Pine River-Van Etten Lake Watershed Management Plan

September 2008

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Funding provided by the Michigan Department of Environmental Quality and the U.S. Environmental Protection Agency

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EXECUTIVE SUMMARY

The 187,000-acre Pine River watershed drains into Van Etten Lake, a 1,409-acre reservoir. The upper watershed is plagued by excessive sediment, elevated water temperatures in the "coldwater" streams and unrestricted livestock access to streams. Van Etten Lake experiences annual algae blooms, exotic species invasions, loss of shoreline vegetation and accumulation of sediment. The Pine River-Van Etten Lake (PRVEL) Watershed Coalition was formed in 1999 to address these water quality concerns.

In 2001 Huron Pines Resource Conservation and Development Area Council, Inc. was awarded a Section 319 Nonpoint Source Watershed Planning Grant by the Michigan Department of Environmental Quality to work with the PRVEL Coalition to develop this watershed management plan. In 2006, Huron Pines was again awarded a Section 319 grant to revise the plan to meet the Environmental Protection Agency's standards for watershed management plans.

Discussing Water Quality Study Results

The Pine River-Van Etten Lake watershed management plan was developed with the active participation of a Steering Committee comprised of a diverse group of stakeholders. The Pine River-Van Etten Lake Watershed Steering Committee is a collaborative partnership of over 25 local, state, federal, nonprofit and citizen's organizations. The Steering Committee provided input during meetings on the threats and issues throughout the watershed, reviewed text related to the management plan, and provided input on the goals and objectives for watershed management efforts.

The 2003 Project

In addition to bi-monthly advertised Steering Committee meetings that were open to the public throughout the eighteen month planning grant, the Coalition sponsored a well attended special public meeting in January 2003 to present the results of the water quality study performed by Central Michigan University. The Coalition also sponsored a Public Forum in February 2003 to present a synopsis of the watershed management plan development process and solicit additional public input prior to submitting the completed plan to the Michigan Department of Environmental Quality.

The following questions, comments and responses were documented during the Public Forum:

- Logjams in the Pine River are not allowing sediment to flush out.
  Response: Log jams help reduce the erosive action of stream velocities and act as natural barriers to sediment migration. They also provide critical habitat to aquatic and near shore terrestrial wildlife.

- How much of the Phosphorus (P) loading is attributed to lakefront property owners and how much from upstream sources?
  Response: The data indicate that the outputs for P are greater at the dam than the inputs at the mouth of the Pine River. This indicates that a source of P is coming from around the lake.

More specific information will be available in the Central Michigan University Water Quality Study report when it is completed.

- What effect does the drastic drop of the water level (from dam management) have on the flushing ability of the river?
  Response: In general, the same amount of water will continue to flow from the Pine River into the lake. A drop in lake level would most likely not have a significant impact on the flushing ability of the river.

- Dam manager made comments about precipitation, dam gates, springtime capacity etc.

- How enforceable are the recommendations and what is the protocol for enacting changes?
  Response: Those recommendations that fall within an existing regulatory scheme may be addressed by the respective enforcement agency, however the promotion of information and education is a large component of enacting the watershed restoration activities identified within the plan.

- How will the grant dollars be spent?
  Response: Grant dollars received will be utilized to implement restoration activities such as installing structural and vegetative best management practices at priority road/stream crossing and streambank erosion sites, developing educational materials and providing technical support and information to target audiences and assisting with land protection and various natural resource management objectives within the watershed.

- How well do/will the townships work together?
  Response: The Coalition has found participating townships to be very cooperative and helpful in supporting the development of the watershed management plan and is confident that such efforts will extend within their (the townships) working relationships as well.

- How long would it take to straighten out the watershed if money was no object?
  Response: That's a tough question. The watershed is extremely large and has numerous problems affecting its water quality and use. Some of the watershed goals and objectives timelines range into 15 years for completion of certain tasks. Let's revisit this question at that time and see where we are.

- Sediment load accelerated; will the plan address the load that is currently at the North Bay of Van Etten Lake?
  Response: Being a reservoir, and the discharge point of the Pine River, Van Etten Lake is going to experience sediment loading. As such, the North Bay is receiving the bulk of this sediment. Restoration activities at sites of streambank erosion along the Pine River and its tributaries will reduce future sediment loading to the lake. However there appear to be few options outside of dredging to address the removal of the sediment at the north end of the lake. This issue is somewhat outside the scope of the Coalition and would best be addressed through the Van Etten Lake Association and Oscoda Township.

Since 2003

The PRVEL Coalition continues to hold quarterly meetings that are open to the public. In 2008, the Steering Committee partnership agreement was changed to make those meetings coincide with the Coalition's. The Coalition advertises the meetings in the local newspaper and invites

resource professionals to give presentations on current resource management in the watershed. Recent presentations have included updates on fish passage and dam management, fisheries and stocking, road/stream crossing repairs, and greenbelting and volunteer opportunities.

Members of the PRVEL Coalition also perform regular *E. coli* and macroinvertebrate monitoring. The Coalition was recently granted funding from the MiCorps monitoring program and in 2008 will begin taking the first data for that program with the help of local volunteers and the Oscoda High School science classes.

The Watershed Management Plan

The watershed management plan and planning process bring together a variety of local partners to identify, prioritize and then implement the plan to remediate nonpoint source pollution problems in the watershed. The PRVEL Coalition identified the following six goals for improving and protecting water quality in the Pine River-Van Etten Lake watershed:

1) Improve and protect the coldwater fishery of the Pine River and its tributaries.
2) Ensure that the total/partial body contact designated use for Van Etten Lake is met.
3) Restore Van Etten Creek to levels that will ensure it is removed from the State's non-attainment list.
4) Improve and protect the aquatic habitat within the watershed.
5) Protect critical wildlife habitat areas within the watershed.
6) Sustain the Pine River-Van Etten Lake Watershed Coalition.

Strategies for accomplishing the above goals generally take the form of one or more of the following: implementing structural and vegetative Best Management Practices at problem sites, educating watershed stakeholders and communicating key watershed concepts to the public, improving upon existing land use planning programs, providing technical assistance to property owners to ensure effective stewardship practices are used, working with land conservancies and property owners on voluntary land protection measures, monitoring problems, incorporating design criteria into new developments before problems are created, maintaining a strong watershed partnership and evaluating efforts.

The Pine River-Van Etten Lake Watershed Coalition Partners recognize the need to work both together and independently on the objectives within this plan in order to accomplish a vision that they all share, an improved quality of water resources and thus an improved quality of life.

Chapter One: Getting to Know the Pine River-Van Etten Lake Watershed

I. DESCRIPTION OF THE PINE RIVER-VAN ETTEN LAKE WATERSHED

A. Geography

The Pine River-Van Etten Lake watershed drains approximately 187,000 acres or 292 square miles of land within Alcona and Iosco counties. There are just over 372 river miles of tributary system and more than 10 recreational lakes. This Northeast Michigan watershed encompasses all of the territory just west of Harrisville, with Lincoln and Barton City on the northern reaches, Glennie as the far western edge and Oscoda, in northeastern Iosco County, tying the southeast corner at the last confluence to the Au Sable River. The village of Mikado is near the latitudinal center.

The primary land uses of the Pine River-Van Etten Lake watershed are forestry and farming, followed by rural community and lakeside residential. The area is popular for its premier whitetail deer hunting, miles of snowmobile trails, boating and fishing opportunities, scenic beauty and rural character. Approximately 33% of the watershed lies within the Huron National Forest. The endangered Kirtland's Warbler, as well as the threatened Bald Eagle and Common Loon are residents of this watershed resource.

The East, West and South branches of the Pine River, Van Etten Creek in Alcona County, and numerous tributaries and creeks, converge to form the Main Branch of the Pine, which flows to Van Etten Lake. Van Etten Lake, a 1,409-surface acre reservoir, impounded by Van Etten dam, spills to an outfall stream (also called Van Etten Creek and actually the continuation of the Pine River) at its southern tip. Van Etten Creek (lower) courses to a confluence at the Au Sable River, which then discharges to Lake Huron approximately two miles downstream.

Van Etten Lake is borderline eutrophic and experiences a significant blue-green algae bloom every summer that ranges across the entire impoundment. High phosphorus levels combined with low nitrogen levels create an ideal environment for blue-green algae to flourish. This type of phosphorus to nitrogen ratio is present in Van Etten Lake. Suggested causes for the high nutrient levels include leakage from septic systems, direct sewage discharge and inputs from the Pine River due to historical livestock operations and other agricultural sources. Michigan Department of Environmental Quality biological surveys indicate that Michigan Water Quality Standards are not being met in Van Etten Creek. Once a productive trout stream, it has recently been described as, nothing more than a typical agricultural drainage ditch (Michigan Department of Environmental Quality [MDEQ], 2000). This water body has been placed on the 1998 Clean Water Act Section 303(d) Non-Attainment list.

Additionally, the annual prolific growth of invasive exotic Eurasian Watermilfoil in Van Etten Lake and the lake's recently identified zebra mussel population underscores the need for a broad based resource management approach in restoring this watershed.

Map 1 delineates the Pine River-Van Etten Lake watershed boundary.

B. History of the Region

In 1840 the Michigan Legislature created the Alcona District. Alcona is a Chippewa word that means "a fine plain." Commercial fishing in the Great Lakes was the industry that helped establish Alcona County's first settlement of Springport in 1846. As the fishing fleet grew larger, other ports were built at Harrisville, Alcona, and Black River. In 1857, rye was successfully raised near Springport as the county's first crop.

The site of a grist and saw mill owned by Benjamin Harris, became the county seat known as Harrisville, when in 1869, Alcona County was established. The availability of good ports and ships accommodated an expanding lumber industry within the county. Logging operations as far west as Curran cut through the county's forests and opened up the area for farming (Alcona Conservation District, 2001).

Today, Alcona County attracts many tourists to its beautiful woods and beaches. Harrisville State Park, located on the shores of Lake Huron, hosts over 170,000 visitors a year.

Within Iosco County, Louis Chevalier was one of the first French fur traders to explore the region, when just prior to 1800, he entered the mouth of the Au Sable River. Ottawa and Algonquin Indians were the native tribes inhabiting the area at that time.

In 1857 the Michigan Legislature created Kahnotin County. It was named after an Indian word meaning "in the path of the big wind." However Henry Schoolcraft renamed it "Iosco" to mean "Water of Light." The first settlement in Iosco County was Au Sable, established in 1848. Tawas City followed in 1855.

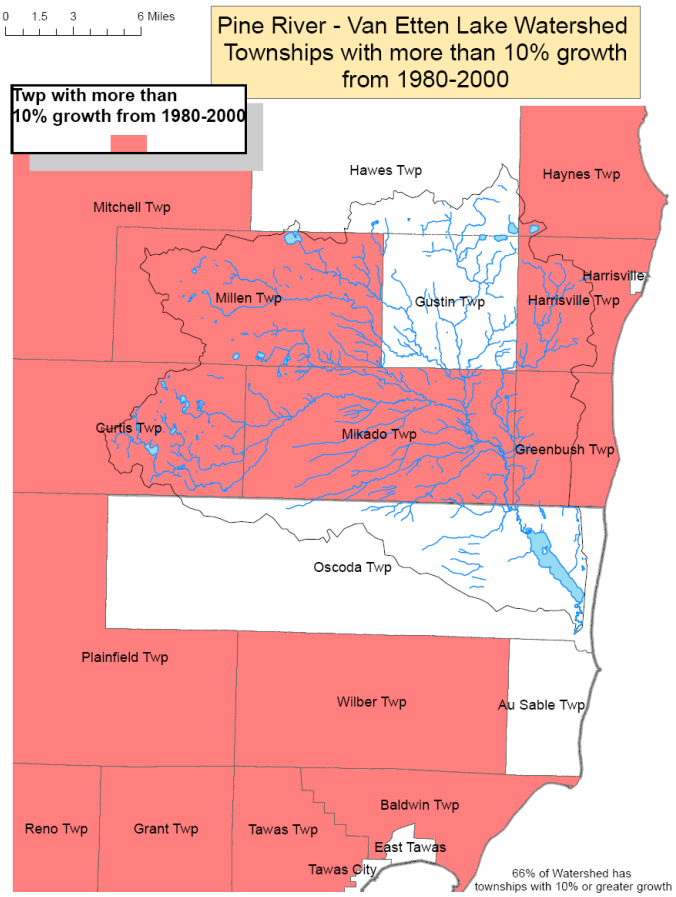
In 1840 gypsum was discovered along the shores of Lake Huron in the southern part of the county. In 1862 quarries began to be mined and by 1891, the progenitor of the present United States Gypsum Company began operations.

As in most northern Michigan communities, the lumbering era, which started in the mid 1860's, contributed to the development of Iosco County. The era effectively ended in 1911 when much of Au Sable and Oscoda burned to the ground.

An Army Air Field, Camp Skeel, was constructed in 1925 outside of Oscoda. The base was used during World War II and in 1953 became the Strategic Air Command's, Wurtsmith Air Force Base (Iosco Conservation District, 2001). The Department of Defense closed the base in 1992, which resulted in a significant loss of population and economic infrastructure to the area.

C. Demographics

Predominately rural, Alcona County has a total population of 11,719, and a median household income of $31,362 per year. Alcona County's population has grown by 15.5% over the last 10 years. Approximately 48% of the housing units in Alcona County are for seasonal use. Approximately 85% of the Pine River-Van Etten Lake watershed is within Alcona County, covering about 36% of the county (US Census Bureau, 2002).



Map 2.

Iosco County has 27,339 residents and a median household income of $31,321. Basically rural as well, there are however, two major urban centers within Iosco County: the Tawas area and Oscoda. Thirty-three percent of the housing units in the county are seasonal, and six of the townships that form the watershed have experienced more than 10% growth since 1980 (Map 2). Oscoda is the location of the former Wurtsmith Air Force Base, which borders the western shore of Van Etten Lake. The 9.5% reduction in population for Iosco County over the last 10 years is attributable to the Base's closure in 1992 (US Census Bureau, 2002).

D. Local Land Use Zoning and Planning

1. In General

Watershed management requires the use of many different tools to be effective. Educational outreach programs, voluntary land protection incentives for property owners of critical habitat areas and on-the-ground implementation of Best Management Practices to restore nonpoint source pollution sites are important. Research, monitoring and incorporating conservation-friendly design standards into new developments also contribute to effective watershed management. Land use planning, zoning and enforcement at the local level, are also important tools for watershed protection. In addition to the direct benefits for aquatic resources, planning and zoning are tools used for ensuring the conservation of wildlife habitat, providing for sustainable development, protecting property values and maintaining community character.

Effective planning and zoning takes commitment and resources. A sound planning and zoning program requires that a community not only "buy in" to the idea, but dedicate the trained personnel and funding to make the program work. For rural townships, this level of commitment can be a very large burden. The result is a limited planning and zoning program, which often leads to strong criticism and diminished commitment from the local community. The oft-repeated sentiment that, "zoning doesn't work here," is commonly expressed in rural northern Michigan, but the reasoning behind it places the blame on a program that has no chance to work—not because of the program itself, but because of how it is implemented.

Once a community makes the commitment to adopt a planning and zoning program (either by dedicating the staff and funds themselves or by working with other townships or at the county level), there is a systematic process used to implement the program. Public input, along with an inventory of community resources, is used to generate a master plan. Within that plan, there are standards that are reasonable yet adequate for protecting what the community feels is important, as well as protecting individual, private property.

A watershed management program is a means of protecting individual property rights. The rights of individual property owners are often seen as a roadblock to a community land use planning and zoning program. This is unfortunate, as this program is actually a method for protecting rights. A land use planning program must be based on input from private property owners, who ultimately derive a benefit from the program. For example, lack of a zoning standard for requiring a buffer zone of vegetation along a waterway can lead to excessive clearing of vegetation along a streambank, which often leads to severe erosion at a particular site, negatively impacting properties downstream by increasing sedimentation, turbidity, increasing the nutrient load and possibly contributing to widening and warming of the stream. All of these problems are found in the Pine River-Van Etten Lake watershed. Thus zoning can work not only as a regulatory tool, but also as an approach for educating landowners before they take actions that (albeit unintentionally) harm the rights of other property owners.

Following adoption of a master plan, the local unit of government creates a zoning ordinance. The zoning ordinance must be based on the goals set forth in the master plan. Assuming both of these documents are written well and made readily available to the public, the community is now on the right track. However, even once local government units have "good" land use policies in place, there is still work that needs to be done—the governing body must keep their policies up-to-date and make decisions regarding infrastructure and zoning in accordance with their plan.

Often, volunteers on local zoning boards are pressured to make a decision on a site-specific issue without considering the whole system. Zoning standards and decisions must be made with the comprehensive master plan in mind; it can be extremely difficult to step back from a particular issue and consider the big picture, but that is exactly what trained planning commission officials must do. In addition, zoning regulations need to be enforced and followed up. Without enforcement, the majority that make the effort to follow land use regulations are, in effect, penalized, as they have gone to greater effort and expense than those not following regulations. Such systems will eventually break down for local units of government—either most everyone will eventually give up on trying to follow the rules or the court system will not hold up the regulations.

In the state of Michigan, planning and zoning are implemented at the township, municipal, or county level. The enabling legislation for land use planning for cities and villages, townships, and counties was consolidated from four acts into two:

Public Act 33 of 2008—Michigan Planning Enabling Act
Public Act 281 of 1945—Regional Planning Act

The state previously had three legislative zoning acts that enabled local units of government to control land uses through regulation of activities on the land. These acts (covering cities and villages, townships, and counties) were consolidated into one overarching act in 2006:

Public Act 110 of 2006—Michigan Zoning Enabling Act
(amended by Public Act 12 of 2008)

In addition to planning and zoning, there are state regulations that are intended to help conserve natural resources. Relevant state laws for water resource protection include (this is only a brief summary, please see the respective law or contact MDEQ for more information):

Act 451, Part 91—Soil Erosion Control and Sedimentation Act
(for earth changes within 500 feet of the shoreline)

Act 451, Part 303—Wetland Protection
(covers the dredging, draining, or filling of regulated wetlands; however, non-contiguous wetlands in rural counties are generally not regulated wetlands)

Act 451, Part 301—Inland Lakes & Streams Act
(covers almost all work done below the ordinary high water mark)

Public Act 368 (1978)—Aquatic Nuisance Control

This following review of local land use regulations is not intended to evaluate the history of planning and zoning within the watershed, nor to be the sole basis for determining the effectiveness of policies regarding water resource management. It may provide insight into how effective local unit of government are at protecting aquatic resources and help to identify some of the glaring weaknesses within current zoning ordinances.

For some of the issues related to watershed management, agencies beyond the local unit of government have a regulatory role. In the case of soil erosion and sedimentation, the Michigan Department of Environmental Quality (MDEQ) has jurisdiction, but they have an agreement with counties to enforce the program at the local level (thus every county has a soil erosion officer). For wetlands, MDEQ also has jurisdiction. Questions regarding wetlands and the permitting process should be sent to MDEQ's Geological and Land Management Division (their field office for Alcona County is in Gaylord). Regulations for septic systems are handled through the District Health Department. In all three of the areas listed above, a local community may adopt their own policies that are equal to or more stringent than the standards already in place. Such a decision may lead to more work for the local unit of government and a greater expenditure of fiscal resources; it may also create an opportunity to better achieve the goals laid out in the master plan.

2. Analysis of Local Planning and Zoning Efforts

Townships located in a county with zoning have the option of having the county handle the entire planning and zoning program or administering their own. (In rare cases, neither a county nor township may have a zoning ordinance, these areas are considered "unzoned"). Alcona, County produced a master plan in 1978. However, the County Planning Commission was later dissolved and no county zoning ordinance was adopted. Townships within the PRVEL watershed are thus responsible for their own program and receive no service from the county in this regard. Below in Table 1.1 is a list of townships within the PRVEL watershed and the adoption date of their master plans and zoning ordinances. (In those instances where major revisions appear to have been made by the township, the "revised" plan/ordinance date is used, rather than the

"adopted" date.) One township in the PRVEL watershed, Oscoda, is not located within Alcona County. Like all of the other PRVEL townships, Oscoda has their own planning and zoning program.

Table 1.1: Planning and Zoning Jurisdictional Units within the PRVEL Watershed

Township/Village	**Zoning Ordinance** Last Date of Revision or Adoption	**Comprehensive Master Plan** Last Date of Revision or Adoption
Village of Lincoln	1996	No MP on file at County Building
Curtis Township	2001	2007
Greenbush Township	1997	2008
Harrisville Township	1995	2008
Hawes Township	2008	No MP on file at County Building
Haynes Township	1972	No MP on file at County Building
Mikado Township	2007	2002
Millen Township	2008	2006
Gustin	Proposed changes 2008	1982
Oscoda Township	Proposed changes 2008	2002

To determine, in part, the efficacy of regulatory coverage for aquatic resources within the PRVEL watershed, local zoning ordinances were reviewed to evaluate what, if any, "environmental provisions" were in place. The ordinances were specifically reviewed for the following:

- *Vegetative Buffer Zones* (Greenbelts): With regard to minimizing the impact of residential development along the waterfront, ensuring that vegetation is left along the shoreline is generally the most important action that can be taken. Vegetative buffers help to filter nutrients, reduce erosion, and provide natural habitat. Much research has been done through the years to determine the effectiveness of different types of buffers (e.g., greenbelts 100 feet wide have been found to reduce nitrates and sediment from runoff by more than 90%). Difficulties with having a "greenbelt ordinance" are that it can be hard to enforce, many local officials and residents are unaware of what an effective greenbelt consists of, historic patterns of development have already degraded many areas (and these may be "grandfathered" in), zoning language is often poorly worded for proper enforcement, and citizens are often unaware that there is an ordinance in place. Even with the negatives, however, maintaining a greenbelt is essential to protecting water resources – even a 25 foot greenbelt can be effective. A mowed lawn to the water's edge is not a greenbelt.

- *Setbacks of structures* along the waterfront are important reducing the amount of impervious surface near the water, helping to ensure that a greenbelt can be maintained, and reducing the potential for serious resource problems. A structure that is setback only 30 or 40 feet is more likely to be associated with negative impacts to water resources than a structure 75 or 100 feet away from the water's edge. Unfortunately, many local units of government that do have an effective setback for homes will make many exceptions for large decks and boathouses. Such exemptions defeat the intent of the setback, as impervious surface cover will still be present near the water's edge. Furthermore, while many local units of government may have a greenbelt requirement of 50 or 75 feet width, they allow the structure setback to be less

than the greenbelt restriction. Such a scenario significantly reduces the effectiveness of the greenbelt requirement. In addition, during the construction period, a structure being built less than 50 feet from the water will have a construction site that runs right down to the water. This leads to the unavoidable problem of the destruction of the greenbelt during construction. Maintaining the natural greenbelt in the first place is much easier than restoring a greenbelt. Setback requirements should be regarded as a key element for water resource protection.

- *Minimum Lot Width for waterfront parcels* is important for waterbodies because it ultimately determines the number of homes that will be built on the water. Developed shorelines with less than a 100-ft minimum lot width often experience water resource problems. Generally, the smaller the lot width around a lake, the more homes, the more septic systems, user conflicts, fertilizer use, degraded shorelines, and the more that impervious cover all contribute to reducing surface water quality.

- *Open space preservation* is used for communities to protect their rural character, as well as maintain prime recreational, farm or forestland. Unfortunately, most zoning ordinances, if implemented correctly, are not written in such a way to accomplish those goals. Many local units of government that have open space guidelines in this watershed typically state something to the effect of, "At least 40% of the total gross project shall be left as open space." Some only require 25%, which is not a way to accomplish their community goals.

  An improvement to the open space section of their ordinances would be to require the developer to increase the amount of open space to 50 or 60% and also make sure that some of the set aside acreage is from the developable portion of the site. Steep slopes, surface water, wetlands, etc., should be excluded from this calculation; otherwise only the most undesirable areas will be set aside as open space. Ordinance language should be something such as, "A minimum of 60% of the parent parcel's gross acreage shall be set aside as permanently protected open space. This area shall include at least half of the parcel's buildable land area."

  In 2001, the State of Michigan amended the county, city, village and township zoning acts to require all qualified communities to amend their zoning ordinances, to provide the "open space/cluster development" option by December 16, 2002. Qualified communities are those with a zoning ordinance in place, 1,800 or more people, and currently have undeveloped land (zoned for residential use) at a density of two dwelling units per acre or less.

  In addition to open space protection zoning, there are incentive programs that local communities can adopt to encourage open space preservation, such as allowing higher development densities on the remaining land in a development or through setting up a Purchase of Development Rights (PDR) program. At the time of this report, no townships in the Pine River-Van Etten Lake watershed had taken this course of action.

- *Septic Systems* are under the jurisdiction of the District Health Department. Typically, only severe problems are addressed, departments are understaffed, and there are poor records of septic systems. Some local units of government have begun to initiate their own programs for inspections, maintenance, or replacement requirements. Generally, such a program is being run as a "Point of Sale" program, whereby inspections of septic systems are required at the time of property transfer. System upgrades are then required for those that are not working properly.

- *Wetland Protection* is handled through the state Department of Environmental Quality. For rural northern Michigan, the law does not cover isolated wetlands. Some communities have addressed this oversight by adopting their own wetland regulatory program, which is authorized through the state wetland act. In the table below, only those ordinances that have standards *in addition to those at the state level* are noted.

- *Stormwater Management* is recognized as critical for keeping oils, greases, organic debris, and trash from running directly into a waterbody. While stormwater control measures are often taken during construction, the post-construction runoff of stormwater is a problem that is often overlooked. Proper management would require that new developments handle their own stormwater on-site (or at least do not increase the amount of runoff that would otherwise occur at the undeveloped site), rather than get the stormwater off their site as quickly as possible (which has been the historic engineering practice).

- *Lot Coverage/Impervious Cover* is, on a watershed-wide level, an important indicator for overall watershed health. (Studies have been conducted that show water quality declines once 10% of the land area in a watershed is covered by impervious surfaces and that serious problems occur once more than 25% of the land area is covered.) Communities that recognize this fact sometimes attempt to address this problem on a parcel by parcel level by placing a maximum on the amount of land that can be covered by impervious cover. While well intended, these standards typically state that the buildings can only occupy a certain percentage of land, but fail to address roads, driveways, decks, patios, and walkways, which are all a part of the impervious cover issue.

Table 1.2 on the following page is a summary of environmental provisions by local government units.

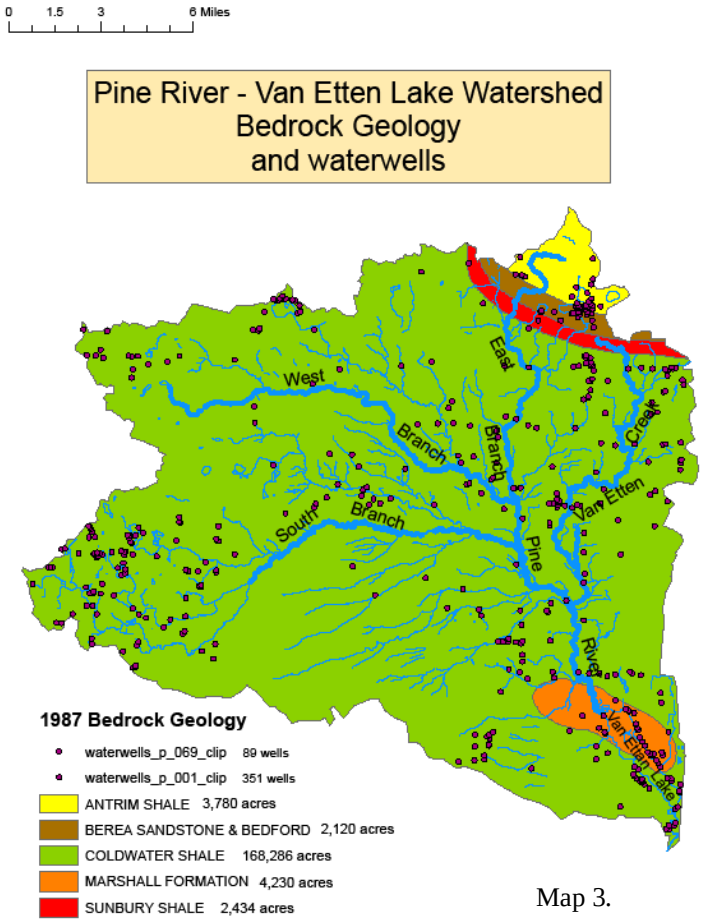
Table 1.2: Summary of (Aquatic Resource-Related) Local Zoning Regulations within the PRVEL Watershed

Type:	Local Government Unit									
	Curtis Township	Greenbush Township	Harrisville Township	Hawes Township	Haynes Township	Mikado Township	Millen Township	Gustin Township	Village of Lincoln	Oscoda Township
Vegetative Buffer Zones (greenbelts)	No	No	Yes (20 ft), but only within the shoreline protection district	No	No	Yes (70% of shoreline)	45 ft	No	No	50 ft from water's edge
Waterfront Setbacks for Structures	25 ft (50 for industrial)	25 ft	60 ft (ag district)	40 ft	40 ft (for R-1 Zone)	75 ft for buildings, 25 for patios	75 ft	40 ft	25 ft	25ft for R-3
Minimum Lot Width for Riparian Parcels	90 ft FRR 90 ft R-1 110 ft R-2	100 ft	330 ft (ag district)	80 ft (Res Zone) 200ft(Forest Rec Zone)	80ft (for R-1 Zone)	Only denotes min lot size; 15,000 sq ft for R-1	100 ft	100 ft	65 ft	50ft for R-3
Open Space	No	No	Yes, in PUD section of ordinance: 40% requirement	No	No	No	No	No	No	Yes, township currently amending this section
Septic Systems	No	No	No	No	No	No	No	No	No	No
Wetland Protection	No	No	No	No	No	No	No	No	No	No
Stormwater Management	Yes, some language under site plan review section	No	No	No	No	No	No	No	No	Yes
Maximum % of Lot Coverage (Impervious Cover)	No	35% Max for riparian lots	Yes, (30%) only for shoreline protection district	No	No	No	30%	No	25% Max lot coverage by building area	35% max lot coverage by principle and accessory buildings

E. Bedrock and Glacial History

The underlying bedrock of the Pine River-Van Etten Lake watershed is from the Mississippian Period of the Paleozoic Era, about 310 to 345 million years ago. At this time, a large inland sea was advancing and receding periodically over the state, leaving deposits of sandstone, limestone, shale and gypsum. Shales like the Coldwater Shale that makes up the majority of the bedrock in this watershed are important for use in the manufacture of brick, tile, and cement.

Of 440 wells in the watershed ranging from 19 to 255 feet deep (85% are 40 feet or deeper), none hit bedrock. This means that the Mississippian bedrock was covered by deposits of sand and gravel as the last glaciers receded about 9,000 years ago.



Map 3.

F. Climate, Topography and Soils Associations

Situated in northern Michigan, the Pine River-Van Etten Lake watershed is at the northern end of the Saginaw Bay lake plain. The growing season is approximately 133 days, shorter than the Saginaw area to the south but longer than the elevated Grayling area to the west. The summers are hot, while the winters are very cold with an average extreme minimum of -26ºC (Albert, 1986). The watershed topography is relatively level, with rolling hills and a few steep areas near the Pine River. There are 15 soils associations within the watershed, each associated with one of eight different glacial landforms that determine the overall topography. The following information has been excerpted from the Soil Survey of Alcona County, Michigan (USDA Natural Resources Conservation Service, 1998) and the Soil Survey of Iosco County, Michigan (USDA Natural Resources Conservation Service, 2002):

Nearly Level and Gently Undulating Soils That Are Very Poorly Drained and Somewhat Poorly Drained

Au Gres-Wakely-Tawas association

Deep, nearly level and gently undulating, somewhat poorly drained and very poorly drained, sandy and mucky soils that formed in sandy material or in organic material underlain by sandy or sandy and clayey material; on lake terraces.

Lupton-Tawas-Leafriver association

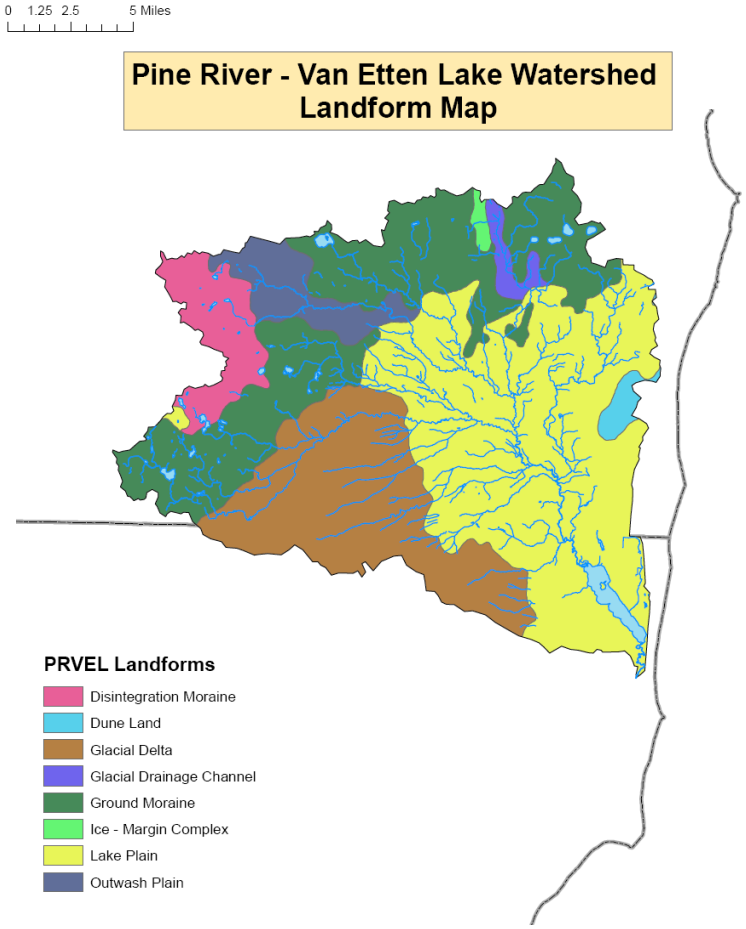
Nearly level, very poorly drained, mucky soils that formed in organic material or organic material and sandy material; on lake plains and outwash plains.

Algonquin-Negwegon-Springport association
Nearly level and undulating moderately well drained to poorly drained, loamy soils that formed in loamy and clayey sediments; on lake plains.

Nearly Level to Rolling Soils That Are Well Drained to Poorly Drained
McGinn-Hoist-Klacking association
Nearly level to rolling, moderately well drained and well drained, sandy and loamy soils that formed in sandy and loamy material; on ground moraines.

Bamfield-Nester-Glossic Eutroboralfs association
Nearly level to gently rolling, moderately well drained and well drained, loamy soils that formed in loamy material; on ground moraines.

Glennie-Sprinkler association
Nearly level to gently rolling, moderately well drained and somewhat poorly drained, loamy soils that formed in sandy and loamy material; on ground moraines.



Map 4. The many different soil types in the watershed occur on eight major landform types.

Nearly Level to Hilly Soils That Are Excessively Drained to Well Drained
Grayling-Graycalm-Typic Udipsamments association
Nearly level and undulating, excessively drained and somewhat excessively drained, sandy soils that formed in sandy material; on deltas, outwash plains, and stream terraces.

Klacking-Graycalm-Grayling association
Gently rolling hilly, excessively drained to well drained, sandy soils that formed in sandy material or sandy material underlain by loamy material; on moraines and outwash plains.

Nearly Level to Very Steep Soils That Are Very Poorly Drained, Moderately Well Drained, Well Drained, and Excessively Drained
Glennie-Bamfield-Lupton association
Nearly level to very steep, very poorly drained and well drained, mucky and loamy soils that formed in sandy and loamy material and organic material; on disintegration moraines and ground moraines.

Klacking-McGinn association
Moderately sloping to very steep, well drained, sandy soils that formed in sandy and loamy material; on dissected moraines.

Zimmerman-Alcona association
Gently rolling to very steep, moderately well drained to excessively drained, sandy soils that formed in stratified sandy and loamy material; on moraines.

Soils on Wave-Built Terraces, Beach Ridges, and Dunes
Au Gres-Tawas-Wurtsmith association
Nearly level and undulating, somewhat poorly drained, very poorly drained, and moderately well drained, sandy and mucky soils on wave-built terraces and beach ridges.

Deer Park-Meehan-Wurtsmith association
Nearly level to rolling, excessively drained, somewhat poorly drained, and moderately well drained, sandy soils on wave-built terraces, beach ridges, and dunes.

Deford-Tawas-Lupton association
Nearly level, very poorly drained, sandy and mucky soils on wave built terraces.

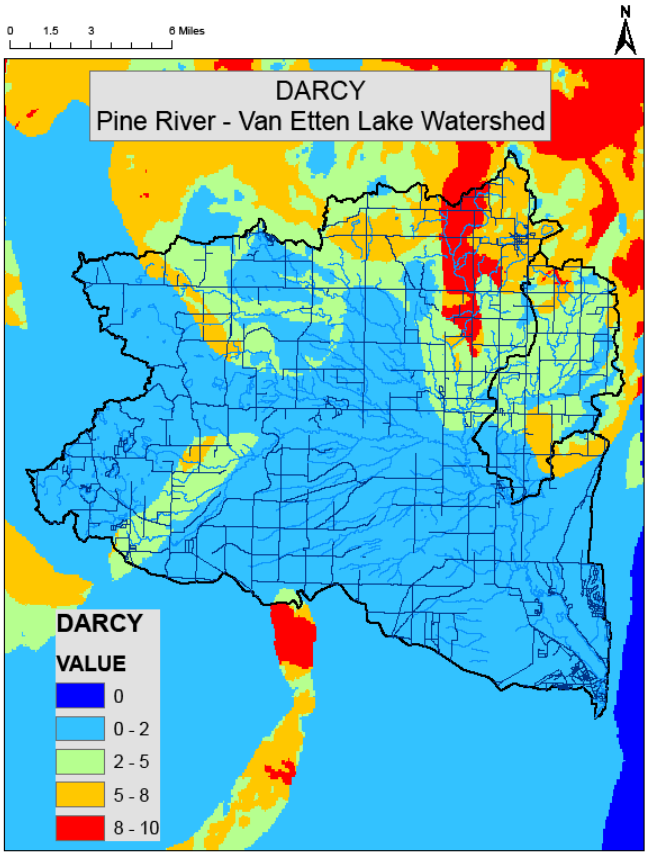
Soils on Outwash Plains, Stream Terraces, and Deltas
Grayling association
Nearly level to rolling, excessively drained, sandy soils on outwash plains and deltas.

Soils on Lake Plains
Algonquin-Allendale-Springport association
Nearly level, somewhat poorly drained and poorly drained, clayey, sandy, and loamy soils.

Soils on Till Plains and Moraines
Kawkawlin-Nester association
Nearly level to gently rolling, somewhat poorly drained and moderately well drained, loamy soils on till plains.

G. Groundwater Flow

The soils and topography of the watershed help to determine the direction and flow of groundwater throughout the system, which feeds and receives water from the surface rivers and lakes throughout the year. Pollutants can enter groundwater in one area of the watershed and be transported to other surface water areas. In the Pine River-Van Etten Lake watershed, the highest rates of groundwater flow are in the area of the East Branch of the Pine River and the northern edge of the watershed in general, mostly in the areas that are considered ground moraines and glacial outwash. Map 5 indicates that the highest potential delivery of



Map 5. The Darcy model shows the potential velocity of groundwater flow in the watershed.

groundwater to the watershed is in these areas, meaning that these areas have the highest potential for pollutants to flow through groundwater into the surface water.

H. Land Use/Land Cover

Developing an accurate representation of existing land use conditions within the Pine River-Van Etten Lake watershed critical area is a crucial step of the land use planning process. The type and intensity of land use may contribute nonpoint source pollution if adequate prevention measures are not incorporated during the development phase. Increasing development places higher demands on the natural resources when forests, riparian lands and open spaces are converted to homes, roads and commercial centers. For this analysis, we used the 1992 National Land Cover Data (NLCD) dataset from the United States Geological Survey.

Table 1.3 depicts each land cover classification in the watershed by number of acres and percentage of the total area.

Table 1.3: Land Cover Classifications

Land Use	Acres in Watershed	Percentage of Watershed
Water	3,096	1.7%
Residential	2,786	1.5%
Pits/Quarry/Rock	5,677	3.1%
Forest	97,515	53.9%
Pasture/Grassland	22,997	12.7%
Row Crops	9,289	5.1%
Wetlands	39,490	21.8%
Total	**180,850**	**100%**

The following definitions describe the land cover classifications (Map 6).

Water: The surface water category includes areas such as lakes, reservoirs, ponds, rivers and streams. Surface water in the watershed covers 3,096 acres (1.7%) of the total land area.

Residential: Residential land includes residential dwelling structures such as single family or duplexes, multi-family residential and mobile home parks. The total residential land use in the watershed is 2,786 acres (1.5%). The largest concentration of people in the watershed is located in Oscoda and Greenbush, around Van Etten Lake and scattered residential along the Pine River.

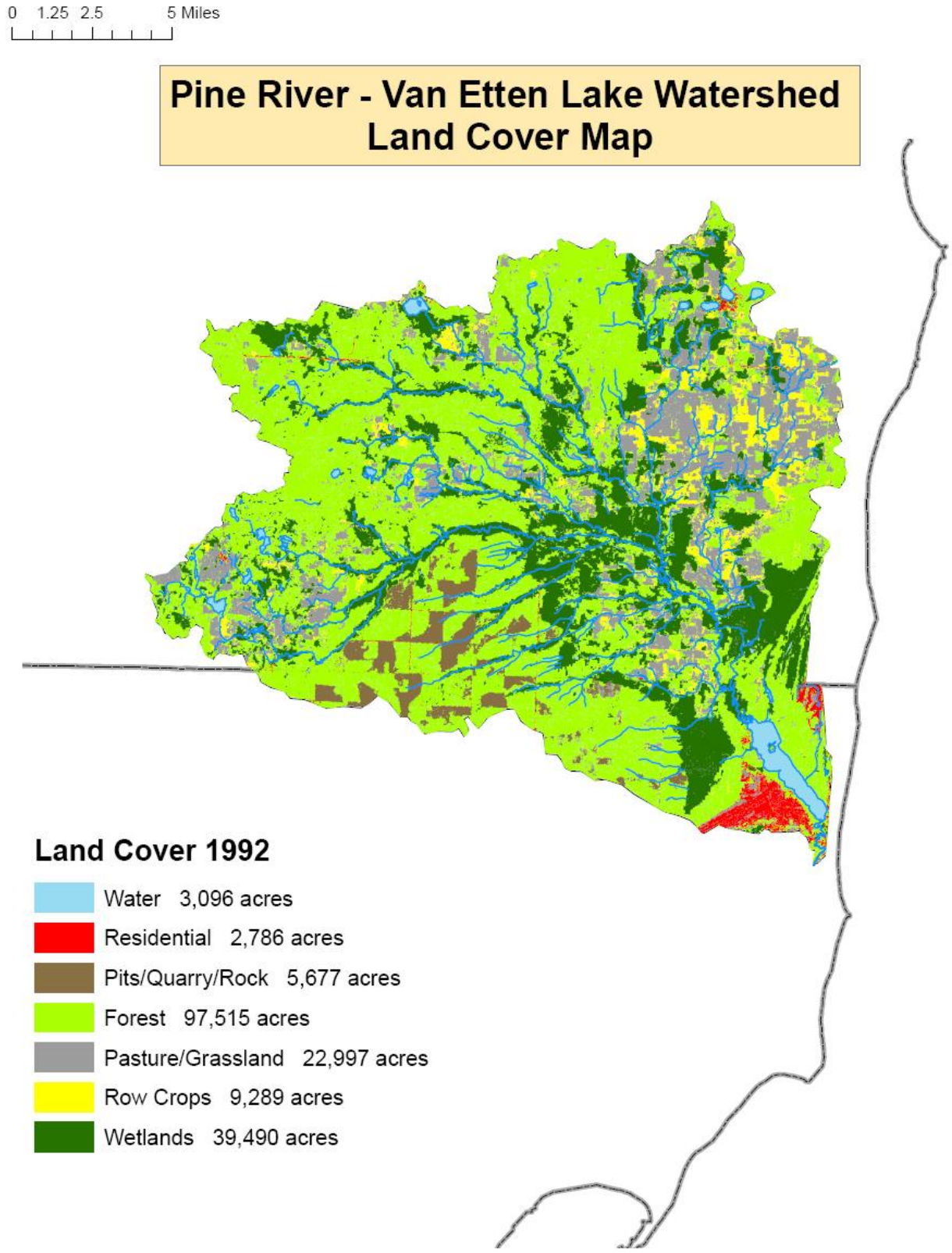
Pits/Quarry/Rock: Pit, quarry and rock land includes both surface and sub-surface mining operations, such as sand and gravel pits, stone quarries, oil and gas wells, and other mines. These areas are devoid of vegetation and oftentimes house large processing plants, stockpiles, and waste dumps. Pits, quarry and rock account for 5,677 acres (3.1%) in the watershed.

Forest: Forest land areas are generally at least 10% covered by trees of any size. The forest category includes upland hardwoods like maple and beech, other upland species like aspen and birch, species of pine like red, white or jack pine, and other upland conifers like white spruce, blue spruce, eastern hemlock, and balsam fir. Lowland forest areas are dominated by tree species that grow in very wet soils. Lowland hardwoods include ash, elm, soft maple, cottonwood and others. Lowland conifers include cedar, tamarack, black and white spruce, and balsam fir. Forested areas in the watershed comprise the majority of land cover with a total of 97,515 acres (53.9%) of the land area.

Pasture, Grassland: Pasture and grasslands include "open land" and rangeland classifications such as barren land, herbaceous open land, and shrubland. Herbaceous open land is usually subjected to continuous disturbance such as mowing, grazing, or burning, and typically it can have a variety of grasses, sedges, and clovers. Shrubland is land in transition from being open to becoming forested. It contains native shrubs and woody plants like blackberry, dogwood, willow, sumac, and tag alder. Pasture and grassland account for 22,997 acres (12.7%) of the watershed. Pasture and grassland are concentrated in the Van Etten Creek subbasin of the watershed.

Row Crops: The agricultural land use category generally includes land that is used for the production of food and fiber. These classes are cropland, orchards (including vineyards and ornamental horticulture), confined feeding operations for livestock of any kind, permanent pasture lands, farmsteads, greenhouse operations, and horse training areas. The total crop land in the watershed is 9,289 acres (5.1%). Like pasture and grassland, row crops are primarily concentrated in the Van Etten Creek subwatershed.

Wetlands: Wetlands are those areas where the water table is at or near the land surface for a significant part of most years. Examples of wetlands are marshes, mudflats, wooded swamps, shallow areas along rivers, lakes or ponds. Wetlands areas include both non-vegetated mud flats and areas of hydrophytic vegetation. Wetlands in the Pine River-Van Etten Lake watershed cover 39,490 acres (21.8%) of the land.


0 1.25 2.5 5 Miles
Pine River - Van Etten Lake Watershed
Land Cover Map
Land Cover 1992
Water 3,096 acres
Residential 2,786 acres
Pits/Quarry/Rock 5,677 acres
Forest 97,515 acres
Pasture/Grassland 22,997 acres
Row Crops 9,289 acres
Wetlands 39,490 acres

Map 6.

I. Wildlife Resources

Extensive wildlife populations exist within the Pine River-Van Etten Lake watershed. A diversity of natural and agricultural ecosystems broadly categorized as wetlands, upland and lowland forest, and croplands provide wildlife habitat for numerous species within the watershed.

Common Loon
Photo courtesy US Fish & Wildlife Service

The greater sandhill crane, great blue heron, red-winged blackbird and wood duck utilize wetlands, including lakes and streams within the Pine River-Van Etten Lake watershed. The state threatened Common Loon (*Gavia immer*) also finds refuge in this habitat. The inland-water environment is host to beaver, muskrat, raccoon, otter and mink. Blanding's Turtle (*Emydoidea blandingii*), a Michigan special concern species (due to its declining population in the state), is found in the watershed as well.

Bald Eagle photo courtesy USF&WS

The upland forest habitat of the Pine River-Van Etten Lake watershed provides food and shelter for ruffed grouse, woodcock, white-tailed deer, snowshoe hare, flying squirrel, porcupine, and black bear. The upland conifer forest provides excellent nesting habitat for the state threatened Bald eagle (*Haliaeetus leucocephalus*), which lives within the watershed. The federally and state endangered Kirtland's warbler (*Dendroica kirtlandii*) requires as breeding habitat the large stands of jack pine that are found in the southern range of the Pine River-Van Etten Lake watershed. Lowland forest areas within the watershed are home to inhabitants like the bobcat, wild turkey and piliated woodpecker.

Kestrels, song sparrows, bobolink, and migratory Canada geese all utilize the croplands and open spaces of the Pine River-Van Etten Lake watershed. The hedgerows, field borders and associated grasslands provide living space for mourning doves, meadowlarks, gold finches, cottontail rabbits and woodchucks.

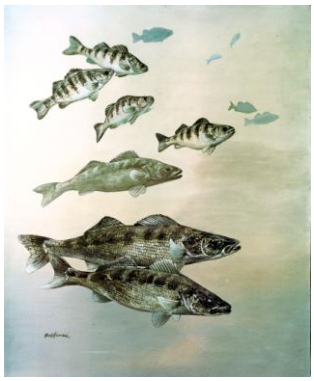
J. Fisheries Resources

Brook Trout photo courtesy USF&WS

The Pine River-Van Etten Lake watershed ecosystem provides critical habitat to numerous species of fish. In particular, the West and South Branches of the Pine River and their tributaries provide quality coldwater fish habitat for brook, brown and rainbow trout as well as the incidental steelhead, seasonal salmon and unusual northern hogsucker. The state threatened channel darter (*Percina copelandi)* is also thought to exist in the South Branch, as it has been noted in the eastern portion of the river (USDA Forest Service, 1992). The riparian corridor within these areas is primarily upland and lowland forest with the dominant acreage being a portion of the Huron-Manistee National Forest.

The East Branch of the Pine River, which flows through large sections of former and current agricultural land, has a brook and rainbow trout population and also hosts creek chub and sucker. This stream is considered mostly warm water habitat except for the headwaters area. A 1992 Michigan Department of Natural Resources (MDNR) biosurvey indicated that stormwater from the town of Lincoln is a source of chromium, copper, lead, nickel and zinc to the East Branch (MDEQ, 2000).

Van Etten Creek in Alcona County is characterized by slow moving warm water predominately influenced by agricultural activity. The riparian corridor consists of extensive tracts of open grazing land sporadically sheltered by limited stretches of lowland forest. Anecdotal information from local residents suggests that the headwaters region of Van Etten Creek produced significant populations of brook trout until about the early 1960s. A 1990 MDNR survey indicates that mottled sculpin, brook sticklebacks and central mudminnows were found in Van Etten Creek. However, no brook trout were observed during the 1997 inventory (MDEQ, 2000). Additionally, in 2002, Huron Pines field staff noted the presence of numerous carp in the creek system. The Michigan Department of Environmental Quality has rated the habitat quality of Van Etten Creek as "Poor" and attributes this rating to the dominance of livestock operations, sediment deposition and a poor benthic invertebrate community (MDEQ, 2000). Subsequently this stream has been placed on the 1998 Clean Water Act Section 303(d) Non-Attainment list for not meeting State of Michigan water quality standards. However, in the 2002 biological survey, the DEQ concluded that the creek appeared to be actually attaining the other indigenous aquatic life and wildlife designated use and should be removed from the 303(d) list if a 2007 survey listed habitat as acceptable (MDEQ, 2003). The 2007 survey did list Van Etten Creek habitat as acceptable, but the 303(d) list continues to list Van Etten Creek (MDEQ, 2008).

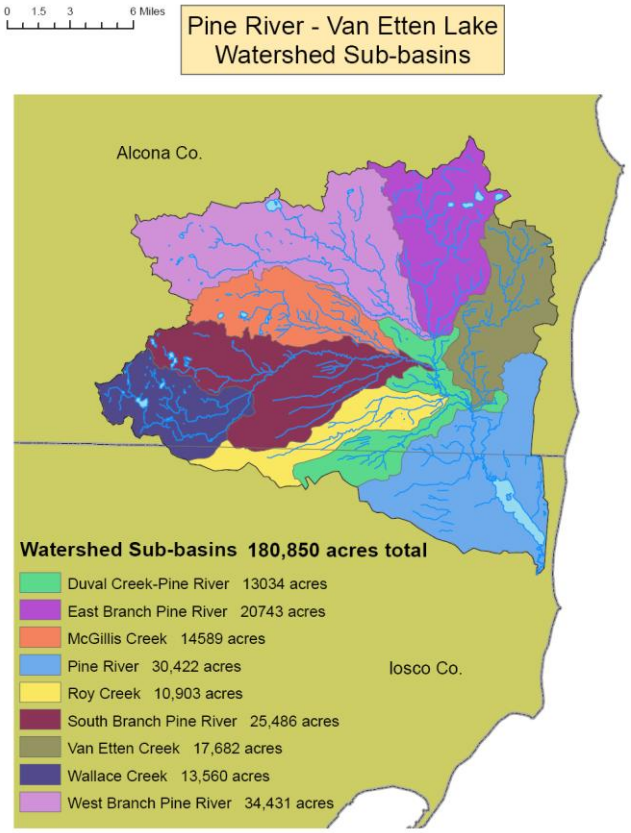


Walleye and Yellow Perch
Photo courtesy USF&WS

The Main Branch of the Pine River is classified as a coldwater stream. The Michigan Department of Environmental Quality has rated the Main Branch habitat quality as only "fair" due to lack of bottom cover, and excessive sediment deposition. Brook, brown and rainbow trout and yellow perch, have all been observed in the river. The presence of non-game species such as creek chub, hogsucker and rock bass have also been recorded (MDEQ, 2000).

Van Etten Lake, an approximately 1,400-surface acre recreational impoundment of the Pine River, is a warm water aquatic habitat which contains a diverse community of fish species. Smallmouth bass, largemouth bass, yellow perch, northern pike and rainbow trout have been observed in the reservoir. Some steelhead and salmon seasonally make their way through Van Etten Dam and enter the lake. Additionally, the Michigan Department of Natural Resources Fisheries Division with assistance from Walleyes for Iosco County has stocked over 100,000 walleyes in Van Etten Lake. Many non-game species have been documented in the lake as well, including carp, redhorse sucker, and freshwater drum.

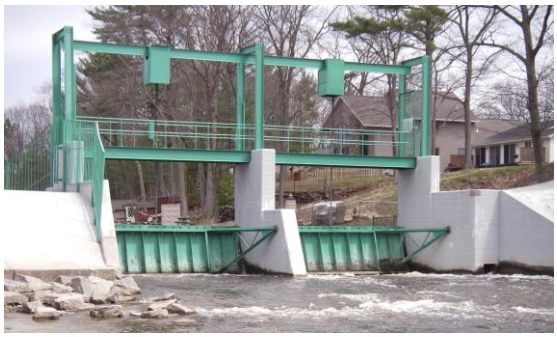
K. Hydrology



Map 7.

The Pine River-Van Etten Lake watershed drains approximately 187,000 acres into the 1,409-acre Van Etten Lake. The watershed to lake ratio is considered large for a Michigan inland lake (Fusilier, 1998). Water flow from most of the approximately 372 river miles of watershed tributaries is from north to south. The upper reaches of the watershed are steep and level out as water flows into the main Pine River and Van Etten Lake, as is common for northern watersheds. (Fongers, 2007) Van Etten Creek's average gradient is about 10 feet per mile (MDEQ, 2008).

Nine subwatersheds, including Van Etten Creek in Alcona County, the East, West and South Branches of the Pine and a number of other creeks converge to form the Main Branch of the Pine River (Map 7). The Pine River discharges to Van Etten Lake with an average flow of about 237 cubic feet per second (Fusilier, 1998). Discharge from the Pine River and Van Etten Lake below the dam is much greater than from the other tributaries in the watershed (McNaught, 2003). The record flow rate for Van Etten Creek was 147.0 cfs in March of 1975 (USGS 2009). Other USGS flow rate records for watershed streams are unavailable.



Van Etten Dam (photo courtesy Wade Trim)

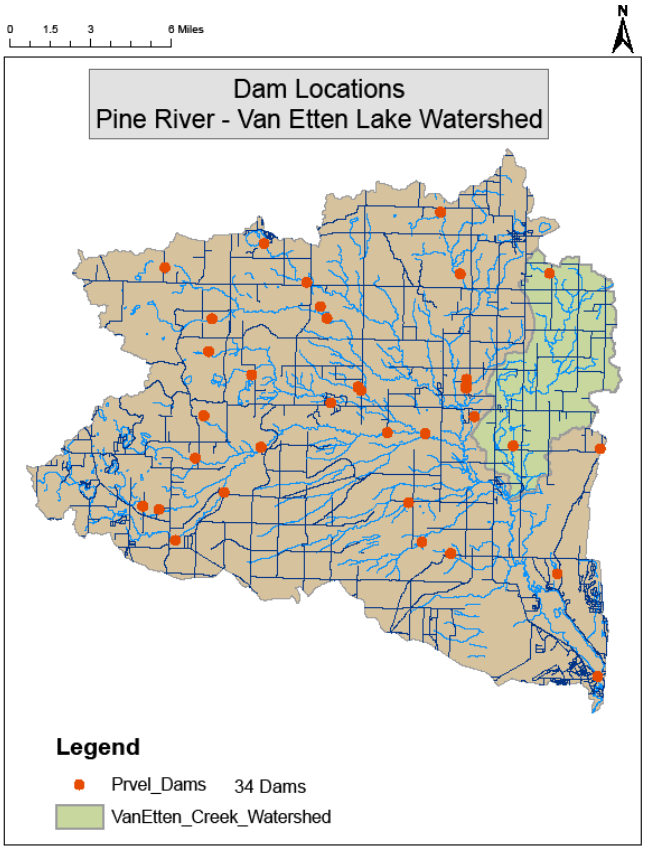
The Van Etten Lake reservoir has 53,346 feet of shoreline (Fusilier, 1998), and a mean depth of 14 feet with a maximum depth of approximately 25 feet and an average water transparency of 4.2 feet (Enviroscience, 2002). The impoundment has a short water residence time (Enviroscience, 2002) and flushes its total volume of 22,835 acre-feet about 8 times a year or approximately every 45 days (Fusilier, 1998). The water flow spills from Van Etten dam at the southeastern tip of the lake to Van Etten Creek in Iosco County. Van Etten Creek meanders for approximately three miles to its confluence with the Au Sable River and then courses into Lake Huron at Oscoda, Michigan.

According to a 2007 DEQ hydrologic study (Fongers 2007), stormwater runoff from most of the watershed did not increase from 1800 to 1978, however Van Etten Creek, Wallace Creek, and the East Branch of the Pine River had the greatest increases in runoff and highest runoff volumes. These results agree with other assessments of the increased contributions of pollutants like nutrients and sediments from these subwatersheds to the whole watershed.

L. Dams

There are 34 known dams in the Pine River-Van Etten Lake watershed. Of these, almost all are located in the Pine River system, many in the upper reaches and on smaller tributary streams. Dams are known to raise temperatures of coldwater streams and impair passage for fish like salmon that move upstream to spawn.

Van Etten Dam, the control structure for Van Etten Lake, has the most impact on the watershed because it is at the outlet of the entire watershed into the greater Au Sable watershed and close to Lake Huron, where fish would be entering looking for smaller streams in which to spawn. This dam opens in the spring and fall to control the level of Van Etten Lake. It opens at the bottom to allow water to pass through. There are currently no fish ladders or other structures to allow passage, although fish may be able to get through when the dam is open.



Map 8.

M. Water Chemistry

While there are varying fishery types throughout the Pine River-Van Etten Lake watershed, some parts of the Pine River are designated as a coldwater stream and therefore need to maintain proper water temperatures, flow, and chemistry to support healthy populations of trout, as well as providing good recreation opportunities and wildlife habitat. Sampling protocols have changed over time and the remoteness and general high quality of the majority of this watershed contribute to inconsistent water quality and chemistry data. However, data collected by state and federal agencies and local volunteers help to provide a baseline to compare with during future monitoring activities (see Chapter 7).

The optimal water temperature for rainbow trout is 54–64°F, while it is 52–61°F for brook trout and 54–66°F for brown trout (Fischenrich, 2000). In the Pine River, water temperatures have historically fallen within or below these ranges, meaning that the water temperature is sufficient for good trout habitat. Water that maintains higher temperatures is suited for fish like bass, walleye, pike, and panfish. Van Etten Creek, the East Branch of the Pine River, and Van Etten Lake are considered warm water fisheries because of slower flow rates allowing for water to stand and be heated by the sun.

While dissolved oxygen is difficult to measure in streams because it fluctuates daily and with temperature, it is important because it also affects the suitability of trout habitat. For rainbow, brook, and brown trout, the optimal level of dissolved oxygen is above 7 mg/L (Griffith Foundation, 2002). Turbulence in the upper reaches of the streams and good habitat indicates adequate oxygen levels in most of the watershed, except for Van Etten Creek where water is

warm and more slow moving. Historical data indicate an average of 91.1% saturation of dissolved oxygen in the downstream portion of the Pine River, which is adequate for fish.

Conductivity measures how well a solution can carry electrical current, but it also indicates the amount of dissolved solids (including nutrients like nitrogen and phosphorus) in the water. A constant conductivity indicates a constant amount of dissolved solids, which determines the amount of water that flows in and out of organisms through osmosis. In the Pine River watershed, the specific conductance was an average of 400, much higher than other Au Sable River watershed sites, which indicates that there are more nutrients and other dissolved solids in the Pine River than other streams.

In the Pine River watershed, the pH levels fluctuate around 8.2 in general, which is at the upper range of the levels needed by aquatic organisms (Griffith Foundation, 2002). It is also below the state-mandated maximum of 9.0 and can therefore be considered appropriate for the quality of the stream given all the other parameters.

The nutrients nitrogen and phosphorus are good indicators of human activity in a watershed and accumulations of these nutrients can lead to eutrophication, depleted oxygen, and other problems in the water. For example, ammonia in the Pine River system in 2002 averaged 3.45 µg/L (for April through December), while in Van Etten Lake it averaged 9.98 µg/L (McNaught, 2003). Of the river systems, nitrogen in all forms is highest in the Van Etten Creek subwatershed, probably due to inputs from the higher concentrations of agricultural practices in that area of the watershed. In addition, the amount of total phosphorus in the watershed illustrates the impairment of Van Etten Creek compared to other tributaries: Van Etten Creek averages 95.0 µg/L seasonally, while the West Branch Pine River and main stem Pine River average 25.9 and 26.3 µg/L respectively, indicating that these streams are more typical undeveloped streams (McNaught, 2003). It will be important in the future to maintain or decrease nutrient input at upstream sites so that it doesn't accumulate to dangerous levels lower in the watershed.

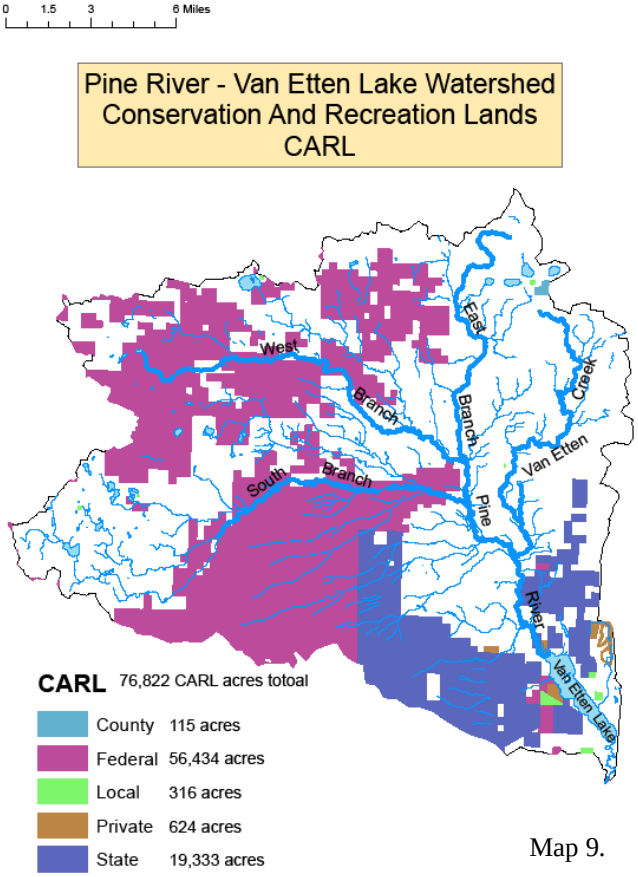
The DEQ performed a Biological Survey of the Pine River watershed in 1997 and 1998 and again in 2002 and 2007 (as part of a larger Au Sable River watershed biological assessment). The surveys were conducted according to Great Lakes and Environmental Assessment Section Procedure 51 and overall results indicate that the Pine River and its tributaries are high quality waters and are meeting water quality standards, with the exception of Van Etten Creek. The following are conclusions from the 2007 survey that indicate some threats to the water bodies:

- Overall, macroinvertebrate community and instream habitat ratings are good or excellent for most of the watershed, with only Van Etten Creek being rated as acceptable for macroinvertebrates and "the lower range of good" for habitat.
- Excessive quantities of sand sediment are affecting the otherwise excellent fish habitats in Kurtz Creek and the main stem of the Pine River.
- Lack of Large Woody Debris and riparian buffers are impacting habitat especially in the highly agricultural Van Etten Creek subwatershed.
- Future improvement in habitat in Van Etten Creek may be limited due to agricultural practices and a lack of riparian buffers.
- Stream flashiness is an issue in Van Etten Creek.

N. Recreation Resources

The Pine River-Van Etten Lake watershed provides a variety of excellent opportunities for outdoor recreation. Fishing, ice fishing, waterskiing, swimming, boating, sailing and canoeing are a few of the water related activities enjoyed by local and visiting recreationists on the watershed's numerous rivers, creeks and lakes.

With vast areas of Federal and State forested land and miles of trails, avid outdoor enthusiasts find plenty of space in the Pine River-Van Etten Lake watershed for large and small game hunting, camping, snowmobile and horseback riding, as well as cross-country skiing, snowshoeing, picnicking and even morel hunting.



Map 9.

II. PREVIOUS STUDIES

As part of the process of developing a management plan for the Pine River-Van Etten Lake watershed, an information search was conducted. All known pertinent studies, reports and documents related to the watershed were gathered and reviewed. A synopsis of each report is entered below. This information is housed as a collection of documents with the Pine River-Van Etten Lake Watershed Coalition.

Watershed Survey Report, Pine River Watershed, Michigan Department of Conservation, 1962

This survey reports the observations and data of a study to investigate the potential requirements for improved recreational trout fishing within the Pine River-Van Etten Lake watershed. Problems noted in the report were excessive sedimentation and turbidity, relatively little cover and pools, water temperature extremes, limited trout reproduction, species competition, fishing pressure and impoundments.

Agricultural Areas of Water Quality Concern, Northeast Michigan Council of Governments, 1980

This report indicates agricultural areas where the potential exists for negative impacts to water quality due to nonpoint source pollutants. It also specifies Van Etten Creek as one of three watersheds within Northeast Michigan identified as a high priority area due to observed agricultural degradation of water quality. Livestock's unlimited access to the creek was the predominant problem found.

USDA ACP Water Quality Special Project Proposal, Van Etten Creek Watershed, Soil Conservation Service, 1990

The context of this proposal was to set objectives and planned actions based upon the conclusions found in the Agricultural Areas of Water Quality Concern document of 1980. The main objectives noted were reducing sediment, phosphorus and manure loading to Van Etten Creek.

Proposed Riparian Management Activities for the South Branch Pine River, McDonald Creek, Bryant Creek, Wallace Creek, Kurtz Creek, and Unnamed Tributary Stream of T25N, R7E, Sec 11-14, Environmental Assessment, USDA Forest Service, 1992

This Environmental Assessment discusses proposed actions to improve the riparian ecosystem for high quality fisheries and wildlife habitat and recreation benefits. The resource and its history are described as well as issues and concerns, opportunities and proposed actions.

Proposed Riparian Management Activities for the West Branch Pine River, Loud Creek and Backus Creek, Environmental Assessment, USDA Forest Service, 1993

An Environmental Assessment to examine the improvement of coldwater fishery through the reduction of sediment within the streams and creating more diverse habitat. The report addresses issues, concerns, opportunities and proposed actions.

Van Etten Lake Oscoda Township Iosco County 1994 Lake and 1997 Inlet Water Quality Study, Fusilier, 1998

A limited water quality study that examined water chemistry and inlet stream nutrient contributions to Van Etten Lake. Additional sampling of the Pine River was suggested to gather a more precise understanding of its effect on the lake. The report indicates that land use upstream is probably contributing to nonpoint source nutrient concentrations.

Staff Report on Biological Surveys of the Pine River Watershed 1997 and 1998, Surface Water Quality Division, Michigan Department of Environmental Quality, 2000

This document reports the results of two biological surveys that were conducted on the Main, South, West, and East Branches of the Pine River and Van Etten Creek in Alcona County as well as Van Etten Lake. The surveys were conducted in response to complaints of blue-green algae blooms on Van Etten Lake. Conclusions indicate among other things, that Van Etten Lake has high levels of chlorophyll a and phosphorus and that Van Etten Creek is not meeting water quality standards for the State of Michigan.

AuSable River Assessment, Michigan Department of Natural Resources, Zorn and Sendek, 2001

This report addresses the biological and physical aspects of the Au Sable River. It also examines human impacts on the watershed as well as providing a document for future management of the

river system. As a subwatershed of the Au Sable River watershed, the Pine River system is described and noted in a number of places in the report.

Fish and Invertebrate Community Composition: A Comparison of Headwater and Adventitious Streams, Michigan State University, Thesis, Thomas, 2001

A dissertation on stream order designation and its correlation to a watershed's metabolic, physical and biotic nature. The Pine River-Van Etten Lake watershed was the study area. Analyses of the fish and macroinvertebrate communities and habitat as they relate to stream order are described in the report.

Predicting the Potential Production of Steelhead based on Habitat Conditions in the Pine River, Alcona County, Annual Study Performance Reports, Michigan State University, Thompson, 1999- 2002

These reports document an ongoing study to assess the habitat conditions within the Pine River watershed as a potential annual spawning, growth and sustainable environment for juvenile steelhead reproduction. The development of a full life history model for steelhead is a component of this study. Data regarding fish species richness and presence are also noted.

Final Progress Report for the Implementation of the Middfoil Process of Eurasian Watermilfoil Control to the Van Etten Lake, MI., Enviroscience Inc., 2002

This report documents the process and results of introducing 125,000 aquatic weevils to biologically control the significant presence of invasive exotic Eurasian Watermilfoil (EWM) in Van Etten Lake. The two-year program resulted in the disappearance and/or drastic reduction of Eurasian Watermilfoil within the lake. The stocking has also established a viable weevil population to continue the control of EWM in Van Etten Lake.

Pine River-Van Etten Lake Watershed Hydrologic Study, Michigan Department of Environmental Quality, Fongers, 2007

This report provides a baseline of data for local governments to use in their stormwater management and prioritize areas for conservation. The study, performed by the Hydrologic Studies Unit of the DEQ, determined that development pressure in the watershed is low and that runoff volumes are also low, leading to a low risk of stream instability or erosion. In addition, Van Etten Creek, Wallace Creek, and the East Branch of the Pine River have the most impact on the watershed's water quality.

III. DESIGNATED USES AND WATERSHED CONCERNS

A. Designated Uses

Water quality in Michigan is defined by whether the waterbody meets the recognized uses established by the State and Federal government. Known as designated uses, it is Michigan's goal to have the waters of the state meet these criteria.

Pursuant to the Water Resources Commission Act (P.A. 451 of 1994, Part 31, Chapter 1), all surface waters of the State of Michigan are designated for and shall be protected for the following uses, except as noted:

1) agriculture
2) industrial water supply
3) public water supply (does not currently apply to this watershed)
4) navigation
5) warm water fishery (Alcona County's Van Etten Creek, Main Branch of the Pine River from F-41 south and Van Etten Lake)
6) other indigenous aquatic life and wildlife
7) partial body contact recreation (applies all year) and total body contact recreation (applies May 1 to October 31)
8) cold water fishery (all streams in the watershed except those designated for warm water)
9) fish consumption

A watershed's impairment for any of the above designated uses is determined by how well its water quality conforms to the State of Michigan's water quality standards. A basic description of the State's water quality standards is below.

Table 1.4: State of Michigan Water Quality Standards (as required by sections 3103 and3106 of 1994 PA 451, MCL 324.3103 and 324.3106)

Pollutant	State-required level	Designated Uses Affected
Dissolved solids	500 mg/L monthly average or 750 mg/L at any time	All
Chlorides	125 mg/L monthly average	Public Water Supply
pH	6.5 to 9/0	
Taste or odor-producing substances	Any concentration	Public Water Supply Industrial Water Supply Agricultural Water Supply Fish Consumption
Toxic substances (selected shown here; see rule for complete listing)	DDT and metabolites: 0.00011 µg/L Mercury, including methylmercury: 0.0013 µg/L PCBs (class): 0.00012 µg/L 2,3,7,8-TCDD: 0.0000000031µg/L	All but navigation
Radioactive substances	Pursuant to U.S nuclear regulatory commission and EPA standards	All but navigation
Plant nutrients	Phosphorus: 1mg/L monthly average for permitted point-source discharges	All

Microorganisms	130 *Escherichia coli* per 100 ml 30-day mean of 5 or more sampling events 300 *E. coli* per 100 ml 30-day mean 1,000 *E. coli* per 100 ml 30-day mean Human sewage discharges (treated or untreated) 200 *E. coli* per 100 ml 30-day mean or 400 *E. coli* per 100 ml in 7 days or less	All Total body contact recreation Partial body contact recreation
Dissolved oxygen	Minimum 7 mg/L for coldwater designated streams, inland lakes, and Great Lakes/connecting waters; minimum 5 mg/L for all other waters Minimum 5 mg/L daily average	Cold water fishery Warm water fishery
Temperature	Natural daily and seasonal temperature fluctuations shall be preserved Monthly averages for inland lakes: J F M A M J J A S 0 N D 45 45 50 60 70 75 80 85 80 70 60 50 Monthly averages for inland streams in this watershed: J F M A M J J A S 0 N D 41 40 50 63 76 84 85 85 79 68 55 43	Cold water fishery, other indigenous aquatic life and wildlife, warm water fishery

Within the Pine River-Van Etten Lake watershed, the Steering Committee has identified some specific factors that are threatening five of the nine state designated uses.

The annual blue-green algae bloom on Van Etten Lake is degrading the use of this water body for partial and/or total body contact recreation due to the thickness of the algae. It impedes swimming and wading. Additionally, invasive aquatic plants are impeding navigation.

Unrestricted livestock access to a number of streams throughout the watershed (particularly Van Etten Creek and the East Branch of the Pine River), suggests that cold and warm water fisheries uses are being degraded by nutrients from animal waste.

Erosion from streambanks and problematic road/stream crossings are adding sediment to tributaries throughout the watershed and thus are impeding the designated uses for warm and cold water fisheries as well as navigation and other indigenous aquatic life and wildlife.

It appears that the designated use for industrial water supply is being met within the Pine River-Van Etten Lake watershed at this time.

Michigan's inland lakes, including those in the Pine River-Van Etten Lake watershed, are included on the Section 303(d) list for fish consumption. The DEQ is developing pollution prevention and abatement strategies for the State of Michigan for mercury contamination and other related toxins and therefore will not be discussed in the Watershed Management Plan. The

Michigan Department of Community Health (MDCH) guidelines allow for unlimited consumption of fish 6 to 8 inches in length and for most larger fish unlimited or one meal per week consumption for men and one meal per month or six meals per year for women and children.

In addition to the watershed-wide listing for fish consumption, two sites within the watershed have been listed on the Section 303(d) list for not attaining water quality standards. A Total Maximum Daily Load (TMDL) was completed in 2004 for a tributary to Hunters Lake (in the Pine River subwatershed in the southwest portion of the watershed) for total body contact recreation due to *E. coli*. There was a sewage issue with a local school that has now been addressed by an updated septic system. Multiple TMDLs are scheduled for 2009 for the Van Etten Creek subwatershed to address the other indigenous aquatic life and wildlife designated use, which is not supported because of excessive ammonia, algal growth, flow regime alterations, phosphorus, and sedimentation/siltation.

The following table lists the affected watersheds and designated uses according to the State of Michigan.

Table 1.5: Sections of the Watershed on Michigan's 2009 303(d) List

Water Body	Impaired Designated Use	303(d) Listing Cause	TMDL Date
All	Fish Consumption	PCBs in water column	2010
Small Creek to Hunters Lake	Total Body Contact Recreation	*Escherichia coli*	9/1/2004
Van Etten Creek	Other Indigenous Aquatic Life and Wildlife	Un-ionized ammonia, excess algal growth, other flow regime alterations, total phosphorus, sedimentation and siltation	2009

It is important to note that the Van Etten Creek non-attainment listing is based on the results of the 1997 DEQ biological survey. However, in the 2002 survey, the DEQ concluded that the creek appeared to be actually attaining the other indigenous aquatic life and wildlife designated use and should be removed from the 303(d) list if a 2007 survey listed habitat as acceptable. The 2007 survey did list Van Etten Creek habitat as acceptable, but the 303(d) list continues to list Van Etten Creek. It is unknown whether any recommendations to remove it from the list were made.

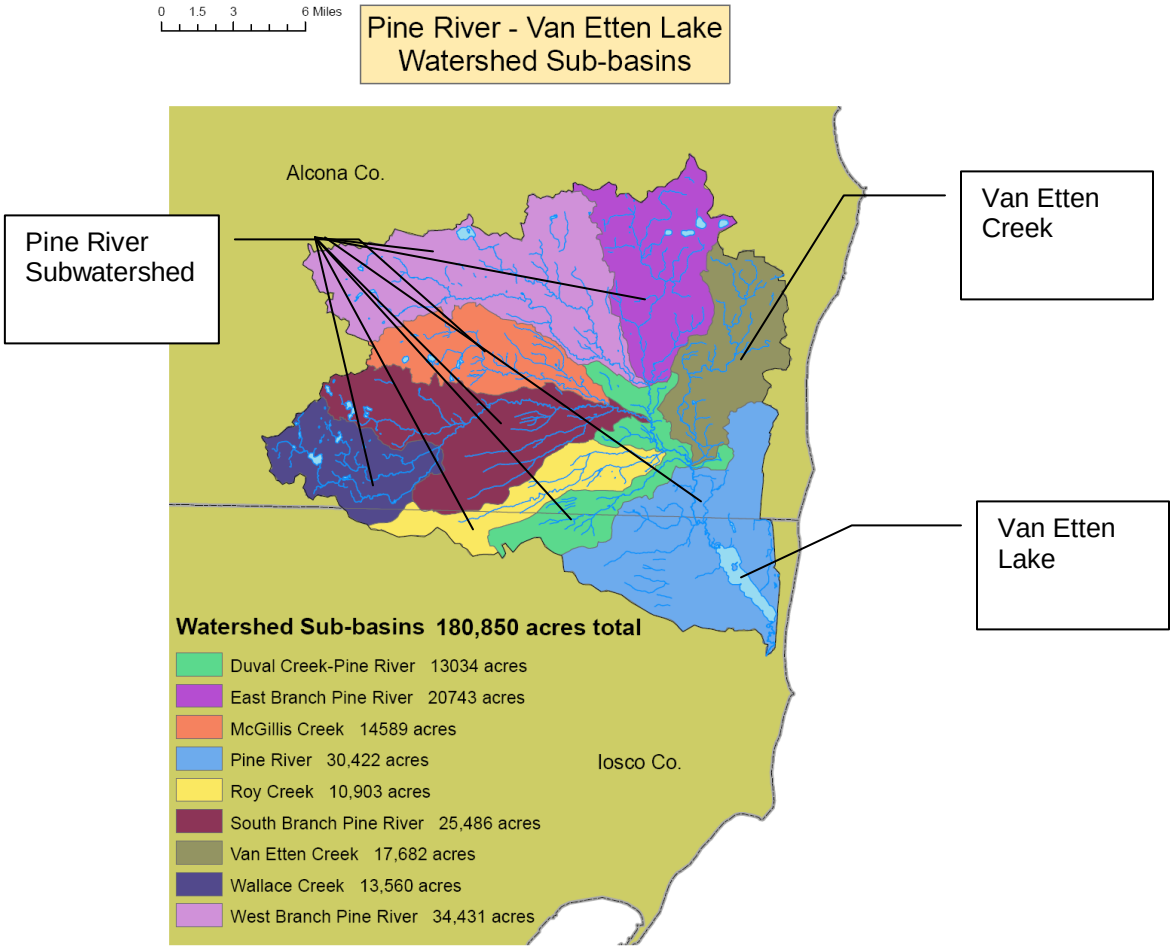
B. Watershed Concerns

A watershed Steering Committee was established to assess the watershed concerns and to provide input into the overall planning effort. Partnership members include federal, state, and local government officials; nonprofit conservation, lake, and citizen's organizations; individual property owners; and other stakeholders within the Pine River-Van Etten Lake watershed. In 2008, the Steering Committee combined meetings with the Pine River-Van Etten Lake Watershed Coalition to reduce meetings and increase participation by the public in both groups.

Quarterly meetings of the Pine River-Van Etten Lake Watershed Coalition are held to discuss concerns about water quality and to guide the development of the management plan. The Coalition identified various issues and concerns within the watershed for the 2003 management plan and then revisited those concerns in 2007. At a quarterly meeting in January 2008, each pollutant threat and cause was discussed and agreed upon by the group for the area of the watershed it affected.

The following list (tables 1.6a-c) is comprehensive of all identified issues, as identified by the Coalition, threatening the water resources in the Pine River-Van Etten Lake watershed. The table is broken into three parts to help differentiate between the different characteristics of the three main subwatersheds—the Pine River, Van Etten Creek, and Van Etten Lake.

The three subwatersheds (Map 10) have their own unique watershed concerns while sharing some basic concerns with each other. The Pine River is a high-quality, coldwater stream with mostly public land surrounding it, while Van Etten Lake is a highly developed lake surrounded by private residences, and Van Etten Creek is an impaired system due to the high amount of agriculture lands surrounding it. This division will be used for the purposes of the designated and desired uses and watershed goals and objectives.



Map 10. The major subwatersheds as divided for determining local concerns.

Table 1.6a: Concerns and Threats to Designated Uses < Pine River >
Sediment from streambank erosion
Agricultural fertilizers entering the watershed
Livestock/Agricultural waste entering tributaries
Sediment from road/stream crossings
Algae blooms in stagnant pools
Wildlife habitat loss
Lack of zoning and enforcement
Poor forest management
Pesticides entering watershed
Watercraft overuse/jet skis
Recreational conflicts
Exotic species, i.e. zebra mussels, Eurasian water milfoil etc.
Wetland loss and degradation
Fisheries concerns
Adfluvial fish passages debate
Solid waste in tributaries and lakes, i.e. fishing line, trash
Lack of education and stewardship
Poaching
Wildlife and fishery predation
Public perception/apathy
Household hazardous waste to septic systems
Great Lakes pollutants within aquatic wildlife, i.e. PCBs

Table 1.6b: Concerns and Threats to Designated Uses < Van Etten Creek >
Sediment from streambank erosion
Agricultural fertilizers entering the watershed
Residential and golf course fertilizers
Livestock/Agricultural waste entering tributaries
Sediment from road/stream crossings
Algae blooms
Wildlife habitat loss
Septic system effluent entering lake
Poor forest management
Exotic species, i.e. phragmites, purple loosestrife, etc..

Wetland loss and degradation
Fishery planning concerns
Adfluvial fish passages debate
Solid waste in tributaries and lakes, i.e. fishing line, trash
Lack of education and stewardship
Poaching
Wildlife and fishery predation - overconsumption
Public perception/apathy
Household hazardous waste to septic systems
Great Lakes pollutants within aquatic wildlife, i.e. PCBs

Table 1.6c: Concerns and Threats to Designated Uses < Van Etten Lake >
Sediment delivery to lake from upstream
Residential and golf course fertilizers
Algae blooms
Aquatic and exotic weeds
Wildlife habitat loss
Septic system effluent entering lake
Chemical treatment of aquatic weeds
Lack of zoning and enforcement
Pesticides entering watershed
Reduction of natural shoreline
Hydrocarbons entering waterbodies from runoff
Watercraft overuse/jet skis
Recreational conflicts
Exotic species, i.e. zebra mussels, Eurasian water milfoil etc.
Wetland loss and degradation
Inadequate fishery planning
Adfluvial fish passages debate
Solid waste in tributaries and lakes, i.e. fishing line, trash
Lack of education and stewardship
Wildlife and fishery predation
Public perception/apathy
Household hazardous waste to septic systems
Great Lakes pollutants within aquatic wildlife, i.e. PCBs

C. Known and Suspected Pollutants

Nutrients, sediments, pesticides, exotic species, pathogenic bacteria and viruses, oils and greases, metals and solid waste were identified as main pollutants of concern that threaten the designated uses of the Pine River-Van Etten Lake watershed. The following table (Table 1.7) lists these pollutants:

Table 1.7: Known and Suspected Pollutants that Threaten the Designated Uses

Designated Use	Pollutants	Subwatershed Directly Affected
Warm Water Fishery	Nutrients (K) Sediment (K) Pesticides (S) Invasive exotic species (K) Pathogenic bacteria and viruses (S) Temperature (S)	Van Etten lake
Cold Water Fishery	Nutrients (K) Sediment (K) Pesticides (S) Invasive exotic species (K) Pathogenic bacteria and viruses (S) Temperature (S)	Pine River, Van Etten Creek
Other indigenous aquatic life/ wildlife	Nutrients (K) Sediment (K) Pesticides (S) Invasive exotic species (K) Pathogenic bacteria and viruses (S) Mercury, PCBs, Metals (S) Solid waste (S)	Pine River, Van Etten Creek, Van Etten Lake **Note: Van Etten Creek is on the non-attainment list for this use because of excessive nutrients, ammonia, algae flow regime alterations, phosphorus, and sediment**
Partial body contact recreation	Invasive exotic species (S) Swimmer's Itch (S)	Van Etten Lake
Total body contact recreation	Nutrients (K) Invasive exotic species (S) Pathogenic bacteria and viruses (S) Swimmer's Itch (S) Solid waste (S)	Van Etten Lake
Navigation	Sediment (K) Nutrients (K) Exotic Species (K)	Pine River, Van Etten Creek, Van Etten Lake

Known (K) and Suspected (S)

D. Sources of Pollutants

To address pollutants within the watershed, it is important to understand their underlying causes. Land uses within this watershed range from large tracts of federal forest and agricultural properties to densely developed resort communities and small rural towns. The Pine River-Van Etten Lake Watershed Coalition Steering Committee identified the annual blue-green algae bloom on Van Etten Lake as the nexus to addressing pollutants and their sources within the watershed. Ideally, it is perceived that nutrient reduction through source management will have the greatest impact on minimizing the algae bloom and thus improve overall water quality within the watershed and remove the threat to the total body contact recreation designated use for Van Etten Lake. The primary pollutants of concern within the Pine River-Van Etten Lake watershed, along with their sources and causes are identified and listed in Table 1.8 below. Pollutants and their sources are prioritized based on the knowledge and concerns of the Steering Committee, the results of field inventories and the water quality study.

Table 1.8: Sources of Pollutants in the Pine River-Van Etten Lake Watershed (in order of priority as discussed by the PRVEL Coalition)

Pollutant	Source	Cause
Nutrients	1. Livestock waste	a. Cattle access to streams b. Stormwater runoff of livestock waste (manure) used as fertilizer
	2. Septic Systems	a. Lack of maintenance b. Poorly sited c. Undersized d. Density e. Age of system
	3. Shoreline practices by landowners	a. Lack of filter strip b. Lack of education c. Excessive development d. Poor shoreline setbacks e. Yard waste dumped into lake
	4. Fertilizer use	a. Near shore fertilization b. Overuse c. Poor timing of application
	5. Construction sites	a. Lack of stormwater BMPs b. Excessive development c. Wetland loss

Table 1.8: Sources of Pollutants in the Pine River-Van Etten Lake Watershed (in order of priority as discussed by the PRVEL Coalition)

Pollutant	Source	Cause
Sediment	1. Road/Stream crossings	a. Stormwater runoff from roadbeds and approaches b. Improperly placed culverts c. Damaged or inadequate culverts and bridges
	2. Streambank erosion	a. Lack of vegetative cover b. Tributary velocities c. Uncontrolled access
	3. New construction	a. Lack of stormwater BMPs b. Poorly sited development c. Impervious surfaces d. Lack of enforcement e. Wetland loss f. Parcel fragmentation g. Lack of effective regulation
	4. Shoreline erosion	a. Lack of filter strips b. Ice c. Natural waves d. Lack of adequate setbacks e. Seawalls f. Large boats
Pathogenic Bacteria and Viruses	1. Septic systems	a. Lack of maintenance b. Poorly sited c. Undersized d. Density e. Age of system
	2. Fertilizer (manure) runoff	a. Lack of filter strips b. Wetland loss
	3. Human waste	a. Lack of sanitary facilities for recreationists b. Lack of education
Invasive Exotic Species	1. Recreational boats and personal watercraft	a. Lack of education b. Apathy
Fuels, Oils & Greases	1. Development	a. Lack of filter strips b. Wetland loss c. Poorly sited roads
Salts	1. Roadways	a. Lack of filter strips b. Wetland loss c. Poorly sited roads

Table 1.8: Sources of Pollutants in the Pine River-Van Etten Lake Watershed (in order of priority as discussed by the PRVEL Coalition)		
Pollutant	**Source**	**Cause**
Pesticides	1. Homeowner practices	a. Improper application and disposal b. Lack of disposal facilities
	2. Agricultural practices	a. Improper application and disposal b. Lack of disposal facilities
Mercury, PCBs, Metals	1. Adfluvial fish, i.e. salmon, steelhead	a. Spawning up tributaries
	2. Rain	a. Contaminants in atmosphere
	3. Point source	a. Direct discharge to waterbodies
Solid waste	1. Recreational users	a. Lack of education b. Lack of facilities c. Apathy

E. Desired Uses

Desired uses are based upon factors important to the watershed community. They help guide watershed restoration and protection efforts in areas that go beyond the State list of designated uses. As population growth and development continues within the watershed, recreational use is also expected to grow proportionally. In meeting that challenge the Pine River-Van Etten Lake Watershed Steering Committee foresees protecting the natural resources within the watershed while promoting their responsible recreational use as the guiding principle for encouraging community support of future project activities. Table 5 below lists the desired uses identified by the Coalition. Issues such as preserving unique wildlife habitat, encouraging water quality stewardship and projecting recreational impacts, form the core of desired uses for this watershed.

Table: 1.9 Desired Uses
1. Improve and protect environmentally sensitive areas such as wetlands and waterfowl habitat.
2. Improve enforcement of water safety laws.
3. Protect wildlife habitat through Conservation Easements.
4. Promote water quality conservation to various recreational user groups.
5. Determine current and future recreational uses and needs.

Although it is a necessary and productive part of the overall planning process to identify desired uses and envision their community and environmental benefits, the need to address the numerous water quality impairment issues within the Pine River-Van Etten Lake watershed is primary. Therefore the overriding focus of the Pine River-Van Etten Lake Watershed Steering Committee is to concentrate on pollutants; their identification, sources and the restoration activities required to reduce or eliminate them and eventually meet the State of Michigan designated uses for all surface waters within the watershed.

Chapter Two: Critical Area

I. INTRODUCTION

Areas adjacent to waterbodies are considered important because land uses within this "critical area" are most likely to have an influence on surface water quality. Defining a critical area also allows for a focus of the geographic scope of a watershed project, which allows inventory and restoration efforts to be targeted toward the areas that generally contribute the majority of nonpoint source pollution.

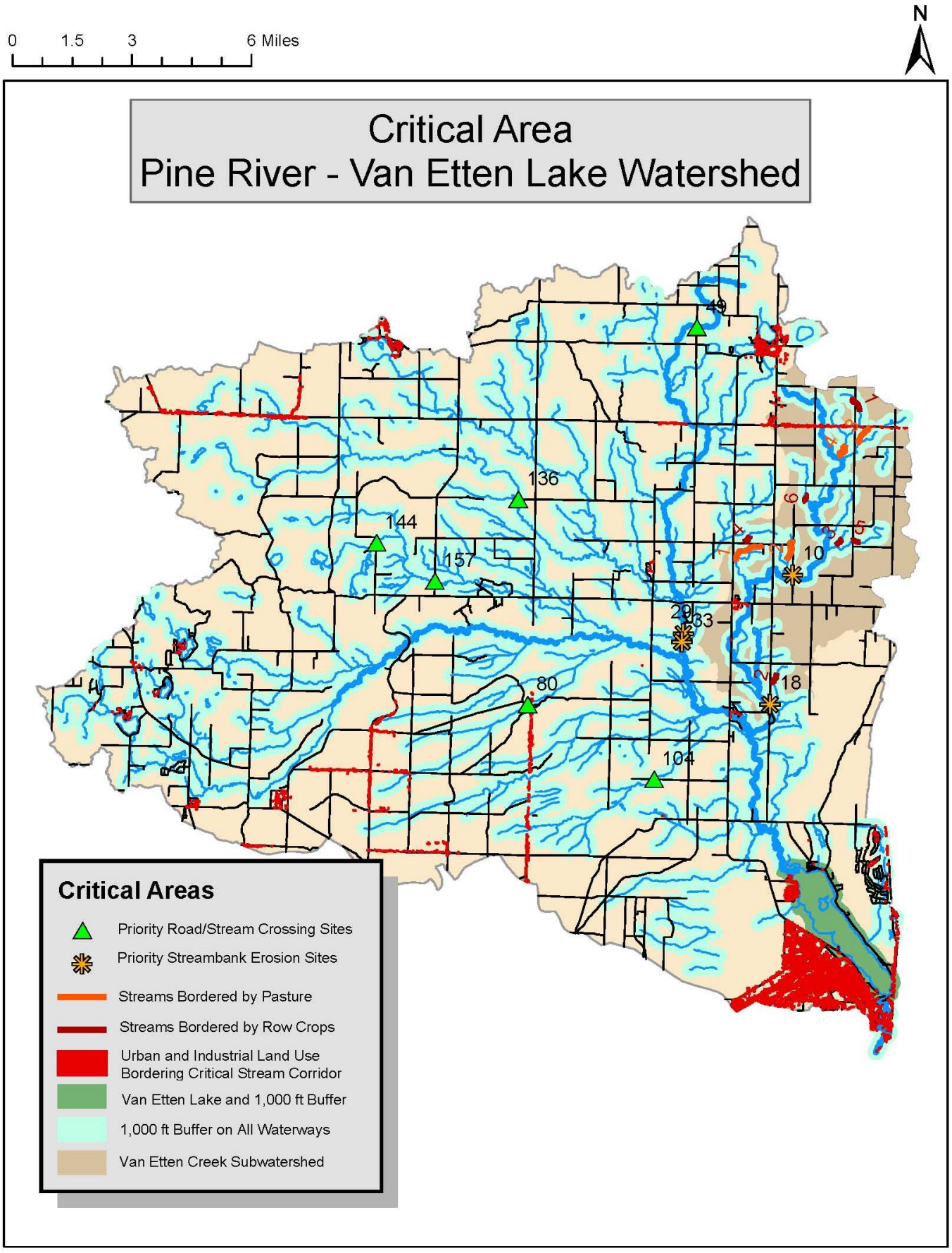
USDA Natural Resources Conservation Service Soil Surveys and US Geological Survey topographic maps were utilized to delineate the critical area for the Pine River-Van Etten Lake watershed. The criteria used to determine the critical area includes

1. All bodies of surface water, including lakes and streams,
2. Intermittent drainages,
3. Priority road/stream crossings, streambank, and agricultural inventory sites,
4. All areas within 1000 feet of surface water, and
5. Urban areas that drain to surface waters.

The critical area for the Pine River-Van Etten Lake watershed is approximately 85,239 acres. This area served as the focus of the resource inventories for the project. Map 6 on the next page indicates the critical area shaded in light blue for the Pine River-Van Etten Lake watershed.

There are several areas in the watershed that are particularly critical to monitor and protect because pollutants could be entering the watershed at these points and affecting water quality downstream to the Au Sable River and even to Lake Huron. Critical areas of concern are:

1. Van Etten Creek, specifically the reaches identified through the agricultural inventory as areas where fertilizer from row crops or manure from pasture lands may be entering the river. There are also two streambank erosion sites that are adding sediment to the stream. Since most of the agriculture in the Pine River-Van Etten Lake watershed is concentrated in the Van Etten Creek subwatershed, it has a disproportionate effect on the downstream water quality and it is therefore important to improve and protect the entire stream.
2. Road/stream crossing sites in the watershed add sediments, oils and greases to streams from the roadways. In this watershed, there are six priority sites that can be addressed to remove the majority of the sediment entering the watershed from roadways.
3. Urban and industrial areas can add sediment, salts, oils and greases, and other chemicals to the watershed. The town of Oscoda is at the southern tip of the watershed but also borders on Van Etten Lake. Smaller villages like Mikado and Barton City are potential sources of pollutants much farther upstream and have the capacity to affect large stretches of the river.
4. All shoreline areas along the rivers and lakes in the watershed are important to protect, but especially the more densely populated Van Etten Lake, which is a large source of pollution through septic systems and fertilizers. Much of the shoreline is armored with seawalls that prevent the lake from cleansing itself of debris and cause erosion on the unarmored properties.


0 1.5 3 6 Miles
N
Critical Area
Pine River - Van Etten Lake Watershed
49
136
144
157
10
29
33
18
80
104
Critical Areas
Priority Road/Stream Crossing Sites
Priority Streambank Erosion Sites
Streams Bordered by Pasture
Streams Bordered by Row Crops
Urban and Industrial Land Use Bordering Critical Stream Corridor
Van Etten Lake and 1,000 ft Buffer
1,000 ft Buffer on All Waterways
Van Etten Creek Subwatershed

Map 11.

Chapter Three: Nonpoint Source Inventories

I. INTRODUCTION

A. Nonpoint Source Pollution

Nonpoint source pollution is the primary pollution threat facing the water resources of the Pine River/Van Etten Lake watershed. Sediment from erosion and nutrients from fertilizers, septic systems and animal wastes all contribute to the degradation of water quality within the Pine River/Van Etten Lake watershed. A series of four natural resource inventories to document and assess the extent and contribution of nonpoint source pollutants within the critical area of the watershed were conducted from July 2001 to November 2002 and updated in 2007 and 2008. These inventories were used to specifically look at road/stream crossings, streambank erosion, agricultural practices and shoreline development issues. Additionally, local volunteers conducted a septic system inventory in 2007 and the Michigan Water Research Center of Central Michigan University was retained in the spring of 2002 to conduct a water quality study of the watershed in order to identify nutrients, their sources and their respective contributions to the Pine River system and ultimately Van Etten Lake. The results of the Central Michigan University study are included in this plan as Appendix F. The purpose of the nonpoint source management plan is to inventory pollutant sources, prioritize the areas of concern and develop management recommendations that can be implemented to restore and protect the water resources of the Pine River/Van Etten Lake watershed.

B. Road/Stream Crossing Inventory

1. Introduction

Bridge on Backus Creek

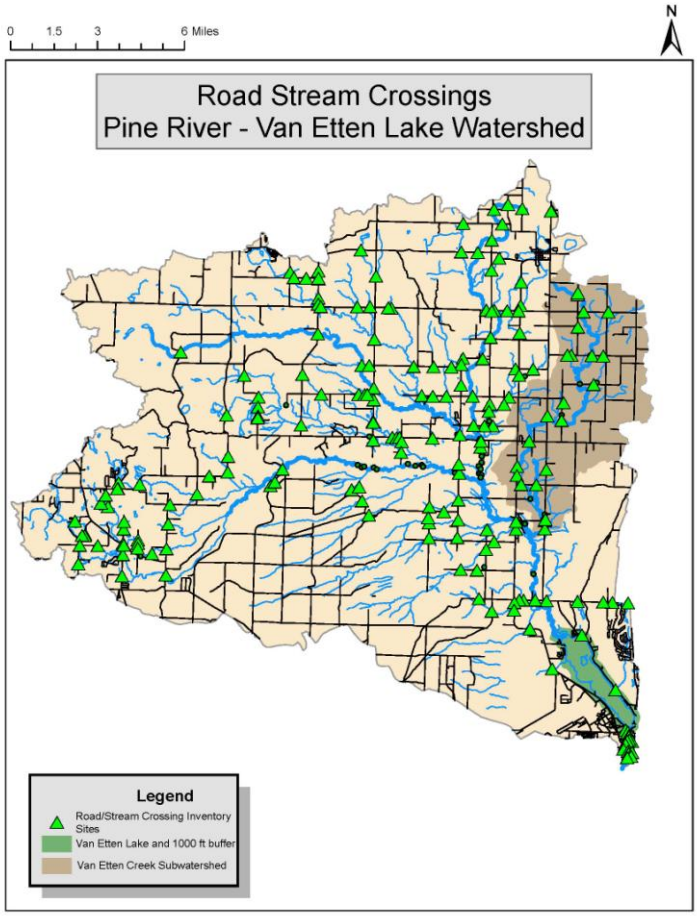
Road/stream crossings can become a conduit for pollution when soil, road salt and deicing agents, oils, soaps and other potential pollutants from roads and/or eroding banks at the culvert placement, flow into the water during rain events. The cumulative effect of these pollutants is an area of concern as they can directly affect the diverse fauna within the stream. As part of the critical area inventory for the Pine River/Van Etten Lake Watershed Plan an inventory of the road/stream crossing sites was conducted. The purpose of this inventory was to identify and document all of the road crossing sites on the tributaries of the Pine River/Van Etten Lake watershed. A total of 189 sites were located and documented during this inventory (see Map 7). All sites were re-inventoried in 2007 following the same methods as in the earlier inventory.

2. Methods

On site field evaluations were performed to inventory each potential crossing. A Road/Stream Crossing Field Data Form (see Appendix B) was completed at each site. A series of photographs

were taken of each site to document existing conditions at each crossing. Each site was visited to assess potential problems that may contribute nonpoint source pollution and impact water quality. Data collected at the crossings included detailed information about the location (Global Positioning System coordinates were marked for each site), road characteristics (width, shoulder, drainage, approaches, surface), culvert condition and erosion and runoff problems. Stream characteristics such as width, depth, current and substrate were also recorded.

At each crossing, soil erosion was evaluated in terms of existing and potential conditions; additionally, various physical measurements were made and each site was documented with an inlet and an outlet photograph. This information was compiled into a database for evaluation. New photos were taken in 2007 of each site. Six new sites were added during the course of the 2007 inventory because they had been missed during the original inventory.



Map 12. PRVEL Road/Stream crossings. A larger copy is with the actual inventory in Appendix B.

In order to help prioritize road/stream crossings for improvement a severity ranking was given to each site. The severity ranking was determined using the scoring worksheet noted in Appendix B. However, a pretreatment site assessment will need to be conducted prior to Best Management Practice (BMP) installation.

3. Results

Of the 189 road/stream crossing sites that were identified in 2007 within the Pine River/Van Etten Lake watershed, 6 sites were ranked as severe, 128 sites were ranked as moderate and 55 sites were ranked as minor. This differs from the 9 severe, 119 moderate, and 55 minor in 2002—three of the most severe sites in 2002 were reassessed as moderate. The problematic condition of sites inventoried is based predominantly on road conditions, culvert size and placement, as described above. See Appendix B for more detailed site information.

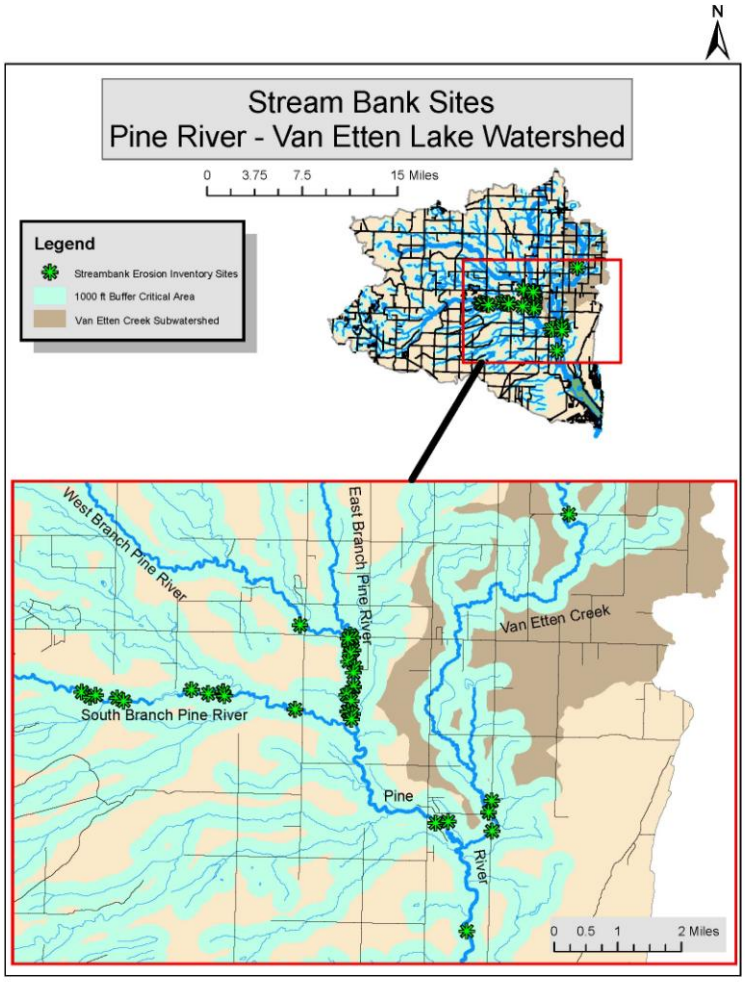
C. Streambank Erosion Inventory

1. Introduction

Moderately to severely eroding streambanks are sources of unwanted soil deposition to river systems. The erosive action of flowing water can cause untold cubic yards of soil to fall into a stream where it becomes suspended and clouds water clarity, disturbs aquatic life, hinders

navigation and may contribute excessive nutrients as they detach from soil particles. Additionally, severe streambank erosion jeopardizes land integrity and may result in the loss of residential property.

In order to reevaluate the severity, quantity and location of streambank erosion sites within the Pine River/Van Etten Lake watershed, a field re-inventory of severe sites was conducted by Huron Pines during the summer of 2008.



Map 13. PRVEL streambank inventory sites. A larger copy is with the actual inventory in Appendix C.

2. Methods

Between October 2001 and September 2002, a field inventory was conducted. Results from that inventory identified 36 streambank erosion sites. Each site was cataloged with a Global Positioning System (GPS) and data was collected to document site accessibility, condition of the bank, percent vegetative cover, apparent cause of the erosion, bank slope, length and height, river conditions, soil types, and recommended treatments. Photographic records were also made of each site.

Using the data collected in the original inventory, pollutant loading calculations were run for each site. Based on the severity of the erosion sites listed in the inventory, and using the pollutant loading calculations, the most severe sites were re-inventoried. This reevaluation focused on assessing the change in erosion severity since the previous inventory. Revisiting each severe site also allowed for a ground truthing of measurements in the previous inventory form. Using information reflecting any changes in erosion measurements or severity, the pollutant loading data was updated. The photographic record present on the attached inventory sheets is the original photo from the streambank evaluation completed in 2001.

3. Results

There were a total of 36 streambank erosion sites identified in the original inventory. Of those, six sites, listed as severe, were chosen for re-inventorying. For a more detailed survey of the specific site scores, characteristics and data forms refer to Appendix C.

D. Agricultural Inventory

1. Introduction

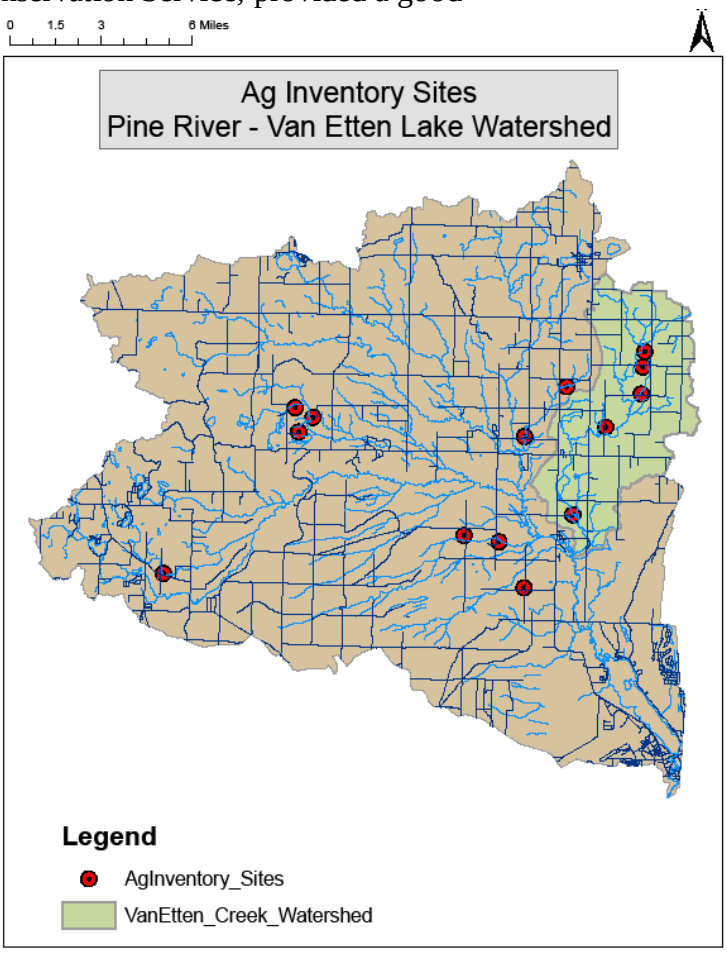
Agricultural practices on the land near riparian corridors may negatively influence water quality. The over-application of fertilizers or manure to the water's edge can introduce an excessive amount of nutrients such as nitrogen and phosphorus into the river system. Improper tilling practices used during row crop and, less frequently, hay production can also contribute to increased quantities of sediment and nutrients entering adjacent surface waters. Livestock that have unrestricted access to streams destroy banks and substrate, causing erosion along the streambank and deposition of sediment in the water. Furthermore, animal waste from livestock in stream or feedlots located close to waterways can add nutrients and pathogens to the river system.

Cattle behind exclusion fencing

In order to assess the agricultural influences within the critical area of the watershed, the inventory completed as part of the original PRVEL management plan was reevaluated. Though the existing information, gathered from the Alcona Conservation District, Michigan State University Extension and the Natural Resources Conservation Service, provided a good summary of active farms that were easily inventoried, there is no inventory that completely describes the agricultural setting in the PRVEL watershed. Coupling the inventory information from the original plan with broader resources such as air-photo interpretation and Geographic Information Systems will provide the best balance of existing information for developing a strategy to reduce nutrient and sediment loads to surface waters from agricultural practices. To provide the broader understanding of farming practices and their potential impacts on the watershed, a GIS analysis of land use data was conducted.

2. Methods

Site information such as: type of operation (i.e. livestock, crops, and orchard) estimated acreage, general topography and estimated riparian frontage were collected. Other information regarding soil type and stream conditions, as well as foreseeable risks to surface water, groundwater or wetlands were noted.



Map 14. PRVEL on-site agricultural inventory sites.

During the 2001-2002 survey apparent pollutant sources within 1,000 feet of surface water were documented. The types of pollutant sources that may have been noted were: unrestricted livestock access to water, crop production adjacent to water, feedlot runoff, manure storage runoff, manure application within 150 feet of a waterway, poor fertilizer storage, or other sources such as milking parlor runoff.

Treatments to reduce or eliminate apparent pollutant source(s) found on the farms inventoried were documented. These were discussed with landowners, when available, during the field visit. The recommended treatments, determined in consultation with the Natural Resources Conservation Service include: livestock exclusion fencing, livestock crossing or access points and/or alternate watering sources. Each of the 12 sites that were identified as having an apparent pollutant source to surface waters from the original agriculture inventory were re-inventoried in August of 2007. Photos were also taken at each site and corrections were made to the data sheets, if any, depending on current site conditions.

In 2008, a GIS spatial analysis was performed to enhance the information from the on-the-ground inventory. While information regarding active agricultural production within the watershed was compiled in an inventory for the original watershed management plan, the acreage of agricultural lands represented in that inventory reflected only 14.6% of lands known to be agricultural in the most recent land use/land cover GIS shapefiles. To better represent the overall picture of agriculture in the watershed, a broader GIS approach was used. This allowed Huron Pines to summarize the existence of farming practices throughout the PRVEL watershed, but also to focus in on Van Etten Creek, the one sub-watershed that is listed as impaired. The impacts leading to the impairment (nutrient loading) are believed to originate from agricultural practices. Comparing the existence of agriculture in the entire watershed to the presence of agriculture in the Van Etten Creek sub-watershed clearly shows that agricultural practices in the PRVEL watershed are concentrated along Van Etten Creek. To that end, the agricultural practices and their potential impacts to the Van Etten Creek sub-watershed are described. Implementing BMPs in the Van Etten Creek sub-watershed will provide the most effective pollutant reduction efforts for the entire PRVEL watershed.

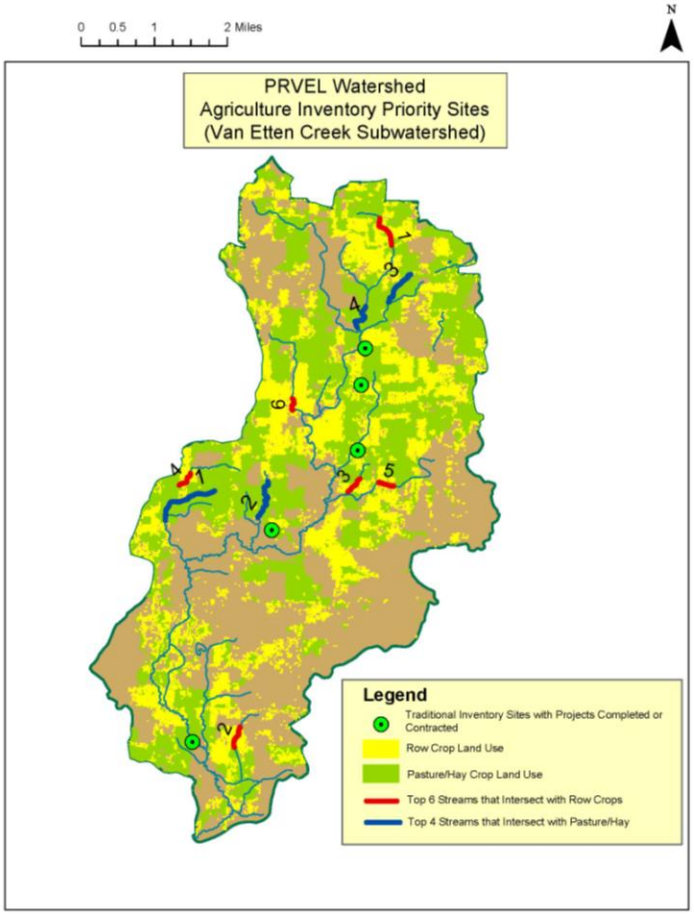
The Van Etten Creek sub-watershed contains 44.77 miles of stream and encompasses 17,682.22 acres. Related to the entire PRVEL watershed, which has 446.74 miles of stream and covers 180,779.48 acres, Van Etten Creek represents 10.02% of total stream miles and 9.78% of total area. Using the watershed and land use/land cover data in a GIS analysis exemplifies the intensity of agricultural practices and the potential for impact to Van Etten Creek.

When analyzing the land use/land cover shapefile, data representing pasture/hay and row crops were isolated as the land uses that best depict agriculture in the watershed. As a means of verification, we found that the active farms from the original inventory are all found within these two land use categories. In the entire PRVEL watershed, there are 9,288.97 acres of row crops and 14,988.90 acres of pasture/hay. Of those totals, 3,589.07 acres of row crop and 5,504.25 acres of pasture/hay are located in the Van Etten Creek sub-watershed. Though Van Etten Creek is only 10% of the watershed area, 38.64% of total row crops and 36.72% of total pasture/hay are located in this sub-watershed.

Evaluating the opportunities to minimize the impact of agriculture on Van Etten Creek will not only provide the most efficient strategy to reducing nonpoint source pollution in the PRVEL watershed, but the methods developed can be used to help inventory and prioritize potential agricultural impacts in other sub-watersheds to guide future efforts.

Without having the ground-truthing capabilities of a full-blown field inventory, there is no perfect method to determine the existence of current BMPs on active farms. Therefore, the analysis of the Van Etten Creek watershed assumes that there are no BMPs installed and that each location of the two types of agricultural lands exhibit the same potential to contribute sediment and nutrients to the river system. It is understood that row crop and pasture/hay practices have different potential impacts to surface waters.

For the purpose of prioritizing the potential impacts to the river, individual stretches of stream were ranked based on distance traveled through an agricultural land use. Using GIS software, all streams within the Van Etten Creek sub-watershed were clipped using the row crop file and the pasture/hay file separately, meaning that the stream map was "cut" to the shape of the maps of parcels showing each land use, leaving only segments where the two files overlapped. The resulting files showed every stream reach as it runs through each agricultural land use. Those stream reaches were ranked based on their length, assuming that installing BMPs on the longest stream reach will provide for the best reduction in nonpoint source pollution.



Map 15. PRVEL agricultural inventory priority sites.

3. Results

In the original and follow-up inventories of active sites, all have some apparent pollutant source to surface water. Two new sites were observed by staff and added to the inventory that includes site Id WP 258 and WP 259. Livestock access to water was documented at WP 258 and WP 259 has a feedlot operation that could potentially be a source of feed lot runoff. In addition to the field inventory, the data sheets were also reviewed by NRCS staff that is familiar with local agriculture producers to cross reference sites that did receive BMP implementation. The following information was provided by NRCS staff in order to initiate BMPs and identify which sites have made improvements:

WP 155—located on Roy Creek, exclusion fencing was installed to keep the herd out of the creek and a watering facility was installed.

WP 210—located on Van Etten Creek, the landowner is interested in installing exclusion fencing that would keep the herd from access of approximately one mile of the creek. NRCS staff stated this would be paid through their CCRP Program, however the landowner stated it would be difficult to complete the project without additional labor assistance.

WP 220—located on Van Etten Creek, the landowner has a contract to install a manure storage pit, however the storage facility has not been installed.

WP 227—located on a tributary of the E. Branch of the Pine River, the landowner plans to install large amounts of exclusion fencing and a pipeline to water his animals in the paddock. To date no work has been completed.

WP 259—located on Roy Creek, the landowner has a contract through NRCS, however no work has been completed.

In the spatial analysis, clipping all streams in the Van Etten Creek sub-watershed by the two agricultural land uses provided data describing the quantity and length of each reach of stream that travels through row crops or pasture/hay land uses. The total length of stream running through agricultural lands within the Van Etten Creek sub-watershed is 19.24 miles, representing 43% of all streams in the sub-watershed. Streams running through row crops totaled 7.92 miles, while streams traveling through pasture/hay summed to 11.32 miles.

Sorting the results of the clipped stream files shows that there are distinct reaches of stream that rank as higher priority sites. These stream reaches, based on length, run a higher risk of impact from agriculture due to the greater exposure to agriculture, in terms of distance. When analyzing the length data for each file, logical breaks in the distribution of length of stream reaches became evident. For the row crop layer, the six longest reaches totaled 1.64 miles (8679.71 ft), or 20.76% of the total amount of stream running through row crops. In terms of the pasture/hay land use, the longest four reaches of stream were found to accomplish 20% coverage of streams affected by pasture/hay. Those four stream reaches total 2.52 miles (13314.92 ft) to represent 22.28% of streams traveling through pasture/hay.

E. Shoreline Development Inventory

1. Introduction

Typical heavy turf management

Van Etten Lake is a borderline eutrophic, nutrient rich impoundment, with a shoreline that is nearly all developed. On such a waterbody, research has shown that excessive nutrients, often attributable to the activities of homeowners, are a major pollutant. While nutrients are essential for life, an overabundance of nutrients can lead to the accelerated eutrophication (aging) of the lake. An inventory of sites where nutrient enrichment is occurring makes for a useful watershed management tool. However, data generated by this inventory must be carefully interpreted and is intended only to help guide watershed management efforts.

Because the riparian zone plays such an important role, an inventory of the shoreline can assist in understanding current and future water quality problems. The critical shoreline area can either be developed in such a way that it is in a near natural state (working to filter nutrients, provide fish and wildlife habitat, and stabilize the shoreline) or be artificial (seawall with mowed, heavily fertilized turf grass to the water's edge). While most parcels may fall somewhere in-between, developed properties generally have shorelines that resemble the latter option. Loss of natural habitat and excessive nutrients work together to drastically change the natural condition of the lake, and while almost everyone wants to improve water resources, few take the relatively easy steps to do so.

As part of the assessment of the critical area of the Pine River/Van Etten Lake watershed an inventory of shoreline development was conducted on Van Etten Lake. The inventory began in August 2001 and was completed in October 2002.

2. Methods

The shoreline inventory was conducted on a parcel by parcel basis. Shoreline property parcels included developed and undeveloped lots, access sites and easements. Parcel numbers were assigned to each shoreline property parcel identified. Some of the categories of information collected for each shoreline property parcel included: substrate of parcel, aquatic plants observed in the nearshore area, turf management, erosion, structural setback, wetland regions and greenbelts. By using a small watercraft technicians were able to be near enough to the shoreline to effectively collect data. Methods for the shoreline inventory were based upon similar studies conducted by the Tip of the Mitt Watershed Council. See field data sheet in Appendix E for more details regarding data collection categories.

Turf management status was given a rating such as light, heavy etc. versus just a yes/no status. Heavy turf management is generally viewed as potentially attributing to water quality impairment. Greenbelts (or vegetated buffer strips along the shoreline) were rated on a scale of zero to 3.0 with 3.0 being an undeveloped shoreline with no disturbance of the natural vegetation and zero being ascribed to a site entirely paved or devoid of vegetation. In terms of water quality enhancement, a site rated as 2.5 to 3.0 would be considered excellent.

3. Results

The entire shoreline of Van Etten Lake, including Loud Island, was inventoried. Data was gathered on a total of 486 shoreline property parcels. Listed below are some of the findings noted in the shoreline inventory.

Turf Management

Number of Parcels rated Heavy	143 or 29%
Number of Parcels rated Moderate	199 or 41%
Number of Parcels rated Light	117 or 24%
Number of Parcels with no management	27 or 6%
Total	486 or 100%

Greenbelts

Number of Parcels rated 0 - 1.9,	Poor	447 or 92%
Number of Parcels rated 2.0 - 2.4,	Good	8 or 2%
Number of Parcels rated 2.5 - 3.0,	Excellent	27 or 6%
Remaining Parcels excluded as tributaries		4
	Total	486 or 100%

Seawalls

Number of Parcels noted with seawalls 312 or 64%

While the information from this study tells the amount of threatened shoreline around the lake, mapping the turf management around Van Etten Lake would show groupings of similar turf management practices and greenbelts, leading to a more efficient targeting of educational efforts and on-the-ground projects to reduce pollution entering the lake.

F. Van Etten Lake Water Quality Study

1. Introduction

Sampling water on Van Etten Lake

Van Etten Lake's annual blue-green algae bloom indicates that high levels of nutrients are entering the watershed. A component of the Pine River/Van Etten Lake Watershed Project was conducting a comprehensive water quality study in order to identify these nutrients, their sources and their respective contributions to the Pine River system and ultimately Van Etten Lake.

The Steering Committee established a technical subcommittee who then developed the parameters and basis for the study and retained an environmental professional to implement it.

Central Michigan University's Michigan Water Research Center conducted the eight-month study from April to November 2002.

2. Methods

Surface water samples were taken at seven stations within the Pine River System throughout the eight-month period. Additionally, water quality data and samples were also taken at three sites on Van Etten Lake.

Lake and stream temperature, conductivity, dissolved oxygen and pH levels were taken. Surface water was analyzed for nitrogen, phosphorus, ammonium and dissolved boron.

3. Results

The study revealed an extreme ratio of high levels of phosphorus to low levels of nitrogen within the lake. It is this nutrient condition that provides excellent growing conditions for blue-green algae.

The study also indicates that the output levels of dissolved phosphorus are higher in the lake system than the inputs at the mouth of the Pine River. This indicates that pollutant sources are being added from around the lake. Suggested sources are groundwater seepage, overland runoff and or sediment from the bottom of the lake. Septic systems leeching pollutants to the groundwater can contribute an overabundance of phosphorus. Phosphorus particles attached to sediment can also be released into the lake. It is noted that if fertilizer were the pollutant source the ratio would be more balanced.

Tributaries found to be contributing the most dissolved (usable to blue-green algae) phosphorus within the watershed are Van Etten Creek in Alcona County and the East Branch of the Pine River. Dissolved phosphorus is generated in animal waste, sewage, and fertilizer. Table 3.1 below describes the results of the different water quality parameters that were measured for selected streams in the watershed (Van Etten Creek because of the suspected high influence of agriculture, West Branch Pine River because of lack of agriculture, and Pine River to show results for lower in the watershed), while Table 3.2 describes the water quality results for Van Etten Lake. Seasonal averages are for the period of April-September 2002.

Table 3.1: Water Quality Study Results—Pine River and Van Etten Creek

Water Quality Parameter	Van Etten Creek Measurement	West Branch Pine River Measurement	Pine River Measurement	Conclusions Drawn
Temperature	Average 16.5º C	Average 16.5º C	Average 16.5º C	These temperatures are within the range usable by trout and other coldwater fish.
Dissolved Oxygen	Average 9.8 mg/L	Average 10.8 mg/L	Average 10.5 mg/L	These DO levels are above the minimum level required by coldwater fish.
pH	Average 8.1	Average 8.3	Average 8.2	Streams in this watershed are moderately basic.
Conductivity	Average 574.5 µS/cm	Average 433.0 µS/cm	Average 412.4 µS/cm	These are high concentrations of ions, particularly in Van Etten Creek. These ions may be entering the river through agricultural activity.
Total Dissolved Solids	Average 365.4 mg/L	Average 282.4 mg/L	Average 252.7 mg/L	These dissolved solid levels are much higher than in the lake, and Van Etten Creek is much higher than other tributaries.

Table 3.1: Water Quality Study Results—Pine River and Van Etten Creek				
Water Quality Parameter	**Van Etten Creek Measurement**	**West Branch Pine River Measurement**	**Pine River Measurement**	**Conclusions Drawn**
Phosphorus (P)	Average 95.0 µg/L	Average 25.9 µg/L	Average 26.3 µg/L	Van Etten Creek has an extremely high level of total phosphorus during the summer, likely from agricultural activity. Other streams exhibit averages closer to those seen in undisturbed and forested streams. In addition, the majority of phosphorus in Van Etten Creek and the East Branch Pine River was dissolved, meaning that the watershed soils are saturated with P or that there are direct inputs of animal or human waste.
Nitrogen (N)	Average Nitrate + Nitrite 14.7 µg/L	Average Nitrate + Nitrite 3.2 µg/L	Average Nitrate + Nitrite 3.6 µg/L	Van Etten Creek exhibited nitrogen concentrations higher than expected for undisturbed streams probably because of summer fertilizer applications, while the more forested branches of the river (West Branch and Pine River) absorbed nitrogen more readily.
Total Suspended Solids	Average 22.4 mg/L	Average 11.1 mg/L	Average 13.1 mg/L	Van Etten Creek had high TSS during the entire season, while the other streams peaked after rain events, meaning that the creek is more disturbed by human activity.

Table 3.2: Water Quality Study Results—Van Etten Lake		
Water Quality Parameter	**Van Etten Lake Measurement**	**Conclusions Drawn**
Temperature	Average 19.7º C at surface and deep hole bottom	Van Etten Lake is a warm water lake
Oxygen Concentration	10.0 ppm at the surface	Van Etten Lake is well-oxygenated, however measurements at the bottom of the lake during stratification periods showed low oxygen concentrations.
pH	Average 8.0-8.3	Van Etten Lake is moderately basic, similar to other Michigan Lakes
Conductivity	Average 322-342 µS/cm	This is a high concentration of ions.
Total Dissolved Solids	Average 188-216 mg/L	This is a high concentration of dissolved solids.
Phosphorus (P)	Total P: 27-30 µg/L seasonal surface average, 38 µg/L average at the deep bottom Total Dissolved P: 50-60% in June-August	Total P concentrations between 10-35 µg/L mean a lake is mesotrophic. This lake is at the high end of mesotrophic bordering eutrophic. Dissolved P is more readily available to algae and bacteria, so a large percentage can lead to algae blooms like those experienced on this lake.
Nitrogen (N)	Dissolved inorganic nitrogen average 5 µg/L seasonally with spikes up to 11 µg/L in April and June	These low levels may result from actively growing aquatic plants and the change from mostly nitrate to mostly ammonium from spring to late summer is common in undisturbed watersheds as microbes use nitrate and plants decompose, producing ammonium. The low ratio of dissolved nitrogen to dissolved phosphorus encourages blue-green algae blooms, common in eutrophic lakes.
Total Suspended Solids	4.1-6.0 mg/L seasonal surface average, 7.8 mg/L at deep bottom	The typical amount in lake systems is less than 5 mg/L
Boron	129-139 µg/L seasonal surface average, 143 µg/L at deep bottom	High concentrations during dry periods suggest that the boron is coming from groundwater inputs, most likely from septic systems (laundry detergent use)

Table 3.2: Water Quality Study Results—Van Etten Lake		
Water Quality Parameter	**Van Etten Lake Measurement**	**Conclusions Drawn**
Sediment Composition	Color: brown/gray, composed of clay, sand, and organic matter	
	Water content: 76% average	
	Organic content: 16.5% average	Van Etten Lake is a highly productive lake.
	Nutrient concentrations: 55 ppm P, 13.4 ppm N	Most N was ammonium, meaning the sediments were anoxic (low oxygen)
	Boron: 3.15 ppm	Boron is probably being stored in the sediments.

For more specific information and data regarding the Water Quality Study on the Pine River/Van Etten Lake watershed please refer to Appendix F for a complete copy of the Central Michigan University report.

G. Other Watershed Water Quality Information

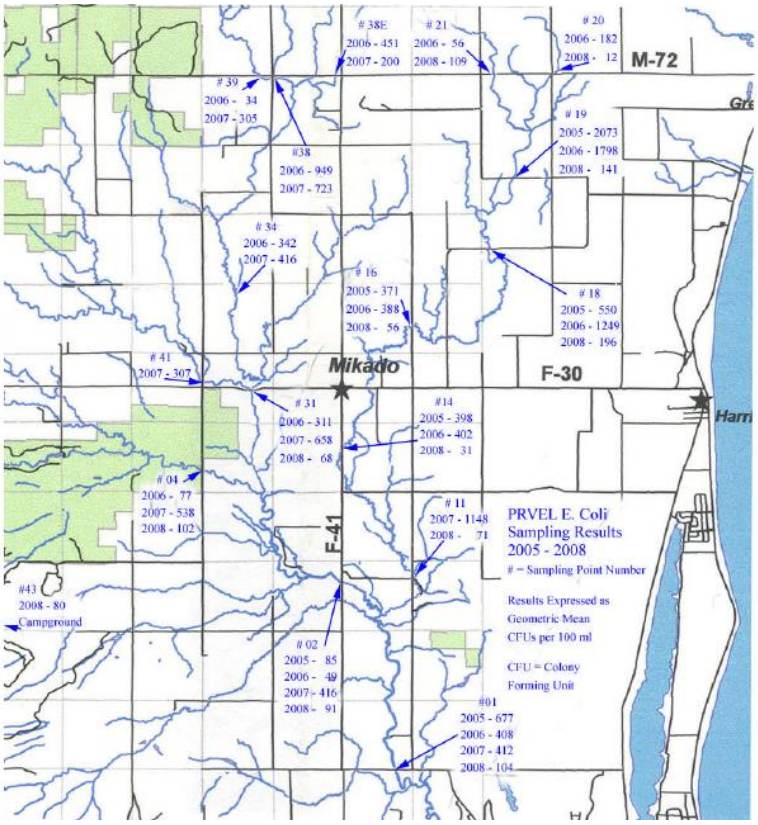
1. Cooperative Lakes Monitoring Program Monitoring

Members of the Van Etten Lake Association participate in the annual Cooperative Lakes Monitoring Program, a program where local citizens collect monitoring data on Michigan's inland lakes that is summarized for the Department of Environmental Quality (DEQ). It is a part of the MiCorps program, which assists the DEQ in gathering data through volunteers across the state. The most recent report was published in 2007 and included the following data (Table 3.2) on Van Etten Lake. The report analyzes the different parameters monitored through calculating Carlson Trophic State Index (TSI) values, which help to determine the overall trophic state of the lake.

Table 3.3: Cooperative Lakes Monitoring Program Results—2007		
Water Quality Parameter	**Van Etten Lake Measurement**	**Conclusions Drawn**
Secchi Disk Transparency (feet)	Mean 7.5 feet (Carlson TSI_{sd}: 47)	Van Etten Lake is in between mesotrophic and eutrophic.
Total Phosphorus (mg/L)	35 mg/L in spring and 21 mg/L in late summer (Carlson TSI_{tp}: 48)	Van Etten Lake is considered eutrophic by this measure.
Chlorophyll a (µg/L)	May: 11.0 µg/L, June: 1.6 µg/L, July: 4.3 µg/L, August: 3.8 µg/L (5.3 µg/L in a replication), September: 18.0 µg/L (Carlson TSI_{chl}: 45)	By this measure, which indicates plant life such as blue-green algae, Van Etten Lake is in between eutrophic and hypereutrophic.

2. Volunteer *E. coli* Monitoring

One of the Pine River-Van Etten Lake Watershed Coalition volunteers developed a monitoring program for *Escherichia coli*, a fecal coliform bacteria whose presence indicates possible water contamination with sewage from humans and agricultural waste. Trends in the amount of colony-forming units of the bacteria at each site will show whether activities in the area are contributing to water contamination or reducing it (i.e., after BMP installation). The volunteer sampled sites throughout the watershed starting in 2005, focusing on the stream portions of the watershed. The site locations are below in Map 16, and the four-year sampling results are in Table 3-3.



Map 16. *E. coli* volunteer sampling locations and results 2005-2008.

Van Etten Creek and the East Branch of the Pine River have the sites with the highest numbers of bacteria, which is expected since they have the highest concentration of agriculture in the watershed. In addition, the site with the lowest *E. coli* levels in Van Etten Creek and the East Branch was at the highest reach of Van Etten Creek, meaning that the bacteria is increasing as the water passes further downstream through agricultural areas. According to the four-year results shown on the map, the numbers of fecal coliform bacteria are decreasing throughout the watershed, although this could be because of a change in media in 2008.

Location	#	2008				4-year Combined Results			
		#	Mean	Max. #/100ml	Min.	n	Mean	Max. #/100ml	Min.
Pine River @ County Line	01	6	104	650	1	16	330	3500	1
Pine River @ F-41	02	4	91	180	33	14	112	2400	1
Pine River @ Andrews Rd.	03	2	40	80	20	2	40	80	20
Pine River @ Cruzen Rd.	04	4	102	240	38	10	162	2600	1
Van Etten Crk @ Barlow Rd S	11	6	71	920	1	9	285	3600	1
Van Etten Crk @ F-41 N	14	4	31	160	1	11	170	2600	1
Van Etten Crk @ Barlow Rd N	16	5	56	140	20	12	200	1300	20
Van Etten Crk @ Dellar Rd.	18	4	196	567	25	8	512	2500	25
Van Etten Crk @ Clemens Rd.	19	4	141	1050	1	11	806	5000	1
Van Etten Crk @ M-72 & McGregor	20	2	12	140	1	5	46	400	1
Van Etten Crk @ M-72 & Colville	21	4	107	340	20	7	78	1200	1
East Br Pine River @ F-30	31	4	68	110	20	10	241	3800	20
East Br Pine River @ Procunier	34					6	377	1000	200
East Br Pine River @ M-72 & F-41	38E					6	300	1750	100
East Br Pine River @ M-72 E	38					6	828	4200	100
East Br Pine River @ M-72 W	39					6	102	950	1
West Br Pine River @ Cruzen Rd.	41					3	307	1450	100
South Br. Pine River @ campground	43	1	80	80	80	1	80	80	80
Phalen Creek @ Loud Dr.	L6	4	35	220	1	11	60	800	1
Huron Creek @ Loud Dr.	L7	3	83	120	40	10	251	500	50
Dry Creek @ Shoreline	L8	4	82	260	20	8	139	500	50
Home tap water	Blank	6	0			17	0	0	0

= Number of samples
All results are expressed as CFU (colony forming units)/100ml
All samples incubated for 48 hours @ 92 +/- 5 deg. F in 2005 and 2006

Table 3.4 *E. coli* volunteer sampling results.

Chapter Four: Nonpoint Source Pollutant Loading and Reductions

I. INTRODUCTION

A. Pollutant Loading

Pollutant loading estimates were calculated to provide a baseline understanding of nonpoint pollution entering the Pine River/Van Etten Lake watershed. Although it is difficult to measure polluted runoff, several models were applied to the watershed to provide the most accurate description. Each model or calculation used and any assumptions made are described under the specific sources of nonpoint pollution.

It is important to note that the following pollution calculations and load reductions are based on models and not on chemical analysis conducted in the watershed. Although each model or calculation used is based on sample testing and applied to the Pine River/Van Etten Lake watershed, they are estimates only.

In addition, load estimates and load reductions are for the critical area of the watershed. The critical area is defined as that portion of the watershed which is most likely to impact water quality. The land area within 1,000 feet of surface water, priority road/stream crossings, and streambank erosion sites serves as the critical area. While land use throughout the watershed is important in determining water quality, nonpoint source pollution control is focused within critical area.

B. Critical Area Runoff and Pollutant Loading Based on Land Use Types

An overall watershed runoff analysis was completed using the Long-Term Hydrologic Impact Assessment (L-THIA) model (www.ecn.purdue.edu/runoff). The model was designed by Purdue University with cooperation from the U.S. EPA. Based on average annual runoff, soil conditions, land use type, and impervious cover, the L-THIA model estimates runoff volume and depths, and expected nonpoint source pollution loadings to waterbodies.

To determine runoff and pollutant loading for current conditions the land use figures (circa 1992) were used for the critical area. The following tables depict estimated runoff amounts and pollutant loading for nitrogen, phosphorus, and sediment. Table 4.1 shows the estimated nitrogen and phosphorus loading on a watershed-wide scale. This information was derived from the existing land use types in the watershed. The Pine River/Van Etten Lake Steering Committee prioritized nutrient loading as the highest pollutant of concern to the watershed. Common sources of nutrient loading include riparian septic systems, fertilizer use, livestock wastes, and stormwater runoff.

Table 4.1: Estimate of Phosphorous (P) and Nitrogen (N) loading to waterbodies (lbs/year)				
Land Use	Phosphorous		Nitrogen	
	Acres	Runoff (lbs.)	Acres	Runoff (lbs.)
Low Density Residential	406	9	406	30
Agriculture	5,038	784	5,038	2656
Grass/pasture	12,245	0.553	12,245	38
Industrial (Pits, Quarries)	1,337	212	1,337	956
Forest	39,026	0	39,026	0
Water (inc. wetlands)	27,197	0	27,197	0
Total acres	**85,239**		**85,239**	
Total annual loading (lbs)		**1005.553**		**3680**

Sediment was identified as the second priority pollutant of concern for the Pine River/Van Etten Lake watershed. Table 4.2 depicts sediment loading on a watershed scale based on existing land use. Common sources of sediment include road/stream erosion, streambank erosion (rivers), access sites/road ends, construction, and shoreline erosion (lakes).

Table 4.2: Average Annual Runoff (acre-ft*) and Sediment Loading Results				
Land Use	Average Annual Runoff		Sediment Loading (lbs./year)	
	Acres	Runoff (acre-ft)	Acres	Lbs./year
Low Density Residential	406	6.06	406	677
Agriculture	5,038	221.62	5,038	64,611
Grass/pasture	12,245	20.32	12,245	55
Industrial (Pits, Quarries)	1,337	278.53	1,337	45,914
Forest	39,026	0	39,026	0
Water (inc. wetlands)	27,197	0	27,197	0
Total acres	**85,239**		**85,239**	
Total annual volume		**526.55**		**111,257**

*Acre-feet=volume of water necessary to cover one acre to a depth of one foot (1 acre-ft=43,560 cu ft)

While the numbers from the L-THIA model give a general idea of the amounts of pollution entering the watershed, they are only estimates using standard numbers. Land uses like pits and quarries do not fit into the available model categories and therefore the amount of sediment entering the watershed as determined by the model may not be accurate. It is important to do further, more specific pollutant modeling combined with actual measurements to determine the true amounts of pollution entering the watershed from all sources.

The Pine River/Van Etten Lake watershed is a high-quality river system that currently meets all of the State of Michigan's designated uses except for the other indigenous aquatic life and wildlife, total body contact, and fish consumption designated uses. Even though installing selected Best Management Practices at erosion sites visibly contributing nonpoint source

pollution will help enhance the watershed and decrease pollution levels, the key to protecting the watershed will be proactive measures to keep it at the water quality level it currently exhibits. Increasing development and its associated impervious surfaces and runoff has the potential to greatly disrupt the system.

Understanding this, community leaders, residents, conservation groups, and other stakeholders have an opportunity to manage growth in a manner that is beneficial to the community's needs as well as protecting their water resources, wildlife habitat, and rural character that are the attraction for many people who live or recreate in the area.

C. Septic System Effluent

As more development occurs within rural areas that do not have centralized water management systems, the reliance on on-site wastewater treatment (septic systems) becomes greater. There also appears to be a greater demand to build vacation and retirement homes along waterbodies or to convert existing waterfront part-time dwellings to permanent residences. Septic systems can be very efficient at treating wastewater if they are properly sited, installed correctly, and maintained regularly. However, the cumulative impact of hundreds or thousands of individual septic systems within a watershed can lead to increased eutrophication (aging) of the lakes.

Septic systems typically consist of two components: a septic tank designed to intercept and hold partially treated solids and a drainfield, which disperses wastewater to surrounding soils. Septic effluent is the substance that passes through the tank to the drainfield and eventually filters through the soils. The major water quality pollutants from septic effluent are nitrogen and pathogenic bacteria. Phosphorus is also found in septic effluent but has a tendency to rapidly adhere to soil particles limiting its ability to move to groundwater or adjacent surface water. The most common shortcoming of septic systems is their inability to remove significant amounts of nitrogen. Only 20% of nitrogen that passes through conventional septic systems is effectively removed, although this number may be influenced by several factors (Siegrist and Janssen, 1989; Gold *et al*., 1990). Once in the drainage field, organic nitrogen is easily converted into nitrates, which are quite soluble and easily mobilized, thus increasing the potential for ground and surface water contamination (WIDILHR, 1991).

Pathogenic bacteria, parasites, and viruses are also found in septic effluent. Improperly treated wastewater from septic systems can contain unhealthy concentrations of bacteria and viruses harmful to many organisms, including humans.

Pollutants not removed by septic systems can migrate into groundwater by leaching through the soils. Much of the watershed is either excessively drained (sandy soils) which may not have adequate filtering capacity before pollutants reach ground or surface water; or poorly drained (clayey soils) soils with restricted permeability resulting in ponding during wet periods, both of which posing a potential risk for septic effluent to negatively impact water quality. Waterbodies may also be directly affected if a nearby system fails and the effluent ponds on or just below the soil surface.

It is difficult to estimate pollutant loading from septic systems. Many factors need to be considered including soil type, age, condition, use of system, and proximity of system to ground

and surface water. However, numerous studies have been conducted sampling effluent from identified septic systems. The following table was documented in the *Onsite Wastewater Treatment Systems Manual* published by the US Environmental Protection Agency in 2002 depicting several septic effluent studies and their associated pollutant levels. All of the studies in Table 4.3 documented septic effluent from residential homes.

Table 4.3: Characteristics of Domestic Septic Tank Effluent

Parameter	University of Wis. (1978)	Harkin, et al. (1979)	Ronayne, et al. (1982)	Ayres Associates (1993)	Ayres Associates (1996)
# tanks sampled	7	33	8	8	1
Location	Wisconsin	Wisconsin	Oregon	Florida	Florida
# samples	150	140-215	56	36	3
BOD mg/L[a]	138	132	217	141	179
COD mg/L[b]	327	445	-	-	-
TSS mg/L[c]	49	87	146	161	59
TN mgN/L[d]	45	82	57.1	39	66
TP mgP/L[e]	13	21.8	-	11	17
Oil/grease mg/L	-	-	-	36	37
Fecal coliforms log/L	4.6	6.5	6.4	5.1-8.2	7.0

[a]Biological Oxygen Demand (BOD) is used to determine how much oxygen is being used by aerobic microorganisms in the water to decompose organic matter. If aerobic bacteria are using too much of the dissolved oxygen in the water, there may not be enough left over for other aquatic organisms.
[b]Chemical Oxygen Demand (COD) is the quantity of oxygen used in biological and non-biological oxidation of materials in water. The higher the concentration the more oxygen the discharges demand from waterbodies.
[c]Total Suspended Solids (TSS) is the amount of filterable solids in a water sample.
[d]Total Nitrogen (TN) is the organically bound nitrogen and ammonia in a water sample.
[e]Total Phosphorus (TP)

Since model estimates represent sources potentially generated, the actual amount that might ultimately reach groundwater, well, or surface water is likely to be less. The opportunity for nutrient uptake is greater in large watersheds with abundant wetlands, where shoreline buffers have high nutrient removal potential, and where septic system setbacks are farther from adjacent waterbodies (e.g. 75-foot setback from water compared to 50-foot setback).

Numerous studies have been conducted researching the effectiveness of conventional septic systems and alternative on-site waste treatment from reducing pollutant loads. The following table compares effectiveness of different waste treatment practices and was provided by the U.S. EPA document *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.*

Table 4.4: Conventional and Selected Alternative Septic System Effectiveness					
On-site wastewater disposal practice	**Average Effectiveness (total system reductions)**				
	TSS (%)	**BOD (%)**	**TN (%)**	**TP (%)**	**Pathogens (logs)**
Conventional Septic System	72	45	28	57	3.5
Mound System	NA	NA	44	NA	NA
Anaerobic Upflow Filter	42	62	59	NA	NA
Intermittent Sand Filter	92	92	55	80	3.2
Recirculating Sand Filter	90	92	64	80	2.9
Water Separation System	60	42	83	30	3.0
Constructed Wetlands	80	81	90	NA	4.0
* an average household of 4 occupants was assumed					

In the Pine River/Van Etten Lake watershed, all residences use on-site septic systems. According to health department records, 57% of septic systems in the watershed are assumed to be more than 25 years old, which means a higher probability of leaks, backups, and failures causing wastewater and nutrients to leach into the lake. The table below shows the results of a volunteer septic system survey of the septic systems around Van Etten Lake.

Table 4.5: Van Etten Lake On-Site Wastewater System Permits							
Category	**Total**	**Years Permits Issued**					
	Systems	**Unknown**	**1969-79**	**1980-89**	**1990-99**	**2000-07**	**Vacant Lot**
Matched Special Assessment District (SAD) Properties	267	283	57	55	86	69	23
Matched Near Lake not in SAD	109	0	30	29	30	20	
Extras w/Permits	50	0	36	9	3	2	
Totals	**426**	**283**	**123**	**93**	**119**	**91**	**23**
Percentage in category	100%	66.4%	28.9%	21.8%	27.9%	21.4%	5.4%
Percent Assumed to be over 25 years old			57%				

For the purpose of the Pine River/Van Etten Lake watershed management plan, the figures from the Harkin et al. study *Evaluation of Mound Systems for Purification of Septic Tank Effluent*

were utilized. As documented by the resource inventory 426 septic systems are located within 1,000 feet of Van Etten Lake.

Unfortunately, we were not able to obtain health department records for septic systems located along the river system. Therefore, we are unable to estimate total watershed pollutant loading from septic systems. We do know however that all residences within the watershed use an on-site septic system and based on conditions in northern Michigan it is safe to assume that numerous systems may be compromised either from sub-standard installation and/or maintenance (placed too close to waterbodies, not regularly inspected) or are undersized due to conversion from seasonal use to full-time use. By educating residents about the impacts of old or faulty systems and encouraging proper maintenance and replacement, the amount of pollution entering the watershed from septic systems will be greatly reduced.

D. Lawn Care Practices in the Riparian Zone

Lawn care practices by those living along waterbodies can greatly influence the water quality of the adjacent lake or stream. Maintaining or reestablishing a native vegetative buffer (greenbelt) along the lake or river provides many benefits to water quality and wildlife habitat. Greenbelts help prevent shoreline erosion, keep river temperatures cooler, provide important habitat for aquatic and terrestrial wildlife, help reduce runoff, and filter pollutants before they can reach the water. The primary nutrient that stimulates excess growth of plants in a lake is phosphorous. One pound of phosphorous can produce up to 500 pounds of aquatic plant or algae growth once it washes into a lake (MNDNR, 1999). Common sources of nutrient loading include riparian septic systems, fertilizer use, livestock wastes, and stormwater runoff.

Results from the shoreline development survey were used to estimate the amount of phosphorus entering the lakes within the watershed. Estimates were calculated for development along lakes and do not include phosphorous loading from residential development along the river for two reasons: phosphorus is typically the pollutant of concern in lake ecosystems and data were not available for residential development and lot size along the Van Etten Lake shoreline. The total developed acres for the lake were calculated and adjusted for the assumption that nearly 70% of riparian landowners fertilize their lawns (Schueler, 2002). This provided the amount of developed acres receiving fertilizer application.

A study was conducted in Minnesota by Lake Access where six small watersheds were selected as the study sites. Three of the sites were located in a community where the use of fertilizer that contained phosphorous was restricted and three were located in a community where there are no such restrictions. Runoff from each of the study areas flowed to a single outlet pipe and phosphorous samples were collected there. (There are other sources of phosphorous to aquatic systems including grass clipping, leaves, and pet waste; however, there are no strong reasons that these alternate sources differ among the study watersheds.)

The study found that the phosphorous runoff was .22 pounds per acre of land in communities without fertilizer restrictions, whereas .09 pounds of phosphorous runoff per acre of land was documented in communities that have phosphorous free fertilizer ordinances. These findings were applied to the number of developed lake acres within the Van Etten Lake subwatershed to

estimate pollutant loading and load reduction if residents used phosphorous-free fertilizers encouraged through education or forced through ordinances.

In addition, the percent parcels with good greenbelts were also taken into consideration. It is estimated that a good greenbelt reduces approximately 75% of runoff and associated pollutants (MDEQ, 1999). A "good" greenbelt is one where minimal vegetation has been removed along the shoreline providing a buffer between homes or other development and the adjacent waterbody.

The following is a description of how pollutant loading from fertilizer use was calculated using shoreline inventory data and phosphorous loading information provided by Lake Access.

Fertilized acres = Developed shoreline * 50 feet (depth) *70% (residents that fertilize)
Phosphorous loading = Fertilized acres *.22 (P loading) **or** .09 (P reduction)
P loading: no greenbelt = Phosphorous loading *% of no greenbelt
P loading good greenbelt = Phosphorous loading *% good greenbelt *.25 (adj. for greenbelt filter capacity)
Total phosphorous loading = P loading no greenbelt + P loading good greenbelt

Table 4.6 estimates pollutant loading from riparian fertilizer use along with the estimated phosphorous loading if phosphorous free fertilizer is applied in place of conventional fertilizers.

Table 4.6: Phosphorous Loading from Riparian Fertilizer Use (lbs/year)

	Developed Shoreline (miles)	Fertilized acres	P loading: no greenbelt (lb/ac)	P loading: good greenbelt (lb/ac)	Total phosphorous (lb/ac)
Regular residential fertilizer use	10.1	42.86	8.67	.189	8.86
Residential use- No Phosphorus Fertilizer	10.1	42.86	3.548	.077	3.63
				Total reduction	**5.23**

The estimated total phosphorous loading with no restrictions or voluntary use of p-free fertilizer is 8.86 pounds per year. The estimated total phosphorous loading using P-free fertilizer is 3.63 pounds per year, a load reduction of **5.23** pounds of phosphorous per year (59% reduction).

E. Road/Stream Crossing Pollutant Loading and Reduction Estimates

1. Inventory Sites

One hundred eighty-nine road/stream crossing sites were located within the PRVEL Watershed. The crossings ranged in size from a bridge over one hundred feet long to culverts twelve inches in diameter. The majority of the crossings were on unpaved roads with one or multiple culverts controlling the water flow under the road.

2. Road/Stream Crossing Pollutant Loading

Total sediment loading was calculated for each road/stream crossing site inventoried within the watershed. Two equations were used to calculate sediment loading. First, the Revised Universal Soil Loss Equation (RUSLE) was used to calculate sediment discharge in tons per year and cubic yards per year for each approach.

$$A = R * K * LS * C * P$$

A = average annual soil loss in tons/acre
R = rainfall-runoff erosivity factor
K = soil erodibility factor
LS = slope factor
C = cover management factor
P = support practice factor

For this application we used a cover management value of 1 for unpaved roads and a value of .12 for paved roads. The second method, Lateral Recession Rate (LRR), was used in an attempt to assess the amount of soil loss occurring at each embankment.

$$LRR = Height * Width * Erosion\ Severity$$

The following values were used for erosion severity: Slight = .02, Moderate = .14, Severe = .4, and Very Severe = .5. The total from each equation was added together for a total sediment loading estimate per site.

Estimated sediment loading for road/stream crossings is 307 ***tons per year.***

In addition to sediment loading, phosphorus and nitrogen loading were calculated. High amounts of nutrients in a waterbody accelerate vegetation and algae growth thus contributing to eutrophication of surrounding lakes.

The amount of phosphorus and nitrogen attached to sediment was calculated using information collected by USDA-ARS researchers. The estimate starts with an overall phosphorus concentration of 0.0005 lbP/lb of soil and a nitrogen concentration of 0.001 lbN/lb of soil. Soil texture is determined and a correction factor is used to better estimate nutrient holding capacity of the soil (MDEQ, 1999). Sand is the dominant soil texture for the PRVEL Watershed, thus a correction factor of 0.85 was used.

Road/stream crossing phosphorus load estimate:

*307 tons/yr * 0.0005 lbP/lb soil * 2000 lb/ton * 0.85=* ***261 pounds of phosphorous per year***

Road/stream crossing nitrogen load estimate:

*307 tons/yr * 0.0001 lbN/lb soil * 2000 lb/ton * 0.85=* ***522 pounds of nitrogen per year***

3. Road/Stream Crossing Pollutant Load Reductions

a. Priority Sites

A total of nine sites were identified as priorities for future Best Management Practices (BMPs) installation and improvement projects. The sites were chosen based on their sediment discharge and their impact on coldwater fisheries. The suggested BMPs are based on the site inventories and source of nonpoint pollution. Improvement to 5% of the road/stream sites will result in 40% reduction of sediment loading to the watershed.

When implementing road/stream BMP's, priority will be given to those sites listed in Table 4.7 because they are contributing significant amounts of sediment to the river system. Although all of these sites ranked high, additional factors were considered while choosing these sites such as the type of crossing and feasibility of implementing BMPs. Other factors may be considered including the amount and availability of funding, location in the watershed, and partner involvement. These factors may contribute to the selection to a site other than those sites listed below.

b. Sediment Reduction

The load reduction estimates were made using the same approach for both road stream crossings and streambank estimates for the embankments. A value of.75 was used in the Load Reduction Estimate Spreadsheet (MDEQ, 1999) for the BMP efficiency. Vegetative buffers remove 75% of sediment and this application closely resembles the suggested BMPs for each site.

The load reduction for the approach work was calculated using the RUSLE. The value for the cover management factor for unpaved roads is 1. The suggested BMP is to pave both approaches lowering the cover management factor to.12.

Table: 4.7 Sediment Load Reduction for Selected Road/Stream Crossing Sites						
Site ID	**Justification**	**Suggested BMP's**		**Current Loading tons/year**	**Estimated Load Reduction tons/year**	**Estimated Cost**
49	Pool formation at culvert outlet Poorly aligned culvert	Replace and realign: elliptical Harden approaches Revegetate	85'x4' 1981' 600 sq ft	19.45	17.12	$41,312
80	Embankment erosion Poor culvert alignment Sand/soil over crossing	Replace culvert: timber bridge Harden approaches Add rock riprap Revegetate	25' 530' 5 cu yds 200 sq ft	13.93	12.26	$139,177
87	Streambank erosion Pool formation at culvert outlet Undersize culvert	Replace culvert: timber bridge Harden approaches Add rock riprap Revegetate	25' 686' 5 cu yds 200 sq ft	2.84	2.5	$139,084
100	Embankment erosion Pool formation at culvert outlet Sand/soil over crossing Deteriorating road	Replace culvert: bottomless arch Harden approaches Add rock riprap Revegetate	49'x10' 370' 5 cu yds 800 sq ft	2.69	2.37	$30,122
104	Embankment erosion Sand/soil over crossing Damaged culverts	Replace culvert: bottomless arch Harden approaches Add rock riprap Install diversion outlets Revegetate	35'x12' 1,028' 5 cu yds 3 500 sq ft	11.38	10.01	$32,364
113	Sand/soil over crossing Long steep approaches Undersize culverts	Replace culvert: bottomless arch Harden approaches Revegetate	52'x15' 657' 800 sq ft	5.07	4.46	$36,530
136	Embankment erosion Pool formation at culvert outlet Long steep approaches	Replace culvert: timber bridge Harden approaches Add rock riprap Install diversion outlets Revegetate	25' 1083' 8 cu yds 2 300 sq ft	17.19	15.13	$148,986
144	Embankment erosion Streambank erosion Pool formation at culvert outlet Fish passage issue Cattle in stream	Replace culvert: bottomless arch Harden approaches Add rock riprap Install diversion outlets Revegetate	45'x12' 1,233' 5 cu yds 2 800 sq ft	32.01	28.17	$39,670
157	Embankment erosion Sand/soil over crossing Long steep approaches	Replace culvert: timber bridge Harden approaches Add rock riprap Install sediment basins Revegetate	35' 1,058' 8 cu yds 2 400 sq ft	35.5	31.24	$149,131
	Totals	**Replace culverts** **Install timber bridges** **Install diversion outlets** **Install sediment basins** **Harden approaches** **Revegetation**	**5** **4** **7** **2** **8,626'** **4,600 sq ft**	**140.06**	**123.26**	**$756,376**

F. Streambank Erosion Pollutant Loading and Reduction Estimates

1. Inventory Sites

There were a total of 36 streambank erosion sites identified in the original inventory. All of the site inventories provided data to be used in the pollution loading calculations. Of the inventoried erosion sites, six were ranked severe. Those six were revisited, to assess any change that may have occurred.

Three of the erosions sites were caused by only "natural" activities such as bends in the river and bank seepage. The other three severe erosion sites were influenced by human activities in addition to the effects of natural features—all are on the outside bend in the river. The human activities aggravating the erosion are varying degrees of foot traffic to the river.

2. Streambank Pollutant Loading

The Lateral Recession Rate (LRR) was used to estimate the amount of sediment loading on identified streambank erosion sites. The following formula was used:

$$LRR = Height * Width * Erosion\ Severity$$

The following values were used for erosion severity: Slight = .02, Moderate = .14, Severe = .4, and Very Severe = .5.

*The estimated sediment loading for streambank erosion is **1043 tons per year***

The same calculations for estimating road stream nutrients were also applied to streambank nutrient loading.

Streambank phosphorus load estimate:

*1043 tons/yr * 0.0005 lbP/lb soil * 2000 lb/ton * 0.85 = **1774 pounds phosphorus per year***

Streambank nitrogen load estimate:

*1043 tons/yr * 0.001 lbN/lb soil * 2000 lb/ton * 0.85 = **887 pounds of nitrogen per year***

3. Streambank Pollutant Load Reductions

a. Priority Sites

Load reductions were calculated for the four most severe sites. Best Management Practices were identified for each site reflecting the source and cause of sediment. Improvement to these four severe sites, or 11% of the eroding streambanks, will address 55%, or 577 tons, of the sediment load.

When implementing streambank BMPs, priority will be given to the sites listed in Table 4.8 because they are contributing the majority of sediment to the river. However, other factors including landowner willingness, availability of funding, site location and accessibility, and partner involvement may contribute to the selection of installing BMPs at erosion sites not listed below.

b. Sediment Reduction

The load reduction estimates for streambank erosion contributing sediment was based on the size and severity of the erosion site. A value of .75 was used in the Load Reduction Estimate Spreadsheet (MDEQ, 1999) for the BMP efficiency. Vegetative buffers remove 75% of sediment and this application closely resembles the suggested BMPs for each site.

Table 4.8: Sediment Load Reduction for Selected Streambank Erosion Sites

Site ID	Justification	Suggested BMPs		Current Loading (tons/year)	Estimated Load Reduction (tons/year)	Estimated Cost
9	Light Foot Traffic along area of Bank Seepage	Tree Revetment Brush Placement Revegetation	75' 750 sq ft 2000 sq ft	83	62	$2,500
18	Bend in River, Steep Banks, Heavy Foot Traffic	Tree Revetments Revegetation Stairway Fencing	250' 7000 sq ft 40 ft 200 ft	193	144	$8,000
29	Bend in River	Tree Revetments Revegetation	250' 3000 sq ft	56	42	$4,500
33	Bend in River	Tree Revetments Brush Placement Revegetation	500' 4000 sq ft 8000 sq ft	245	184	$10,500
	Totals	Stormwater Basin Tree revetments Installation of bio-logs Roadway Hardening Revegetation Riprap Extend Stairway Terracing	**200 sq ft** **175'** **95'** **500'** **1350 sq ft** **25'** **30'** **30'**	**577**	**432**	**$25,500**

c. Nutrient Reduction

Because the pollutant load estimates for nutrients were based on sediment loading, the load reduction estimated for phosphorus and nitrogen is based on the amount of sediment reduced at each site.

Table 4.9: Phosphorus and Nitrogen Load Reduction for Selected Streambank Erosion Sites

Site ID	Phosphorus (lbs/year)		Nitrogen (lbs/year)	
	Estimated Load/Year	Estimated Reduction/Year	Estimated Load/Year	Estimated Reduction/Year
9	70	53	140	105
18	164	123	327	245
29	48	36	95	71
33	208	156	417	313
Total	**41**	**30**	**80**	**60**

G. Agriculture Pollutant Loading and Reduction Estimates

1. Pollutant Loading

The most comprehensive method for determining the amount of pollution entering the watershed from all agriculture as opposed to the few sites represented in the 2002 inventory is to use GIS. Sorting the results of the GIS agriculture analysis shows that there are distinct reaches of stream that rank as higher priority sites of pollution entering streams. These stream reaches, based on length, run a higher risk of impact from agriculture due to the greater exposure to agriculture, in terms of distance. When analyzing the length data for each file, logical breaks in the distribution of length of stream reaches became evident. For the row crop layer, the six longest reaches totaled 1.64 miles (8679.71 ft), or 20.76% of the total amount of stream running through row crops. In terms of the pasture/hay land use, the longest four reaches of stream were found to accomplish 20% coverage of streams affected by pasture/hay. Those four stream reaches total 2.52 miles (13314.92 ft) to represent 22.28% of streams traveling through pasture/hay.

Using the 1,000 ft buffer as a means to determine the level of impact on the stream by these two agricultural land uses lends a strategy to calculate pollutant loading and potential reduction of nonpoint pollution sources in the watershed. Calculating the amount of sediment and nutrients from the acreage of farmland adjacent to the ten stream reaches identified above was done using the Long-Term Hydrologic Impact Assessment (L-THIA) model (www.ecn.purdue.edu/runoff).

Within the 1,000 ft buffer, there are 398.49 acres of row crops through which the 6 longest segments of stream run. The potential input of sediment and nutrients along those 6 reaches, based on the L-THIA model and assuming there are no BMPs in existence, is 5,110 lbs of sediment, 210 lbs of N, and 62 lbs of P. The four longest segments of stream running through pasture/hay are bordered by 611.34 acres of that land use. The potential input of nonpoint source pollution to the streams from that acreage of pasture/hay is 2 lbs of sediment, 1 lb of N, and 0.027 lbs of P. The low amounts of potential sediment and nutrient loads are under the auspice that there are no cattle pastured on this land use within the L-THIA model. Overlaying the GPS locations of known cattle operations in the watershed shows that many are located on lands classified as pasture/hay. Therefore, caution needs to be used when proceeding with values set forth in the above calculations.

One site from the original inventory of active farms provides the best opportunity to begin the further investigation of possible BMP installation needs. That farm, found downstream of the outlet of Sprinkler Lake, can be seen from the road where Adams Rd. crosses the stream. That farm has direct access for the cattle to the stream as a watering source. This farm would be a good starting point for working with the agricultural community to reduce nonpoint pollution to the stream.

2. Load Reductions

Using the GIS methodology set forth above provides a result that should be used to guide the next level of investigation. When approaching residents of the agricultural community, the landowners that are in the proximity of the six longest reaches of stream flowing through row crops should be approached with a list of BMP recommendations. With the assumption that the

existing farmlands do not have any BMPs in place, efforts should focus on working with landowners to install filter and/or buffer strips along crop lands and pastures. Conservation tilling practices should also be discussed with all agricultural producers. For the purpose of calculating nutrient and sediment loads, the L-THIA model was used based on the amount of acreage of farmlands surrounding each stream reach. A value of .75 was used in the Load Reduction Estimate Spreadsheet (MDEQ, 1999) for the BMP efficiency. Vegetative buffers remove 75% of sediment and the suggested BMPs are predominantly based on vegetation.

Reductions in pollutant loading for each individual stream reach can be seen in Table 4.13 below. With BMP installation on each of the recommended stream reaches, yearly reductions in pollutant loading are expected to be in the realm of 3,850 lbs of sediment, 157 lbs of Nitrogen, and 45 lbs of Phosphorus. Again, these calculations are based on the assumption that cattle are not being pastured on each of these land uses. Using the GPS points of working cattle farms from the original inventory, several sites are known to occur in the pasture/hay land use. However, not enough data exists to assume that all of the pasture/hay parcels have cattle being pastured.

Working from the original inventory of active cattle farms, the focus should be on approaching the land owners of those farms to determine what level of interest the land owner has in BMP installation, as well as what BMPs may be in action already. It is recommended that known livestock operations install exclusion fencing and an alternative watering source or cattle access/crossings. Along with the fence installation it is suggested that a riparian buffer strip be planted within the fence zone. BMPs for other farms bordering surface water include conservation cover, filter strips, exclusion fencing, and alternate water sources. Table 4.10 below shows the estimates for removal of nutrients and sediment by installing these BMPs to protect streambanks.

Table 4.10: Agriculture Pollutant Loading and Load Reduction Estimates for Row Crops

Stream Reach ID	Sediment (lbs/year)		Phosphorous (lbs/year)		Nitrogen (lbs/year)		Costs
	Estimated Load/Year	Estimated Reduction/Year	Estimated Load/Year	Estimated Reduction/Year	Estimated Load/Year	Estimated Reduction/Year	
RC1	1390	1043	16	12	57	43	$8,676
RC2	948	711	11	8	39	30	$5,918
RC3	773	580	9	7	31	23	$4,826
RC4	770	578	9	7	31	23	$4,805
RC5	665	499	8	6	27	20	$4,149
RC6	562	437	6	5	23	17	$3,506
PH1	1	.75	.01	.007	.7	.5	$17,617
PH2	.68	.51	.01	.005	.48	.36	$12,183
PH3	.58	.44	.01	.004	.41	.31	$10,319
PH4	.5	.38	.004	.003	.35	.26	$8,788
Total	**5111**	**3850**	**59**	**45**	**210**	**157**	**$80,787**

H. Total Watershed Pollutant Loading and Reduction Estimates

The following table is a summary of the pollutant loading and reduction results in the preceding sections of this chapter. Comparing the L-THIA model to the RUSLE and BMP calculations for the inventories provides significantly different numbers for pollutant loading. The amounts of sediment and phosphorus being added to the watershed are lower in the L-THIA model, while the amount of nitrogen entering the watershed is much higher in that model than the other calculations. While the actual reasons that the models are different are unknown, it appears that the road/stream crossing and streambank erosion sites are adding much more sediment than a general model would suggest. Treating the most severe sites of each type would prevent large amounts of pollution from entering the system. In addition, treating severe streambank erosion sites first would remove a greater percentage of pollutants from the system than any other treatment. Using these models to help prioritize the sources of pollution to the watershed informed the goals and objectives of this watershed plan, contained in Chapter 5.

Table 4.11: Total Watershed Pollutant Loading and Reduction Estimates

Pollution Source	Sediment (lbs/year)		Phosphorous (lbs/year)		Nitrogen (lbs/year)	
	Estimated Load/Year	Estimated Reduction/Year	Estimated Load/Year	Estimated Reduction/Year	Estimated Load/Year	Estimated Reduction/Year
All Watershed (L-THIA)	**111,257**		**1,005.553**		**3,680**	
Lawn Care Practices			8.86	5.23		
Road/Stream Crossings	614,000	460,500	261	195.75	522	391.5
Streambank Erosion Sites	2,086,000	1,564,500	1,774	1,330.5	887	665.25
Agriculture	5,111	3,850	59	45	210	157
Total	**2,705,111**	**2,028,850**	**2,102.86**	**1,576.48**	**1,619**	**1,213.75**

Chapter Five: Goals and Objectives

I. INTRODUCTION

A. Implementation

The goals for the Pine River-Van Etten Lake watershed were developed by the Steering Committee to protect the designated and desired uses of the watershed. The goals are recommendations for implementation efforts within the watershed. Each goal has multiple objectives that outline how the goal can be reached. Tasks were identified for each objective indicating steps needed to reach the objective. Implementing most objectives requires a combination of four types of activities, each with associated tasks. These include:
1. Implementing Best Management Practices (BMPs), 2. Reviewing and modifying existing projects, programs and ordinances, 3. Designating and implementing education and information activities, and 4. Evaluating the effectiveness of planned activities.

For each objective the Steering Committee has identified the subwatersheds for which the goal is a priority, the organizations that are best suited to implement the tasks, an estimated timeline for completion, estimated costs for implementation, and signs of success to evaluate the status of implementation efforts. This information is found in subsection C. Goals and Objectives.

B. Priority Method

Prioritization of the goals for the Pine River-Van Etten Lake watershed was completed by the Steering Committee. Each Steering Committee member present for the June 2002 meeting was given the opportunity to vote on chart-sized listings of the goals. Each member was given priority stickers to post on the charts to record their preference for the identified goals. The votes were tallied and the goals prioritized based upon the final count for each. In 2008, the goals were revisited by the Steering Committee and updated to include more information and current status reports. These are the goals and objectives for the Pine River-Van Etten Lake watershed generated and prioritized by the Steering Committee:

C. Goals and Objectives

1. Project Goals

Each project goal addresses an overall improvement in the watershed and contains objectives with specific tasks and details as organized below. The milestones for each objective are set on a 10-year implementation schedule, which will begin once funding to achieve each objective is obtained. The goals for the Pine River-Van Etten Lake watershed are

Goal 1: Improve and protect the coldwater fishery of Pine River and its tributaries.

Goal 2: Ensure that the total/partial body contact designated use for Van Etten Lake is met.

Goal 3: Restore Van Etten Creek of Alcona County to levels that will ensure it is removed from the State's non-attainment list.

Goal 4: Improve and protect the aquatic habitat within the watershed.

Goal 5: Protect critical wildlife habitat areas within the watershed.

Goal 6: Sustain the Pine River-Van Etten Lake Watershed Management Process.

2. Objectives

Under each objective are the following categories:

Milestones needed to execute this strategy: Sub-tasks to ensure the overall strategy is being implemented (signs of success)
Task Products: General water quality goals for objective
Typical System of BMPs: BMPs that may be used to accomplish the water quality benefits
Water Quality Benefits: Load reductions or other water quality or habitat benefits
Evaluation Methods: Methods to determine if the tasks are being implemented and whether they are effective at reducing nonpoint pollution
Lead Organization(s) for ensuring this project is implemented: Group(s) responsible for each strategy
Technical assistance: Support from experts other than the lead organization needed to properly implement the strategy
Timeline: Number of years needed to complete the strategy (overall total is 10 years for the management plan)
Cost: Funding needed to implement each strategy
Funding Sources: The partners, programs, foundations, and grants where funding might be sought
Level of Effort: Specific details related to successfully initiating each strategy
Priority: Level of importance given to each strategy
2008 status: Review of projects completed during 2006–2008

Goal 1: Improve and protect the coldwater fishery of Pine River and its tributaries.

Subwatershed: Pine River, Van Etten Creek

Objective 1.1: Reduce sediment at the 9 priority road/stream crossings that have been ranked as severe.

Milestones:

- Conduct analysis of sites (including stream geomorphology) for appropriate treatment and develop engineering designs by year one.
- Stabilize eroding road/stream crossings needing culvert replacement or culvert extensions by implementing BMPs by years two through five.
- Conduct post-BMP stream geomorphology survey at each site in years two through five.

Task Products: Completion of BMP installation at the nine priority eroding road/stream crossings as specified in chapter 4 (2,800 sq feet of revegetation, 31 cubic yards of rock riprap, 2 sediment basins, 7 diversion outlets, 6,383 linear feet of pavement, 5 culvert replacements).

Typical System of BMPs: Replace culverts with single span bridge or new culverts or extend culverts. Then reshape and vegetate side slopes, install water turnouts with stabilized outlets, rock at abutment. Some paving of approaches; some detention or infiltration for treatment of runoff may be necessary.

Water Quality Benefits: Reduction of sediment and nutrients entering the watershed from these sites by 75%.

Evaluation Methods: Before and after photos, stream geomorphology assessment, calculate BMP load reduction

Lead Organization: Huron Pines

Partners: Alcona and Iosco Road Commissions, USDA Forest Service, Natural Resources Conservation Service

Technical Assistance: Engineering services

Timeline: 5 years

Cost: $115,000/site (total: $1.033 million)

Funding Sources: 319 and CMI programs, County Road Commissions, US Fish & Wildlife Service, USDA Forest Service

Level of Effort: Two severe sites completed per year.

Priority: High

2008 Status: The USDA Forest Service has two agreements in place with the Alcona County Road Commission to replace a number of road stream crossings within the proclamation boundary of the Huron National Forest. The following sites were reported to be on the Forest Service's priority list for replacement as of 2006: Stout Road at McGillis Creek, F-30 at a Kurtz Creek tributary, and F-30 at the North Lake outlet. In 2007, Alcona County Road Commission crews revamped the stream crossing at Buhl Road and Gimlet Creek south of F-30 replacing existing culverts with a retired railroad tanker car. All road/stream crossings in the watershed were reinventoried in 2007.

Objective 1.2: Provide one-on-one technical assistance with agriculture producers to utilize exclusion fencing/buffer strips along the entire riparian corridor.

Milestones:
- Identify current agricultural practices in year one
- Distribute educational materials in year one
- Encourage participation in USDA matching funds programs in years one through five
- Conduct seminars on BMPs in year two

Task Products: Educational materials and seminars

Typical System of BMPs: Livestock exclusion fence and filter strip installation, educational and managerial efforts to change operating procedures

Water Quality Benefits: Reduction of pollution entering the watershed from agricultural lands through increased awareness of agricultural producers to implement water quality conservation practices

Evaluation Methods: Before and after photos, stream geomorphology assessment, calculate BMP load reduction

Lead Organization: Natural Resources Conservation Service

Partners: Alcona and Iosco Conservation Districts, Michigan State University Extension, Huron Pines

Technical Assistance: Engineering services

Timeline: 5 years

Cost: $10,000/year (total: $50,000)

Funding Sources: 319 and CMI programs, Natural Resources Conservation Service-Wildlife Habitat Incentives Program and other agricultural cost-share programs

Level of Effort: Conduct one BMP seminar and actively promote livestock exclusion fencing/buffer strips one-on-one to 15 riparian agricultural producers in the first year.

Priority: High

2008 Status: In 2006, the Natural Resources Conservation Service installed a Heavy Use Protection Area which is the first step in a 3 year project to reduce feedlot run off into Roy Creek. This project will significantly reduce the amount of organic waste deposited into this creek. An animal crossing was planned for 2007 at a third location which will keep a buffalo herd out of a small creek that drains into the Pine River. In 2007, Huron Pines and US Fish & Wildlife Service teamed up to install several measures of biotechnical erosion control. Techniques ranging from bank re-sloping, to native plantings, to coir log installations were employed to slow the rate of erosion, while still providing a natural stream bank environment. Biotechnical erosion control methods focus on using live and dead plants and inorganic materials such as field stone to reduce the erosion of a particular stream bank. Huron Pines installed Large Woody Debris as fish habitat and a means to buffer erosive water energy in the summer of 2008.

Objective 1.3: Reduce sediment at the 6 eroding streambank sites ranked as severe and the 17 ranked as moderate.

Milestones:
- Conduct analysis of site (including stream geomorphology survey) for appropriate treatment by year two.
- Obtain Permits by year three.

- Develop engineering designs in years three through six.
- Stabilize eroding stream bank sites identified as severe and moderate during years three through ten.
- Conduct post-BMP stream geomorphology surveys on all sites by year ten.

Task Products: Completion of 20,000 sq ft. of revegetation, 355 linear feet of streambank stabilization structures.

Typical System of BMPs: Stabilize eroding streambanks with rock riprap, whole tree revetment, biotechnical engineered revegetation or log terracing or a combination of these BMPs. Sites may require treated stairways and/or lunker structures in the case of prescribed rock riprap placement.

Water Quality Benefits: Reduction of nutrients and sediments entering the watershed by 75%.

Evaluation Methods: Before and after photos, stream geomorphology assessment, calculate BMP load reduction

Lead Organization: Huron Pines

Partners: USDA Forest Service, riparian property owners, Natural Resources Conservation Service

Technical Assistance: Engineering services

Timeline: 10 years

Cost: $20,000/site (total: $120,000)

Funding Sources: 319 and CMI programs, County Road Commissions, US Fish & Wildlife Service, USDA Forest Service

Level of Effort: Three severe sites completed first year.

Priority: High

2008 Status: In 2007, Huron Pines and US Fish & Wildlife Service teamed up to install several measures of biotechnical erosion control at the Joslin property in Alcona County. The East Branch of the Pine River runs through their farm and has been removing large chunks of stream bank during the past few years. Techniques ranging from bank re-sloping, to native plantings, to coir log installations were employed to slow the rate of erosion, while still providing a natural stream bank environment. Biotechnical erosion control methods focus on using live and dead plants and inorganic materials such as field stone to reduce the erosion of a particular stream bank. Huron Pines also installed Large Woody Debris as fish habitat and a means to buffer erosive water energy in the summer of 2008 as part of a workshop on stream stewardship for agricultural landowners.

Objective 1.4: Provide educational programs to riparian property owners on topics such as erosion control, forest stewardship, wetlands and vegetative buffer strips.

Milestones:

- Identify specific riparian target audiences by year one.
- Design Power Point® presentations and online content in year one.
- Develop and distribute educational materials in years two and three.
- Conduct educational workshops in conjunction with volunteer workdays in years two and three.

Task Products: Increased awareness of riparian property owners to implement erosion control practices on their property to protect water quality.

Typical System of BMPs: Forest road planning with buffer strips and livestock exclusion from forested areas, streambanks, and wetlands if necessary. Educational and managerial efforts to change operating procedures.
Water Quality Benefits: Reduction of 34 lbs/year phosphorous, reduced runoff and sediment input, increased wildlife habitat
Evaluation Methods: Attendees at workshops, post workshop survey
Lead Organization: Huron Pines
Partners: Alcona and Iosco Conservation Districts, Michigan State University Extension, Van Etten Lake Association
Technical Assistance: Experts on watershed topics as speakers, engineering services on any volunteer erosion sites
Timeline: 3 years
Cost: $10,000/year (total: $30,000)
Funding Sources: Private foundations, 319 and CMI programs
Level of Effort: Conduct 2 training workshops within first year.
Priority: Medium
2008 Status: Huron Pines held one workshop on lakeshore greenbelts in June of 2008 that included a presentation on greenbelts and lakeshore stewardship as well as a visit to a greenbelt that had been installed in 2007 as a volunteer project for the PRVEL Coalition. In August 2008, Huron Pines held a workshop on river stewardship for farmers that included a presentation by Natural Resources Conservation Service staff on river stewardship and programs available to farmers along with a Large Woody Debris demonstration by Huron Pines staff. These events were actively promoted by the PRVEL Coalition through fliers, newspaper articles, and a booth at the Alcona County Fair.

Objective 1.5: Present local units of government with information on the importance of vegetative buffer strips along streams, including a model ordinance (see section E of this chapter for specific townships to target).

Milestones:
- Develop a model ordinance in year one.
- Present model ordinance to all townships and counties within watershed in year two.

Task Products: Increased awareness of local government officials of the importance of water quality protection measures and implemented ordinances.
Water Quality Benefits: Reduced runoff and sediment input, increased wildlife habitat
Evaluation Methods: Adoption of buffer strips in zoning ordinances, review building permits to assess whether the buffer strips are being implemented.
Lead Organization: Huron Pines
Partners: Local Townships, Northeast Michigan Council of Governments
Technical Assistance: Land use planning professional
Timeline: 2 years
Cost: $5,000/ year (total: $10,000)
Funding Sources: Local government
Level of Effort: Model ordinance applied at the township level.
Priority: High
2008 Status: No work done in 2007.

Objective 1.6: Develop and implement a stormwater management ordinance for new developments and adopt stormwater management practices and policies at existing communities.

Milestones:
- Develop a model ordinance by year one.
- Implement BMPs at stormwater runoff areas in years two through five.
- Conduct pre- and post-installation water quality monitoring at each site in years two through five.

Task Products: Adoption of stormwater management practices by local communities.
Typical System of BMPs: May include the creation of infiltration trenches and basins, native plant detention basin landscaping or rain gardens. Other measures include storm drain stenciling, reduction of impervious surfaces and proper disposal of hazardous substances.
Water Quality Benefits: Reduced runoff and sediment input, increased wildlife habitat
Evaluation Methods: Adoption of stormwater management ordinances, review building permits to assess whether the management practices are being implemented.
Lead Organization: Huron Pines
Partners: Alcona and Iosco Road Commissions, Northeast Michigan Council of Governments, MDEQ Water Division, MDNR Fisheries Division, Oscoda Township, Village of Lincoln, City of Harrisville, Alcona and Iosco County Commissioners
Technical Assistance: Land use planning professional
Timeline: 5 years
Cost: 10,000/year (total: $50,000)
Funding Sources: Local government
Level of Effort: Application of model ordinance and implementation of BMPs at problem sites.
Priority: High
2008 Status: No work done in 2007.

Objective 1.7: Create a subcommittee to explore with the MDNR Fisheries Division the issue of adfluvial fish passage above Van Etten Dam and the impacts of impoundments.

Milestones:
- Review previous and current studies concerning fish passage in year one.
- Conduct public input and informational meetings in year one.
- Prepare a document of findings in year two.
- Consider the options and come to a decision by year two.

Task Products: The compilation of scientific materials to initiate informed public participation in the recommendations regarding fish passage at Van Etten dam
Water Quality Benefits: Increased fish habitat
Lead Organization: MDNR Fisheries Division
Partners: Iosco County Commissioners, Iosco County Drain Commission, Oscoda Township, Van Etten Lake Association, USDA Forest Service, US Fish & Wildlife Service, Michigan State University Department of Fish and Wildlife, Huron Pines
Technical Assistance: Not applicable
Timeline: 2 years
Cost: $8,000

Funding Sources: MDNR Fisheries Division, US Fish & Wildlife Service
Level of Effort: The publication of an interdisciplinary, multi agency document of findings with conclusions and recommendations within 2 years.
Priority: Medium
2008 Status: Steve Sendek, fisheries biologist, collected preliminary information in 2006. Funding has also been approved for the DNR to conduct an engineering study for the fish passage over the dam at Van Etten Lake. This project will produce a design and an estimated cost for a fish passage structure for review and comment so that a determination of the feasibility of the project can be made.

Goal 2: Ensure that the total/partial body contact designated use for Van Etten Lake is met

Subwatershed: Van Etten Lake

Objective 2.1: Provide educational programs and materials to property owners on actions they can take to reduce their nutrient contribution.

Milestones:
- Distribute water quality stewardship information packets to property owners in year one.
- Conduct seminars for property owners in year two.
- Develop a system to track new property owners and insure they receive water quality stewardship information in year one.
- Involve real estate agencies in the distribution process in year one.
- Educate property owners on proper disposal of hazardous waste and promote hazardous waste collection opportunities in years two and three.
- Promote water quality stewardship practices in local newspaper in years one and two.

Task Products: Landowner perceptions and attitudes incorporate water quality awareness into their property management practices.
Water Quality Benefits: Reduced runoff and sediment input to Van Etten Lake.
Evaluation Methods: Property owner survey
Lead Organization: Michigan State University Extension
Partners: Michigan Groundwater Stewardship Program, Iosco Conservation District, Van Etten Lake Association, Michigan Lakes and Streams Association, Oscoda Township Office of Economic Development, Oscoda High School, Local newspapers, Huron Pines
Technical Assistance: Not applicable
Timeline: 3 years
Cost: $5,000/year (total: $15,000)
Funding Sources: 319 and CMI programs
Level of Effort: One seminar completed, information packets distributed and tracking system developed in the first year.
Priority: Medium
2008 Status: The landowner stewardship toolkits have been designed and will be disseminated at workshops and meetings, as well as libraries and other places. A realtor on the watershed Steering Committee distributed copies to other local realtors for them to use and share with new potential landowners in the watershed.

Objective 2.2: Continue yearly volunteer Michigan Cooperative Lakes Monitoring Program.

Milestones:
- Collect and submit sampling data yearly.

Task Products: Sampling report is generated.
Water Quality Benefits: An established library of results will help show trends and enable stakeholders to make better decisions addressing water quality concerns.
Evaluation Methods: Use of the data in local decision making and project planning
Lead Organization: Van Etten Lake Association
Partners: Michigan Lakes and Streams Association, Oscoda Township
Technical Assistance: Sampling training and equipment
Timeline: 10 years
Cost: Volunteer
Funding Sources: Not applicable
Level of Effort: Sampling data published in Cooperative Lakes Monitoring Program Annual Report.
Priority: High
2008 Status: The Van Etten Lake Association is continuing to participate annually in the Cooperative Lakes Monitoring Program for Secchi Disk Clarity, Chlorophyll a, and spring and summer Phosphorous sampling. Beach sampling for E-coli was conducted by both Van Etten Lake Association volunteers and District Health Department #2 over the summer of 2006.

Objective 2.3: Use a shoreline technician to work one-on-one with property owners to voluntarily re-establish shoreline vegetative buffers.

Milestones:
- Find a source of matching funds (as an incentive) for property owners interested in implementing biotechnical erosion control methods by year one.
- Provide training for contractors/landscapers to ensure they have the knowledge to implement BMPs for protecting water quality along the shoreline by year two.
- Involve lawn maintenance service providers.
- Identify potential sites for vegetative buffers by year two.
- One-on-one meetings with property owners and technicians.
- Secure funding for staff technician by year three.
- Find sources for native plant purchases by year six.

Task Products: Prioritize project selection, seeking funding, implement projects.
Typical System of BMPs: Shoreline reestablished by utilizing biotechnical erosion control practices including native plantings and/or tree revetments, rock revetments and bulkheads.
Water Quality Benefits: Natural shoreline protective measures increased. Native plantings produce subsequent benefits to fish and wildlife in increased habitat.
Evaluation Methods: Number of visits, number of projects completed
Lead Organization: Huron Pines
Partners: Van Etten Lake Association, Michigan Lakes and Streams Association, Natural Resources Conservation Service, Iosco Conservation District
Technical Assistance: Not needed
Timeline: 6 years

Cost: $12,000/year (total: $72,000)
Funding Sources: Private foundations, 319 and CMI programs
Level of Effort: Shoreline technician hired; 35 one-on-one property owner contacts completed and three sites reestablished w/vegetative buffers in the first year.
Priority: Medium
2008 Status: A shoreline improvement demonstration project was completed on the property of long time Van Etten Lake resident, Marilyn Forrest and her son in 2007. With the combined efforts of Huron Pines ecologists and PRVEL volunteers, Mrs. Forrest now has a new rock riprap and fiber-log buffered shoreline to help stabilize the previously eroding bank. In addition, over 100 native plants, shrubs, and grasses were planted to help filter out any pollutants/contaminants that might otherwise flow directly into the lake.

Objective 2.4: Educate shoreline landowners about septic system inputs of pollution into Van Etten Lake and reduce the impact of those inputs.

Milestones:
- Create landowner packets about shoreline stewardship and septic maintenance in year one.
- Hold workshops to discuss septic system pollutants in year two.
- Work with septic inspectors to provide information on proper septic maintenance and impacts on the lake in year two.

Task Products: Residents are made aware of a potential correctable source of pollution that may be causing the blue-green algae blooms each summer on the lake.
Water Quality Benefits: Reduced phosphorus entering Van Etten Lake from faulty or aged septic systems.
Evaluation Methods: Before and after surveys, researched alternatives installed
Lead Organization: Huron Pines
Partners: Michigan State University Extension, Van Etten Lake Association, Michigan Lakes and Streams Association, Natural Resources Conservation Service, Iosco Conservation District
Technical Assistance: Wastewater management expert/engineering services
Timeline: 2 years
Cost: $2,000/year (total: $4,000)
Funding Sources: Pine River-Van Etten Lake Watershed Coalition, local foundations
Level of Effort: one presentation in the first year
Priority: Medium
2008 Status: A survey of septic permits in the Van Etten Lake tax assessment area was completed by a Coalition volunteer in 2007. Results are shown in Chapter 4.

Objective 2.5: Present local officials with information on the significance of vegetative buffer strips and assist them in adopting effective, consistent standards.

Milestones:
- Develop model ordinance in year one.
- Present model ordinance to local officials in year one.
- Provide training to local officials in year one.
- Assist with publicizing ordinance in year one.

Task Products: Adopted vegetated buffer strip ordinances implemented.
Water Quality Benefits: Reduced runoff and sediment input
Evaluation Methods: Model ordinance approved as actual ordinance, enforcement of ordinance
Lead Organization: Huron Pines
Partners: Van Etten Lake Association, Oscoda Township, Oscoda Township Office of Economic Development, Northeast Michigan Council of Governments
Technical Assistance: Not applicable
Timeline: 1 year
Cost: $5,000
Funding Sources: 319 and CMI programs
Level of Effort: Model ordinance adopted and applied at the local level.
Priority: Medium
2008 Status: The landowner stewardship toolkits have been designed with a section focusing on resources for officials (including sample ordinances) and will be disseminated at workshops and meetings, as well as libraries and other places.

Goal 3: Restore Van Etten Creek of Alcona County to levels that will ensure it is removed from the State's non-attainment list

Subwatershed: Van Etten Creek

Objective 3.1: Implement exclusion fencing/buffer strips at priority agriculture sites within riparian corridor to improve nutrient management.

Milestones:
- Continue to seek out grant sources to provide matching funds to agricultural producers to assist with implementing agricultural BMPs in years one through five.
- Revise agricultural inventory annually to verify active livestock operations.
- Technically assist with the implementation of exclusion fencing/buffer strips on private land in years two through five, including pre- and post-installation water quality monitoring and stream geomorphology surveys.

Task Products: BMPs installed.
Typical System of BMPs: Installation of livestock exclusion fencing with filter strips.
Water Quality Benefits: Increased revegetation of streambanks, exclusion fencing, watering stations and other alternative feeding/watering methods. Nutrient contribution reduced at agricultural sites with unrestricted livestock access to streams.
Evaluation Methods: Before and after photos, stream geomorphology assessment, calculate BMP load reduction
Lead Organization: Natural Resources Conservation Service
Partners: Huron Pines, Alcona Conservation District, Farm Services Agency
Technical Assistance: Natural Resources Conservation Service District Conservationists, Farm Services Agency staff, Huron Pines
Timeline: 5 years
Cost: $20,000/year (total: $100,000)
Funding Sources: 319 and CMI programs, Natural Resources Conservation Service-Wildlife Habitat Incentives Program and other agricultural cost-share programs

Level of Effort: Implement exclusion fencing/buffer strips at two priority sites per year within the Van Etten Creek subwatershed.

Priority: High

2008 Status: In 2006, the Natural Resources Conservation Service installed a Heavy Use Protection Area which is the first step in a 3 year project to reduce feedlot run off into Roy Creek. This project will significantly reduce the amount of organic waste deposited into this creek. An animal crossing was planned for 2007 at a third location which will keep a buffalo herd out of a small creek that drains into the Pine River. In 2007, Huron Pines and US Fish & Wildlife Service teamed up to install several measures of biotechnical erosion control. Techniques ranging from bank re-sloping, to native plantings, to coir log installations were employed to slow the rate of erosion, while still providing a natural stream bank environment. Beyond the techniques used to date, Huron Pines intends to also install Large Woody Debris as fish habitat and a means to buffer erosive water energy in the spring of 2008.

Fecal Coliform Sampling was conducted monthly at one site on Van Etten Creek and at several other sites on the Pine River and its tributaries in 2007. The intent of this sampling is to inexpensively screen sites to help identify potential sources of contamination by animals and humans.

Objective 3.2: Continue to provide one-on-one technical assistance with agricultural producers to encourage the use of BMPs.

Milestones:

- Identify current agricultural producers and their management practices in years one and two.
- Distribute educational materials in years two and three.
- Encourage participation in USDA matching funds programs in years three through ten.
- Technically assist in the implementation of BMPs on private lands in years three through ten.

Task Products: BMPs installed on private agricultural lands.

Typical System of BMPs: Proper manure storage, manure testing, well protection and livestock exclusion fencing with filter strips. Educational and managerial efforts to change operating procedures.

Water Quality Benefits: Increased vegetated buffers and alternative cattle feeding/watering processes

Evaluation Methods: Before and after photos, stream geomorphology assessment, calculate BMP load reduction

Lead Organization: Natural Resources Conservation Service

Partners: Huron Pines, Alcona Conservation District

Technical Assistance: Not applicable

Timeline: 10 years

Cost: $5,000/year (total: $50,000)

Funding Sources: 319 and CMI programs, Natural Resources Conservation Service-Wildlife Habitat Incentives Program and other agricultural cost-share programs

Level of Effort: Meet one-on-one with 10 agricultural producers within the Van Etten Creek subwatershed to actively encourage the use of BMPs to promote water quality and offer technical assistance within in the first year.
Priority: High
2008 Status: The Natural Resources Conservation Service District Conservationist in the area continues to meet with local agricultural producers and promote funding programs.

Objective 3.3: Highlight local examples of agricultural BMPs.

Milestones:
- Identify producers utilizing BMPs in year one.
- Promote local farms using BMPs through coordinated cooperative tours and news releases in years one and two.
- Provide additional local agency awards, recognition and incentives to innovative producers in year two.

Task Products: Enthusiasm and awareness of the soil and water conservation practices being successfully implemented in the local agricultural community is created.
Typical System of BMPs: Planned grazing systems, livestock exclusion fencing with filter strips, contour buffer strips and alternate livestock water supplies.
Water Quality Benefits: Increased awareness leads to BMPs implemented and reduced pollutants entering the watershed.
Evaluation Methods: Attendance, survey attendees
Lead Organization: Alcona Conservation District
Partners: Natural Resources Conservation Service, Michigan State University Extension, Huron Pines
Technical Assistance: Not applicable
Timeline: 2 years
Cost: $3,000/year (total: $6,000)
Funding Sources: Local sponsors
Level of Effort: One BMP auto tour and recognition event each summer.
Priority: Medium
2008 Status: No known work completed on this objective.

Goal 4: Improve and protect the aquatic habitat within the watershed

Subwatershed: Van Etten Creek, Pine River, Van Etten Lake

Objective 4.1: Support local enforcement officials to ensure that rules pertaining to the watershed are consistently followed.

Milestone:
- Publicize local and state regulations and ensure that information on adopted standards is clear, concise and available to the public in years one through three.

Task Products: Public is better informed and their awareness of watershed related rules is raised.
Water Quality Benefits: Not applicable
Lead Organization: Van Etten Lake Association

Partners: Northeast Michigan Council of Governments, Local Townships, Alcona and Iosco County Building and Zoning Departments
Technical Assistance: Land use planner
Timeline: 3 years
Cost: $5,000
Funding Sources: Local governments, community foundations
Level of Effort: Conduct awareness surveys of watershed residents before and after publicizing information.
Priority: Medium
2008 Status: See section E of this chapter for specific recommendations and analysis of local zoning ordinances and master plans.

Objective 4.2: Develop shoreline erosion control demonstration sites.

Milestones:
- Evaluate potential site locations in year one.
- Evaluate site to determine appropriate BMPs in year one.
- Secure funding for implementation in year two.
- Coordinate design and installation with local landscaping companies in year two.
- Publicize and promote project to encourage use of erosion control practices in year three.
- Conduct tours of demonstration sites for local officials and interested public in year three.

Task Products: Community enthusiasm and awareness is created regarding shoreline erosion control practices within the context of landscaping for improved aquatic habitat.
Water Quality Benefits: Reduced sediment and runoff input.
Lead Organization: Huron Pines
Partners: Alcona and Iosco Conservation Districts, local landscaping companies, Alcona and Iosco Road Commissions, Van Etten Lake Association, Natural Resources Conservation Service, Local Townships, Cities and Villages
Technical Assistance: Engineering and installation
Timeline: 3 years
Cost: $10,000/site (total of $20,000 in the first year)
Funding Sources: Local landowners, PRVEL Coalition, Van Etten Lake Association, CMI and 319 programs.
Level of Effort: Development of two demonstration sites in the first year.
Priority: Medium
2008 Status: In 2007, volunteers from the PRVEL Coalition and Huron Pines staff installed a demonstration greenbelt at a property on Van Etten Lake that had been experiencing erosion (over 110 feet of coir logs were installed along with 12 cubic yards of rock riprap and 500 square feet of native plants). The event was publicized on the Huron Pines website and in the Oscoda Press and will be used as a teaching site and example for future projects. Erosion control work also continued at the Joslin streambank site, with the final installation of Large Woody Debris in August 2008.

Objective 4.3: Conduct a county-level soil erosion workshop yearly.

Milestones:

- Identify potential target audiences in year one.
- Promote and publicize workshop to those target audiences in year two.
- Conduct training on soil erosion issues particularly as related to water quality in year three.

Task Products: A trained target audience with knowledge to make informed decisions regarding soil erosion control practices

Water Quality Benefits: Reduction in sediment and runoff input to the watershed; increased reporting and maintenance of road/stream crossings to prevent future failures

Lead Organization: Alcona and Iosco County Soil Erosion and Sedimentation Control Officers

Partners: Alcona and Iosco County Building and Zoning Departments, Natural Resources Conservation Service, Alcona and Iosco Conservation Districts, Michigan State University Extension, Huron Pines, DEQ Water Division

Technical Assistance: Soil erosion expert, engineer, or other speakers

Timeline: 3 years

Cost: $3,000/year (total: $9,000)

Funding Sources: Natural Resources Conservation Service, CMI and 319 programs, local foundations

Level of Effort: County-level soil erosion workshop conducted in the first year.

Priority: Medium

2008 Status: No activity on this objective.

Objective 4.4: Conduct yearly Invasive Exotic Species monitoring program.

Milestones:

- Review current and previous studies and inventories in year one.
- Cooperatively develop a basic program that that can be incorporated into ongoing statewide data collection and that includes citizen participation in year two.
- Collect, record and summarize findings in years two through 10.

Task Products: The possession of current information to assist in taking proactive measures to prevent introduction or reduce or eliminate exotic species presence in the watershed

Water Quality Benefits: Reduce the amount of invasive species threatening the watershed.

Lead Organization: Van Etten Lake Association

Partners: Riparian property owners, Oscoda Township, Michigan Lakes and Streams Association, local high schools, USDA Forest Service, MDNR Fisheries Division, DEQ Water Division

Technical Assistance: Botanist or certified pest manager

Timeline: 10 years

Cost: $2,000

Funding Sources: CMI and 319 programs, volunteers, MDNR, US Fish & Wildlife Service, USDA Forest Service.

Level of Effort: Program developed and data recorded and summarized.
Priority: High
2008 Status: No action taken.

Objective 4.5: Create a watershed-wide monitoring program to observe trends in water quality and provide a baseline of data for directing future efforts (see chapter 7).

Milestones:

- Coordinate volunteer Cooperative Lakes Monitoring Program (lake) *E. coli* and stream macroinvertebrate sampling yearly.
- Obtain funding for a continuing water quality monitoring program by year two.
- Train technical staff and volunteers to conduct monitoring by year three.
- Conduct biological habitat and water quality monitoring (at sites described in chapter 7) yearly (DEQ biological surveys continue on a 5-year cycle).
- Prepare and present periodical reports for the public to explain changes in the watershed.
- Conduct Bank Erosion Hazard Index monitoring throughout the watershed (repeat every 5 years)

Task Products: Data about water quality in lakes and streams, educated volunteers, and public awareness
Water Quality Benefits: Not applicable
Lead Organization: PRVEL Coalition, Michigan DEQ
Partners: United States Geological Survey, Van Etten Lake Association, USDA Forest Service, US Fish & Wildlife Service, Michigan State University Department of Fish and Wildlife, Huron Pines
Technical Assistance: Michigan DEQ
Timeline: 10 years
Cost: $10,000/year (total: $100,000)
Funding Sources: MDNR Fisheries Division, US Fish & Wildlife Service
Level of Effort: The publication of an interdisciplinary, multi-agency document of findings with conclusions and recommendations within 2 years.
Priority: High
2008 Status: Local volunteers are conducting Cooperative Lakes Monitoring Program monitoring on Van Etten Lake and *E. coli* and MiCorps macroinvertebrate monitoring on the watershed's streams. For details of other monitoring, see chapter 7. In July 2008, MDEQ staff trained Huron Pines staff and watershed volunteers to conduct BEHI analysis, which is a good tool for determining erosion trends across a watershed.

Goal 5: Protect critical wildlife habitat areas within the watershed

Subwatershed: Van Etten Creek, Pine River, Van Etten Lake

Objective 5.1: Coordinate master planning efforts among local units of government.

Milestones:

- Address watershed management practices within master plans for all townships by year five.
- Update and/or revise master plans for all townships by year ten.
- Promote consistency of master plans for all townships in years one through ten.

Task Products: Master planning efforts among local units of government are coordinated to include provisions that promote watershed protection and water quality restoration.

Water Quality Benefits: Reduced sediment and runoff, increase in wildlife habitat

Lead Organization: Northeast Michigan Council of Governments

Partners: Alcona County Commissioners, local Townships, USDA Forest Service, Huron Pines

Technical Assistance: Habitat specialist, land use planner

Timeline: 10 years

Cost: $15,000/year (total: $150,000)

Funding Sources: Local governments

Level of Effort: One township master plan updated and watershed management practices addressed within each one per year.

Priority: Medium

2008 Status: Although NEMCOG has not been directly involved in any partnership activities related to the watershed plan, they have been working with Mikado Township to update their Zoning Ordinance and working with Curtis Township and Hawes to update their master plans. All three of these activities indirectly address water quality.

Objective 5.2: Promote riparian landscaping for wildlife and water quality through educational presentations to professional landscapers and waterfront owners.

Milestones:

- Develop and distribute educational materials specific to riparian wildlife habitat by year two.
- Conduct workshops focusing on riparian property enhancement for wildlife in year three.
- Promote innovative practices and native species utilization in year two.
- Provide one-on-one technical assistance to riparian property owners interested in wildlife habitat improvements in years two through five.
- Secure funding to staff technician in year one.

Task Products: Staff technician hired, increased awareness and knowledge of professional landscapers and waterfront owners to implement landscaping for wildlife and water quality

Water Quality Benefits: Increased wildlife habitat, reduced erosion and runoff

Lead Organization: Huron Pines

Partners: Alcona and Iosco Conservation Districts, MDNR Wildlife Division, MDNR Forest, Fire and Mineral Division, local Lake Associations, USDA Forest Service, local landscaping companies, Michigan State University Extension, Michigan Groundwater Stewardship Program, US Fish & Wildlife Service, Village of Lincoln

Technical Assistance: Not applicable

Timeline: 5 years

Cost: $20,000/year (total: $100,000)
Funding Sources: 319 and CMI programs, PRVEL Coalition, DNR, US Fish & Wildlife Service
Level of Effort: Conduct one workshop and visit 15 riparian property owners in first year.
Priority: Medium
2008 Status: Huron Pines has developed a riparian stewardship toolkit that will be distributed in 2008. Staff organized and held two workshops in the summer of 2008, one with a focus on riparian property owners on the lake and the other with a focus on agricultural landowners.

Objective 5.3: Work to make a voluntary Conservation Easement program more readily available to property owners within the watershed.

Milestones:
- Identify environmentally sensitive parcels by year five.
- Identify large privately owned contiguous tracts of land within the critical riparian zone by year six.
- Initiate and promote conservation easements to potential candidates in years seven through ten.

Task Products: Privately owned environmentally sensitive parcels identified and landowners made more aware of the benefits of conservation easements.
Water Quality Benefits: Increased wildlife habitat and undeveloped riparian areas
Lead Organization: HeadWaters Land Conservancy
Partners: Alcona and Iosco Conservation Districts, Natural Resources Conservation Service, Huron Pines
Timeline: 10 years
Cost: $3,000/easement (total: $30,000)
Funding Sources: Natural Resources Conservation Service, HeadWaters Land Conservancy, local foundations
Level of Effort: One conservation easement established in the watershed per year.
Priority: Medium
2008 Status: The HeadWaters Land Conservancy is currently working with Arnot Heller to protect his 360 acres with a conservation easement. His property is in Reno Twp., Iosco Co. T22N, R5E, Section 17. This is a great parcel with extensive frontage on Hope Creek.

Objective 5.4: Provide training opportunities for planning and zoning commissioners.

Milestones:
- Coordinate training seminars for local planning and zoning personnel in years one and two.
- Conduct follow-up seminars regarding new planning topics and issues in year three.

Task Products: Increased training opportunities for planning and zoning commissioners to assist them with making current and informed decisions.
Water Quality Benefits: Not applicable
Lead Organization: Michigan State University Extension

Partners: Local Townships, Alcona and Iosco County Building and Zoning Departments, Planning Commissions, Recreation Commissions, Michigan Association of Planning Officials, Alcona and Iosco County Commissioners, Community Foundation for Northeast Michigan
Technical Assistance: Land use planner
Timeline: 3 years
Cost: $5,000/year (total: $15,000)
Funding Sources: Local foundations and governments
Level of Effort: Completion of Citizen Planner program for Alcona and Iosco Counties.
Priority: Medium
2008 Status: No action taken.

Objective 5.5: Develop and distribute education packets that promote the conservation of aquatic and terrestrial organisms and their habitats to real estate agents, developers and contractors.

Milestones:

- Design written materials specific to the land sales industry regarding fish and wildlife concerns with respect to development issues in year one.
- Meet with local agents to introduce concept in year one.
- Publish and distribute education packets in year two.
- Design Power Point ® presentation in year two.
- Promote wildlife habitat awareness through presentations in year three.

Task Products: Real estate agents, developers and contractors perceptions and attitudes incorporate wildlife habitat awareness into their property sales and development practices.
Water Quality Benefits: Increased wildlife habitat
Lead Organization: Huron Pines
Partners: MDNR Fisheries Division, MDNR Wildlife Division, DEQ Water Division, Michigan Association of Realtors, Local Real Estate Agencies, Developers and Contractors, Michigan State University Extension, HeadWaters Land Conservancy
Technical Assistance: Not applicable
Timeline: 3 years
Cost: $5,000/year (total: $15,000)
Funding Sources: 319 and CMI programs, local foundations, PRVEL Coalition
Level of Effort: Education packets developed and distributed the first year. Two speaking engagements conducted in the first year.
Priority: Medium
2008 Status: No action taken.

Objective 5.6: Produce and distribute GIS maps to landowners and local units of government.

Milestones:

- Secure funding for implementation in year one.
- Identify and map the distribution of aquatic and near shore terrestrial species diversity within the watershed in year two.

- Develop future land use maps for the watershed, showing projected development patterns 10, 20, and 50 years into the future and track trends (development or conservation) in sensitive areas in year three.
- Identify and map environmentally sensitive parcels and ecological corridors throughout the watershed in years four and five.

Task Products: A series of GIS maps produced identifying aquatic and wildlife diversity within the watershed to help guide land development, zoning and conservation efforts.
Water Quality Benefits: Increase in protection of habitat
Lead Organization: Northeast Michigan Council of Governments
Partners: USDA Forest Service, MNDR Fisheries Division, MDNR Wildlife Division, US Fish & Wildlife Service, Alcona County Commissioners, Iosco County Planning Commission
Technical Assistance: Land use planner, GIS specialist
Timeline: 5 years
Cost: $5,000/year (total: $25,000)
Funding Sources: Local governments, foundations
Level of Effort: Secure funding within the first year and completion of one task per/year thereafter.
Priority: Medium
2008 Status: No action taken.

Goal 6: Sustain the Pine River-Van Etten Lake Watershed Management Process

Subwatershed: Pine River, Van Etten Creek, Van Etten Lake

Objective 6.1: Continually seek funding sources to carry out the objectives.

Milestones:

- Seek out grant funding opportunities from public and private sources each year.
- Write and apply for grants that are applicable to the goals and objectives of the watershed management plan yearly.

Task Products: Funding secured to implement the goals and objectives of the watershed management plan.
Water Quality Benefits: Increase in projects that reduce sediment and nutrient input and increase habitat protection
Lead Organization: Huron Pines
Partners: Alcona and Iosco Conservation Districts
Technical Assistance: Not applicable
Timeline: 5 years
Cost: $1,000/grant (total: $5,000)
Funding Sources: Not applicable
Level of Effort: One $100,000 or more grant applied for annually.
Priority: High
2008 Status: In 2006, Huron Pines sought and received a grant from the Community Foundation for Northeast Michigan, which was used to develop educational materials and mail packets out to watershed residents. As a part of this effort, the current

watershed mailing list was expanded to include riparian property owners in Alcona County. This allowed for a mailing to promote Coalition efforts and will allow for future mailing to promote riparian landscaping for wildlife and water quality.

Objective 6.2: Revisit Watershed Management Plan yearly and update as needed.

Milestones:

- Convene a series of sessions of the Technical Subcommittee to review the implementation and management progress of the project each year.
- Technical Subcommittee then provides report and recommendations to the Full Steering Committee annually regarding the management plan each year.

Task Products: Watershed management plan implemented and monitored with technical oversight and guidance.
Water Quality Benefits: Not applicable
Lead Organization: Huron Pines
Partners: PRVEL Coalition
Technical Assistance: Watershed Management Plan (DEQ) technical assistance
Timeline: 5 years
Cost: $2,000
Funding Source: Not applicable
Level of Effort: Technical Subcommittee written report and recommendations provided to the Steering Committee annually.
Priority: High
2008 Status: The goals and strategies of the watershed management plan are reviewed every year and progress is monitored by the Steering Committee.

Objective 6.3: Promote the efforts of the Watershed Coalition through ongoing public relations and marketing campaigns.

Milestones:

- Develop short version of the watershed plan to share with the public and local units of government in year one.
- Continue to publish and distribute Coalition newsletter yearly.
- Continue to provide news releases and interview opportunities to local news
- Media yearly.
- Continue to integrate cooperative public relations and informational programs with other agencies and organizations yearly.

Task Products: Public enthusiasm and awareness of the PRVEL Coalition and their mission enhances support of the restoration and conservation efforts and opportunities within the watershed.
Water Quality Benefits: Not applicable
Lead Organization: Huron Pines
Partners: Alcona and Iosco Conservation Districts, Van Etten Lake Association, Natural Resources Conservation Service, USDA Forest Service
Technical Assistance: Not applicable
Timeline: 5 years
Cost: $5,000/year (total: $25,000)

Funding Sources: PRVEL Coalition, local foundations
Level of Effort: Short version of watershed plan developed and professionally printed in the first year.
Priority: High
2008 Status: Huron Pines and the Steering Committee arranged for news articles, posted press releases on the web and sent update letters to donors relating PRVEL Coalition activities in 2007. A semiannual newsletter will be published in 2008. In addition, PRVEL Coalition activities will be highlighted on the Huron Pines website and press coverage will continue to be sought. Huron Pines has developed a watershed plan summary, which will be distributed in 2009.

D. Implementation Costs

Table 5.1 below indicates the total estimated costs associated with implementing the Pine River-Van Etten Lake watershed management plan goals and objectives. These costs cover different items for each project, but include educational materials, construction materials, staff time, meeting locations and publicity, printing and postage, and other costs necessary for completing each objective. Each objective's timeline is shown in the table to optimize its effects in conjunction with other objectives and to capitalize on the enthusiasm of the local partners that will be generated at the start of the 10-year project timeline.

Table 5.1: Timeline and Cost of Implementation Efforts											
Objective Title	**Objective Cost (total for 10 years)**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
1.1 Road/Stream Crossing BMPs	$1,033,000										
1.2 Ag BMPs	$50,000										
1.3 Streambank BMPs	$120,000										
1.4 Education of Riverfront Property Owners	$30,000										
1.5 Model greenbelt ordinance	$10,000										
1.6 Stormwater ordinance	$50,000										
1.7 Fish Passage Committee	$8,000										
2.1 Van Etten Lake Property Owner Education Program	$15,000										
2.2 Volunteer Lake Monitoring	No cost—volunteers										
2.3 Re-establish shoreline buffers	$72,000										
2.4 Septic inputs education for lake residents	$4,000										
2.5 Improved greenbelt ordinance for the lake	$5,000										
3.1 Exclusion fencing along Van Etten Creek	$100,000										
3.2 One on one technical assistance	$50,000										
3.3 Highlight local Ag examples	$6,000										
4.1 Support local enforcement of zoning	$5,000										
4.2 Shoreline erosion demo sites	$20,000										
4.3 Soil Erosion Control Workshop	$9,000										
4.4 Monitoring of exotic species	$2,000										
4.5 Water quality monitoring	$100,000										
5.1 Master Plan Coordination	$150,000										
5.2 Lakescaping Workshops	$100,000										
5.3 Conservation Easements	$30,000										

5.4 Citizen Planner Program	$15,000										
5.5 Real Estate Agent info packets	$15,000										
5.6 Distribute GIS Maps to local government units	$25,000										
6.1 Obtain funding to implement plan	$5,000										
6.2 Review/update watershed plan	$2,000										
6.3 Promote PRVEL Coalition Efforts	$25,000										
Total	**$2,056,000**										

E. Recommendations for Effectively Using Planning and Zoning Policies for Water Resource Protection

1. General Recommendations for Alcona County

Most townships within Alcona generally do not include specific requirements that are helpful for protecting water quality. For those that do have some, the lack of coordination among townships results in different standards for each. The result of this is that, even if one township were to be vigilant about protecting water quality, the approach taken in another township may translate into headaches for them (water does not "stay" in one township). The most significant thing the townships could do is work together to consolidate local zoning under one county ordinance. Under a county system, policies would be coordinated and resources (financial, people, time) could be better utilized. For such a change to work at this point in time, the townships themselves would have to lead the effort to work together.

A review of township planning and zoning programs in the watershed uncovered what appeared to be general resistance to a countywide program. While steps could possibly be taken to make that a viable program, it will not likely occur in either the short- or mid-term. In lieu of county zoning, it would still be beneficial for the county to once again activate a planning commission, which could provide guidance and technical assistance to the townships, as well as review and comment upon proposed planning and zoning decisions. Currently, copies of most township zoning ordinances are available at the county building, although many of the master plans are not and much of the material is out of date. Other Michigan counties have begun providing their zoning ordinance on a web site, which makes it easy to access, reproduce, and amend the document, with little cost. Alcona could lead such an effort and host a site for all of the townships.

In addition to the involvement of the county, the following general suggestions are offered for townships within the watershed:

- Training is essential to ensure that planning commission members are able to carry out their jobs. These volunteer members are often put in a decision-making position without understanding all of the issues involved with their new role. The Watershed Partnership (or perhaps the county) should ensure that these training workshops are made available (either freely or at a low cost) at least every other year. As there is no county zoning, there are many planning commission members (every township), most of these members would benefit from annual training programs.

- Recent changes in the state of Michigan's planning and zoning enabling legislation, such as requirements for open space and conservation planning, mandatory review of plans every five years, and involving adjacent units of government in planning process, must be incorporated by local government units. Local units of government may not be aware of these changes or how to incorporate them. The Watershed Partnership should contact each planning commission to make sure they are aware of the legislative changes and how to incorporate them.

- There is a regional planning and zoning council that is available to provide assistance to local government units (the Northeast Michigan Council of Governments). Townships contemplating updating their master plan or revising their zoning ordinance should contact NEMCOG as a first step in the process.

- Because local communities have different goals, resources, and socio-economic status, local communities often differ in the types of regulations they utilize. Generally, within a given watershed there are enough similarities that the same standards could be used throughout the watershed. Where one unit of government works to manage resources wisely and the adjoining unit does not, resources impacts cross the line on the map. If there is to be no county zoning, the townships should at least work more closely together to better coordinate zoning districts and standards.

2. Specific Notes for Individual Townships

Curtis Township
Curtis Township makes up a relatively small amount of the acreage within the PRVEL watershed. The zoning ordinance, while not outdated, generally has no provisions that help to protect water resources. Within the Site Plan Review section of the ordinance, Curtis Township has some provisions that would allow the zoning board to require control of stormwater runoff, although this could be strengthened. The major zoning districts also require only a 25-foot setback of structures from surface water (50 feet for industrial buildings), which does not do much to prevent many of the problems in this watershed (such as excess runoff, streambank erosion, and riparian corridor habitat loss). The recently updated master plan includes future land use recommendations.

Greenbush Township
Both the Zoning ordinance (1997) and the Master Plan (2008) need to be reviewed and updated regularly by the Planning Commission. The Master Plan was based (in part) on a 2005 township opinion survey, this should be repeated (or a similar method used for getting public input) as a first step in updating the master plan. In updating their master plan, the township should be more specific in outlining goals they would like to accomplish, include a future land use plan, and outline a capital improvements program to provide a realistic look at how they will fund future community improvements.

Greenbush does have a "shoreline protection district." This is a step in the right direction for protecting water resources, but is not relevant to the PRVEL watershed project, as it applies only to the Lake Huron shoreline. The ordinance also mentions soil erosion control, has good guidelines for the procedure of dealing with variances (always a source of confusion), and specifies a maximum amount of lot coverage for riparian lots (35%). The last standard could be improved by changing the wording for the impervious cover section, which now reads, "The part or percent of the lot occupied by buildings, including accessory buildings." From a watershed management perspective, the text would be better if the provision also included driveways, patios, decks, walkways, etc., when determining what constitutes impervious cover.

Harrisville Township
Shoreline Protection District is a good start for Lake Huron (50-foot setback, 20-foot greenbelt, 30% max lot coverage). The standards for maintaining a greenbelt and the setback requirement should both be strengthened. Most of the PRVEL watershed, however, is zoned agriculture. For the PRVEL watershed, Van Etten Creek runs through this zoning district and could benefit from improved zoning regulations. In addition, while Harrisville Township does have a Planned Unit Development section that can help to maintain open space the language needs to be improved (see the definitions section of environmental provisions: open space).

Hawes Township
The township zoning ordinance was amended in 2008. Much of the land is zoned forest-recreation, which requires a minimum width of 200 feet (minimum lot size of one acre). Residentially zoned areas have a minimum lot width of 80 feet and require only a 40-foot setback from the water. Hawes includes some headwaters areas of streams in the PRVEL watershed. Due to the importance of managing the upper reaches of streams in order to effectively maintain water quality in the entire watershed, the township should place more emphasis on water resources when they update their master plan and zoning ordinance.

Haynes Township
Haynes has a very minor amount of acreage within the PRVEL watershed. Their zoning ordinance (1972, amended 2008) is very brief and in need of review and update by the planning commission. In the Haynes file at the County Building, a handwritten note is attached to the zoning ordinance which reads, "Lakefront setback now depends on the 'soil erosion act.'" This provision is not sufficient for water resource protection and is misleading. One hopes that someone attempting to develop their property would contact the County Soil Erosion Officer who could not only outline the soil erosion control requirements but also make sure they return to the township for appropriate guidance regarding zoning standards (the soil erosion program is not intended to replace a well thought out zoning ordinance).

Mikado Township
Mikado Township's 2007 zoning ordinance now includes sections on shoreline greenbelts and setbacks. The greenbelt section requires 70% of the lot width at the water line to remain in its natural vegetated state (excepting boat launches, docks, etc.), no burning or composting in the greenbelt, and no dredging or filling except with a permit. The setback section sets a 75-foot setback for all main buildings and covered decks, 25 feet for patios and ground decking, and no dredging or filling in floodplains. In July 2002 Mikado Township adopted a new comprehensive master plan. Within that document are many recommendations (based on input from township residents) that have implications for the watershed. Perhaps most notably are the recommendations that the township do the following:

- Develop a waterfront overlay district in the zoning ordinance that will set forth special requirements and standards for development in these sensitive areas adjacent to streams.
- Implement groundwater protection and stormwater management regulations in the zoning ordinance, while encouraging the continued natural use of wetlands as groundwater recharge, stormwater filtering and stormwater holding areas.

- Maintain greenbelt areas adjacent to lakes, ponds, streams, and wetlands through development of a greenbelt section in the zoning ordinance.
- Consider the adoption of a septic system maintenance ordinance to protect and improve water quality.
- Work cooperatively with adjacent townships in providing guidance and input on zoning decisions that impact the township.
- Utilize the proactive master planning process as a check and balance on decision making.
- Develop open space residential and commercial development design standards to preserve scenic views, rural character, farmland, meadows, woodlands, steep slopes and wetlands with a target of preserving 50% of the land within a development.

Additionally, comments from the September 25, 2001 township input-gathering workshop indicate a need for consistent enforcement and better local support for zoning (Mikado Township Master Plan, 6-1, 2002).

From a watershed management perspective, if Mikado Township has successfully implemented their own recommendations from the master plan into guidelines within the zoning ordinance (which is how the process should work), they have taken a big step in protecting resources for the future.

Millen Township
The current Millen Township Zoning Ordinance was adopted in 2008. The current ordinance does emphasize water resource protection within its Resort-Residential Zone, with adequate standards for maintaining a greenbelt zone. Millen's ordinance does put a 30% maximum on lot coverage (impervious surfaces), although this standard is short and does not include requirements for vegetation. Improving the text within this section would be a pro-active move for accomplishing the goals in their master plan.

Gustin Township
The two-page master plan for Gustin Township should be updated to better represent the needs of the region, input from residents, documentation of current conditions, present a future land use plan, and outline clear goals for the township. The zoning ordinance (1982) also needs to be updated by the township planning commission. Along the waterfront, Gustin requires a 40-foot setback and a minimum lot width of 100 feet.

Village of Lincoln
The zoning ordinance for the village was adopted in 1996. Occupying very little acreage in the PRVEL watershed, Lincoln nevertheless does include two small lakes. These lakes are zoned residential use (although the zoning ordinance unfortunately does not include a copy of the zoning map), with a shoreline setback of 25 feet for homes and a minimum lot size of 65 feet. The Village also has a requirement on amount of impervious surface (25%) for the "building area." One is left to assume that this does not include walkways, driveways, etc.

Oscoda Township

Within the PRVEL watershed, Oscoda has some of the most up-to-date information and has made protection of water resources a priority. The ordinance has an adequate section on managing stormwater runoff, a comprehensive section on the natural rivers program for the Au Sable part of the township, and is currently incorporating provisions for open space preservation.

Ordinance language should be improved for the section on vegetative buffers, which currently states, "No more than 25% of the vegetation and tree cover can be removed in the thinning process." While the intent of a greenbelt ordinance is obvious, the specific language is vague enough that one could ask of the above statement: is that each year, or every time there is a thinning, or every time the property changes hands, or total? Someone not following the intent of this section could degrade their greenbelt to next to nothing. In addition, the greenbelt section currently allows the zoning board to approve cutting in excess of 25%, provided two conditions are met: 1) It will not cause erosion, and 2) It will not adversely affect the neighbors. The intent of the greenbelt section, however, is not only to reduce erosion and please the neighbors, but to provide natural habitat, slow runoff, and filter nutrients. The conditions for getting around the ordinance should be changed to ensure that runoff control and nutrient filtration are still provided for and are addressed by the property owner proposing to exceed the maximum amount of thinning. In addition, the current waterfront building setback requirement of 25 feet essentially leads to the situation whereby the home is located within the greenbelt. By the time construction of the home is complete, the greenbelt is generally destroyed. (It is much easier to maintain in the first place than restore.) Beyond simply the loss of natural vegetation, the shoreline zone is important for the infiltration capacity the ground provides. This capacity is severely degraded (particularly on a lakeside lot that is only 80 feet wide to begin with) when a structure is so close to shore.

Oscoda is the one township in the watershed that is not a part of Alcona County, but it would most certainly benefit from other townships in the PRVEL watershed doing a more effective job of using zoning to protect water resources, since all of the land in this watershed eventually drains to Van Etten Lake in Oscoda Township.

Chapter Six: Information and Education Strategy

I. INTRODUCTION

A. In General

The long-term protection of the Pine River-Van Etten Lake watershed will depend on the values and actions of future generations. Educating the residents and riparian property owners of the Pine River-Van Etten Lake watershed about how their actions influence water quality is a high priority with the Pine River-Van Etten Lake Steering Committee. Increasing awareness and ultimately changing behaviors is a long-term strategy for restoring and protecting water quality.

An information and education (I&E) strategy is a tool that informs the public and motivates them to take action. It is a coordinated strategy tailored to both the specific water quality concerns and the people who live in the watershed.

An I&E strategy is effective because most behavioral changes that are required to minimize or eliminate pollution in the watershed will be voluntary—rather than required by law. Before individuals will consider changing their behavior, they need to understand the concerns for the watershed and how their individual activities can help protect the quality of water in the region. The (I&E) activities will involve a variety of approaches including installing demonstration sites, building partnerships, sponsoring seminars and distributing education materials.

B. Summary of Outreach Activities

Some of the information and education activities that have already been implemented as part of the watershed planning efforts include:

- Presentations of the Pine River-Van Etten Lake watershed project to Alcona Elementary School, Glennie Elementary School, Oscoda High School, Spring Arbor University, Van Etten Lake Association, the Michigan Lakes and Streams Association, Alcona Conservation District, and Iosco Conservation District.

- Promotion of the Pine River-Van Etten Lake watershed project at the Alcona County Fair and the Oscoda Home and Garden Show.

- Participation in the Michigan Lakes and Streams Association High School Macroinvertebrate Stream Survey Project with Oscoda High School.

- Publication and distribution of a Pine River-Van Etten Lake watershed project brochure.

- Watershed Interpretive Signs placed throughout the Huron National Forest part of the watershed in cooperation with the USDA Forest Service.

- A distinctive Pine River-Van Etten Lake Watershed Coalition logo design and use.
- Publication of quarterly newsletter Watershed World.
- Purchase of a tabletop display and replaceable panels with general watershed and water quality information on them.
- Bulk mailing to all Van Etten Lake property owners regarding watershed and shoreline stewardship.
- Numerous articles regarding the watershed project in the Alpena News, Alcona County Review and the Oscoda Press.
- A dedicated web page on Huron Pines website (www.huronpines.org).
- Two watershed seminars—one on shoreline stewardship for lakefront landowners, and one focused on river stewardship for agricultural landowners. Both workshops included demonstrations of on-the-ground projects to protect the watershed.

C. Community Education

After review of the goals and objectives, resource inventories and water quality study, as well as the prioritized list of pollutants and sources, the Pine River-Van Etten Lake Watershed Steering Committee identified a number of groups whose active support will be important in addressing watershed implementation and restoration activities. The Watershed Target Audiences were prioritized based upon the impact of the pollution source and the relative acceptance of the message by the proposed target audience. Table 6.1 lists the specific target audiences identified by the Steering Committee.

Agricultural owners with livestock, particularly those within the Van Etten Creek subwatershed, should be made aware of the impact unrestricted livestock have on the creek's water quality. As this stream is on the Department of Environmental Quality's Non Attainment list, the message of reduction of nutrient loading to the water by limiting cattle access to it has been given first priority. Additionally, the agricultural inventory results and staff discussions with members of the agricultural community indicate that not all livestock producers readily embrace this message.

The results of the water quality study on the watershed revealed that the output of dissolved phosphorus levels in Van Etten Lake are higher than the inputs at the mouth of the Pine River. This indicates that pollutant sources are being added from around the lake. Septic systems leeching pollutants to the groundwater can contribute to an overabundance of phosphorus in the lake. Information and education regarding the negative impact riparian septic systems have on water quality and the actions by lakefront owners that can reduce that impact need to be introduced. Public participation in Steering Committee meetings suggests that lakefront owners are willing to be proactive in protecting water quality, but need specific guidance to make informed "lake friendly" decisions.

Closely aligned with the message of septic system maintenance is the need to raise the awareness level of riparian owners and agricultural producers regarding fertilizer use and its potential as a water pollutant source when applied in overabundance and improperly.

Additionally, it will be very important to maintain the PRVEL Coalition partnerships that have developed with major land management and infrastructure agencies. Cooperation and the promotion of land management activities that restore and protect water quality will need to continue throughout project implementation.

Finally, it is important to review and modify the goals and objectives of the plan itself periodically. As education continues and more citizens are made aware of the threats to the watershed and ways to protect it, they may have input on what watershed tasks should be done when and how, as well as giving an idea of what further outreach is necessary. Reviewing the entire plan every five years at PRVEL Coalition meetings is a good way to start, but the document should be open to change at any point if a new threat or opportunity to address a threat arises.

Table: 6.1 Watershed Target Audiences

Sources	Target Audiences	Specific Target Audiences	Priority
Septic Systems	Homeowners	Lakefront owners with septic systems	2
Livestock Access to Streams	Riparian Agricultural owners	Agricultural owners with livestock that have access to streams	1
Residential Fertilizer Use	Homeowners, Agricultural Producers	Lakefront homeowners, Riparian Ag Producers in the Critical Area	3
Eroding Streambanks	Homeowners, Federal land managers	Riparian owners with streambank access, USDA Forest Service	4
Road/Stream Crossings	Road Commissions State and Federal Road Management Agencies	Alcona and Iosco Road Commissions, Michigan Department of Transportation, USDA Forest Service	5

The identification of groups or individuals whose support or action will be needed to achieve the watershed project's goals is integral to developing the Information & Education strategy. Listed in table 6.2 are some of the target audiences identified for specific pollutant problems along with particular messages and delivery mechanisms for each audience.

Table: 6.2 Pine River-Van Etten Lake Watershed Information and Education Strategy					
Pollutant or Water Quality Problem	**Cause**	**Target Audience**	**Messages**	**Delivery Mechanisms**	**Potential Evaluation**
Lack of appreciation for watershed characteristics		General public	Watershed "Homeowner's Guide" Describe why the PRVEL watershed is unique and worth protecting Highlight areas of improvement and provide contact information	Selective mailing, distribute at local events, and provide at desirable locations within the community	Survey, interviews
Sediment	Road/Stream crossings	Road Commissions, land managers	Make water quality concerns a priority when designing and installing RSXs.	Presentations to Road Commissions and land managers. Database and inventory sharing.	Monitor new RSX installation within the critical area.
	Stream bank erosion	Riparian owners, land managers	Stay on designated trails. Use stairs.	Watershed interpretive signs.	
	Shoreline erosion	Riparian owners, land managers	Protect your investment and water quality for future generations	Volunteer demonstration project (implemented 2007), provide materials and site visits to educate landowners about greenbelting and shoreline stewardship	Photographs and survey of landowners.
	Stormwater	Local townships, officials	Protect and improve fishing and water quality	Meet with local township officials to discuss stormwater management techniques.	Photographs and interviews, ordinance adoption

Table: 6.2 Pine River-Van Etten Lake Watershed Information and Education Strategy					
Pollutant or Water Quality Problem	**Cause**	**Target Audience**	**Messages**	**Delivery Mechanisms**	**Potential Evaluation**
Nutrients	Livestock unlimited access to streams	Riparian agricultural producers	Exclude or limit cattle access to streams to protect water quality and improve herd health. Utilize alternative watering sources.	Provide one-on-one contacts with riparian livestock producers in cooperation with the Natural Resources Conservation Service and Alcona Conservation District.	Inventory riparian farms that implement cattle exclusion practices.
	Fertilizers	Riparian homeowners, agricultural producers, golf courses	Sample soil and apply in accordance with accepted BMPs. Use phosphorus free fertilizer. Landscape with vegetative buffers.	Educational workshops. One-on-one contact. Mailing of information. Newspaper articles and radio spots.	Track mailings and requests for assistance from homeowners. Track number of agricultural producers sampling soil and using fertilizer application BMPs. Perform follow-up Shoreline Inventory
	Septic Systems	Riparian homeowners	Properly maintain and inspect septic system regularly. Monitor inputs into the system. Use phosphorus free detergents.	Work with MI Groundwater Stewardship Program to provide Lake-A-Syst information and one-on-one contact. Encourage Lake Associations to promote proper septic system care.	
Oils, Grease and Heavy Metals	Stormdrains runoff			Stormdrain decals and stenciling	

Table: 6.2 Pine River-Van Etten Lake Watershed Information and Education Strategy					
Pollutant or Water Quality Problem	**Cause**	**Target Audience**	**Messages**	**Delivery Mechanisms**	**Potential Evaluation**
Toxins	Stormwater	Homeowners	All actions affect everyone's water quality.	Media campaign with local newspapers, radio, and TV. Mail residents information on reducing nonpoint source pollution.	Survey
	Lawn Maintenance	Homeowners, riparian property owners	Don't harm fisheries and aquatic life	Sponsor seminars for landscaping companies to learn more about "lake friendly" property practices. Sponsor workshops for homeowners. Use print media to reach residents. Meet one-on-one with property owners.	Focus group and survey
	Lack of Greenbelts	Riparian property owners	Keep the water safe for swimming	Sponsor seminars for riparian homeowners to learn more about developing a natural shoreline. Use print media to reach riparians.	Survey and evaluation forms
	Car care	Urban residents, riparian residents	Don't harm fisheries and aquatic life	Use print media to reach residents.	Survey

Table: 6.2 Pine River-Van Etten Lake Watershed Information and Education Strategy					
Pollutant or Water Quality Problem	**Cause**	**Target Audience**	**Messages**	**Delivery Mechanisms**	**Potential Evaluation**
Pathogens	Stormwater	Pet owners	Keep the water safe for swimming	Implement media campaign about proper disposal of pet waste.	Survey
	Septic systems	Riparian property owners	Keep the water safe for swimming	Meet one-on-one with property owners that may have potential septic system problems. Provide assistance to address problems. Use print media to reach riparians.	Interview and survey

Chapter Seven: Evaluation of Implementation Strategies

A. Evaluating the Success of the Watershed Planning Project

The Pine River-Van Etten Lake watershed management plan is intended to set forth the strategies and actions to restore and protect the integrity of the river system and it is important to periodically evaluate the implementation efforts to determine 1) whether the project is on track and the tasks are implemented in a timely manner and 2) whether the projects are successful in restoring and protecting water resources and that funds are spent wisely. A focus group comprised of PRVEL Coalition members will meet once a year to discuss whether or not the plan is being implemented and determine what can be done to improve the implementation process.

Possible methods of evaluating whether a strategy is actually successful are such things as before and after photographs, fish surveys, a before and after survey of property owner awareness, before and after water quality testing, documentation of water quality trends through a long-term monitoring program, and replicating the field inventories several years from the initial inventory.

The majority of the Pine River-Van Etten Lake watershed is considered "high quality," meaning that all of the designated uses are being met. The one exception to that high quality is the tributary Van Etten Creek. Van Etten Creek is listed as an impaired watershed based on its nutrient load. The strategies are, therefore, based on the aspects of watershed management that protect and preserve the resource where it is in good condition and to focus on cleaning and restoring the water quality in Van Etten Creek.

In cases where erosion has been identified, monitoring the water quality benefits can be fairly easy. It is known how much nonpoint pollution is entering the river at each site and the effectiveness of the chosen best management practices to reduce the pollution. Huron Pines staff conducted before and after stream assessments and photographs to document the reduction of pollution from the site. However, when managerial and educational practices are implemented measuring the water quality benefits becomes much more difficult, even though in the long term they are the solution to protecting water quality in a more cost-effective manner. It is difficult to identify changes in behavior, but indicators like increased volunteerism and attendance at workshops would indicate a higher level of interest in the watershed, hopefully equating to changing behaviors. Improvements in land use policies such as increasing setbacks, mandatory greenbelt ordinances and septic inspections also indicate a higher level of interest in protecting the water resources.

Finally, the ultimate measure of success of the water quality strategies set forth in the plan would be achieved when Van Etten Creek is removed from the 303(d) list. By meeting the goals of attainment, Van Etten Creek would prove to have been restored to water quality levels approved by the state for all designated uses.

B. Monitoring Programs

1. Current Monitoring and Watershed Needs

Monitoring change in the condition of streams can be done both on a point/site basis as well as more of a watershed-wide approach. As mentioned above, the point/site monitoring can be done easily with before and after stream assessments, loading calculations with new measurements, and photographs. In addition to evaluating these point/site implementation efforts, it is also important to monitor conditions over the whole watershed to determine the effectiveness of implementation over time.

Several efforts currently exist to monitor the condition of the Pine River-Van Etten Lake watershed. Fisheries surveys, performed by the Michigan Department of Natural Resources, document the condition of the river system and the fishery it supports. The Michigan Department of Environment Quality continues to monitor the watershed for changes in biological and chemical conditions throughout the watershed on their 5-year rotating schedule. As the DEQ replicates the biological and chemical surveys, results will be compared to the previous study to determine if water quality has improved, remained the same, or declined. Comparing data collected in past studies to data from future studies will provide an overall watershed indicator of water quality.

Unique to the Pine River-Van Etten Lake watershed is that the active volunteers and members of the PRVEL Coalition have been continuing to make progress on developing and implementing their own watershed-wide monitoring programs. One active coalition volunteer, who also serves as the Lake Monitor for Van Etten Lake for the Cooperative Lakes Monitoring Program, has been collecting data on *E. coli, Escherichia coli*, throughout the watershed. His goal is to create a collection of baseline data, against which changes in the condition of the watershed can be compared.

Most recently, the PRVEL Coalition, in partnership with Huron Pines, has been awarded a full grant, by the Michigan Clean Water Corps (MiCorps), to begin assessing water quality through a volunteer-based aquatic macroinvertebrate sampling program. This program will focus on collecting aquatic macroinvertebrates and capturing data on the species present and their abundance and the habitat type. That data will be entered into a state-wide database of volunteer stream monitoring results. Changes in water quality will be reflected in the aquatic macroinvertebrate communities at each site. Those changes will become evident as species presence and abundance change. At that time, volunteers have the ability to compare new data to previous sampling events. In the case of the aquatic macroinvertebrate community reflecting a change towards decreasing water quality, volunteers will notify state government agencies, which can look into possible causes of that change. As sampling events continue, volunteers will be able to maintain an awareness of the water quality and assess improvements and/or the preservation of current levels.

Finally, another method for involving volunteers in the monitoring process, the DEQ provided training to begin the monitoring strategy of the Bank Erosion Hazard Index, or BEHI. As more volunteers are trained to implement the BEHI monitoring strategy, watershed-wide inventories can be completed, as well as regular site-specific measurements, such as during each MiCorps sampling event.

The purpose of the watershed management plan is to maintain and enhance the water quality of the river system. In order to evaluate the effectiveness of implementation measures over time watershed partners will compare the results of the fishery and biological surveys as they are repeated. The recently started volunteer-based stream monitoring will establish baseline data of water quality, based on aquatic macroinvertebrate communities, in the watershed. Other types of monitoring that will be coupled with the MiCorps and/or BEHI sampling events include temperature loggers, periodic grab samples, routine sampling at identified areas of concern, and groundwater monitoring.

Other indicators of overall watershed improvement would be to re-inventory nonpoint erosion sites. If there are fewer moderate and severe sites in 5 or 10 years, it would indicate that the number one pollutant, sediment, is decreasing over time.

Sediment and nutrient input have been identified as the top pollutants of concern for the Pine River-Van Etten Lake watershed. In order to maintain the areas of high quality, and restore the impaired waters, implementation strategies were developed to reduce and prevent these pollutants from entering the watershed. Monitoring procedures are also designed to evaluate whether or not these pollutants are increasing, decreasing or remaining the same.

There are several different monitoring procedures that are useful in determining watershed health over time. Stream geomorphology assessments, water chemistry sampling, invasive species monitoring, social evaluation and biological sampling are the different surveys that will be used to monitor whether the implementation strategies are protecting water quality.

2. Continuing Watershed Monitoring Efforts

a. Biological Assessment and MiCorps

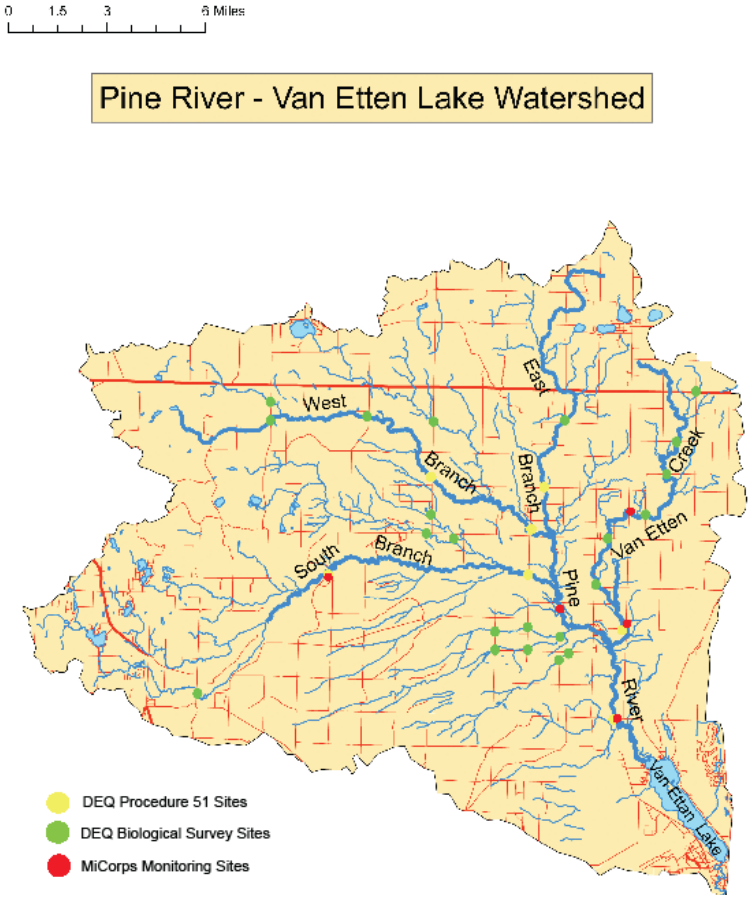
Biological assessments of each watershed are completed on a five-year cycle by the DEQ. The objective of biological surveys is to evaluate the existing conditions of the watershed including habitat availability and the impact on the fish and macroinvertebrate communities. Information is gathered about the macroinvertebrate community and integrity of instream habitat conditions according to Procedure 51 protocol methods. In addition, MiCorps sampling done yearly by volunteers shows more nuanced trends in the populations of macroinvertebrates at the different watershed sites. Additional biological sampling, or an increase in sampling frequency, may be requested if changes in conditions are observed by volunteers through their monitoring programs.

The following is a map of DEQ sampling sites and a list of sampling stations identified for the MiCorps volunteer-based stream monitoring program. Several of these sites overlap with DEQ sampling locations.

- Pine River (South Branch)—Pine River Campground: N 44^{o} 33’ 55” W 83^{o} 35’ 50”
    - The reason for monitoring this site is that upstream from this site, the majority of the river and its tributaries flow through National Forest. It is important to ensure

that this part of the river is not degraded. It currently holds a trout population indicating it is in good health.

- Pine River (Main Branch)—Denolf Property: N 44° 32' 00" W 83° 24' 25"
    - This site was chosen because the North Branch, East Branch and South Branch of the Pine River come together upstream of this site to form the nainstream of the Pine River. Additionally, there are several feeder streams that feed into the Pine River branches and the mainstream of the Pine River. The upper reaches of the North and East branches flow through both National Forest and mixed used private property, some of which is farmland.
- Pine River (Main Branch)—Kings Corner Road, N 44° 30' 30" W 83° 24' 20"
    - This site was chosen because it will monitor the Main Branch of the Pine after the confluence of Van Etten Creek, Roy Creek, Gray Creek and Duval Creek with the Main Branch of the Pine River.
- Van Etten Creek—Barlow Road, N 44° 36' 00" W 83° 23' 30"
    - This site was chosen because there are two sites upstream of this location that typically show high levels of coliform (noted from other volunteer monitoring), however, by the time the creek flows through this site, water quality is not as deteriorated. It is important to monitor and ensure this site does not degrade further.



Map 17. Monitoring sites on the Pine River system.

- Van Etten Creek—State Land on Barlow Road, N 44° 33' 00" W 83° 24' 00"
    - This site was chosen because it is the last easily accessible site on Van Etten Creek before it enters the Pine River. Monitoring this site will allow us to ensure that the health of the stream is not adversely affected between this site and the site on King Road.

b. Stream Geomorphology Assessment

Stream geomorphology assessments are conducted in order to determine the physical integrity and stream stability at a particular location in the watershed. This type of stream assessment is useful to show stream changes; often at locations where a series of best management practices

have been implemented. Stream assessments should be performed by trained professionals and can cost between $500 and $700 per site.

Parameters measured include stream dimension, channel pattern, stream profile, and bed material. This will give a "picture" of the stream channel and help determine changes after BMPs have been installed.

It is recommended that a stream geomorphology assessment be conducted before and after any major road/stream or streambank improvement projects. Though not every improvement project will have a profound impact on the physical characteristics of the stream, the stream assessments provide another avenue to monitor the condition of the river. Other projects will have exhibited a measurable impact on the stream after BMP installation. For example, at a poor road/stream crossing, one would typically see an increase in sand-sized sediments in the bed material; the river will be straightened going through the culvert; the outlet may have a plunge pool; and the stream channel may be constricted through the culverts. Once proper BMPs are installed, a follow-up assessment should show a more natural stream flow through the culvert and reduced amounts of sand-sized sediments in the bed load downstream of the crossing, indicating a reduction in sediment-laden runoff entering the river from the approaches.

c. Chemical Water Quality Sampling

In order to determine if water quality in the Pine River-Van Etten Lake watershed is being protected, and/or improved, it is recommended that at the very least a volunteer water quality monitoring program be established in addition to the current volunteer programs. To do this, specific criteria need to be established such as determining the parameters the volunteers will test, selecting sampling location, and frequency of sampling. It has been recommended by DEQ Water Bureau staff that parameters including chlorophyll a, total suspended solids, water temperature, dissolved oxygen, phosphorous, and nitrates be sampled.

Chlorophyll a is a pigment that allows plants to convert sunlight into organic compounds through the photosynthesis process. High levels of chlorophyll a typically indicate poor water quality because it is the predominant pigment found in algae and cyanobacteria and typically indicates the presence of algae bloom (New Chesapeake, 2006).

Total Suspended Solids (TSS) are solids in the water column that will not pass through a filter. High levels of TSS can increase water temperatures, decrease dissolved oxygen levels and water clarity, interfere with photosynthesis and cover gravel substrate, which is necessary for certain species to spawn.

Water temperature often determines what type of animals live in certain waters. Trout and stoneflies are very sensitive to high or fluctuating temperatures. Higher water temperature also decreases the amount of dissolved oxygen in a water body; warmer water holds less oxygen than cooler water.

Dissolved oxygen is the amount of gaseous oxygen (O_2) dissolved in water. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste

product of photosynthesis. Adequate levels of dissolved oxygen are vital to maintaining a healthy lake and stream ecosystem.

Phosphorous is a nutrient found in fertilizers, human and animal waste, and stormwater runoff. It is typically the limiting nutrient in lake ecosystems. Excess phosphorous can cause algae blooms and increased weed growth, which can choke waterways and use up large amounts of oxygen once the plant material decomposes.

Nitrogen compounds, such as nitrates, also act as nutrients in a waterbody. As with phosphorous, too much nitrogen can accelerate eutrophication (aging) of a waterbody. Nitrate reactions in fresh water systems can cause oxygen depletion and possibly lead to fish kills. In addition, high levels of nitrates in drinking water (from wells of public water supplies) can decrease the blood's ability to carry oxygen.

Sampling procedures vary depending on the type of information which needs to be gathered. The following is a list of recommendations for sampling location and frequency based on the current conditions of the watershed.

- Volunteer water quality sampling should take place at least twice a year, once after spring runoff and once during low-flow in August. It is important that volunteers work with the DEQ and DNR to develop a monitoring program. Water quality sampling by volunteers is used as a screening tool for the DEQ to identify sites where more detailed sampling should take place. It also establishes a water quality baseline for the watershed and helps promote water resources awareness among the community.

- Equipment and data would be housed by the PRVEL Coalition or Huron Pines along with the equipment for the MiCorps program.

- Regular sampling of the parameters identified above should occur at the sites selected in the table below. Having data collected in consistent locations enables those evaluating the data to compare results across the different monitoring programs and perhaps derive cause and affect relationships to better guide restoration or remediation efforts. In addition to the five sites currently used for MiCorps monitoring, to gain a better representation of the watershed monitoring will be conducted at existing DEQ sampling stations, volunteer *E. coli* monitoring sites, and the sites used during the 2002 CMU Van Etten Lake study.

d. Fecal Coliform Sampling

Fecal coliform are bacteria found in the digestive system of warm-blooded animals, the most common species being *Escherichia coli* (*E. coli*). The presence of fecal coliform in water typically indicates fecal waste from humans, livestock, pets, and birds and can cause health problems in high concentrations. It is recommended that fecal coliform be tested at least once a year at the already-sampled 13 river system sites and 3 lake tributary sites. If levels are found above 130 units/100 ml then more regular testing should take place and in different locations in order to pinpoint the cause of the bacteria. There is currently a volunteer-based program focused on measuring levels of coliform throughout the watershed. Results from the sampling efforts, or

changes in baseline data, will drive increased involvement by state agencies to increase state monitoring of the site.

e. Invasive Species Monitoring

Invasive species are an emerging problem in northern Michigan, brought to inland rivers, lakes and wetlands through development and recreation. Plants like phragmites, purple loosestrife, and buckthorn threaten wetlands while Eurasian water milfoil and hydrilla threaten aquatic systems. Zebra and quagga mussels and a host of other invasive animals have been introduced to the Great Lakes and are spreading inland. Because of its proximity to Lake Huron and the town of Oscoda, the Pine River/Van Etten Lake watershed is vulnerable, but early detection and response could mean that the watershed will have a better chance of maintaining its high quality. Monitoring for invasives in the watershed will be easily combined with other watershed-wide monitoring like BEHI, *E. coli* and water quality.

f. Social Evaluation

There are several different strategies to evaluate the effectiveness of information and education programs. Focus groups and surveys are the primary social evaluation tools which will be utilized. The PRVEL Coalition should serve as a focus group to analyze the effectiveness of outreach programs. The coalition will be made up of watershed residents active in the community. They are familiar with watershed attitudes and are getting better at understanding how to deliver conservation messages. This is extremely important in a watershed so dominated by a closely-knit agricultural community. Surveys will also be used to gather information about social behaviors. Event participants and volunteers will be asked to complete a short survey about the activity they attended. Results of these surveys will identify strengths and weaknesses of the program and help guide future events.

Table 7.1 Water Quality Monitoring Protocol					
Type of Analysis	**Monitoring Site(s)**	**Parameters**	**Frequency**	**Environmental Target(s)**	**Management Plan Objective**
Stream Geomorphology	Instream BMP installation sites (road/stream crossings, streambank erosion sites, etc.)	Sediment	Pre and post BMP installation	Reduce the amount of overall sediment input from erosion sites Improvement in stream channel (reduced downcutting, presence of riffles, reduced embeddedness, decreased erosion, improved spawning habitat)	1.1, 1.2, 1.3, 3.1, 3.2
Bank Erosion Hazard Index (BEHI)	Periodically throughout river portion of the watershed (i.e., near bends, erosion sites, road/stream crossings, and other important watershed features	Sediment, vegetation	Every five years for entire watershed, pre and post BMP installation	Reduce the amount of overall sediment input from erosion sites Improvement in stream channel (reduced downcutting, presence of riffles, reduced embeddedness, decreased erosion, improved spawning habitat)	4.5
Water Chemistry	Van Etten Lake CLMP monitoring sites: surface and deep water at inlet of Pine River and deep hole 34 DEQ watershed biological survey stations CMU study locations:	Chlorophyll a Total suspended Solids (TSS) Water Temperature Dissolved Oxygen Phosphorous Nitrogen	Twice a year	No statistical increase in nutrients levels tested from grab samples at all testing locations including the river mouth Dissolved oxygen levels at 7 mg/l or above in coldwater streams TSS levels should not exceed 80 mg/l (levels over 150mg/l and water clarity drastically decreases)	4.5
Biological Assessment	34 DEQ watershed stations: see map above	Macroinvertebrates Water Temperature Substrate	5 year interval	Procedure 51 macroinvertebrate and habitat scores at “good” to “excellent” for all sampling locations	4.5

MiCorps Macroinvertebrate	Van Etten Creek—Barlow Road Van Etten Creek—State Land on Barlow Road Pine River (South Branch)—Pine River Campground Pine River (Main Branch)—Denolf Property Pine River (Main Branch)—Kings Corner Road	Benthic macroinvertebrates	Twice yearly, spring and fall dates as determined by the State of Michigan	Improved fish habitat as indicated by high macroinvertebrate diversity	4.5
Cooperative Lakes Monitoring Program	Sites in Van Etten Lake	Secchi Disk Transparency Total Phosphorus Chlorophyll A	Yearly as indicated by the CLMP monitoring protocol	Improved clarity, reduced phosphorus and chlorophyll a over time mean a less nutrient-rich trophic status of the lake and reduced algal blooms and weeds.	

Fecal Coliform	**River sites** Pine River @ County Line Pine River @ F-41 Pine River @ Andrews Rd. Pine River @ Cruzen Rd. Van Etten Crk @ Barlow Rd S Van Etten Crk @ F-41 N Van Etten Crk @ Barlow Rd N Van Etten Crk @ Dellar Rd. Van Etten Crk @ Clemens Rd. Van Etten Crk @ M-72 & McGregor Van Etten Crk @ M-72 & Colville East Br Pine River @ F-30 East Br Pine River @ Procunier East Br Pine River @ M-72 & F-41 East Br Pine River @ M-72 E East Br Pine River @ M-72 W West Br Pine River @ Cruzen Rd. South Br. Pine River @ campground **Lake sites** Phalen Creek @ Loud Dr. Phalen Creek @ Loud Dr. Dry Creek @ Shoreline	*E. Coli* bacteria	Once a year (More frequent testing if levels exceed 130 units/100 ml)	Not to exceed 130 units/100 ml over a 30 day average Note: Levels above 300 units/100 ml impair total body contact	4.5
Invasive Species	Throughout watershed, in conjunction with BEHI, MiCorps, biological surveys, and BMP installations	Invasive plants and animals	Yearly	Reduce the spread of invasive aquatic and terrestrial plants and animals	4.4

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ATTACHMENT 1

Watershed Partnership Agreement

ATTACHMENT 2

Typical Nonpoint Source Pollutants

Typical Nonpoint Source Pollutants

Nonpoint source pollutants are any of the substances listed below that can degrade the water quality by impairing the designated uses(s) of the water.

Animal manure –Manure is a source of nutrients, salts, and organic matter that can degrade water quality.

Depressed dissolved oxygen – When the oxygen dissolved in water and readily available to aquatic organisms (mg/1) is below optimal levels.

Hydrologic flow fluctuation – When the natural hydrology of the watershed changes due to increases in storms water runoff.

Metals – Toxic substances, such as mercury and lead that come from urban runoff or atmospheric deposition.

Nitrogen – An element that at certain levels can cause excessive algae and aquatic weed growth.

Organic matter – Residue from plant and animal origin (including leaves and grass clippings). In excessive amounts organic matter can lower dissolved oxygen levels.

Pathogens – Human disease causing bacteria or viruses.

Pesticides – Chemical substances used to kill pests such as weeds, insets, algae, rodents, and other undesirable agents.

Petroleum and petroleum by-products (oil and grease) – Urban pollutants that are transported by rainfall from roads, parking lots, and improper storm drains.

Phosphorus – An element that at certain levels can cause excessive algae and aquatic weed growth.

Salts – Chemical compounds from winter road deicing, septic systems, and water softener outwash.

Sediment – Soil that is transported by air and water and deposited on the stream bottom

Temperature – An elevation in water temperature that stresses fish and aquatic insects.

APPENDIX A

Glossary of Terms

Glossary of Terms

Anoxic: Deprivation of oxygen.

Best Management Practices (BMP): Structural, vegetative and managerial practices implemented to control nonpoint source pollution.

Carlson's Trophic Status Index: Classification system used to classify lakes based on degree of enrichment. Carlson's Trophic-State Index (TSI) is used to evaluate nutrient concentration and its effects on biological productivity. The TSI is a numerical scale ranging from 0-100. Lakes with index values less than 40 are classified as oligotrophic (low productivity).

Chlorophyll *a*: A pigment in all plants that is necessary for photosynthesis.

Critical Area: That part of the watershed that is contributing a majority of the pollutants and is having the most significant impacts on the waterbody.

Cultural Eutrophication: An accelerated input of plant nutrients and sediment into a waterbody that promote excessive plant growth and results in diminished or detrimental changes in water quality.

Designated Uses: Recognized uses of surface water established by state and federal water quality programs.

Erosion: Detachment and movement of rocks and soil particles by gravity, wind, and water.

Eutrophic: Designation of a body of water rich in nutrients which cause excessive growth of aquatic plants.

Eutrophication: A natural aging process where lakes begin to fill in with sediment and nutrient materials.

Fauna: The animals of a specified region or time.

Groundwater: The subsurface water supply in the saturated zone below the water table.

Impervious: A surface through which little or no water will move. Impervious areas include paved parking lots and roof tops.

Mesotrophic: Trophic state between oligotrophic (nutrient poor) and eutrophic (nutrient rich) systems.

Nonpoint Source Pollution: Pollution caused when rain, snowmelt, or wind carry pollutants off the land and into the waterbodies.

Oligotrophic: Designation of a body of water poor in plant nutrient minerals and organisms and usually rich in oxygen at all depths.

Pathogens: Human disease causing bacteria or viruses.

Pollutant: Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it contributes to the degradation or impairment of its usefulness or renders it offensive.

Phosphorus: A plant nutrient that is needed for processes such as growth and photosynthesis. Increased levels can cause excessive growth of aquatic plants.

Riparian: Person who lives along or hold title to the shore area of a lake or bank of a river or stream.

Riparian corridor: Area bordering streams, lakes, rivers, and other water courses. These areas have high water tables and support plants requiring saturated soils during all or part of the year.

Runoff: That portion of the precipitation or irrigation water that travels over the land surface and ends up in surface streams or water bodies.

Secchi disk: A circular disk that can be lowered into the water to obtain an estimate of light penetration.

Sediment: Soil, sand, and minerals which can take the form of bedload, suspended, or dissolved material.

Slope: Ground that is not flat or level; measured as deviation from the horizontal.

Soil Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber cutting.

Stakeholder: Any organization, governmental entity, or individual that has a stake in or may be affected by a given approach to environmental regulation, pollution prevention, or energy conservation.

Storm Drain (Storm Sewer): A slotted opening leading to an underground pipe or an open ditch that carries surface runoff.

Stormwater: Runoff from a storm, snow melt runoff, and surface runoff and drainage.

Succession: The slow, regular sequence of changes in the regional development of communities of plants and associated animals.

Surface Water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, wetlands, impoundment, and seas).

Topographic Map: Land map that display elevation along with natural and man-made features.

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made features.

Tributary: A river or stream that flows into a larger river or stream.

Water Quality: The biological, chemical, and physical conditions of a waterbody, often measured by its ability to support life.

Watershed: The geographic region within which water drains into a particular river, stream or body of water. Watershed boundaries are defined by the ridges separating watersheds.

Wetland: An area that is regularly saturated by surface or groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

APPENDIX B

Road/Stream Crossing Inventory

Road/Stream Crossing Inventory

1. Introduction

Sediment has been identified as one of the primary pollutant threats to our water quality. Road/Stream crossings can become a conduit for this pollution when excessive soil from roads and/or eroding banks at the culvert placement, flow into a tributary. These road/stream crossings range from 18-inch culverts to two lane highway bridges. The cumulative effects of sedimentation are an area of concern in stream systems, as they can directly affect diverse fish and riparian dependent wildlife. Sediment can cover aquatic spawning beds and clog fish gills as well as impair water quality. As part of the critical area evaluation for the Pine River/Van Etten Lake Watershed Plan an inventory of all public road/stream crossings within the watershed was conducted. The purpose of this inventory was to identify and document all of the road crossing sites on the numerous tributaries of the Pine River/Van Etten Lake Watershed. A total of 183 sites were located and documented during this inventory.

a. Methods

On site field evaluations were performed to inventory each potential crossing. A Road/Stream Crossing Field Data Form was completed at each site. (See page 79). A series of photographs were taken of each site to document existing conditions at each crossing. Each site was visited to assess potential problems that may contribute nonpoint source pollution and impact water quality. Data collected at the crossings included detailed information about the location (Global Positioning System coordinates were marked for each site), road characteristics (width, shoulder, drainage, approaches, surface), culvert condition and erosion and runoff problems. Stream characteristics such as width, depth, current and substrate were also recorded.

At each crossing, soil erosion was evaluated in terms of existing and potential conditions; additionally, various physical measurements were made and each site was documented with an inlet and an outlet photograph. This information was compiled into a database for evaluation.

One of the key functions of an inventory is to aid in the prioritization of sites for improvement. Each crossing was assigned a "score" along with a corresponding severity ranking category: Minor, Moderate or Severe. The ranking is designed to reflect the relative severity of existing and potential erosion conditions at each site. In general, the severity ranking will be one of several considerations for improvement decisions. Point scores were calculated using the scoring work sheet noted on page 81, and the sites were assigned the severity rankings as follows:

Point Score Total	Severity Category
0-15	Minor
16-29	Moderate
≥30	Severe

Severity rankings are useful as a quick reference to sites that fall within a specific category. However, it is expected that resource mangers will carefully review candidate sites for improvement by paying closer attention to individual scores before selection of sites for implementation.

Definitions of the terms used in data collection and severity ranking are provided below:

Adjacent Landowners: Ownership was determined from county plat book maps. Recent ownership may not be reflected and should be re-checked prior to any improvement work.

Corrective Measures/Drainage Control Features: Any best management plan measures used to correct site-specific erosion problems, generally these include diversion outlets, erosion blankets, and sediment basins.

Embankment: The area surrounding the culvert. The slope association with the inlet and outlet of a corrugated metal pipe or box culvert.

Extent of Erosion: This category provides a subjective assessment of the observation of sand deposition, gullies, or similar conditions at the sites. It does not reflect erosion potential.

Fish Passage Problem: This refers to the flow through a culvert and whether or not fish can move through the culvert in either direction. Certain obstructions have the potential to impede passage such as a perched culvert.

Flow Through Culvert: This is an indication of obstruction to flow. Obstructed flow is generally associated with large debris accumulations such as beaver dams or due to large sediment inputs associated with run-off or grading.

Fill: Refers to the amount of material (e.g. sand, soil, gravel, etc.) over the culvert.

Length of Approaches: The downward slope of a road approaching a stream crossing where typically the stream is located at the low point.

Recommended Treatment: One or more best management practices recommended for each crossing. The practices were selected based on proven ability to reduce sedimentation and are generally accepted by road and water resource professionals.

Run-off Pathway: The course of run-off to a stream channel. This may be via two general routes, the road or ditch/shoulder. Typically, roads with a surface of either gravel or sand result in run-off traveling down the road.

Slope of Approaches: The ratio of an increase in height over the distance of a given road and is usually expressed as a percentage.

Stream Current: Average upstream and downstream current was observed and classified as slow, medium, or fast.

Vegetation: Defines the presence, absence, and relative abundance/condition of existing vegetation on the embankments of a given crossing. Generally, vegetation that is at all disturbed by access or road grading is considered to be partial.

Wetlands: Any stand of vegetation that is typical of an area of land that is at least partially inundated by water for part of the year.

Visible Down Cutting: This indicates the distance or drop from the base of the culvert outlet to the surface of water.

b. Results

Of the 183-road stream crossing sites that were identified within the Pine River/Van Etten Lake Watershed, 9 sites ranked as severe, 119 sites were ranked as moderate and 55 sites ranked as minor. A number of common factors contributed to the severity of those sites scoring 30 or more points. Most of the severe sites were located on relatively narrow sand roads with lengthy and steep approaches of 6-10% slopes and vertical embankments. A number of the sites exhibited pool formations at the culvert outlets. This pooling is attributable to flash events of high velocity streams flows coursing through the culverts with intense erosive power and undercutting the banks. These problem sites were found on Duval, Backus, Gimlet, McGillis and Vandercook Creeks, as well as one site on the West Branch and two near Sprinkler Lake. The problematic condition of sites inventoried is based predominately on road conditions, culvert size and placement, as described above.

Individual sites data may be found starting on page 82.

Road/Stream Crossing Data Form

Page 1 of 2

ROAD STREAM CROSSING FIELD DATA FORM

Collected By: _____ Field I.D. Number: _____
Date: _____ Site I.D. _____

LOCATION

Stream Name: _____ County: _____ Road Name: _____
Crossing Name: _____ Township: _____ T_____ R_____ Sec._____

Type of Crossing:
- _____Brigde
- _____Single Culvert
- _____Twin Culverts
- _____Triple Culverts_____
- _____Other_____

Adjacent Landowners:
- _____USA
- _____State
- _____Local Gov't.
- _____Private
- _____Other_____

ROAD DATA

Width at Crossing _____ft.
Road Surface: _____paved
_____gravel
_____sand

Maintenance: _____seasonal
_____year around

APPROACHES

	Left	Right
Length:	_____ft.	_____ft.
Slope:	_____0%	_____
	_____1-5%	_____
	_____6-10%	_____
	_____>10%	_____

Location of low point:
- _____at stream
- _____other_____
- _____
- _____

Ditch/Shoulder Vegetation
- _____none _____
- _____partial _____
- _____heavy _____

Existing drainage control features:
_____None _____Present and functional
_____Need repair_____
_____

Average width of grade, including shoulders and ditches _____ft.

Runoff path: _____roadway _____ditch

CULVERT DESCRIPTION

Length _____ft
Diameter _____inches
Material: _____galvanized
_____concrete
_____other_____

Condition: _____good
_____fair
_____poor

Flow through culvert: _____clear
_____obstructed

Fish passage problem? _____

	Inlet	Outlet
Fill Depth:	_____ft.	_____ft.
Embankment:	_____vertical	_____
	_____ 1:1	_____
	_____ 1.5:1	_____
	_____ 2:1	_____
	_____ >2:1	_____

STREAM CHARACTERISTICS

	Upstream	Downstream
Ave. Width:	_____ft.	_____ft.
Ave. Depth:	_____ft.	_____ft.
Ave. Current	_____ slow	_____
	_____moderate	_____
	_____ fast	_____
Predominant substrate type:	_____ sand	_____
	_____snd/grav	_____
	_____ gravel	_____
	_____ muck	_____
	_____ other	_____

Adjacent wetlands: _____yes _____no

Water Temperateure: _____

Visible down cutting _____yes _____no _____inches

Comments: _____
_____

Page 2 of 2

Field I.D.
Site I.D.

)NDITIONS AND TREATMENT

Erosion Conditions:

_____Streambank erosion
beside crossing
_____embankment erosion
_____culvert outlet erosion
_____pool formation at culvert outlet
_____shoulder/ditch erosion
_____sand/soil over bridge or crossing
_____other _____

Recommended Treatment (number):

_____pavement
_____paved curb & gutter
_____erosion control structures ( )
_____sediment basins ( )
_____extend culverts ( )
_____diversion outlets ( )
_____increase fill
_____replace culverts ( )
_____other_____

Extent:

_____minor _____moderate _____extreme

Reason for recommendation:_____
_____

Cause:_____
_____ _____

PHOTOS Film Number_____

imes:_____
_____

SITE SKETCH

Road/Stream Crossing Severity Scoring Sheet

Road/Stream Crossing Individual Sites Data

APPENDIX C

Streambank Erosion Inventory

Stream Bank Erosion Inventory

1. Introduction

Severe to moderately eroding streambanks are a source of unwanted soil deposition to river systems. The erosive action of flowing water can cause untold cubic yards of soil to fall into a stream where it becomes suspended and clouds water clarity, disturbs gill breathing aquatic life and eventually settles over critical gravel spawning beds. Soils that may contain excessive nutrients from historic fertilizer application, can over enrich the water system, and negatively change its trophic state. Sediment choked rivers run slower and hence potentially warmer, which then adversely effects cold water dependent species. Sediment can hinder navigation and contribute to the over abundance of aquatic vegetation. Additionally, severe streambank erosion jeopardizes land integrity and may result in the loss of residential property.

An integral part of any watershed planning initiative is to find and document sites of streambank erosion. In order to gain an overall indication of the severity, quantity and location of streambank erosion sites within the Pine River/Van Etten Lake Watershed, a field inventory was conducted from October 2001 to September 2002. During that time 36-streambank erosion sites were identified.

a. Methods

Using US Geological Survey topographic maps and aerial photographs an initial evaluation was performed to determine those areas that could be inventoried using personal watercraft to float tributaries of the Pine River system. Based upon the evaluation and field scoping, the entire Main Branch and approximately seven river miles of the South Branch of the Pine River were determined to be navigable. The remaining rivers and tributaries within the watershed were inventoried by automobile travel, to crossing or access locations and observing on foot, portions of the streambank corridor. Each site location was cataloged with Global Positioning System (GPS) technology to accurately record its position along the stream. Data was collected to document site accessibility, condition of the bank, percent of vegetative cover, apparent cause of the erosion, bank slope, length and height, river conditions, soil types and recommended treatments. (See field data form on page 86). A photographic record was also made of each site. Sites were then scored using a standard streambank erosion severity index. Scores of less than 30 points were ranked as minor, with 30- 36 points determined as moderate and scores of more than 36 points indicating severe streambank erosion. A site scoring work sheet is on page 88.

b. Results

During the field collection of data it was noted that most of the watershed area from the headwaters regions within the subwatersheds ranging down to within approximately five

miles from their confluence's with the Main Branch of the Pine River, where relatively free of identifiable streambank erosion sites. Particularly, small creeks such as Gimlet, Backus, Roy Grey and Duval had very little topographic relief and could be generally characterized as relatively narrow, highly vegetated unnavigable waterways with low banks. Within about five miles of the confluence of the Pine River, the topography surrounding the major tributaries begins to rise and contributes to the presence of the majority of streambank erosion sites within the watershed.

The West Branch follows this pattern with no sites noted in the headwaters, however; the second highest-ranking severe site was identified close to where it crosses the Cruzen Road Bridge, approximately one mile from its confluence with the Main Branch. Fast flowing water taking a bend along tall steep banks of stratified sandy soils all contribute to the high score of this site.

The South Branch is a predominately clay substrate, fast flowing narrow stream. This river contains large amounts of woody debris tangled over gravel beds, with an abundance of tag alder and cedar corridors. It exhibits few erosion problems until it reaches the Buhl tract area of the Huron-Manistee National Forest. The riverbanks then become high vertical sand walls. The serpentine flow pattern exacerbates the numerous streambank erosion sites that were documented along this stretch of river. A total of 11 sites were recorded on this tributary.

Only a couple of sites were identified along the banks of the East Branch. Again, these locations were found close to its confluence with the Pine River.

Van Etten Creek of Alcona County begins to exhibit taller erosive banks south of Mikado and near to its crossing at Barlow Road. Relatively few major sites, however, were identified along this stream system.

The Main Branch of the Pine River begins at the confluence of the West and East Branches, which meet at the F-30 (Mikado-Glennie Road) Bridge, located 1.5 miles west of Mikado. 19 streambank erosion sites were identified on the Main Branch with the last significant site noted just north of King's Corner Road Bridge. The highest scoring site in the watershed is found on the Main Branch along with two other severely eroding locations. Large stretches of this river run wide and shallow. After it receives the outflows of Van Etten Creek and the South Branch it begins to take on more depth. However, the large volume of sediment that has settled throughout the last one third of the river diminishes its depth once again. Much of the Main Branch is checkered with scatterings of deadfalls and woody debris. In a few places, great thick log jams, some piled as high as eight feet above the water, stretch across the width of the river. Powerful flash events appear to have heaved smaller upstream jams onto these jumbled masses. Although a hindrance to navigation, the presence of these logjams is assisting with preserving the riverbank from the water's erosive energy. These logjams also serve as natural structures that slow sediment migration to downstream areas. The woody debris is also providing critical habitat to aquatic and near-shore terrestrial wildlife.

Of the 36 identified streambank erosion sites, 4 were ranked as severe. These are three on the Pine River, one on the West Branch. 17 sites were ranked as moderate. Two of the moderate sites scored right at 36 points and are located on the South Branch of the Pine River. 15 sites were ranked as minor. See page 89 for a more detailed survey of the specific site scores and characteristics etc.

Streambank Erosion Inventory Data Collection Sheet

Streambank Erosion Severity Ranking Score Sheet

Streambank Erosion Inventory Individual Sites Data

APPENDIX D

Agricultural Inventory

Agricultural Inventory

1. Introduction

Agricultural practices on the land near riparian corridors may negatively influence water quality. The over application of fertilizers or manure to the water's edge can introduce an over abundance of nutrients such as nitrogen and phosphorus, into the river system. Livestock that have unrestricted access to streams destroy banks and substrate, causing erosion and sediment deposits in the water. Unrestricted livestock also add unwanted nutrients to the streams by urinating and defecating in them. Feedlots located close to waterways can contribute livestock waste to the watershed as well. In order to assess the agricultural influences within the critical area of the watershed, an inventory was conducted from August 2001 to November 2002. During that time 24 active farms were inventoried. Of those, 12 were noted as having an apparent pollutant source to surface water.

a. Methods

Information regarding active agricultural production within the critical area was gathered from the Alcona Conservation District, Michigan State University Extension and the Natural Resources Conservation Service. Aerial photographs and field observations were used to determine inventory sites. The majority of the sites identified were located within the Van Etten Creek subwatershed.

Site information such as: type of operation (i.e. livestock, crops, and orchard) estimated acreage, general topography and estimated riparian frontage were collected. Other information regarding soil type and stream conditions, as well as foreseeable risks to surface water, groundwater or wetlands were noted.

During the survey apparent pollutant sources within 1000 feet of surface water were documented. The types of pollutant sources that may have been noted were: unrestricted livestock access to water, crop production adjacent to water, feedlot runoff, manure storage runoff, manure application within 150 feet of a waterway, poor fertilizer storage, or other sources such as milking parlor runoff.

Treatments to reduce or eliminate apparent pollutant source(s) found on the farms inventoried were documented and discussed with landowners, when available, during the field visit. These recommended treatments, determined in consultation with the Natural Resources Conservation

Service may have included: livestock exclusion fencing, livestock crossing or access points, alternate watering sources, riparian buffer strips, fertilizer and pesticide storage, animal waste facilities or feedlot diversions.

b. Results

Twelve sites were found to have some apparent pollutant source to surface water. All of these farms are livestock operations. Predominately beef cattle. The overall problem observed on approximately 85% of these sites, was unrestricted livestock access to streams. Van Etten Creek has the majority of livestock operations allowing cattle unrestricted access to it. However, McGillis, Duval, Roy and Wallace Creeks were all found to have at least one farm with cattle having open access to them. Two beef operations on tributaries of the East Branch of the Pine were observed with cattle having unlimited access. It is recommended that these livestock operations install exclusion fencing and an alternative watering source or cattle access/crossings. Along with the fence installation it is suggested that a riparian buffer strip be planted within the fence zone. Other problems encountered were feedlot runoff, milk parlor runoff, field tile runoff to a tributary, and cattle access to a ditch dug from a creek. A copy of the agricultural inventory form and individual sites data may be found starting on page 93.

Agricultural Inventory Data Collection Sheet

Agricultural Inventory Individual Sites Data

APPENDIX E

Shoreline Development Inventory

Shoreline Development Inventory

1. Introduction

Van Etten Lake is a borderline eutrophic lake with a shoreline that is nearly all developed. In recent years there have been many complaints regarding substantial growths of blue-green algae and the spread of Eurasian Water Milfoil. These conditions are indicative of elevated nutrient levels and the nuisance impairs both swimming and boating uses of the lake. While nutrients are essential for life, excessive amounts can lead to accelerated eutrophication (premature aging) of the lake. An inventory of sites where nutrient enrichment is occurring makes for a useful watershed management tool, although data generated by this inventory must be carefully interpreted and is intended only to help guide watershed management efforts. Through the collection of data on all parcels of property along the shore, and the subsequent sharing of information with property owners, improved shoreline stewardship practices are more likely to be implemented.

Because the management of the riparian zone plays such an important role in water quality, an inventory of the shoreline can serve as a useful tool for understanding current and future water quality problems. While the owner of a small lakefront lot may feel insignificant in terms of the impact they may have, shoreline stewardship practices, one small parcel at a time, cumulatively equal a shoreline that will ultimately either help or hurt water resources. This critical area can either be developed in such a way that it is in a near-natural state (working to filter nutrients, provide habitat, and stabilize the shoreline) or be nearly completely artificial (seawall with mowed, heavily fertilized grass to the water's edge). While most parcels may fall somewhere in-between, developed parcels generally have shorelines that resemble the second option. Loss of natural habitat and excess nutrients work together to drastically change the natural condition of the lake, and, while nearly everyone wants to improve water resources, few take the relatively easy steps to do so.

a. Methods

As part of the critical area inventory for the Pine River/Van Etten Lake Watershed Plan, an inventory of the shoreline of Van Etten Lake was conducted. The inventory began in August 2001 and was completed in October 2002. A shoreline inventory form (See page 100) was used to collect data for each property parcel. The following is a brief description of each category of information collected for this inventory:

- **Shoreline property parcels** include developed and undeveloped lots, access sites, road ends, etc. These are identified by order, map number, address, and last name. Order is simply the numbering system given to the parcels by the technician. Some sort of easily identifiable landmark serves as site one, with the other parcels numbered in order around the lake. Map number refers to the tax ID number and is helpful for tying our database into other maps from local governmental units. Address and name are completed if known; this category will typically be completed at a later time.
- **Property description** is a few abbreviated words that could be useful in later attempts to identify the property.
- **Developed** property parcels refers to whether a significant permanent structure is present. Generally this would be a home, although in park areas a boat launch or pavilion are also counted as developed. Road ends were also considered to be developed parcels for this inventory.
- **Parcel width** is an estimate of how may feet wide the lot is. This is particularly important when summarizing shoreline data.
- **Access site** includes any parcel open to public use (boat launches, road-ends, parks, etc.)
- **Substrate** will be completed where the bottom is visible and will note what is typically within 40 feet of the shore.
- **Aquatic weeds** are observed in the nearshore area where the bottom was visible such as pondweed, chara, Eurasian watermilfoil, etc.
- **Turf management** is for classifying the apparent intensity of lawn management. This would either be heavy use of fertilizer and watering, moderate, or light. Along lakes, turf management plays an important role in the quality of water resources. Lawns that are managed like a golf course can contribute to the water looking more like a golf course water hazard than a pristine lake.
- **Setback distance** is the number of feet that the dwelling is set back from the shore. The farther back the structure, the better the opportunity for maintaining a natural buffer area along the shoreline.
- **Erosion** for the purposes of this survey, will include those obvious areas of the accelerated wearing away of land (observed by gullies, slumping banks, bare soil on steep banks, and undercut banks). These will be ranked as severe, moderate, or slight. Erosion can result in both property damage and environmental problems. Perhaps even more problematic is the commonly used method of controlling shoreline erosion along lakes – seawalls. Such a practice leads to a total loss of natural shoreline habitat. Erosion control structures will be noted when observed.
- **Wetland** is a note on whether such an ecosystem was observed from shore, as indicated by vegetation or hydrology. (Obviously, this does not replace the need for more detailed onsite delineation).
- **Greenbelts** will be scored by the shoreline technician on a scale ranging from 1 to 3 (i.e., a 1 being a greenbelt with sparse vegetation and 3 being a nearly undeveloped shoreline). A zero would indicate a paved shoreline, devoid of any vegetation and a .5 would generally be mowed turf-grass along the shore, with most other vegetation removed. Depth of the greenbelt, type of plants, and slope of the parcel will also be considered. Although this is a more subjective category than many of the others, the same shoreline technician collected the data throughout the process for consistency. Utilization of greenbelts has been proven to be one of the most effective shoreline practices for protecting water quality and lots that do not have them often end up developing other associated problems (such as algae growth, erosion, or runoff).

- **Tributary** streams will be noted when present, as they are an important part of the watershed.
- **Priority to protect** includes such areas as large undeveloped parcels, unique habitats, or sensitive areas with tributaries or wetlands. A yes response might indicate a potential parcel for voluntary land protection, such as a conservation easement. This is simply a suggestion for perhaps pursuing the issue further, possibly through a land conservancy.
- **Comment** is a space for any additional items that could help for clarification or note something that space is not already provided for.

Considerations such as time, funding, technical expertise and expected project benefits were all used to evaluate which items to study as part of the shoreline inventory. To determine which data should be collected and the best method of doing so for Van Etten Lake, other shoreline surveys on similar lakes in northern Michigan were carefully reviewed. Those sample shoreline inventories were designed by the Tip of the Mitt Watershed Council and conducted through out the Elk River Chain of Lakes as well as on Walloon Lake. Huron Pines RC&D also successfully conducted a similar shoreline inventory on Higgins Lake.

The Van Etten Lake shoreline inventory was conducted on a parcel by parcel basis. Shoreline property parcels included developed and undeveloped lots, access sites and easements. Parcel numbers were assigned to each shoreline property parcel identified Some of the categories of information collected for each shoreline property parcel included: substrate of parcel, aquatic plants observed in the nearshore area, turf management, erosion, structural setback, wetland regions and greenbelts. By using a small watercraft technicians were able to be near enough to the shoreline to effectively collect data. Methods for the shoreline inventory were based upon similar studies conducted by the Tip of the Mitt Watershed Council. See field data sheet on page 100 for more details regarding data collection categories.

Turf management and erosion status were given a rating such as light, heavy etc. versus just a yes/no status. Greenbelts (or vegetated buffer strips along the shoreline) were rated on a scale of zero to 3.0 with 3.0 being an undeveloped shoreline with no disturbance of the natural vegetation and zero being ascribed to a site entirely paved or devoid of vegetation.

While the shoreline inventory does not replace the need for more detailed follow-up work at some locations, it is a good starting point and a useful management tool for future watershed restoration and protection efforts. Through a confidential follow-up with property owners and an on-site visit, practical recommendations can be offered which are often simple and relatively inexpensive. This sort of educational outreach effort connects with a target audience that can have a significant influence on water quality.

b. Results

The entire shoreline of Van Etten Lake, including Loud Island, was inventoried. Data was gathered on a total of 486 shoreline property parcels. A complete table of results can be found starting on page 101.

Shoreline Development Inventory Data Collection Sheet

Shoreline Development Data Table

APPENDIX F

Central Michigan University Water Quality Study