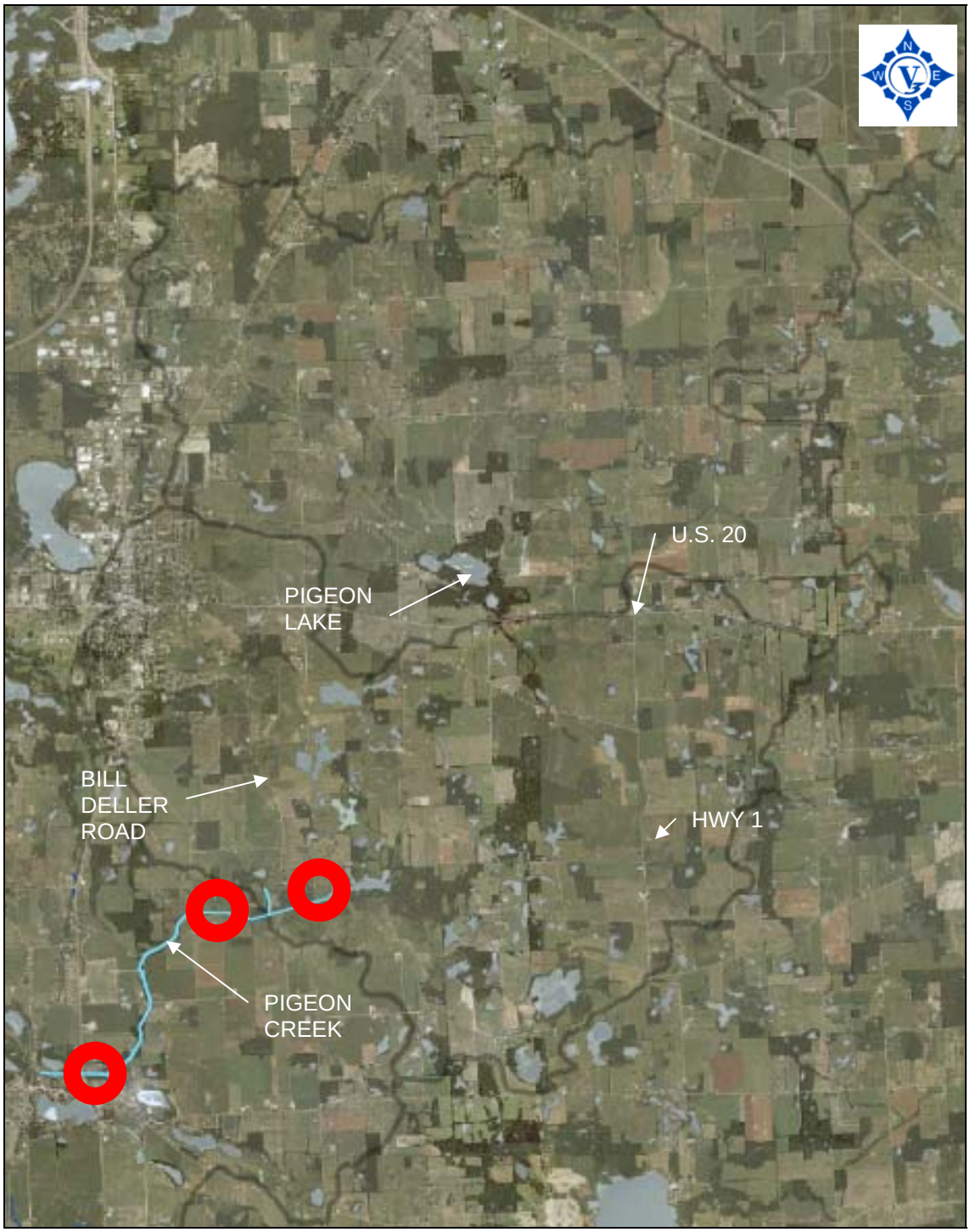

Figure 27: Location of Potential Rock Vortex Weirs and Cross Vanes in the Upper Watershed.

Filter Strips or vegetated buffers (15) are established vigorous vegetative cover that is adjacent to a waterbody (either stream of lake) and provides the following benefits to the watershed: slows the velocity of overland flow, which reduces erosional damage and provides for the deposition of transported sediment; provides an opportunity for binding nutrients in the plant's tissues; prevents streambank and shoreline erosion; and provides wildlife habitat including travel corridors, nesting sites and food sources.

The establishment of dense grasses will provide a sediment trap and will absorb sheet flow from overland flow. The establishment of woody vegetation provides for deeper roots of trees and shrubs which consolidate bank soil and prevent erosion.

Locations of potential filter strips in the Upper Watershed include large areas of unfiltered channel overbanks adjacent to agricultural properties, especially horse farms along Wood Ditch, as shown in Figure 28. The control of sediment transport within the Upper Watershed's agricultural areas will affect improvements throughout the downstream portions of the Lake Chain and Lower Watersheds.

Locations for potential filter strips were identified as part of the windshield and canoe surveys.

Figure 28: Location of Potential Filter Strips in the Upper Watershed.

Monitor CR 150W Culvert Replacement (16) – The culvert crossing CR 150W over Pigeon Creek was constructed in the around 1920. The county is currently working with a consultant to develop plans for replacement of the structure. As of June 2004, the culvert was scheduled to be replaced with a bridge crossing with a large opening. This raises concerns that the flood storage currently held upstream by the existing culvert will be lost when the structure is replaced. The county should ensure that any flood storage currently provided upstream of the existing culvert in maintained in the proposed design to avoid increasing flood damages downstream of the crossing.

The location of this project is shown in Figure 29.

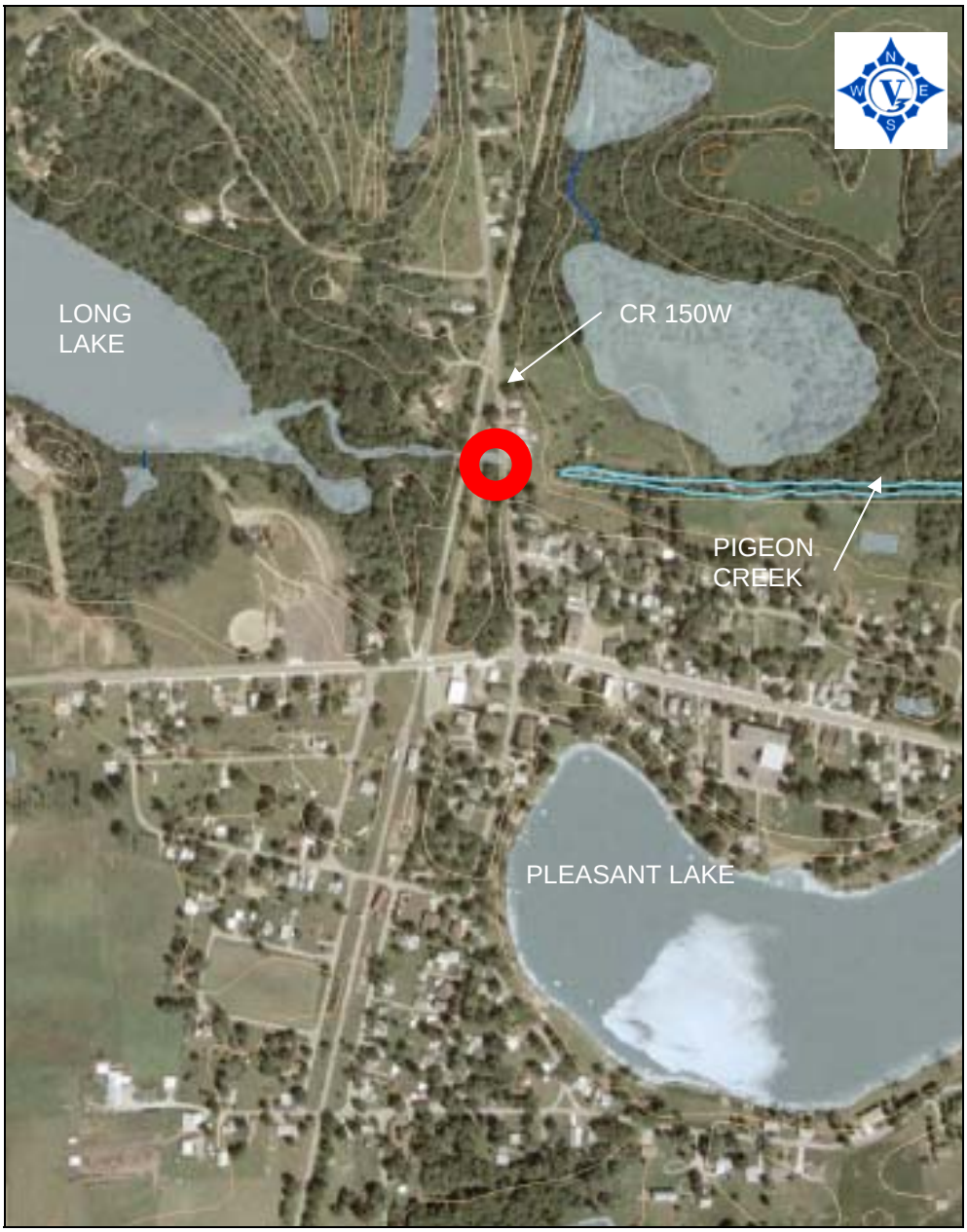

Figure 29: Location of Proposed CR 150W Culvert Replacement.

Lake Chain
Measures identified for implementation in the Lake Chain include:

- Sediment Basins (12)
- Shoreline Stabilization (17)

Sediment Basins (12) – As in the Upper Watershed, sedimentation is also a concern in the Lake Chain. Specifically, sedimentation in the lakes can reduce the water depth, which accordingly degrades both the water quality and recreational function of the lake system. The following locations have been identified as potential locations for installation of a sediment basin with potential associated boat ramp access: inlet to Long Lake, Malone Ditch at Long Lake, between Long Lake and Little Bower Lake, and the inlet to Hogback Lake. There is an existing sandbar at the Long Lake Inlet that may require locating the Long Lake Sediment Basin further upstream. Maintenance of the sediment basin through the removal of accumulated sediments is crucial to the success in selecting these locations.

Locations of potential sediment basins in the Lake Chain are shown in Figure 30.

Figure 30: Location of Potential Sediment Basins in the Lake Chain.

Shoreline Stabilization (17) – Shoreline erosion is a major concern of lake homeowners. The loss of property over time can be extremely costly and may threaten trees or even homes near the water. This measure provides for stabilization or eroding shorelines with vegetative or engineered methods, as dictated by the individual site requirements. Locations identified for shoreline stabilization include:

- Golden Lake Road
- Entrance to Hogback Lake
- Between Long Lake and Little Bower Lake
- Other sites as identified

Locations of potential shoreline stabilization projects in the Lake Chain subwatershed are shown in Figure 31. Stabilization will reduce erosion at the project site.

Figure 31: Location of Potential Shoreline Stabilization in the Lake Chain.

Lower Watershed
Measures identified for implementation in the Lower Watershed include:

- West Otter Lake Pump Station (18)
- Sediment Basins (12)
- Gravel Pits (19)
- Rock Vortex Weirs (13)
- Rock Cross Vanes (14)
- Filter Strips (15)
- Culvert Modifications (20)
- Arrowhead Lake Outlet (21)

West Otter Lake Pump Station (18) – West Otter Lake is located immediately south of U.S. Route 20 near the Steuben / LaGrange County line. The lake drains into Pigeon Creek via a box culvert under the highway. During heavy rainfall events, the water level in Pigeon Creek is higher than the water level of West Otter Lake, which inhibits the ability of the lake to release storm water. As a result, the Steuben County Surveyor's Office has proposed to install a pump station near the lake outlet to pump storm water from the lake to Pigeon Creek during these events.

The location of this project is shown in Figure 32.

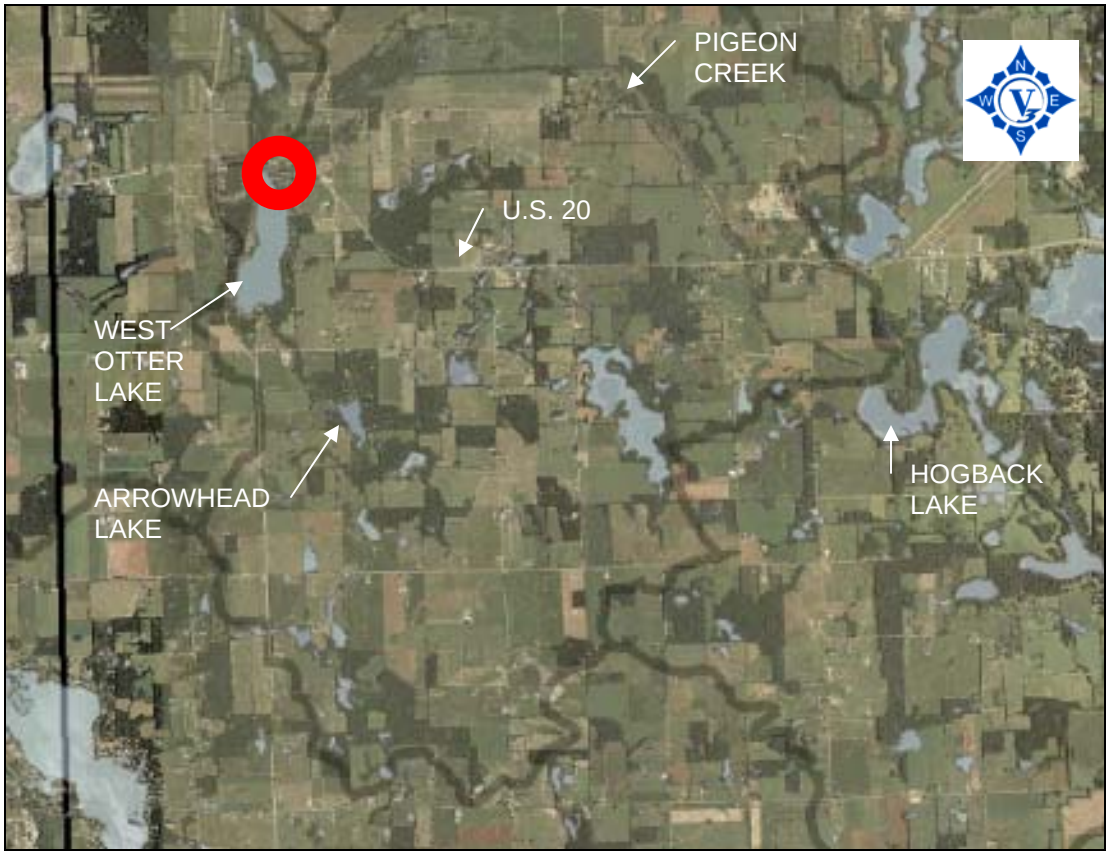

Figure 32: Location of West Otter Lake Pump Station.

Sediment Basins (12) – Sedimentation is also a concern in the Lower Watershed. The inlet to West Otter Lake on Hammond Ditch and the curve before West Otter Lake on Pigeon Creek have been identified as potential locations for the installation of a sediment basin. The ability to access these locations is key to the success of removing the sediment from the basins in order to maintain their functionality.

Locations of potential sediment basins in the Lower Watershed are shown in Figure 33.

Figure 33: Location of Potential Sediment Basins in the Lower Watershed.

Gravel Pits (19) – Closed or abandoned gravel pits offer potential to improve the flood storage and water quality of the Pigeon Creek Watershed. If the gravel pit is dry, an overflow from Pigeon Creek could be constructed to utilize the storage volume of the gravel pit during extreme rainfall events. The stored water could then be removed from the pit by infiltration into the ground or by pumping back into Pigeon Creek. If the gravel pit is filled with water to create a man-made lake, Pigeon Creek could be rerouted through the pit for water quality treatment during periods of low flow. The main channel would be preserved to convey higher stream flows during severe rainfall events.

The locations of gravel pits for potential use are shown in Figure 34.

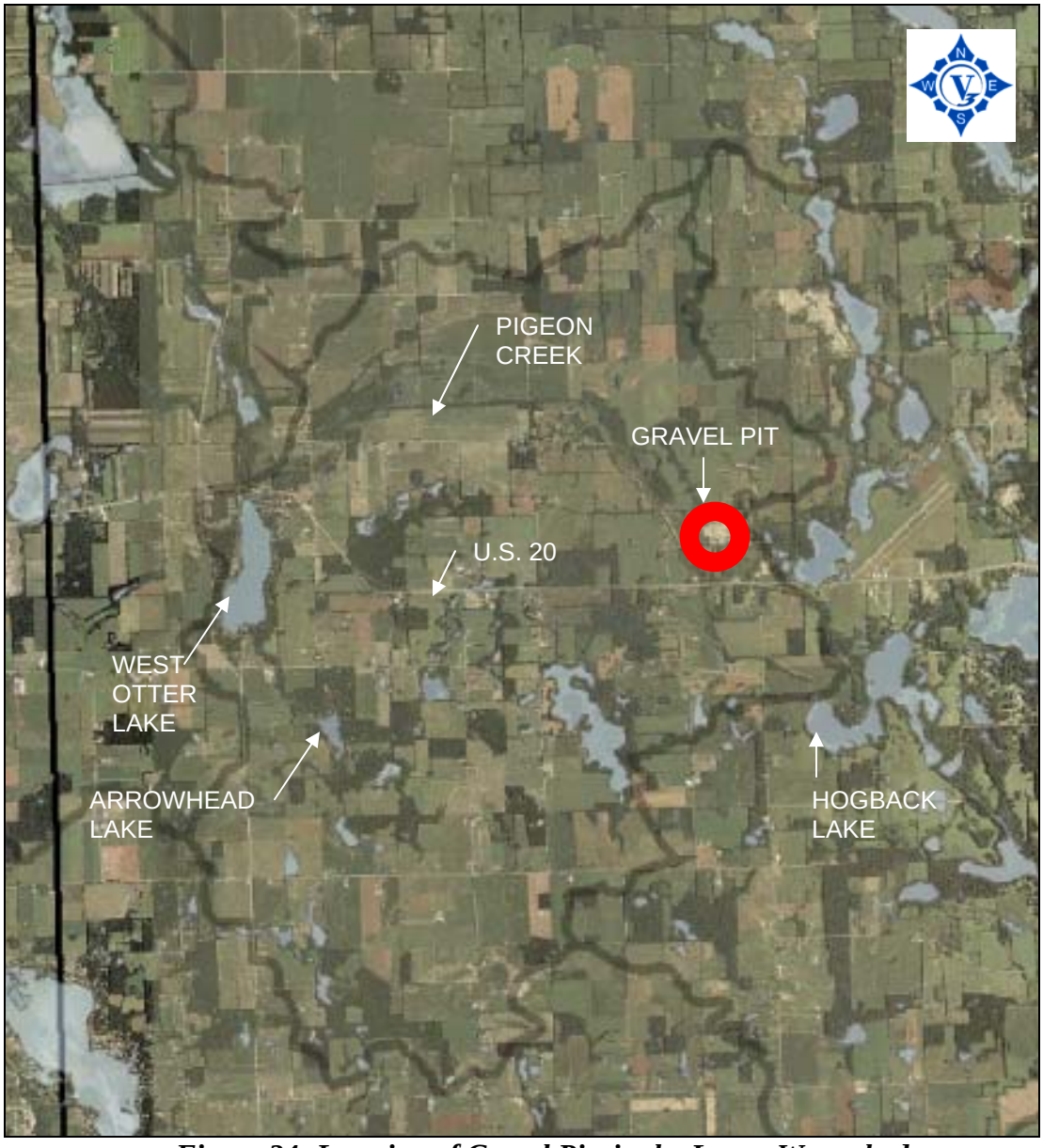

Figure 34: Location of Gravel Pits in the Lower Watershed.

Rock Vortex Weirs (RVW) (13) are in-stream structures designed to provide grade control in smaller streams and create a diversity of flow velocities. An advantage of RVW is that it can accomplish grade control and flow velocity diversity while still maintaining bedload transport and fish passage. The RVW arches upstream with the two arms angling downstream and extending into the streambank up to the bankfull elevation. During baseflow conditions, water flows around and between the weir stones, creating a diversity of flow velocities and depths that allow fish to pass. During higher flows, water rises over the weir stones to form a scour pool below the structure while allowing bed load to pass through. Properly built RVWs should not cause upstream sediment deposition or streambank erosion on the flanks of the weir. As a grade control devise, the RVW can prevent further channel incision, thereby reducing upstream bank erosion (Center for Watershed Protection 2004).

Rock Cross Vanes (RCV) (15) are similar to the RVW but differ in that the rocks barely extend above the stream invert. The RCV consists of a rock sill located perpendicular to the stream flow that is situated at the bottom elevation of the stream channel. The two arms of the sill extend downstream, rising in elevation until they meet the streambank at bankfull height. The low profile of the RCV makes it less vulnerable to scouring and upstream sediment deposition. The RCV is generally used to provide grade control, narrow the baseflow channel and reduce the local bank erosion. RCVs are often located at the top and bottom of meander bends to establish invert elevations for riffle-pool formation (Center for Watershed Protection 2004).

Locations of potential rock vortex weirs and cross vanes in the Lower Watershed are shown in Figure 35.

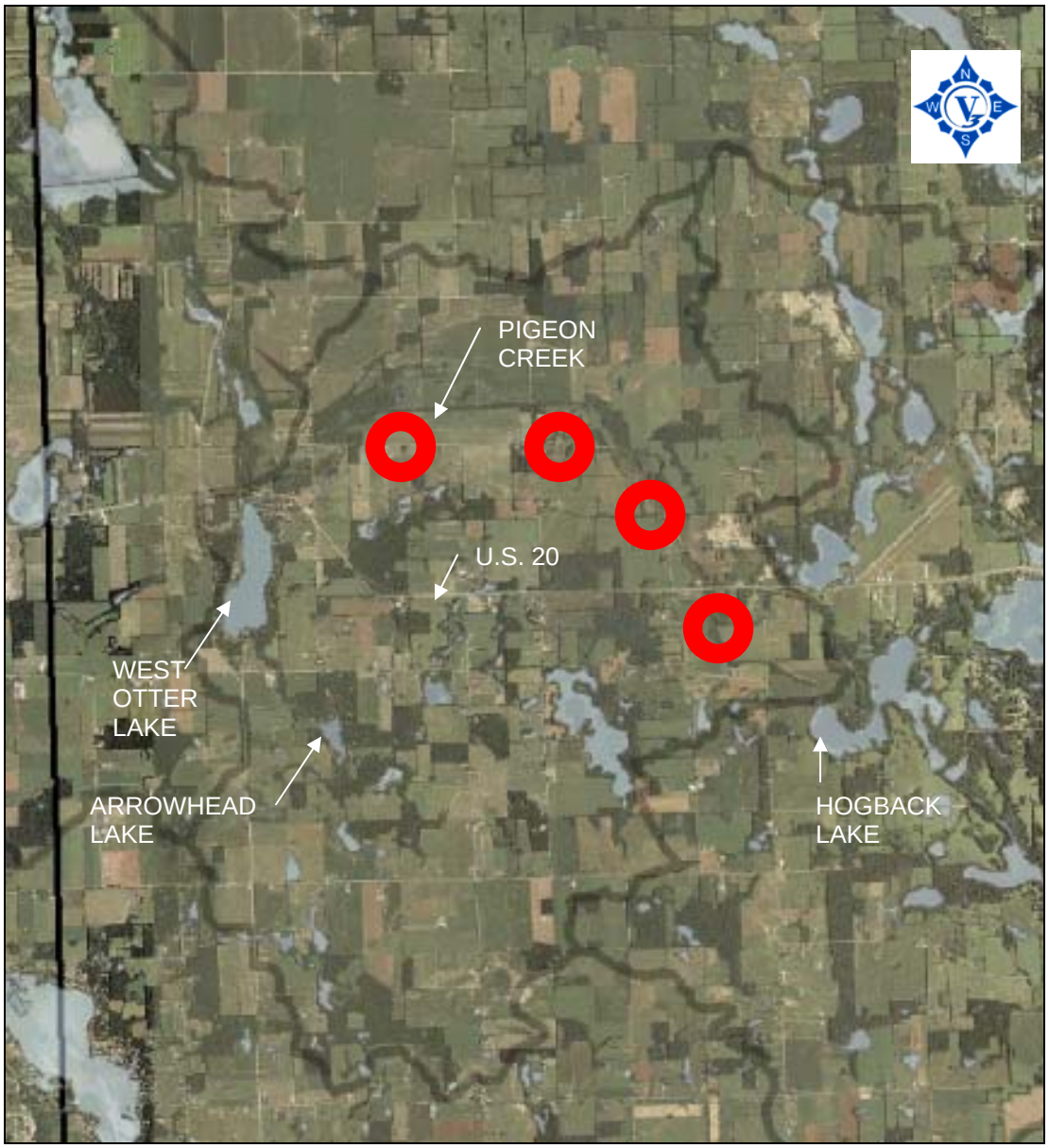

Figure 35: Location of Potential Rock Vortex Weirs and Cross Vanes in the Lower Watershed.

Filter Strips or vegetated buffers (15) are established vigorous vegetative cover that is adjacent to a water body (either stream of lake) and provides the following benefits to the watershed: slows the velocity of overland flow, which reduces erosional damage and provides for the deposition of transported sediment; provides an opportunity for binding nutrients in the plant's tissues; prevents streambank and shoreline erosion; and provides wildlife habitat including travel corridors, nesting sites and food sources.

The establishment of dense grasses will provide a sediment trap and will absorb sheet flow from overland flow. The establishment of woody vegetation provides for deeper roots of trees and shrubs which consolidate bank soil and prevent erosion.

Locations of potential filter strips were identified during windshield and canoe surveys and include large areas of unfiltered channel overbanks adjacent to agricultural properties as shown in Figure 36.

Figure 36: Location of Potential Filter Strips in the Lower Watershed.

Hammond Ditch Culvert Modifications (20) – Areas along Hammond Ditch near 100S and 250S appear to offer additional storage volume for flood water without negatively impacting adjacent properties. Projects would involve constructing a control structure at the inlet to the culvert to backup flood waters to utilize the additional storage area without negatively impacting adjacent property owners. The roadway is elevated high above the channel, so road overtopping is not anticipated.

The location of this project is shown in Figure 37.

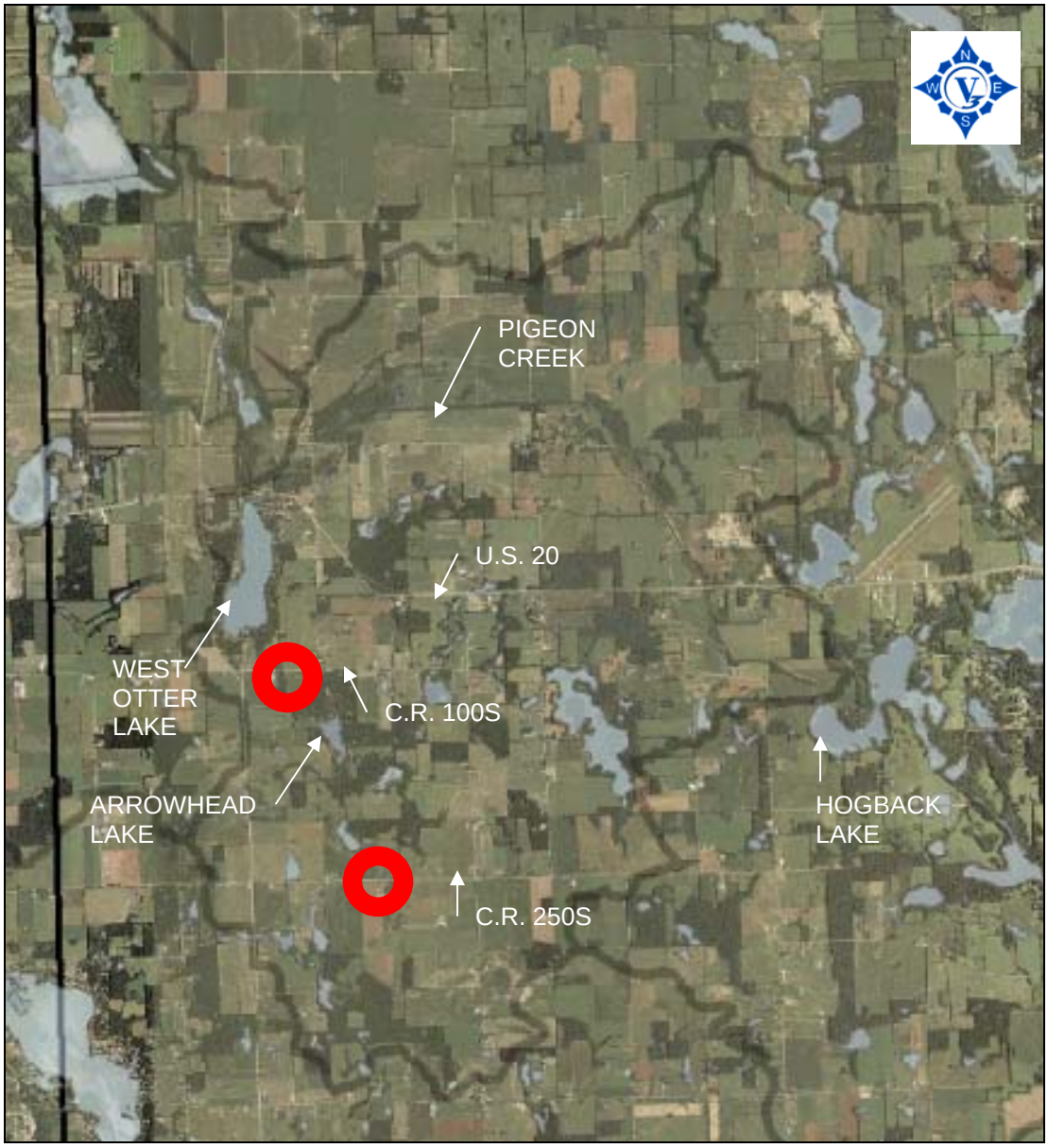

Figure 37: Location of Potential Hammond Ditch Culvert Restriction.

Arrowhead Lake Outlet (21) – West Otter Lake residents have noted a substantial increase in both sediment and flow entering West Otter Lake from Hammond Ditch. The Arrowhead Lake Outlet should be inspected to determine if additional flow control is required.

The location of this project is shown in Figure 38.

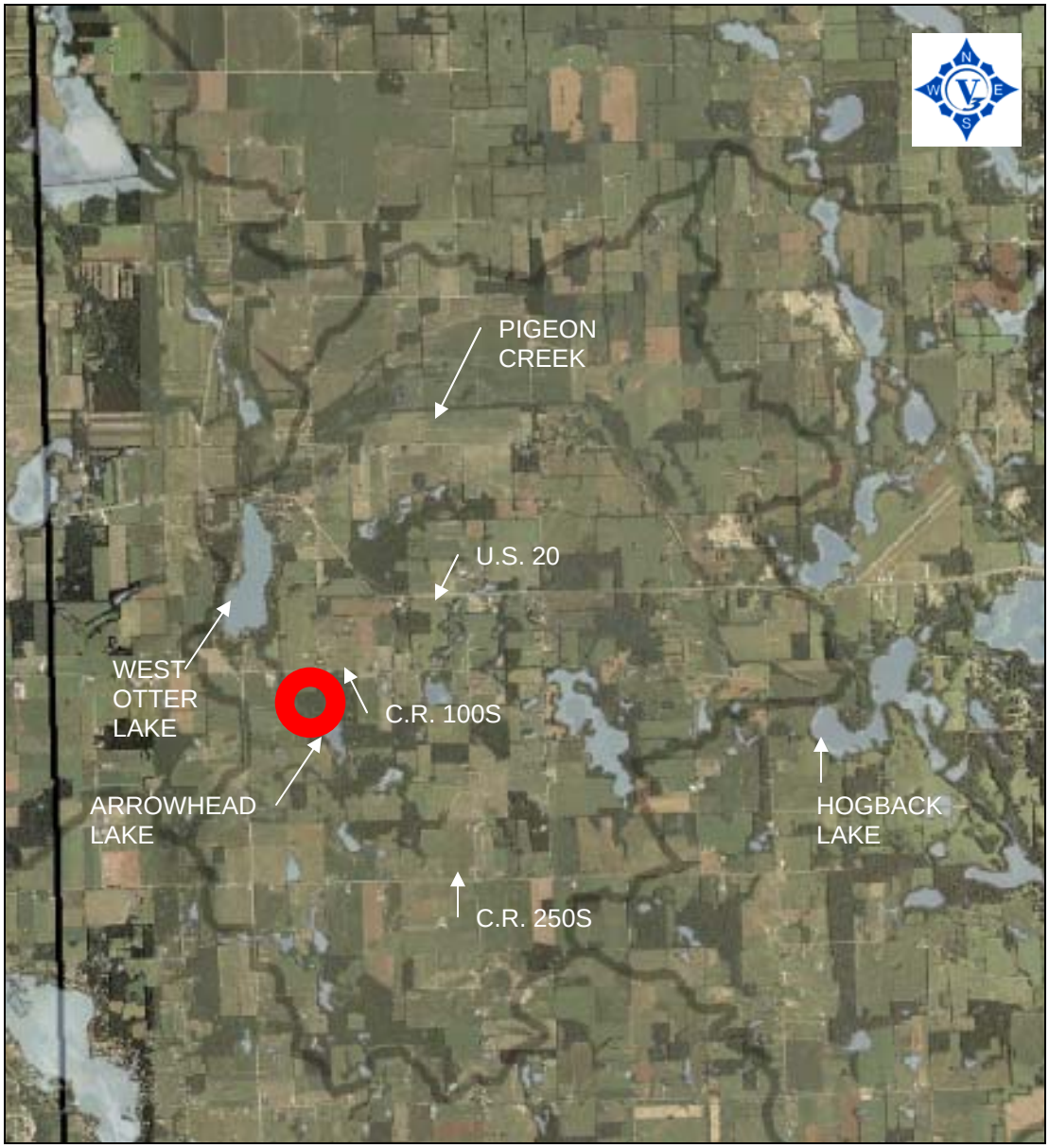

Figure 38: Location of Potential Arrowhead Lake Control Structure.

Summary of Improvement Measures

Table 23 presents a matrix of each improvement measure, along with the measures target area within the watershed, as well as the concern the measures attempts to remediate.

Table 24 presents anticipated level of benefit for each improvement measure.

Table 25 correlates improvement measures to stakeholder concerns and causes.

Measure	Watershed			Benefit
	Upper	Lake Chain	Lower	
Stream Maintenance (1)	x	x	x	Water Quality, Flood Control
Development Code Enforcement (2)	x	x	x	Water Quality, Flood Control, Development Regulation
Removal of Illicit Connections (3)	x	x	x	Water Quality
Public Education (4)	x	x	x	Water Quality
Obtain IDNR Hydrologic and Hydraulic Models (5)	x	x	x	Flood Control Planning
Voluntary Buyout and Structure Elevation (6)	x	x	x	Reduced Flood Damages
Wetland / Habitat Restoration (7)	x	x	x	Water Quality
Site BMP Restoration / Retrofitting (8)	x	x	x	Water Quality
Flood Access Plan (9)	x	x	x	Flood Control
Kankamp Property (10)	x			Water Quality, Flood Control
Bill Deller Road (11)	x	x		Water Quality, Flood Control
Sediment Basins (12)	x	x	x	Water Quality
Rock Vortex Weirs (13)	x		x	Water Quality
Rock Cross Vanes (14)	x		x	Water Quality
Filter Strips (15)	x		x	Water Quality
Monitor CR 150W Culvert Replacement (16)	x	x		Structure at End of Life Cycle, Needs Replacement. Possible Negative Impact if Existing Flood Storage is Lost.
Shoreline Stabilization (17)		x		Water Quality, Erosion Control
West Otter Lake Pump Station (18)			x	Flood Control
Gravel Pits (19)			x	Water Quality, Flood Control
Hammond Ditch Culvert Modifications (20)			x	Flood Control
Arrowhead Lake Outlet (21)			x	Flood Control

Table 23: Summary of Improvement Measures.

Measure	Potential Level of Benefit			
	Water Quality Improvement	Sediment Control	Flood Damage Control	Erosion Control
Stream Maintenance (1)	Maintain	Maintain	Maintain	Maintain
Development Code Enforcement (2)	Maintain	Maintain	Maintain	Maintain
Removal of Illicit Connections (3)	Medium	Low	Low	Low
Public Education (4)	Medium	Low	Low	Low
Obtain IDNR Hydrologic and Hydraulic Models (5)	Low	Low	Planning	Low
Voluntary Buyout and Structure Elevation (6)	Low	Low	Medium	Low
Wetland / Habitat Restoration (7)	Medium	Medium	Low	Low
Site BMP Restoration / Retrofitting (8)	Medium	Medium	Low	Medium
Flood Access Plan (9)	Low	Low	Medium	Low
Kankamp Property (10)	Medium	Medium	Medium	Low
Bill Deller Road (11)	High	High	High	Low
Sediment Basins (12)	Medium	High	Low	Low
Rock Vortex Weirs (13)	Medium	Low	Low	Medium
Rock Cross Vanes (14)	Medium	Low	Low	Medium
Filter Strips (15)	Medium	Low	Low	Low
Monitoring CR 150W Culvert Replacement (16)	Low	Low	Maintain	Low
Shoreline Stabilization (17)	Medium	Low	Low	High
West Otter Lake Pump Station (18)	Low	Low	Medium	Low
Gravel Pits (19)	High	Medium	Medium	Low
Hammond Ditch Culvert Modifications (20)	Low	Medium	Medium	Medium
Arrowhead Lake Outlet (21)	Low	Medium	Medium	Medium

Level of Benefit Definitions:
High = Substantial Potential Benefit
Medium = Some Potential Benefit
Low = Low Potential Benefit
Maintain = Necessary to Maintain Existing Conditions
Planning = Planning Aid, No Direct Benefit. Benefit Obtained Through Follow Up Projects.

Table 24: Summary of Improvement Measures Benefit Potential.

Stakeholder Concern	Land Dev	Lack of Buffers	Lawn Fertilizer Application	Waste Interaction With Runoff	Flooding	Sedimentation	Limited Maintenance Treatment Plant Effluent	Storm Sewer Discharges	Illicit Discharges
Long Lake Water Quality				**4,7,8,11,15**	**8,10,11**	**12,13,14**	**1**	**7,10**		**3**
Water Quality	**2**	**8,15**	**4,15**	**4,7,8, 9,11,15**	**8,11**	**12,13,14,19**	**1**	**7,10**	**8**	**3**
Water Pollution	**SIMILAR TO WATER QUALITY**									
Prevent West Otter Lake Flooding	**2**				**6,8,18,20,21**	**12,13,14,20**				
Unsewered Areas / Non Point Source	**2**				**8**					
Pigeon Creek Dredging					**8**	**12,13,14**				
Flooding	**2**				**5,6,8,9,10, 11,18,20,21**					
Angola Bypass Sewage to Pigeon	**2**				**8,10**			**7,10**		
Bacteria				**4,7,8,15**				**7**	**8**	**3**
Soil Erosion	**2**	**8,15,17**			**8**		**1**			
Less Development	**2**									
Hogback Lk Flooding					**6,8,10,11**	**12**	**1**			
Farm Runoff		**8,15**		**4,7,8,15**						
Drainage – Open Ditch, Highway, Road	**2**				**8,9**		**1**			
Property Values Because of Retention Ponds		**4**	**4**		**8**					

Table 25: Correlation of Improvement Measures and Stakeholder Concerns.

Consequences of No Action

The possibility exists that none of the improvement measures identified in this watershed management plan will be implemented. If this were to occur, water quality and flood control in the watershed would continue to be maintained only through existing programs. As large scale flood control facilities cannot be funded locally, flooding will continue to occur on a yearly basis damaging homes and allowing nutrients and septic overflow to enter the waterways. Water treatment will also be limited to natural treatment provided by the existing waterways plus any small scale projects that can be funded locally. As identified from the number of concerns raised at public meetings for this plan, the existing conditions are not acceptable to the watershed stakeholders.