INTRODUCTION

The primary goal of the Lower Dead River Watershed Management Plan is to develop a strategy for the protection and enhancement of natural resources within the Lower Dead watershed. This management plan is designed to provide long-term water quality and aquatic habitat benefits to the Dead River, its tributaries, and Lake Superior. In addition to the environmental benefits associated with proper watershed management, this approach can help to shape the development patterns of an area to ensure they are sustainable. Such careful development practices can result in not only the protection of the environment, but the quality of life for the residents of the watershed as well.

Goals of the Lower Dead River Management Plan:

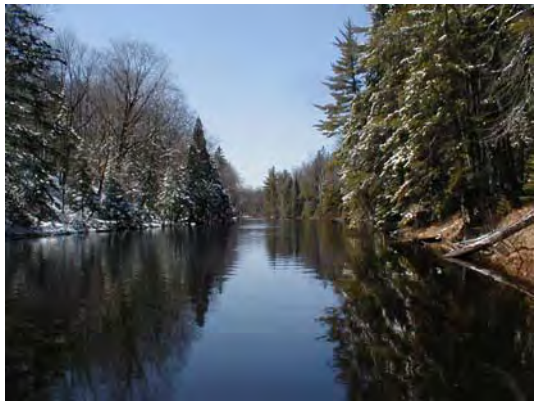
- Identify areas of sedimentation, erosion, and **stormwater** runoff contributing to the decline of water quality and aquatic habitat in the Lower Dead River watershed
- Create stream monitoring programs, improve **riparian** zoning ordinances, and develop better stormwater management techniques that will help to protect the water quality and aquatic habitat in the Lower Dead River watershed
- Identify open space planning and low impact development practices in order to protect ecological resources while still supporting economic and social growth within the community
- Create a watershed management plan that assists in the realization of the vision for Lake Superior as defined by the Lake Superior Binational Forum

This management plan includes an inventory and analysis of both the natural and built features of the watershed. It also includes a discussion of specific areas of concern and their effects on the health of the watershed. From the inventory conducted on the natural features, the watershed council prioritized these areas based on human disturbances (altered hydrology, transportation issues, increased development, and recreational activities). Finally, a series of management strategies and recommendations are presented. These strategies are designed to allow local communities to continue their growth without compromising the environmental quality and designated uses of the watershed.

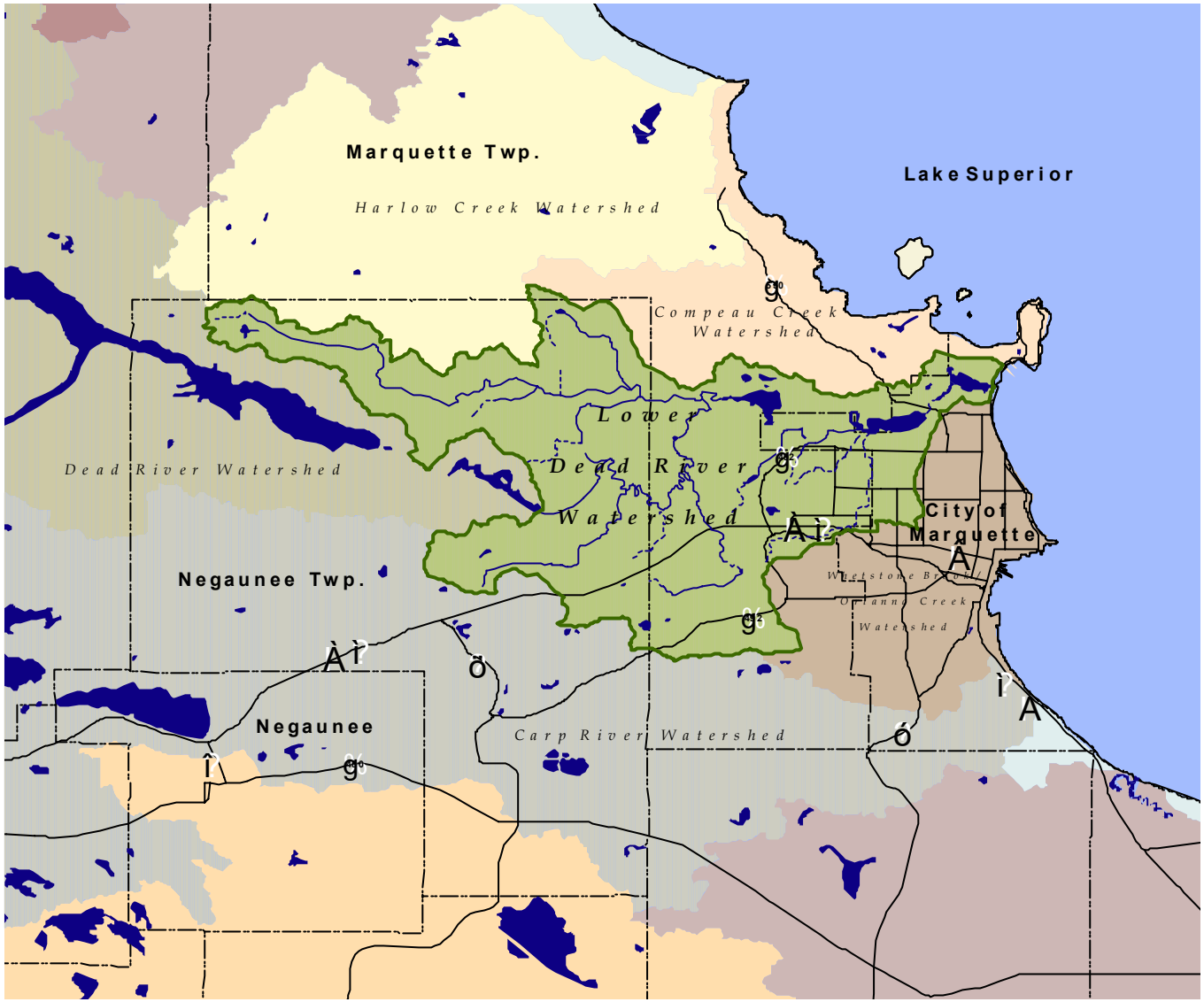
Stakeholders:

- Riparian landowners
- Local residents
- Marquette Township
- Negaunee Township
- City of Marquette
- Marquette County Conservation District
- Central Lake Superior Watershed Partnership
- Northern Michigan University
- Planning Commissioner
- Marquette County Road Commissioner
- Marquette County Drain Commissioner
- Non-profit Organizations
- Michigan DEQ
- Michigan DNR
- Industrial and Commerical Developers

Upper Harbor at dusk



Lower Dead River

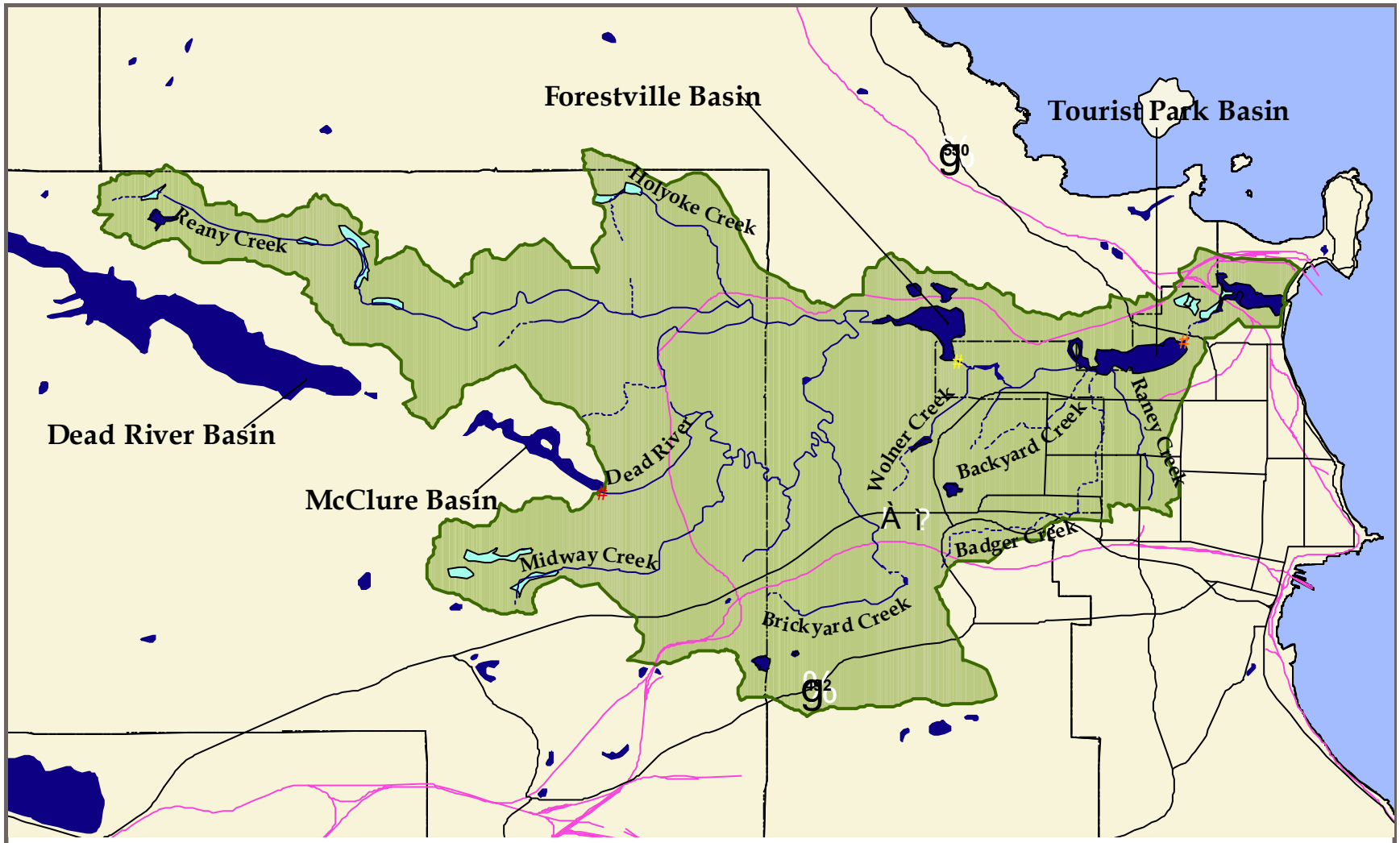


LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN

Regional Context

ANALYSIS OF THE NATURAL ENVIRONMENT

The Lower Dead River Watershed covers a 22 square mile area located within the Lake Superior Basin. The watershed includes the main stem of the Dead River as well as several tributaries, a storm drainage outlet, and the mouth of the river, which empties into Lake Superior. Although the entire Dead River Watershed from headwaters to mouth covers a 164 square mile area, the most heavily impacted region is found within the boundaries of the Lower Dead River sub-watershed. This sub-watershed is located within the municipalities of Negaunee Township, Marquette Township, and the City of Marquette. A map of the regional context for the Lower Dead River watershed is shown on the facing page.


Forestville Basin
Tourist Park Basin
Holyoke Creek
Reany Creek
Dead River Basin
McClure Basin
Dead River
Wolner Creek
Backyard Creek
Raney Creek
Badger Creek
Midway Creek
Brickyard Creek
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Watershed Hydrology
Lower Dead River Watershed
Roadway
Railroad
Intermittent Stream
Perennial Stream
Wetlands
Lake, Pond
McClure Dam
Forestville Dam
Tourist Park Dam
0.5 0 0.5 1 Miles

HYDROLOGY

Eight main tributaries, along with several smaller, unnamed streams feed into the main stem of the Dead River. The Watershed Hydrology map (see facing page) shows the location of each of these tributaries, while a general description of each tributary is given in Table 2.1. As the Dead River makes its way towards its final outlet into Lake Superior, it is impounded 3 times: McClure Dam, located just downstream of the McClure Storage Basin, Forestville Dam, located at the Forestville Storage Basin, and Tourist Park Dam, located at the Tourist Park Storage Basin. In addition to these man-made impoundments, streams are affected by various beaver dams or other debris that interrupt the natural flow regime.

Table 2.1: Description of Dead River Tributaries

Stream Branch	Headwater Location	Avg. Stream Width	Avg. Stream Depth	Substrate Material
Reany Creek	T48N, R26W Section 06	5-10′	1.5 – 4′	gravel
Midway Creek	T48N, R26W Section 22	4′	1-2′	gravelly sand
Holyoke Creek	T48N, R26W Section 02	1-3′	1-2′	sand/gravelly sand
Brickyard Creek	T48N, R25W Section 20	2.5 – 9′	1-2′	sand/gravelly sand
Wolner Creek	T48N, R25W Section 17	4′	1-1.5′	sand/gravel
Backyard Creek	T48N, R25W Section 16	1-2.5′	1-2′	sand
Badger Creek	T48N, R25W Section 20	4-6′	1-2′	sand
Raney Creek	T48N, R25W Section 15	1-3′	1-2′	sand/gravel

In general, the tributaries located within the Lower Dead River watershed are relatively high quality. In an analysis of coastal tributaries conducted in July of 2001 by the MDEQ (Godby 2002), 5 of the main tributaries in the watershed were given a habitat rating of fair or good (See Table 2.2). The analysis also showed each were meeting the requirements outlined in the Michigan Water Quality Standards (Godby 2002).

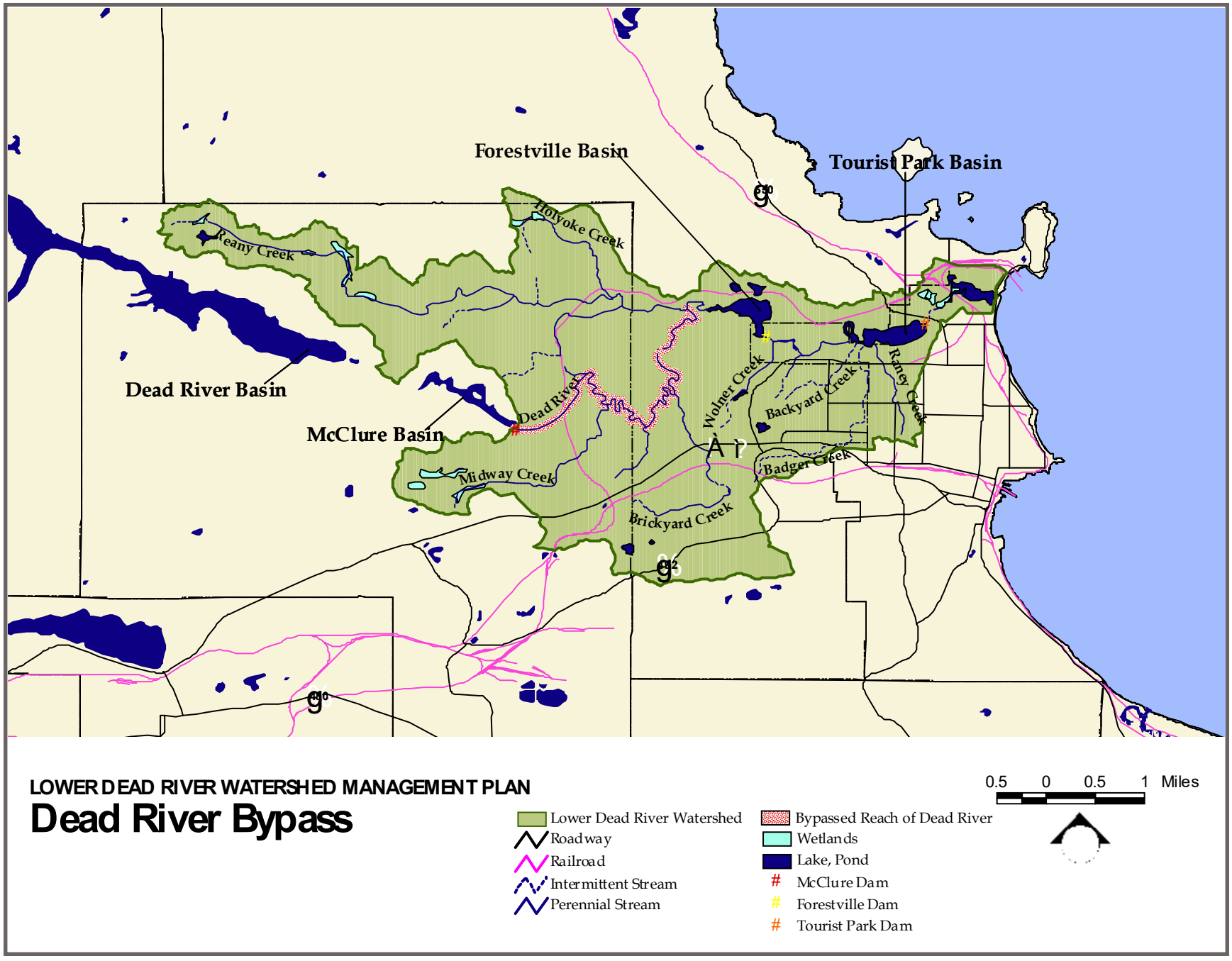
There are 2 major water bodies within the Lower Dead River watershed: Forestville Basin and the Tourist Park Basin. In addition to these large impoundments, there are several smaller ponds and lakes scattered throughout the watershed including Bishop Pond, Long Lake, and the Three Lakes. In total, 295 acres (2%) of the watershed is covered by water with an additional 130 acres (1%) of associated wetlands. Bishop Pond is considered the headwaters of Brickyard Creek and begins as a flat system of wetland drainage (Simandl 2002). These wetlands are of particular significance, as they serve to help buffer Brickyard Creek and adjacent streams from spikes in water volume or velocity, while using these natural fluctuations in water level to maintain biological diversity. According to the Lake Superior Lakewide Management Plan updated in 2002, the "greatest threat to wetlands are water level regulations and site-specific stresses such as shoreline development" (LaMP 2002).

Table 2.2: Habitat Rating

Stream Branch	Habitat Rating	Macroinvertebrate Rating
Dead River (Bypassed Channel)	Good	Acceptable
Reany Creek	Good	Excellent
Midway Creek	Fair	Excellent
Brickyard Creek	Fair	Acceptable
Badger Creek	Fair	Acceptable

Brickyard Hydrology Study

In an attempt to further understand the potential effects of U.S.-41 corridor development, the Lower Dead River Watershed Council sought out engineering services from STS Consultants to complete a detailed analysis of Brickyard Creek. Please see Appendix B for the results of this report, including its field investigation, hydrologic modeling, conclusions, and recommendations.


Forestville Basin
Tourist Park Basin
Dead River Basin
McClure Basin
Reany Creek
Holyoke Creek
Dead River
Wolner Creek
Backyard Creek
Ramsy Creek
Badger Creek
Midway Creek
Brickyard Creek
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Dead River Bypass
0.5 0 0.5 1 Miles
Lower Dead River Watershed
Roadway
Railroad
Intermittent Stream
Perennial Stream
Bypassed Reach of Dead River
Wetlands
Lake, Pond
McClure Dam
Forestville Dam
Tourist Park Dam

High-risk Areas

Areas of the watershed that have suffered degradation of habitat or water quality are generally being impacted by human changes made to the hydrology, either through the creation of impoundments, or simply due to the additional stress that expanding development places on watershed resources.

Dead River Bypass

One area of the watershed whose hydrology and aquatic habitat has been particularly impacted by the creation of impoundments, is the Dead River between the McClure Dam and the Forestville Storage Basin. In this area, the main flow of water is being diverted via a pipeline to the McClure Powerhouse further downstream. From the McClure Dam, downstream for 6.1 miles, the Dead River is bypassed and receives only dam leakage and tributary flow that is estimated to be 7 cubic feet per second (cfs) (Godby and Suppnick 2001). The map on the facing page identifies the location of the bypass channel in the Dead River. In August of 2000, the Michigan Department of Environmental Quality conducted an analysis of this bypassed reach of the Dead River to ascertain its effect on the fish community and temperature of this stretch of river. Results of their analysis are summarized below (Godby and Suppnick 2001).

Fish Communities

The MDEQ sampled fish populations in three reaches of the Dead River bypassed channel: Reach A (from the LS& I railroad tracks to the mouth of Midway Creek), Reach B (from Midway Creek to the mouth of unnamed tributary), and Reach C (from unnamed tributary to the mouth of Brickyard Creek). Brook trout were the most abundant fish, however, their size was substantially smaller than what would be expected. Only 2.7% of the fish sampled were of legal size, while 63% of all captured trout were the young of the year. This imbalance is due to the low volume of water that exists in the bypassed reach (average depth = 1.1 feet). This shallow channel does not provide suitable habitat for larger trout.

Temperatures

Temperatures in the bypassed reach met Michigan's temperature standard for coldwater fisheries and were found to be suitable habitat for trout. According to the readings taken by MDEQ, temperatures increased an average of 5.2 degrees centigrade from the upstream start of the bypass to the downstream end.

Expanding development is contributing to the reduced water quality of local streams

Flow Augmentation
Plans have been made to augment the flow in the bypassed channel by requiring the Upper Peninsula Power Company to release a minimum flow of 20 cfs from the McClure Dam to the bypassed river channel in the 2004-2005 timeframe. The augmented flow is expected to increase the velocity and average depth of the water in the bypass, resulting in improved habitat for larger trout. There may be some changes in the channel shape in areas that are susceptible to scouring due to the increased velocity. The temperature of the water is not expected to be affected, due to the deep-water draw at the McClure Dam.

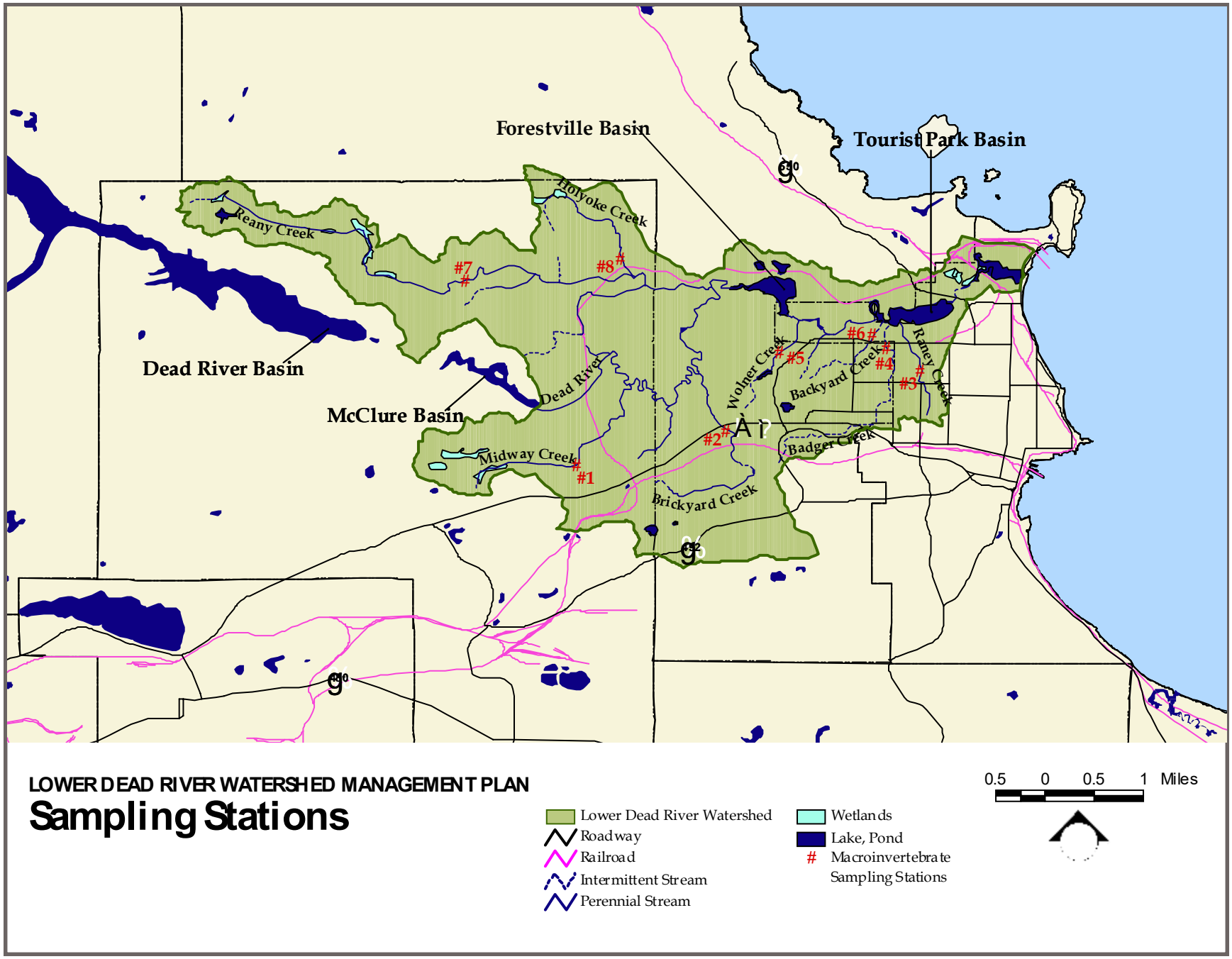
Expanding Development

A second potential cause for water quality degradation is the influence of expanding development. Because most of this development is taking place near the City of Marquette and along the US41-M28 corridor, water quality in the southeastern portion of the watershed is most at risk. This increased development prompted the Central Lake Superior Watershed Partnership to conduct a stream monitoring study of 3 local streams: Reany Creek, Brickyard Creek, and Whetstone Brook. Researchers used water quality, aquatic habitat conditions, and fish populations to help determine the general health of each stream. Their study showed that the reaches directly affected by development (Brickyard and Whetstone) had lower overall stream health than Reany Creek, which is still in a relatively undisturbed area of the watershed. "Although these streams are less than 3 miles apart respectively, they are light years apart in terms of overall stream health. Monitoring showed that an increase in the amount of development and **impervious surfaces** (roads, parking lots, roofs) directly correlated with a decrease in water quality, aquatic habitat conditions, and fish populations" (CLSWP 2002).

Other analyses of this area have found that, while development has not yet had a significant impact on the water quality, the potential exists for streams to suffer from future degradation. For example, in the areas of Brickyard and Wolner Creeks, erosion is beginning to affect stream banks, while poorly placed culverts increase the scouring of the stream channel due to excessive velocity (ALNM 2002, Simandl 2002).

Erosion along the Brickyard Creek access road

Scouring of stream bank along Brickyard Creek


Forestville Basin
Tourist Park Basin
Dead River Basin
McClure Basin
Holyoke Creek
Reany Creek
Dead River
Midway Creek
Brickyard Creek
Wolner Creek
Backyard Creek
Raney Creek
Badger Creek
#1
#2
#3
#4
#5
#6
#7
#8
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Sampling Stations
Lower Dead River Watershed
Roadway
Railroad
Intermittent Stream
Perennial Stream
Wetlands
Lake, Pond
Macroinvertebrate Sampling Stations
0.5 0 0.5 1 Miles

MACROINVERTEBRATE STUDIES

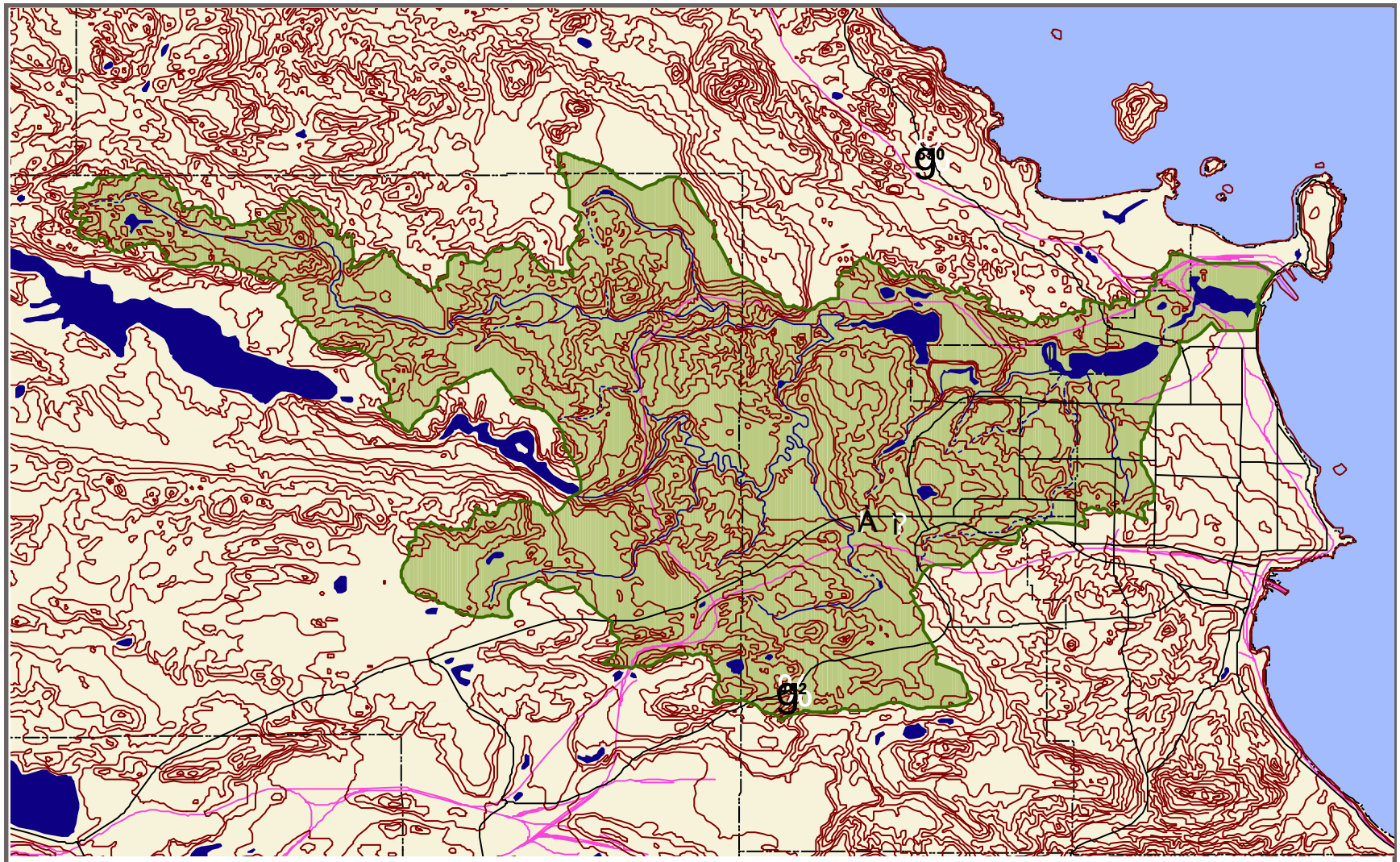
The number and diversity of macroinvertebrates found within a stream system can be an indicator of the habitat's quality. In 2002, the Michigan Department of Natural Resources conducted a field study of the macroinvertebrates present at five of their eight sampling stations within the Lower Dead River watershed (see map on facing page for sampling locations). The results of this study are presented in Table 2.3. All streams studied received a rating of "Fair" with the exception of Badger Creek, which received a rating of "Poor". Badger Creek contained a limited amount of macroinvertebrate activity with only eight taxa present. Of the eight types of organisms found, only three were found in quantities greater than ten organisms per stream reach. Badger Creek is a designated storm drain for the city of Marquette and is located within the most developed area of the watershed. This would explain the reduced aquatic habitat that often accompanies this type of heavy development.

Table 2.3: Results of Macroinvertebrate Sampling

TAXA	Station 1	Station 2	Station 4	Station 5	Station 7
Group 1 (Sensitive)	**Midway Crk**	**Brickyard Crk**	**Badger Crk**	**Wolner Crk**	**Reany Crk**
Coleoptera (Adult beetles)		R		R	
Coleoptera (Water penny)	R	R			
Diptera (Black fly larvae)	R				
Ephemeroptera (Mayfly nymphs)	R	C	R	C	C
Gastropoda (Gilled snails)					
Megaloptera (Hellgrammites)		R		R	
Plecoptera (Stonefly nymphs)	R	R	R	C	C
Trichoptera (Caddisfly larvae)	C	C	C	C	C
Group 2 (Somewhat-sensitive)					
Amphipoda (Scuds)			C		
Coleoptera (Beetle larvae)	R	R	R		R
Decapoda (Crayfish)					
Diptera (Crane Fly larvae)	R			R	R
Megaloptera (Alderfly larvae)		R			R
Odonata (Damselfly nymphs)				R	
Odonata (Dragonfly nymphs)	R	R	R	R	R
Pelecypda (Clams)					
Group 3 (Tolerant)					
Diptera (Midge larvae)	R	R			R
Diptera (Other)	R	R			
Gastropoda (Pouch snails)	R				
Hemiptera (True bugs)					
Hirudina (Leeches)		R	R	R	
Isopoda (Sowbugs)				R	
Oligochaeta (Aquatic worms)	C	C	C	C	C
Stream Quality Rating	**Fair**	**Fair**	**Poor**	**Fair**	**Fair**

NOTE:
R = 1-10 organisms in each taxa found in stream reach
C = 11+ organisms in each taxa found in stream reach

Macroinvertebrates, such as this dragonfly, are an indicator of stream health
(Source: NABS 1999)


LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Topography
Lower Dead River Watershed
Water
Intermittent Stream
Perennial Stream
Contours
Roadway
Railroad
0.5 0 0.5 1 Miles

TOPOGRAPHY

The effects of the Pleistocene ice age can be seen in the varying topography throughout the Lower Dead River watershed. This variety includes relatively flat areas, gently rolling hills, and very steep slopes, particularly adjacent to stream and river corridors (Godby and Suppnick 2001, CUPPAD 1998). In Marquette Township nearly 25% of the township has slopes greater than 15% (Sundberg et al. 1995). The map on the facing page shows the topography of the watershed area.

This varied topography can be a determining factor in the pattern of development in the watershed. Current construction techniques and the market's strong desire to take advantage of long views and attractive vistas exerts significant development pressure on these fragile areas. However, when development occurs near steep slopes there is an increased risk of erosion, sedimentation, and damage to aquatic habitat. In their comprehensive development plans, both Marquette and Negaunee Townships discourage high-density development on moderate slopes (15%-25%), preferring such development be located on areas with less relief (Sundberg et al. 1995, CUPPAD 1998). According to Marquette Township's development plan, improper planning as it relates to the area's topography can result in not only the destruction of an aesthetic feature, but also "soil stability disturbances, altering of established drainageways, elimination of natural windscreens (vegetation), land slippage, and rapid erosion which adds silt and sediment to downstream waterways" (Sundberg et al. 1995).

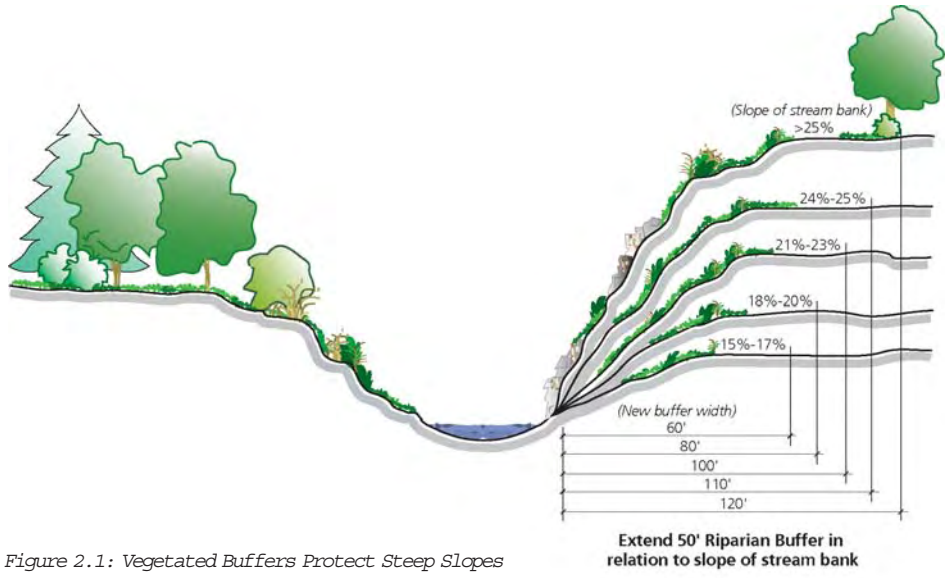
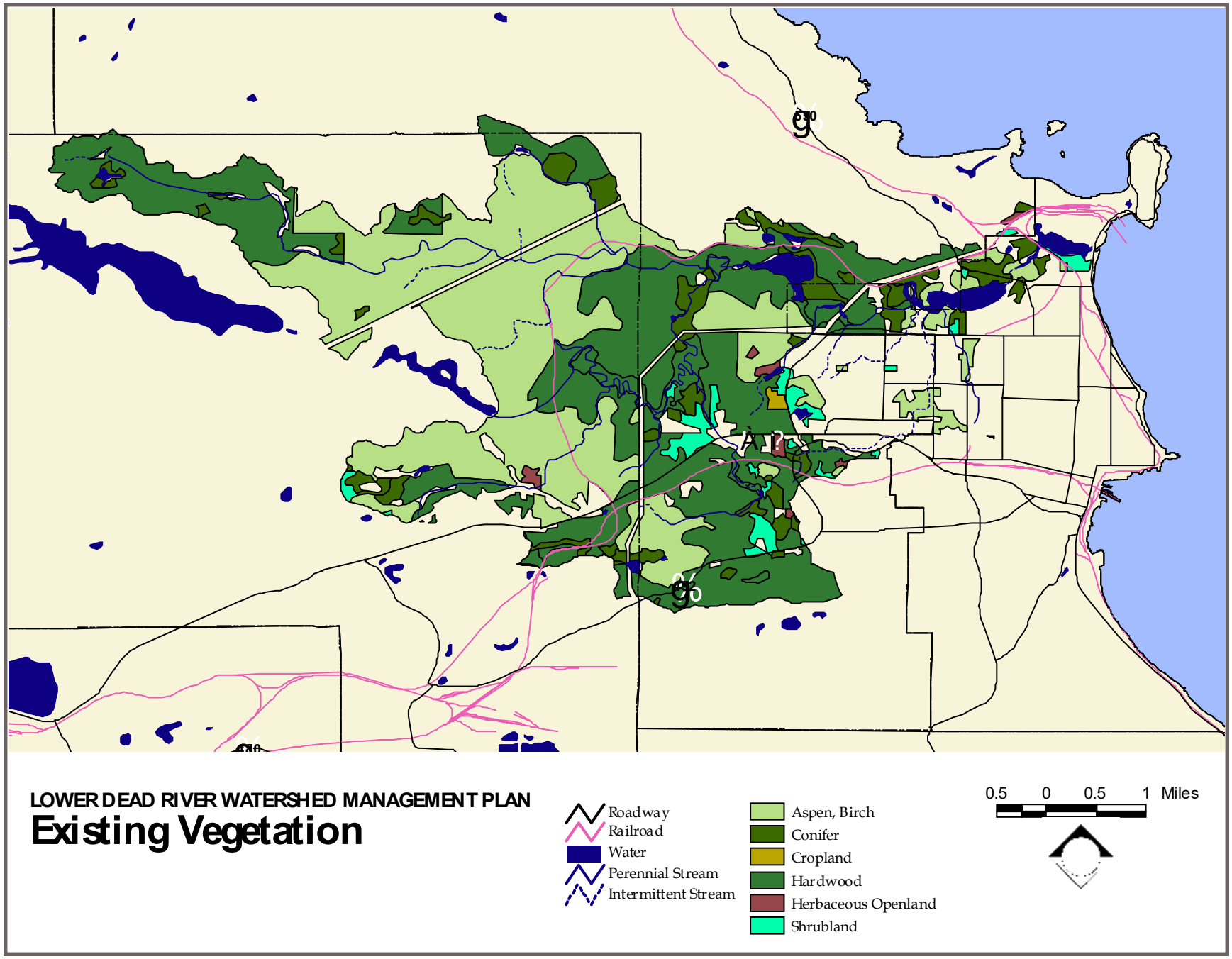


Figure 2.1: Vegetated Buffers Protect Steep Slopes

Protecting Steep Slopes:
The Lower Dead River watershed contains steeply sloped areas, many of which are adjacent to waterways. In order to protect these fragile slopes, it is recommended that vegetation along the edge of the stream not be disturbed. This vegetation helps to control erosion and prevents polluted stormwater from flowing into the stream. Figure 2.1 gives general guidelines for how large this riparian buffer area should be. More information on riparian buffers is presented in Chapter Five - Strategies & Recommendations.


LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Existing Vegetation
Roadway
Railroad
Water
Perennial Stream
Intermittent Stream
Aspen, Birch
Conifer
Cropland
Hardwood
Herbaceous Openland
Shrubland
0.5 0 0.5 1 Miles

VEGETATION

An examination of land use throughout the watershed shows that the majority (78.5%) of the watershed remains forested, with another 3% classified as open field or agriculture areas. The remaining land is designated as urban, barren, or water-related land uses (See Table 2.4).

Forests species include mature stands of northern hardwoods such as oak and maple and stands of mature hemlock. There are also lower quality species such as tag alders, aspen, and birch (Godby and Suppnick 2001, CUPPAD 1998). The Existing Vegetation map on the facing page shows a detailed mapping of vegetation within the watershed, while Table 2.5 shows the breakdown by acreage.

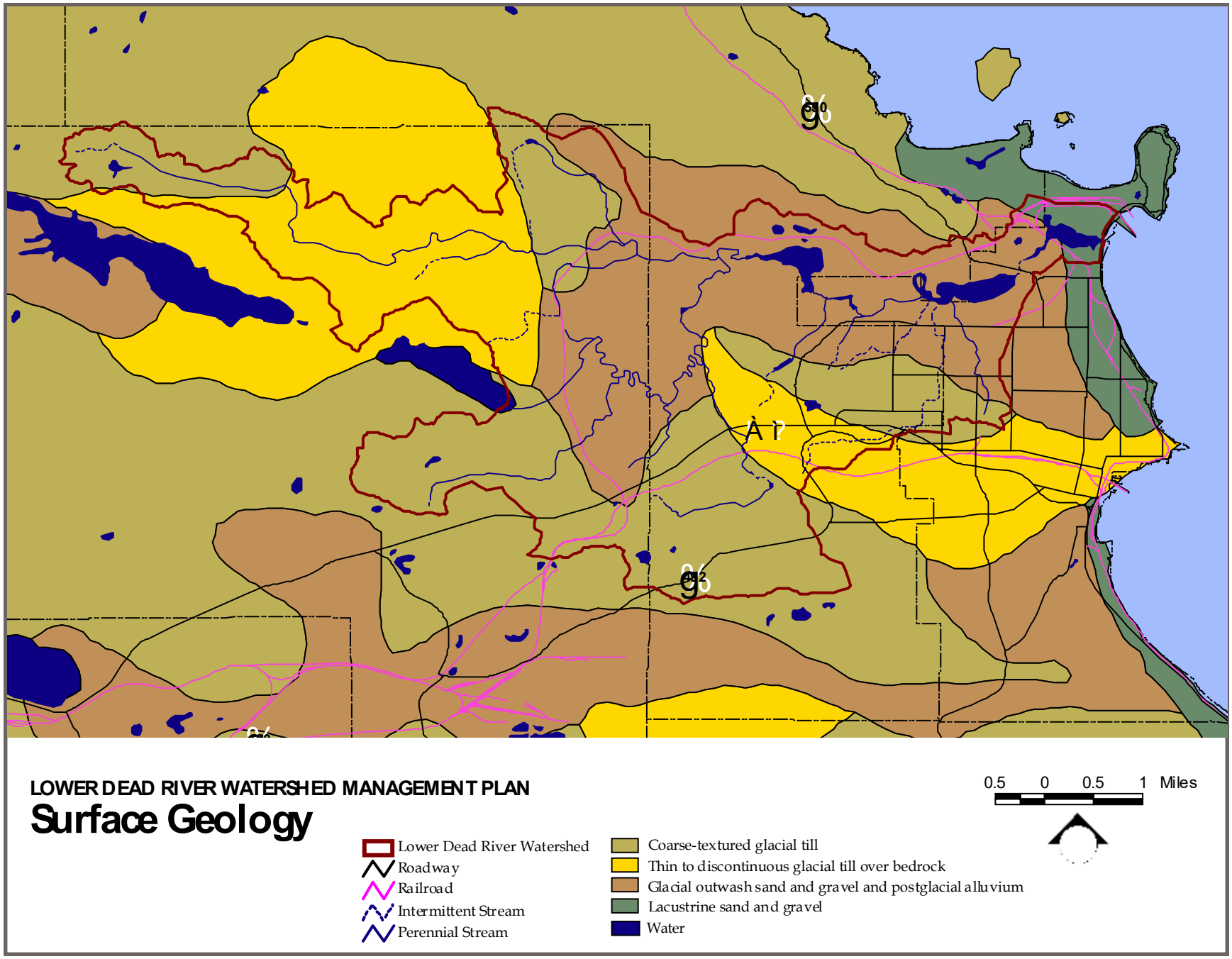
Much of the forested area is owned by large corporations and is designated as Commercial Forest Reserve (CFR). Owners include corporations such as Escanaba Paper Co., Benson Forest Ltd., Longyear Realty, and the Cleveland-Cliffs Iron Company (Sunberg et al. 1995, CUPPAD 1998). Areas that are designated as a Commercial Forest Reserve must be maintained as a forested tract of land and allow public access for daytime recreation activities such as hunting or fishing (CUPPAD 1998).

Table 2.4: Existing Land Use

Land Use	*Acres*	*% of Total*
Forested	11,183	78.5%
Agricultural	21	0.1%
Barren	16	0.1%
Open Field	394	2.8%
Urban	2,207	15.5%
Water	295	2.1%
Wetland	130	0.9%
Total Acreage	**14,246**	**100%**

Table 2.5: Existing Vegetation

Vegetation Type	*Acres*	*% of Total*
Aspen, Birch	5,008	43%
Conifer	927	8%
Cropland	21	<1%
Hardwood	5,247	45%
Openland	73	<1%
Shrubland	321	3%
Total Acreage	**11,597**	**100%**


LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Surface Geology
Lower Dead River Watershed
Roadway
Railroad
Intermittent Stream
Perennial Stream
Coarse-textured glacial till
Thin to discontinuous glacial till over bedrock
Glacial outwash sand and gravel and postglacial alluvium
Lacustrine sand and gravel
Water
0.5 0 0.5 1 Miles

SURFACE GEOLOGY

The surface geology and soil composition of a watershed can be important factors when seeking ways to best protect the water quality of an area. Within the Lower Dead River watershed the surface geology consists primarily of 4 categories (as shown in the map of Surface Geology on the facing page):

- Coarse-textured glacial till
- Thin till over bedrock
- Glacial outwash sand and gravel
- **Lacustrine** sand and gravel

The areas of glacial outwash, sand and gravel are of particular importance since they serve as groundwater recharge areas. These sandy soils provide opportunities for infiltration and serve to replenish local water systems through groundwater recharge (ALMN 2002). Areas where bedrock is near to the surface do not provide good sources of groundwater.

New development along the US41-M28 corridor

ANALYSIS OF THE BUILT ENVIRONMENT

Although a large portion of the Lower Dead River watershed still remains in its natural state, existing growth and development are already having an effect on the quality of the watershed's natural resources. In order to better understand the pattern of this development, this chapter will focus on identifying the watershed's designated uses, the pattern of existing land use, and areas that are likely to experience future growth.

DESIGNATED USES

According to Brown et al. (2000) the identification of designated uses within a particular watershed is a critical first step toward analyzing those uses that are not being met and those that are being threatened by activities on land. These "designated uses" are defined as the protected uses of water as they are established by state and federal water quality programs (Brown et al. 2000). The state of Michigan provides a set of designated uses that all surface waters in the state are required to meet. The following list identifies the designated uses that are currently being met by the Lower Dead River Watershed:

- Industrial water supply - The WeEnergies Presque Isle Power Plant, located at the mouth of the Dead River, extracts water to cool their generating facility. The water is then discharged into Lake Superior.

- Public water supply at the point of intake – Potable water is supplied to the City of Marquette by the city water system. The municipal water intake is located near Lower Harbor. **Townships within the watershed boundaries extract groundwater as their means of potable water.**

- Navigation – The Dead River system is considered navigable waters with public access sites located at the McClure Basin, the Forestville Basin, and the Tourist Park Basin.

- Coldwater fishery – Streams in the watershed are known to support coldwater fish habitat

- Indigenous aquatic life and wildlife – According to natural resources inventory the Lower Dead River Watershed is recognized to support a variety of aquatic and wildlife species.

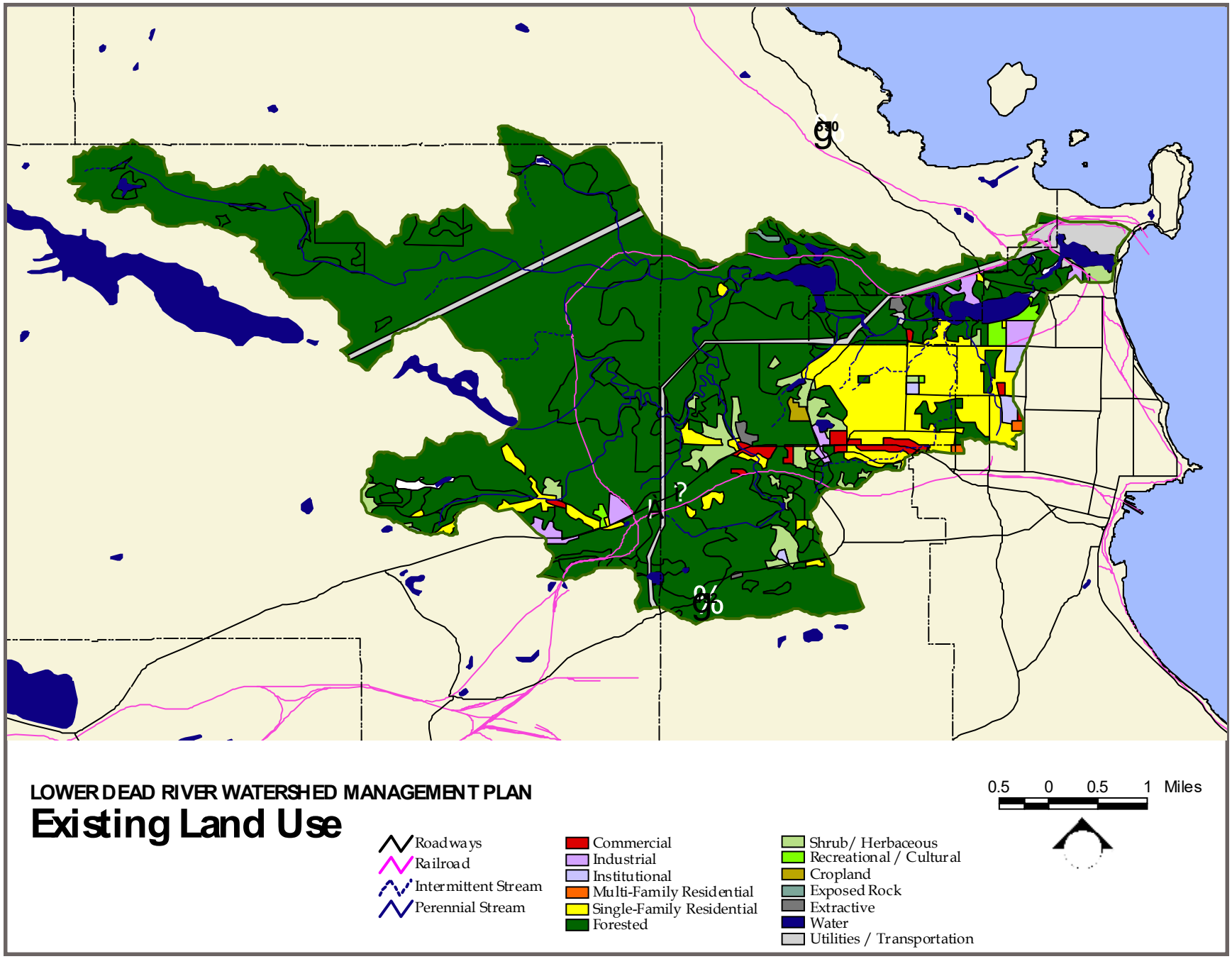
Table 3.1: Threatened Uses in the Lower Dead River Watershed

Threatened Uses	Source of Impairment	Pollutants	Sources
Public Water Supply	Increased stormwater inputs Sedimentation	Oils, grease, and metals	Urban Runoff
Navigation	Dam impoundments Stream channelization	Sediment	Stream banks
Coldwater fishery	Sedimentation Nutrient Loading Stream crossings Hydrologic flow Dam impoundments	Sediment Nutrients	Stream crossings Failing septic systems Residential fertilizer use
Indigenous Aquatic life/Wildlife	Eroding stream crossings River flooding Transportation/Utility corridors Increased development Loss of riparian vegetation	Sediment Hydrologic flow	Stream crossings Stream banks Hydrologic flow Urban stormwater

- Partial body contact recreation – Waters are considered suitable for partial body contact recreation, with minimal threat to public health due to water quality.

- Total body contact recreation between May 1 and October 31 – All waters within the Lower Dead River Watershed are considered suitable for full body contact during the recreation season.

As development continues and the effects of the built environment have a greater effect on the quality of natural resources, many of these designated uses can be at risk. Pollutants, sediments, stormwater runoff, and other man-made impairments can significantly reduce the number of designated uses that a particular water body can support. The Lower Dead River Watershed is beginning to see some of these designated uses being threatened due to impacts from the built environment. Table 3.1 identifies these threatened uses along with potential sources for impact within the watershed.


LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Existing Land Use
0.5 0 0.5 1 Miles
Roadways
Railroad
Intermittent Stream
Perennial Stream
Commercial
Industrial
Institutional
Multi-Family Residential
Single-Family Residential
Forested
Shrub/ Herbaceous
Recreational / Cultural
Cropland
Exposed Rock
Extractive
Water
Utilities / Transportation

EXISTING LAND USE

Understanding the current pattern of development within the watershed is a critical first step toward identifying key areas of the watershed that may be impacted by further urban development. A map of Existing Land Use is presented on the facing page, while a breakdown of the high-level land uses is given in Table 3.2. Approximately 2,207 acres (15.5%) of the total watershed is currently developed for urban uses. Within this "urban" designation, the land use can be further broken down into a variety of specific uses. This breakdown is given in Table 3.3.

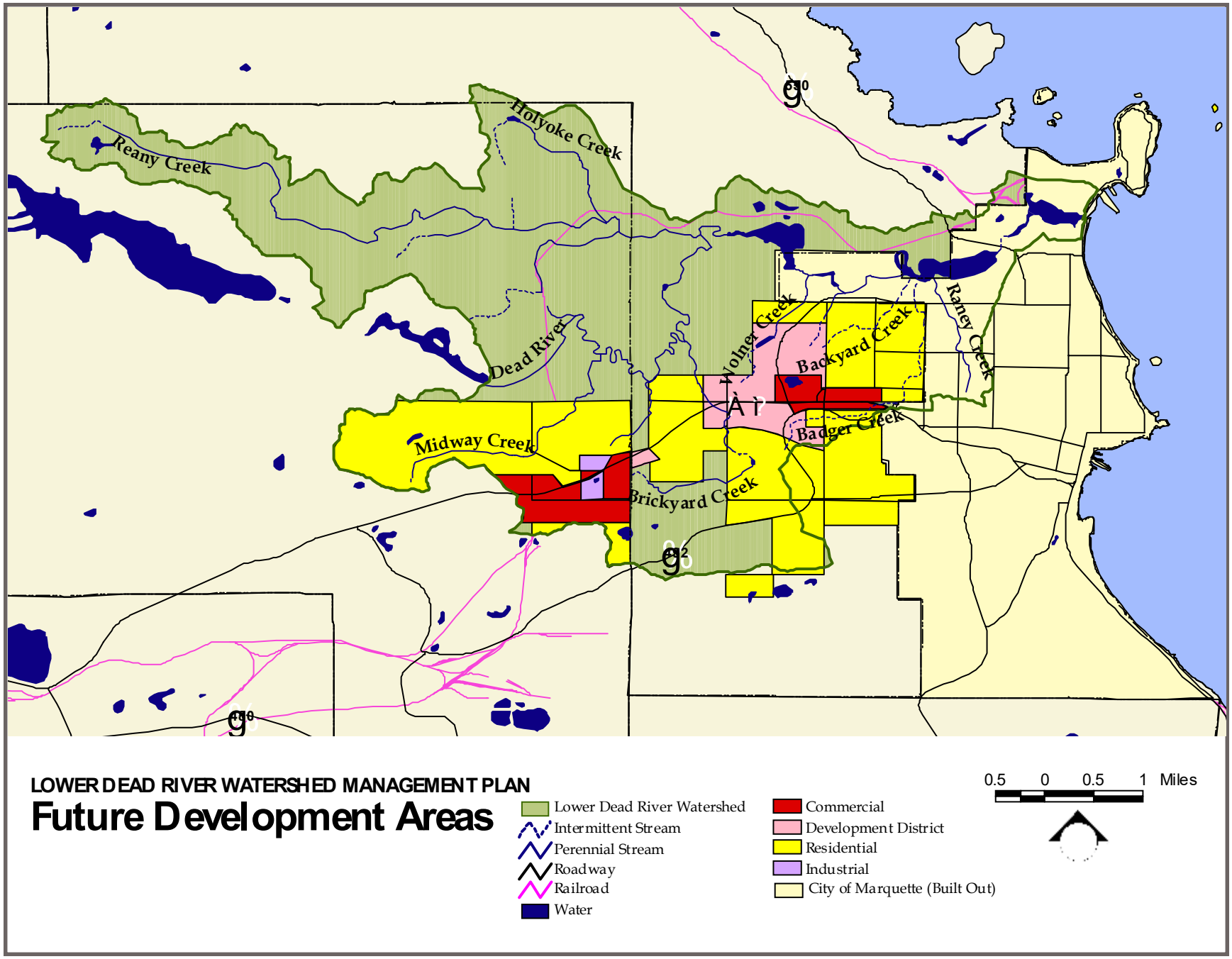
As is shown on the land use map, the majority of development is located in the southeastern portion of the watershed, adjacent to the City of Marquette and along the US41-M28 transportation corridor in Marquette Township.

Table 3.2: Existing Land Use

Land Use	*Acres*	*% of Total*
Forested	11,183	78.5%
Agricultural	21	0.1%
Barren	16	0.1%
Open Field	394	2.8%
Urban	2,207	15.5%
Water	295	2.1%
Wetland	130	0.9%
Total Acreage	**14,246**	**100%**

Table 3.3: Breakdown of Urban Land Uses

Land Use	**Acres**	**% of Total**
Cemetery	26	1 %
Commercial	130	6 %
Extractive	34	1.5%
Industrial	171	7.75%
Institutional	67	3 %
Multi-Family Residential	14	< 1 %
Recreation	36	1.6%
Single-Family Residential	1,258	58 %
Utilities, Waste Disposal	451	20 %
Total Acreage	**2,207**	**100%**

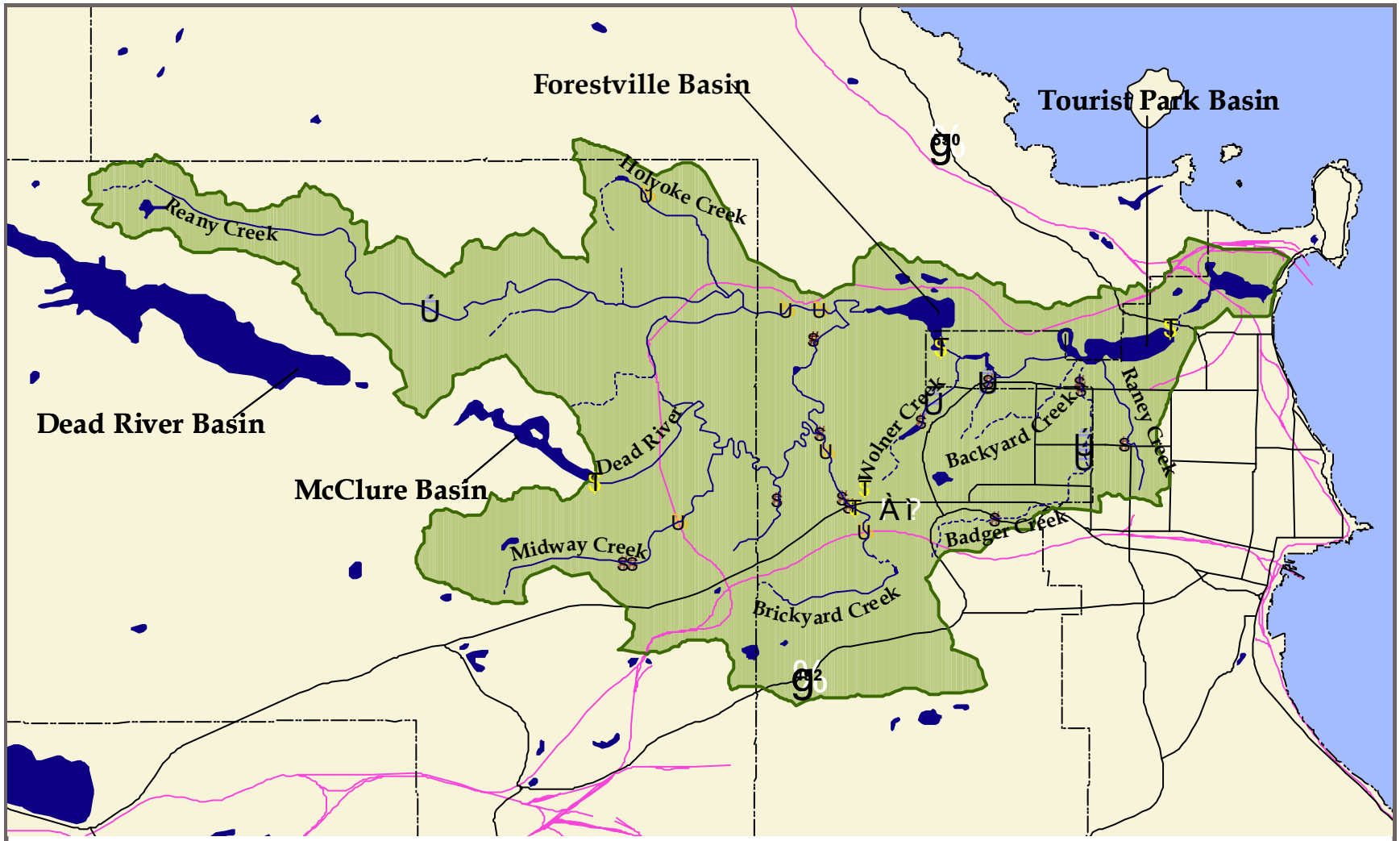

Holyoke Creek
Reany Creek
Dead River
Midway Creek
Brickyard Creek
Wolner Creek
Backyard Creek
Badger Creek
Raney Creek
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Future Development Areas
Lower Dead River Watershed
Intermittent Stream
Perennial Stream
Roadway
Railroad
Water
Commercial
Development District
Residential
Industrial
City of Marquette (Built Out)
0.5 0 0.5 1 Miles

FUTURE GROWTH AREAS

Because the area of the watershed that is within the City of Marquette is fully developed, most of the future growth within the watershed will happen in the Marquette and Negaunee Townships. Both townships have experienced rapid growth over the last 50 years. Marquette Township saw a 62% increase in population between 1970-1990 (Sundberg et al. 1995), while Negaunee's population increased over 300% since 1940 (CUPPAD 1998). This growth has prompted both townships to develop comprehensive plans to help guide future growth and to ensure the protection of their existing natural resources. Both townships have placed a priority on protecting their rural image and are making concerted efforts to control the pattern of development. In general, future growth will be directed towards infill areas north and south of the US41-M28 highway and in areas where infrastructure and services are already available (Sundberg et al. 1995, CUPPAD 1998). These potential development areas are indicated on the map of Future Development Areas.

The US41-M28 highway serves as the backbone for much of the development in these two townships. According to the Comprehensive Plan for Marquette Township, the commercial development and regional shopping malls along the US41-28 corridor serve as a "major core for a variety of functions" (Sundberg et al. 1995). While this development area provides a set of retail amenities it is not without issues. According to Marquette's Comprehensive Plan, the cost of development has included "environmental degradation, traffic congestion, housing shortages, changes in the rural landscape and the skyrocketing costs of municipal services" (Sundberg et al. 1995).

In addition to the new commercial development along the US41-M28 corridor, several areas within Negaunee and Marquette Townships are experiencing new residential development pressures in their outlying rural areas and adjacent to the large storage basins, particularly Dead River and McClure Basins. Unfortunately, much of this new development is not served by municipal services and residents rely on septic fields and private wells to meet their infrastructure needs (CUPPAD 1998). These outlying areas of residential development can be a burden on municipalities due to the increased cost of services to these areas. They can also have a detrimental impact on the environment, particularly where development exceeds the capacity of an area to support septic systems, thus posing a risk for groundwater contamination. Though it may be possible to extend the public infrastructure, planning for additional service areas is a difficult task. Currently, Marquette Township is exploring options to extend municipal wastewater in the Trowbridge Park area. While utilities such as city sewer and water can allow for more dense development, perhaps halting the sprawling tendencies of large lot development, this expansion can also have significant detrimental effects on the environmental resources of these newly developed areas.


Forestville Basin
Tourist Park Basin
Dead River Basin
McClure Basin
Holyoke Creek
Reany Creek
Dead River
Wolner Creek
Backyard Creek
Raney Creek
Badger Creek
Midway Creek
Brickyard Creek
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Areas of Stream Degradation
0.5 0 0.5 1 Miles
Lower Dead River Watershed
Intermittent Stream
Perennial Stream
Roadway
Railroad
Dam
Erosion
Physical Hazard
Water Quality
Water

AREAS OF CONCERN

The Lower Dead River Watershed is impacted in myriad ways from human interaction with the watershed's natural systems. In its 2002 Progress Report, the Lake Superior Lakewide Management Plan identified a number of stressors that can have a direct effect on the health of a watershed. These included items such as increased levels of contamination, dam construction, habitat fragmentation, recreation, road construction, and shoreline residential development (LaMP 2002) (See map on facing page showing existing areas of stream degradation). While their effects may be easily demonstrated, it can sometimes be difficult to diagnose the source of these problems due to the variety of ways in which our actions can affect the health and vitality of the watershed. Evidence of human impact ranges from the obvious, such as direct manipulation of the stream hydrology, to the subtle effects that even small personal choices can have on the health of a stream system miles away. In the face of increasing development pressures, establishing protective measures to buffer these disturbances is paramount if the biotic integrity of the river system is to be protected according to the established goals of this study. Additionally, the protection of these watersheds directly affects the quality of the aquatic ecosystem in Lake Superior.

In the Lower Dead River watershed system, the following human disturbances have led to substantial impacts on the watershed's health:

1) Altered Hydrology – dam impoundments and stream channelization has resulted in decreased stream length and severe loss of aquatic habitat.

2) Transportation Issues – creation of transportation and utility corridors including stream crossings and the use of riparian corridors for roads and utilities, has led to increased sediment, nutrient, and contaminant inputs, and the reduction of habitat quality.

3) Impacts of Development – increasing urbanization within the watershed has resulted in increased impervious surfaces, increased stormwater inputs, point and non-point source pollution, sedimentation, surface water drainage, nutrient inputs, and loss of riparian vegetation.

4) Recreational Activities – recreational access can result in the trampling of vegetation, soil compaction, soil erosion, and other disturbances leading to increased sedimentation and nutrient inputs into the stream system.

New development along US41-M28

New development within the watershed

Marquette Valley Milling Company

Historical Highlight – Remnants of History Along the Dead River

There were several industries that once lined the banks of the Dead River. Areas along the waterway saw the establishment of dams, generating plants, blast furnaces, silver and gold mines, flour mills, sawmills, and blasting furnaces. One such industry's remains that can still be found in the Lower Dead River watershed is the foundation of the late Marquette Valley Milling Company.

The first flour mill in the U.P. was owned and operated by Alphonse Bertrand in 1887. The original site was situated on a small creek that emptied into the Dead River, downriver from the town of Collinsville. The creek was dammed and served as an abundant water supply for milling operations. 600 bushels of locally raised wheat were ground in the fall in addition to rye and grain for feed.

During the next few years, the mill experienced insufficient water supply. In March 1891, Mr. Bertrand sold the mill to local businessmen and the Marquette Valley Milling Company was established. The Milling Company negotiated with the city to purchase a new site along the Dead River. The first flour was ground in March 1892. The best grades of flour were sent to its U.P. merchants while various other grades were shipped to New York, Georgia, and as far as England.

After the turn of the century, the flour mill business began to wane. Competition from bigger mills, higher freight costs, and the loss of water power from the Dead River attributed to the Marquette Valley Milling Company closing its doors. The last flour was milled in June 1904 and soon thereafter the mill and elevator buildings were torn down. The ruins of the old stone foundation can still be seen on the south bank of the Dead River, east of the old light plant on Wright Street.

ALTERED HYDROLOGY

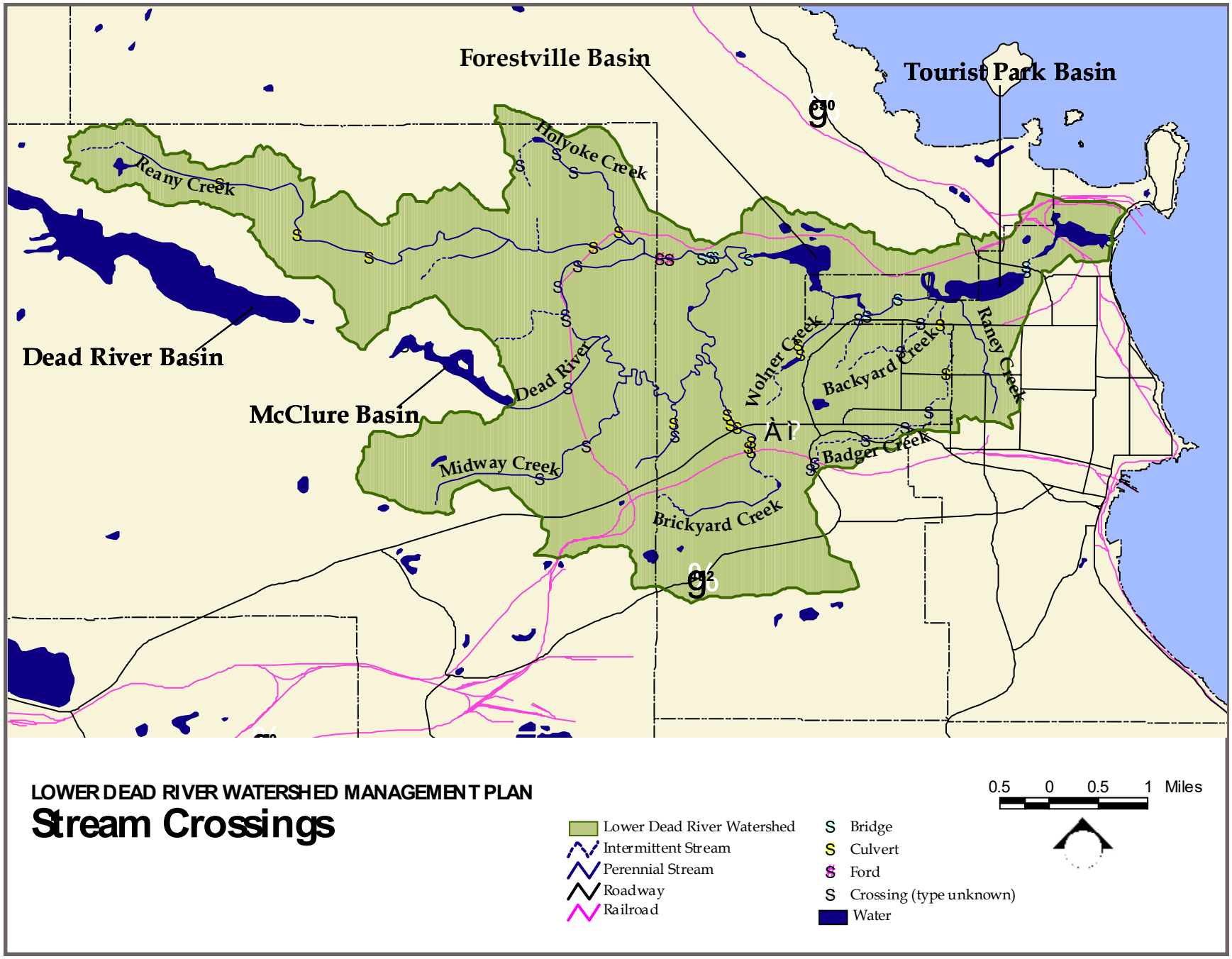
Man has modified the Dead River for over 130 years. Since the original settlers to Marquette discovered the river, dams were constructed to aid in log drives, assist in power for sawmills, and to create hydroelectricity for the community. Beginning in 1889 when the city built a wooden dam for its first electrical plant (currently known as the Tourist Park dam) there has been a series of changes to the natural flow regime of the Dead River system. By 1919 three more dams had been built on the Lower Dead River including the Forestville and McClure Dams. These impoundments contribute to the 2.5 million dams found on rivers and streams throughout the United States. While dams and the hydroelectric facilities they power can be important energy producers for an area, they also exact a toll on the health of the river system they depend on. Although the reduction in the use of coal-fired plants can reduce the amount of toxic output being emitted into the system, the change in the river hydrology can lead to degraded aquatic habitat. By holding the water, there is potential for lowered stream depth, increased water temperatures, and a reduction in the dissolved oxygen levels in the water, all of which can affect aquatic species (LaMP 2002).

As dams become decommissioned and dilapidated, there are compelling reasons to consider removal of these structures. Aside from the potential cost of dam maintenance and repair, there are ecological reasons to consider their removal:

- Dams fragment rivers and block the movement of fish and other species
- Dams harm water quality, both above and below the structure
- Dams impede the river's natural "flushing" functions
- Dam failure can be devastating to people, animals, property, and habitat

Forestville Dam

Small residential dam along Brickyard Creek


Forestville Basin
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Brickyard Creek
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Backyard Creek
Raney Creek
Badger Creek
LOWER DEAD RIVER WATERSHED MANAGEMENT PLAN
Stream Crossings
Lower Dead River Watershed
Intermittent Stream
Perennial Stream
Roadway
Railroad
Bridge
Culvert
Ford
Crossing (type unknown)
Water
0.5 0 0.5 1 Miles

TRANSPORTATION ISSUES

For any developing municipality, a transportation system that can adequately serve the needs of its population is crucial. According to Marquette Township's Comprehensive Plan, "to a significant degree, the success of a given land use area is determined by the ability of streets to afford vehicular access" (Sundberg et al. 1995). While this network of roads is critical to ensure the movement of people and goods throughout an area, they can also have a significant effect on the ecology of the area. Specifically, the installation of culverts to provide for river crossings can potentially reduce the habitat quality of streams and may directly contribute to the reduction in fish populations in some instances. The map on the facing page shows the locations of existing stream crossings that may be contributing to habitat degradation.

Culverts have long been used in stream crossings because they are much less expensive than bridges and are easier to install. However using culverts can reduce the habitat and fisheries potential of streams. Habitat can be degraded through increased sedimentation and plunge pools, which create waterfalls at the culvert outlet and can block fish migrating upstream.

Plunge pools are caused by the installation of culverts too small in diameter for the amount of stream flow. As water collects upstream of the culvert, a hydraulic "head" is created which causes the water to shoot through the culvert with increasing velocity. This causes erosion on the downstream end of the culvert as soil is scoured from the stream bottom and transported downstream. In severe cases, the downstream end of the culvert is left hanging above the stream, potentially blocking fish from migrating upstream. An example of just such a situation can be found along Brickyard Creek. According to a hydrologic study of the Brickyard Creek system, STS Consultants found the stream was being routed through a 4' culvert to accommodate a railroad grade (Simandl 2002). When it was originally installed, the culvert was set too high and resulted in a free-fall of water for 3.5 feet into a pool that was the result of scouring by the force of the water. In order to help reduce the effect of this increased velocity, this area was stabilized along the bank with large boulders and rip-rap.

Improperly installed culvert

Culvert on Brickyard Creek

The impervious surface associated with new development can have a detrimental effect on the health of the watershed

IMPACTS OF DEVELOPMENT

Research has shown that increased development can have profound effects on the water quality and habitat potential within a watershed. Most municipalities, however, recognize that halting all development is not a practical way to address these issues. This management plan identifies some of the most common factors that contribute to watershed degradation. By concentrating on addressing these issues, communities can protect their natural resources, while still protecting their community's quality of life. Some of the worst offenders that contribute to the degradation of habitat and water quality include:

- Impervious Surfaces
- Stormwater
- Sedimentation / Erosion
- Temperature Fluctuations

Impervious Surface

As the need for development in Marquette County continues, so does the amount of land cleared for impervious surfaces. While the upper reaches of the Dead River watershed system is mostly forested, the land use within the Lower Dead River watershed includes 2,207 acres (15.5%) of developed land. Structures within this area, such as roads and rooftops, all contribute to the amount of impervious surface found in the watershed.

While some naturally impervious sources, such as rock-outcroppings or clay soils, do exist, the majority of them are man-made. As more impervious surfaces are created, the amount of water running off of these surfaces and into local water systems also increases (See Figure 4.1). Studies show that on average, a typical city block generates nine times more runoff than a natural woodland area of the same size (EPA 1996). According to studies conducted by the Michigan DNR, "higher runoff correlates to decreased ground water recharge, decreased baseflow, increased and flashier stream flow, increases in temperature, turbidity, pollutants, erosion, and changes in aquatic biota" (Premo et al. 2001). Experts generally consider a watershed that has 11%-25% impervious surface to be "impacted", while areas that contain more than 25% impervious surfaces are considered "degraded" (Premo et al. 2001).

Fortunately, there are steps that can be taken to reduce the impact of impervious surfaces on the health of the watershed. Developers and stakeholders have shown a concern regarding stormwater and related non-point source pollution, and are looking for innovative ways to help mitigate some of their effects. Specific strategies for reducing the impact of impervious surfaces will be addressed in the "Management Strategies & Recommendations" section of this watershed management plan.

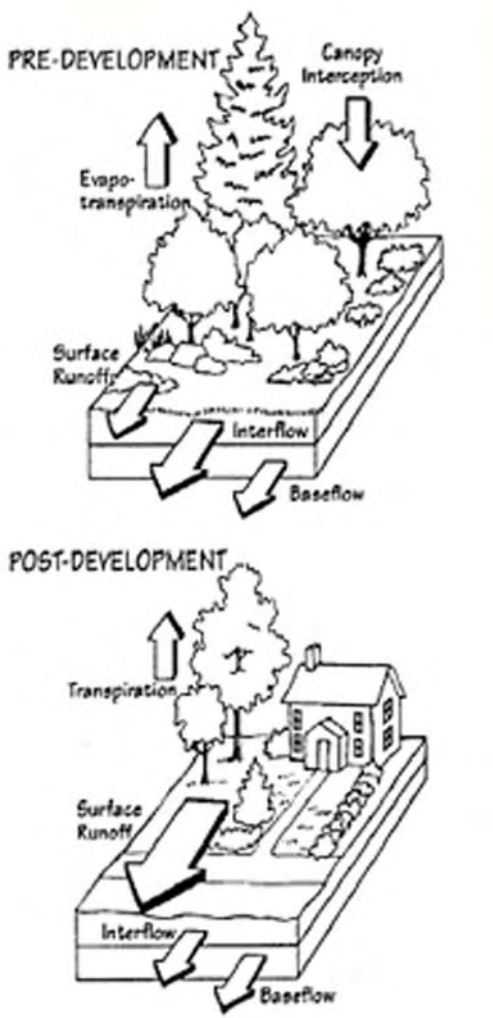


Figure 4.1: Impacts of Impervious Surfaces (Source: Schueler 1994)

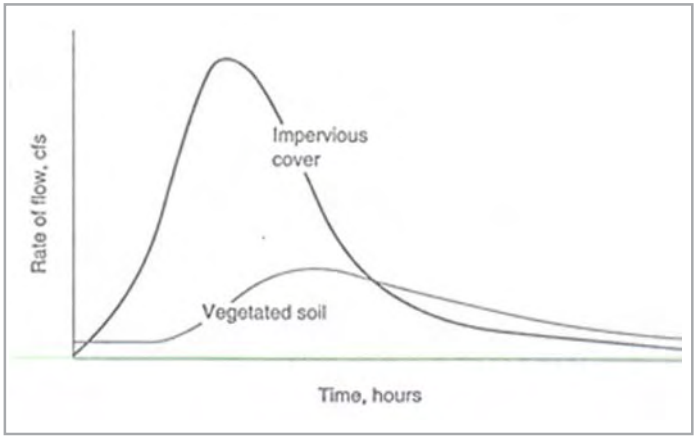


Figure 4.2: Depiction of Stormwater "Flash"
(Source: Ferguson 1998)

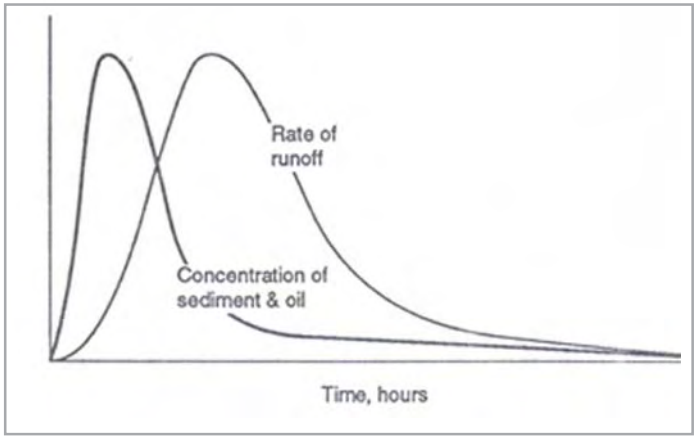


Figure 4.3: High Level of Contamination in "First Flush"
(Source: Ferguson 1998)

Stormwater

Because the issue of stormwater is closely related to that of impervious surfaces, stormwater issues are typically associated with broad land use categories, such as residential, commercial, or industrial uses. As rainwater falls on an impervious surface, it is quickly collected in stormwater systems and released into the local stream system, usually with no pre-treatment. When the rate at which this stormwater is released is not properly managed, it can enter the stream system at a much higher velocity and temperature than water would naturally enter (See Figure 4.2). This "flash" of water entering the stream can erode stream banks, damage riparian vegetation, and alter the shape of stream channels. Since the stormwater is often a much higher temperature than the natural stream water, it can also cause significant fluctuations in the temperature of the waterway, resulting in damage to aquatic species.

Stormwater is also a transport mechanism for sediment and pollutants that can adversely affect the health of a stream system. According to the EPA, "sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas" (EPA 1996). These pollutants are collected from areas such as construction sites, parking lots, roadways, and residential lawns, and enter the stream system with the initial runoff (referred to as "first flush") (See Figure 4.3). Contaminants can include "oil, grease, and toxic chemicals from automobiles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; road salts; and heavy metals" (EPA 1996). See Table 4.1 for a list of principal contaminants commonly found in stormwater.

In 1997, Steuer et al. (1997) conducted an analysis of stormwater runoff for 12 storm events within a 300-acre watershed in the Marquette area. Although these studies are not specific to the Lower Dead River watershed, these data may reflect stormwater trends in the Marquette area and offer ideas in better management practice.

According to these studies, the highest runoff coefficient was recorded for commercial parking lots, followed by streets. Parking lots produced a disproportionately high load of hydrocarbons and metals compared to all other source areas (Pitt, R. and J. Voorhees. 1989). As such, watershed managers can justifiably classify many parking lots as stormwater "hotspots". With development increasing along the US41-M28 corridor, proper stormwater treatment will become a critical component of watershed protection as more roadways and parking lots are constructed.

Table 4.1: Principal Contaminants in Stormwater (Source: NRDC 2001)

Pollutants	Examples
Metals	zinc, cadmium, copper, chromium, arsenic, lead
Organic compounds	pesticides, oil, gasoline, grease
Pathogens	viruses, bacteria, protozoa
Nutrients	nitrogen, phosphorus
Biochemical Oxygen Demand (BOD)	grass clippings, fallen leaves, hydrocarbons, human / animal waste
Sediment	sand, soil, silt
Salts	sodium chloride, calcium chloride

Sedimentation in Reany Creek

Erosion and Sedimentation

Sediment deposition in trout streams is a chronic problem in the Lower Dead River watershed. As stream banks erode or as stormwater washes into streams, sediment is deposited into the waterway. These deposits can have a serious effect on aquatic species, particularly trout. According to Michigan DNR fisheries biologists, the number one pollutant affecting fisheries in the area is sediment (Sundberg et al. 1995). These deposits can fill the holes and spawning areas of cold-water streams, leaving the trout with inadequate habitat for reproduction.

The source of this sediment is varied. Roadways that have inadequate ditches, banks, and vegetation can all contribute to the release of sediment into waterways. Construction sites can also release tons of sediment if preventative measures are not taken to control erosion. Poorly planned development adjacent to lakes and streams can also create unstable conditions, particularly if a vegetated buffer is not maintained along the river's course.

Severe erosion adjacent to Brickyard access road

Erosion along Brickyard Creek

Coldwater streams in the Lower Dead River watershed support trout populations like the Brook Trout shown here

Temperature Fluctuations

Based on current fish community and stream temperature data collected by the Michigan Department of Environmental Quality, the Lower Dead River continues to be classified as a coldwater fishery. At present, however, the trend of the watershed is leading towards a warm water fishery due to environmental degradation, a decline in mature fish population, and existing dam impoundments. The Lower Dead River Watershed Council, whose mission includes a commitment to sustain the coldwater fisheries in the Lower Dead River watershed, is seeking ways to reverse this degradation and protect the existing coldwater habitat for fish populations in the Lower Dead River.

Most types of environmental degradation (e.g. discharges, channelization, watershed development) increase summer temperatures in streams (Hynes 1970; Warren 1971; Kara and Schlosser 1978). Open canopies, decreased shading, and wider, shallower stream channels create more effective solar radiation absorption and lead to warmer stream temperatures. Culverts and ponds intensify the problem by backing up water and allowing suspended sediments to settle to the bottom, thus decreasing depth, widening the stream, and increasing water temperature. Stormwater runoff, which is generally at a much higher temperature, can also raise the average temperature of local stream systems and may be a source for non-point source pollution.

In August 2000, a study was performed by the Michigan DEQ to measure the temperature of the Dead River along the bypassed channel between the McClure dam and the Forestville Storage Basin (Godby and Suppnick 2001). This study documented temperature trends in this bypassed area and compared them to readings taken from Reany Creek, which is only affected by natural weather patterns. Results confirmed a general pattern of increasing temperature from one monitoring station to the next, with an average temperature increase of 5.2° centigrade along the entire bypassed reach. While the stream segment still meets Michigan Water Quality Standards for a coldwater stream, the fluctuation in temperature may point to potential future problems. The expansion of development in the watershed coupled with man-made and natural impoundments are factors in warming temperature trends resulting in degradation of coldwater streams and a decrease in biotic integrity.

Sampling of local fish population

Designated stream crossings should be used to protect fragile stream banks

Footpaths can encourage erosion, particularly on slopes

RECREATIONAL ACTIVITIES

Activities such as boating and hiking can often lead to the gradual degradation of the watershed. The loading and unloading of watercraft can impact stream banks by trampling the vegetation, creating a footpath to the water's edge, and encouraging erosion. These threats can be eliminated by establishing public access sites and permanent dock structures along navigable water bodies. As new hiking trails are created, constant foot traffic to these areas can lead to soil compaction and erosion. By directing hikers to a designated trail or creating permanent walkways in areas that are susceptible to erosion, these threats can be eliminated.

Stream monitoring is an important tool for assessing the health of a watershed
(Source: USDA Forest Service 2003)

MANAGEMENT STRATEGIES, RECOMMENDATIONS, & WATERSHED PROTECTION GOALS

It can be discouraging to consider that human actions and the impact of our expanding development remain the primary sources of environmental degradation within the Lower Dead River watershed. Fortunately, our involvement can also be the starting point for meaningful change that results in the protection of the integrity of the Lower Dead River watershed. In order to affect this change, the sustained commitment from a variety of involved parties is required. These participants include local government, community leaders, city and township planners, developers, business owners, landowners, and local residents. This chapter focuses on several management strategies participants can use to address many of the issues described in Chapter Four as well as a watershed protection goal for each recommendation.

STREAM MONITORING

In order to clearly track the impact of development on the health of the watershed, a thorough inventory of resources and periodic monitoring of local waterways should be undertaken. Although several studies have been done on individual reaches of the watershed, it is necessary to compile a complete inventory of baseline data from which future progress can be measured. One recommendation is to employ the SWQAS Procedure #51 Survey Protocols for Wadable Rivers (formerly known as the GLEAS Procedure #51) as defined by the Michigan Department of Environmental Quality Surface Water Quality Division (Schneider 2000). This protocol involves the measurement of biological and habitat indicators that result in a rating of the relative health of a stream system. The survey consists of 3 parts; evaluation of the macroinvertebrate community, evaluation of the fish community, and evaluation of habitat quality. (Schneider 2000). A series of metrics are used to evaluate the water system at a number of sampling locations and a rating indicating the level of stream quality is assigned (excellent, good, fair, or poor). This rating system also incorporates an analysis of limiting factors that can be a useful diagnostic tool when a detailed analysis of the cause for stream impairment is required. Stream surveyors note stream disturbances such as impoundments, canopy removal, or the presence of invasive fish or plant species. This thorough collection of baseline data will serve as a starting point from which future progress can be measured, and the success of remediation strategies can be evaluated.

WATERSHED PROTECTION GOAL

It is the objective of the Lower Dead River Watershed Council to maintain the established stream monitoring program. As watershed enhancement projects are installed, streams will be assessed with the goal of water quality ratings to be improved by five points on each tributary. Additional sites will be created as the need for monitoring arises.

SWQAS Procedure No. 51:
For a more detailed description of the P51 protocol, an outline of this process is presented through Michigan's Department of Natural Resources website. For additional assistance, contact the Surface Water Quality Division of the Michigan Department of Environmental Quality or the Michigan Department of Natural Resources.
www.michigan.gov/dnr/
www.michigan.gov/deq/

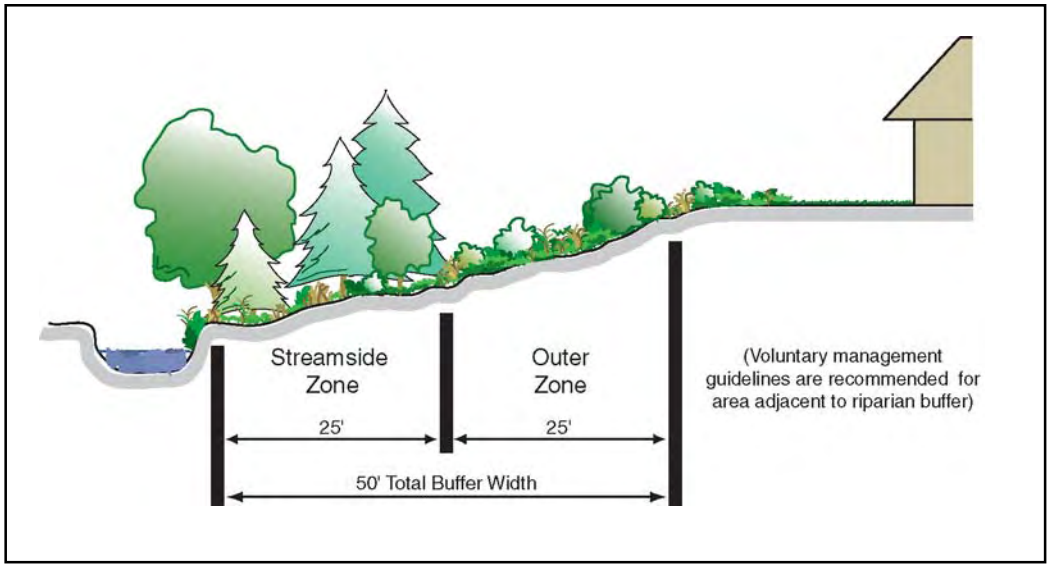


Figure 5.1: Two-zone Riparian Buffer

Table 5.1: Guidelines for Two-zone Buffer

Zone	Location	Guidelines
Zone 1: Streamside Zone	Extends 25 feet from stream edge	Protects the physical and ecological integrity of the steam system. Should consist of undisturbed natural vegetation.
Zone 2: Outer Zone	Extends 25 feet from edge of streamside zone	Allowable uses include biking or hiking paths, stormwater management facilities, recreational uses, and removal of mature tree cover.
Voluntary Management Area	Recommended for area adjacent to buffer zone	Do not site septic fields, impervious surfaces, or permanent structures adjacent to buffer zone. Retain native vegetation when possible.

Table 5.2: Exceptions to Buffer Width

	Sensitive area	Additional buffer width
Steep Slopes	15%-17%	+ 10 feet
	18%-20%	+ 30 feet
	21%-23%	+ 50 feet
	24%-25%	+ 60 feet
	> 25%	+ 70 feet
Wetlands		Extend to encompass wetland + 20 feet past wetland edge
Water Pollution Hazards		Site 150'-300' from edge of waterway

RIPARIAN BUFFERS

One simple, yet extremely effective tool for protecting the health and integrity of local waterways is the use of vegetated buffers along riparian corridors. These riparian buffers are areas of vegetation located immediately adjacent to a water body or stream system. According to the EPA, these simple strips of vegetated land can offer enormous environmental benefits, including:

- Restoring and maintaining the physical and biological integrity of the water resources
- Removing pollutants from urban stormwater
- Stabilizing stream banks resulting in reduced erosion and sedimentation
- Providing infiltration of stormwater runoff
- Maintaining base flow of streams
- Contributing organic matter that serves as a source of food and energy for the aquatic ecosystem
- Providing tree canopy to shade streams and regulate temperature (EPA 2002)

To help establish guidelines for permitted and restricted uses, the EPA and the Michigan Department of Environmental Quality recommend using a multi-zone approach to differentiate appropriate levels of activity within different areas of the riparian corridor. The Central Lake Superior Watershed Partnership is currently working on a draft of a riparian buffer ordinance in hopes that it might be applied to waterways in Marquette County. Such an ordinance would recommend a buffer of 50 feet in total width for both sides of the stream system. Within this 50 feet, the buffer would be divided into two distinct zones, a Streamside Zone and an Outer Zone (See Figure 5.1). Corresponding to each zone would be a set of permitted and restricted uses that would help to protect the water quality and aquatic habitat in the adjacent stream (See Table 5.1 for a summary of these guidelines).

While the 50' buffer is considered the general standard, there are situations where the presence of an ecologically sensitive area requires a modification to this buffer width. In order to ensure the protection of stream integrity, buffer expansions would be required for wetlands and areas of steep slope. See Figures 5.2 for a summary of these buffer extensions.

WATERSHED PROTECTION GOAL

It is the goal of the Lower Dead River Watershed Council to work cooperatively with the Central Lake Superior Watershed Partnership and local city and township officials to establish the recommended buffer strip and setback guidelines. Special areas of concern that need remediation include approximately 5,000 feet of eroded streambank caused by the Dead River flood. In conjunction with the mentioned agencies, the Watershed Council will also support the mission of the Central Lake Superior Land Conservancy by promoting conservation easements with riparian land owners.

Model Ordinance:
To see a full copy of the draft riparian buffer ordinance that is being developed by the CLSWP, please see Appendix C. Both the EPA and Michigan's Department of Environmental Quality have also specified best management practices for the implementation of these riparian buffers and offer additional information regarding their use. For additional assistance with this process, contact the EPA's Office of Wetlands, Oceans, and Watersheds or the Michigan Department of Environmental Quality.
www.epa.gov/owow/
www.michigan.gov/deq/

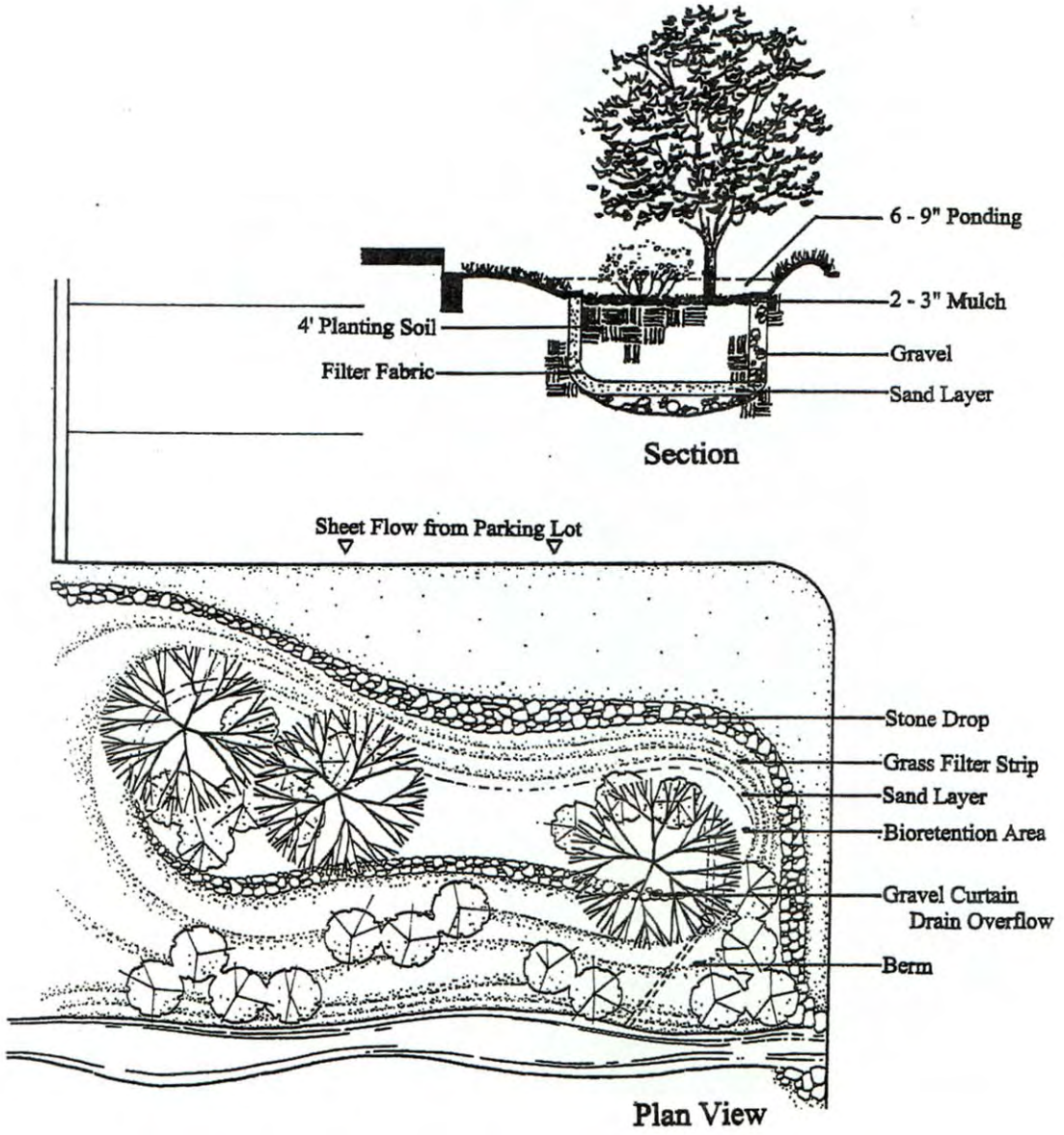


Figure 5.2: Bioretention System

STORMWATER MANAGEMENT

There are several stormwater management strategies that can be adopted in areas experiencing increased development in the Lower Dead River watershed. These strategies are designed to address the three most critical components of a successful stormwater management plan: treatment of contaminants, management of water release rates, and temperature moderation. The strategies outlined below are designed to address these issues, ultimately resulting in the increased protection of local waterways.

Infiltration Systems

Infiltration systems most closely resemble natural hydrologic processes. These systems allow stormwater to naturally infiltrate back into groundwater aquifers that eventually replenish local streams and waterways. According to a study conducted by Ayres, Lewis, Norris, & May, Inc (2002), strategies "such as infiltration trenches, rain gardens, and bioretention areas should be utilized, site permitting". Unfortunately, the success of an infiltration system is highly dependent on the specific characteristics of a site, such as soil properties and potential for groundwater contamination. Generally, it is also only feasible for small drainage areas (Bobrin 2000).

Because they can be implemented on a smaller scale, infiltration systems may be a good alternative for retrofit projects where existing development does not allow for the necessary space to install a conventional detention basin. For example, an existing parking lot can be modified to include a bioretention swale that can process runoff from the lot and direct it into a small infiltration system. Figure 5.2 shows how such a system could be implemented in a relatively small area.

Grassed Swales

In a natural, undeveloped system, water often takes a slow, circuitous route toward its final destination. Today, with our increased attention toward efficiency and safety, our use of pipes and engineered stormwater systems "focus on directing and draining water off of paved surfaces as quickly and efficiently as possible" (Arnold and Gibbons 1996). This system of conveyance, while efficient, has serious environmental impacts. The use of grassed swales and sediment forebays attempt to more closely mimic the natural system of water conveyance. Grassed swales help to slow the water and allow the water to be "cleaned" by the vegetation as it moves through the system.

Detention/Retention Ponds

One of the most common strategies for addressing on-site stormwater treatment is the use of storage facilities such as detention or retention ponds. Generally, the goal of these systems is to collect stormwater runoff from the developed area of a site, hold it for a predetermined period of time, and release the water at a rate that is similar to pre-development rates. By holding the

The "daylighting" of a local stream demonstrates how vegetation can help encourage infiltration of stormwater run-off

water, particulate matter such as sediment, heavy metals, and other pollutants are allowed to settle out of the water. This process results in less contamination being released into the local stream system. The effectiveness of this system can be increased by incorporating sediment forebays into the design of the detention basin (Ayres, Lewis, Norris, & May 2002). Sediment forebays are small, shallow pools located near the inlet of the storage basin. Forebays serve as a type of pre-treatment, allowing coarse sediments to drop out prior to entering the larger storage basin. In areas where the basin will be discharging to a coldwater stream, temperature, as well as pollution control must be considered. In this cases, the use of a bottom-draw discharge should be considered as a way to ensure water entering the local stream system will not cause significant peaks in water temperature.

A detention basin retains and treats stormwater

Maintenance

Regardless of the type of stormwater strategy employed, the success of any system is highly dependent on regular maintenance. Maintenance may include inspection of facilities, removal of contaminated sediment, maintenance of vegetation, and replacement of filters or other supporting mechanisms.

Homeowner Efforts

Homeowners can also take steps to control the stormwater on their own property. Significant amounts of rainwater and snowmelt are collected from rooftops and driveways of private homes and become part of the larger volume of stormwater that is directed into local storm sewers. The following is a list of easy steps that local homeowners can take to reduce the amount of stormwater that flows off of their property and into the stormwater system:

- Direct downspouts to discharge into yards or other vegetated areas rather than onto driveways or other impervious surfaces.
- Reduce the amount of fertilizer or pesticides used. These can be transported via stormwater into local waterways.
- Park automobiles on lawns before washing them. Lawns will appreciate the extra water and will help breakdown the soap, keeping it out of nearby streams.
- Use native vegetation when possible. These species generally have deep root systems that will soak up excess water, preventing it from becoming runoff.

WATERSHED PROTECTION GOAL

It is the goal of Lower Dead River Watershed Council to encourage alternative stormwater management strategies that will result in increased protection of the tributaries leading into the Dead River. The council envisions a 20% load reduction from parking lots and impervious surfaces over the next three years.

Table 5.3: Public Participation and Education Strategies

The following materials and activities are an essential part of the Lower Dead River Watershed Planning Project:

- A regular project newsletter mailed to all residents and businesses of the watershed
- Annual community events to raise public awareness:
  - Conservation festival
  - Watershed public meetings
- Volunteer opportunities:
  - Adopt-A-Stream cleanups
  - Stream monitoring
  - Native plant nursery volunteering
- Youth education:
  - Grade school programs
  - Internship opportunities
- Regular newspaper articles and news updates on local television and radio
- Public participation on the Lower Dead River Watershed Council and the Central Lake Superior Watershed Partnership
- Public workshops on watershed-related issues:
  - Soil erosion control
  - Riparian land management
  - Buffer strips

PUBLIC PARTICIPATION & EDUCATION

Involving the public in watershed protection through education and stewardship practices maintains the integrity of our local streams and reinforces a connection with our natural resources. The participation of local residents is extremely important to the success of a watershed management plan, since the "majority of behavioral changes that will be needed to address the sources and causes of pollution in the watershed will be voluntary, rather than be required by law" (Brown et al. 2000). The power of an effective public education component cannot be overestimated in a watershed management project. The Lower Dead River Watershed Council continually recognizes this fact and is working to ensure that public education opportunities continue to be available to residents of the Lower Dead River Watershed.

The Watershed Management Planning Process

A critical first step in the public participation and education process is the actual development and implementation of the Watershed Management Plan. In order to ensure that there are opportunities for pubic input and education, The Lower Dead River Watershed Council will present the plan for public comment at the Peter White Public Library. During a two-week period, the management plan will be available for the public to read and make comments. The Lower Dead River Watershed Council will also host a public hearing at the Marquette Township Hall as an additional means to solicit public comment and discuss issues relative to the watershed. All partners, agencies, and watershed land owners will be encouraged to attend.

In addition to the efforts being conducted by the Lower Dead River Watershed Council as a part of the watershed management plan effort, there are numerous other methods of outreach that can be used to promote involvement by a variety of community members.

Resident / Land Owner Education

"Potentially unsustainable activities are not conducted by large, industrial polluters alone. Individual land use choices can either support or undermine sustainability in a given area" (LaMP 2002). Because of the important role watershed residents and riparian homeowners play in the protection of water quality, information on how their actions around the home impact water quality is a key message to address in a public education effort. Bi-annual newsletters and public seminars are two methods of informing residents on happenings in the watershed and will continually keep the door open for participation. Informational inserts in regular mailings such as residential water bills can alert people as to how their actions affect the resources we depend on everyday. Field days and volunteer stream clean-up projects get watershed members actively involved while increasing their awareness of their watershed surroundings. Table 5.3 presents a list of activities that are included in the Lower Dead River watershed management effort, that enable residents to become involved. Such participation offers people an opportunity to witness first-hand the impacts of proper stormwater management and watershed protection.

Boy Scout Troop #305 stenciled drains to help educate residents about their stormwater system

A volunteer works with a group of school children at the annual Conservation Festival

Developer Education
Through contact with the Soil Erosion and Sediment Control Program, developers should be encouraged to view site planning in terms of watershed-wide effects and promote low impact development into the site design process. Assistance with riparian buffers, bioretention, and infiltration methods can be offered to lessen the impact of stormwater run off.

Youth Education
Watershed education to area school children is a fundamental tool that encourages future stewards of the environment. Watershed education in the classroom, field day exercises, as well as the annual Conservation Fest hosted by the Marquette County Conservation District are some ways that children learn of human impact on the environment. Such educational projects should include information on natural features of the local area, erosion, watershed protection, and tips for how they can individually make an impact on the health of their environment.

Involvement from Municipalities
Local municipalities are an integral connection in overseeing local development without compromising the sustainability of the watershed. Involvement of township and city board members with the Lower Dead River Watershed Council will help maintain an active relationship and encourage a dialogue regarding zoning issues, upcoming development, and best management practices.

WATERSHED PROTECTION GOAL
It is the goal of the council to continuously improve resident awareness of the Lower Dead River Watershed. Outreach activities such as project newsletters, newspaper articles, and public workshops on watershed-related issues are ways to increase this awareness, with the hopes of increasing council participation by 50%.

Youth education at Vandenboom Elementary School

Table 5.4: Components of a Watershed Overlay Ordinance

Component	Definition	Potential Examples
Purpose	Goals and objectives for the enactment of the overlay zone	
Definitions	Definition of terminology	
Watershed Overlay Zone Boundary	Physical boundary defined by the natural drainage basin of the watershed being protected	
Review Authority	Identification of parties responsible for the review and enforcement of the overlay zone	
Application Use and Provisions	Specifications of restricted and permitted uses within environmentally sensitive areas	Sensitive areas include: - Riparian corridors - Recharge areas - Wetlands - Critical slopes
Development Guidelines	Specification of restricted and permitted uses during site development	May include restrictions on: - Grading and filling - Use of fertilizer and pesticides - Roads and infrastructure - Treatment of existing conditions

PLANNING STRATEGIES

Because watershed boundaries typically span multiple municipal jurisdictions, the successful implementation of a watershed management plan depends on the cooperation of a number of different governmental organizations.

Creating Lines of Communication

An important first step toward the protection of watershed resources is the creation of communication channels between the three municipalities located within the Lower Dead River watershed. While most of the new development will take place within the townships of Marquette and Negaunee, the City of Marquette, as the community located in the lowest reaches of the watershed, may be most directly affected by the health and stability of the watershed. The interconnectedness of all of these communities as they relate to the Lower Dead River watershed was made painfully obvious in the Spring of 2003, when the City of Marquette suffered severe flooding due to degraded conditions further upstream in the watershed. By establishing regular communication among the governing and planning boards in each of the municipalities, each community will be better informed and prepared to make the necessary changes to ensure the protection of the entire Lower Dead River watershed.

Communication between involved municipalities is critical

Build Out Analysis

In Chapter Three's analysis of existing built conditions, several areas were designated as likely development sites based on existing land use plans and zoning. To better understand the effect that fully building these development areas would have on the health of the watershed, a detailed build out analysis of these areas should be conducted. This process uses existing zoning and land use plans to identify the fullest extent to which development could occur. This analysis takes into account the scope of "buildable land" based on physical characteristics (slope, suitable soils, etc.) as well as the what impact current ownership patterns might have on development. For example, if the large tracts of CFR forest land currently held by private corporations were to become available for private development, the effect on potential buildable areas would be significant.

Watershed Overlay Ordinance

Because the Lower Dead River watershed crosses several jurisdictional boundaries, the implementation of a watershed overlay ordinance can be a convenient way to ensure the same protection measures are applied in multiple municipalities. An overlay zone is a separate zoning designation that is placed on top of the existing zoning classification. Overlay zones are routinely used for the protection of specific areas such as floodplains, wetlands, historical districts, and stream setbacks. Table 5.4 shows information typically addressed in a watershed overlay ordinance.

Figure 5.3: Example of a Conservation Subdivision (Source: Adapted from Arendt et al. 1994)

PLANNING STRATEGIES (CONTINUED)

Open Space Planning

All of the communities located within the Lower Dead River watershed have expressed an interest in maintaining the natural qualities of their communities. This not only protects their vital natural resources, but also the quality of life for local residents. A number of planning tools can be employed to facilitate this process. Such tools include the use of cluster development and conservation subdivision design for new residential development, greenways and conservation corridors for the protection of open space, and Planned Unit Developments (PUDs) to control the speed and pattern of new commercial development within the watershed.

Each of these tools attempts to mitigate the effects of development by maintaining areas of open space where natural ecological systems are still permitted to function (See Figure 5.3). Open space areas often encompass environmentally sensitive areas, such as unique forest stands or large wetland areas. In some cases, however, the purpose of the designated open space is to promote public access and appreciation of these "green" spaces. City parks, greenway corridors, or interpretive trails can all be useful tools for promoting conservation behavior within the local community. It also helps to maintain the rural aesthetic preferred by local residents. In a study conducted by the Central Lake Superior Watershed Partnership, local residents expressed their concern regarding fragmentation of forest areas, loss of green space, and commercial sprawl without consistent land use planning among municipalities. They also expressed a desire to protect the rural character, natural viewshed, and public access to the extensive natural resources of the Lower Dead River watershed (People and Land).

Low Impact Development

Low Impact Development (LID) is defined by Ayres, Lewis, Norris, & May, Inc (2002) as a development process that "integrates site hydrology considerations into the site design process in order to achieve storm water control through the development of a landscape that mimics the natural hydrologic regime of the site". This type of development includes a suite of tools that can be helpful in protecting the natural hydrology of a newly developed site. These include:

- Reducing the amount of impervious surface
- Protecting natural resources and ecosystems
- Maintaining natural drainage courses
- Minimizing the amount of grading
- Specifying proper maintenance of stormwater control measures

Table 6.1: Public Participation and Education Strategies

The following materials and activities are an essential part of the Lower Dead River Watershed Planning Project:

- A regular project newsletter mailed to all residents and businesses of the watershed
- Annual community events to raise public awareness:
  - Conservation festival
  - Watershed public meetings
- Volunteer opportunities:
  - Adopt-A-Stream cleanups
  - Stream monitoring
  - Native plant nursery volunteering
- Youth education:
  - Grade school programs
  - Internship opportunities
- Regular newspaper articles and news updates on local television and radio
- Public participation on the Lower Dead River Watershed Council and the Central Lake Superior Watershed Partnership
- Public workshops on watershed-related issues:
  - Soil erosion control
  - Riparian land management
  - Buffer strips

IMPLEMENTATION

THE PLANNING PROCESS

The Lower Dead River Watershed Planning project was developed with the assistance and oversight of several local agencies. Members of the Lower Dead River Watershed council include representatives from:

- Marquette Township
- Negaunee Township
- City of Marquette
- Marquette County Board of Commissioners
- Marquette County Drain Commission
- Michigan DEQ
- Trout Unlimited
- Watershed Property Owners

A complete list of participants by name and agency is included on the inside cover of this report.

Throughout the course of this plan, the Lower Dead River Watershed Council will host public information meetings to review the progress of the study and discuss issues relative to the watershed. As a means to solicit public involvement, meetings will be advertised in the Mining Journal, local radio, and local television stations. In addition to these public meetings, the watershed council will continue to pursue a number of other public participation and education opportunities as described in Chapter Five's "Public Participation and Education" section (See Table 6.1 for a review of the materials and activities that will be included in the council's public education efforts). Throughout the planning process, the watershed council will continue to work with the local media to reach a wider watershed audience.

It is the function of the Lower Dead River Watershed Council to advise the project manager in the planning process and to help coordinate the implementation strategies outlined in the plan.

Enforcement of zoning ordinances and buffer guidelines will help protect the existing stream system

Residents want to protect scenic resources, such as Reany Falls

PRIORITIZING AREAS OF CONCERN

In order to identify threatened uses, pollutants, and their potential sources, the Watershed Council will conduct a physical inventory and analysis of the Lower Dead River Watershed. Methods used to inventory the watershed include:

- Road crossing inventory – create a baseline inventory of culverts, identify areas where stormwater or sediment may be reaching the stream, recognize associated land use and future development that may occur.
- Macroinvertebrate monitoring – evaluate habitat for macroinvertebrate and fish community, establish baseline data from which future progress can be measured, identify sources or areas that may be impacting the stream.

Using the identified "Areas of Concern", the Lower Dead River Watershed Council created an overall prioritization methodology based on the following water quality concerns: contaminated stormwater runoff, flashy stormwater flow, obstructions to fish migration, stream crossings, lack of public education, water quality impacts to Lake Superior, and potential impacts to drinking water supply. These concerns were organized into general categories – stormwater, fish migration obstruction, erosion, sedimentation, transportation, and public education – and ranked individually within each category. Each project was assigned a priority of "high," "medium," or "low." The results of this prioritization process was the identification of the watershed enhancement projects identified later in this chapter.

IDENTIFYING DESIRED USES

In addition to water quality concerns, desired uses for the Lower Dead River Watershed should also be identified. A desired use is based on factors important to the watershed community, how residents want to use the watershed, or how they want it to look. The following list identifies the desired uses for the watershed:

- Restoration of the designated uses to the Lower Dead River Watershed that includes physical improvements and quantifiable protection goals
- Protection of the Dead River system through enforcement of zoning ordinances, buffer strip and setback guidelines, and permanent conservation easements
- Creation of better stormwater management techniques through education/ demonstration sites and stormwater ordinances implemented by local municipalities
- Continuation of watershed outreach through bi-annual newsletters, community watershed events, youth education, and volunteer clean ups and monitoring
- Identification of open space planning and low impact development practices that will protect the ecological resources of the watershed.

Table 6.2: Summary of Watershed Enhancement Projects

Site #	Watershed Enhancement Project	Estimated Cost	Priority	Suggested BMP
14	Railroad culvert replacement, Midway Creek	100,000	Low	Replace old 1912 railroad culvert, improve stream channel
5	Sanderson's culvert, Brickyard Creek	5,000	Low	Remove culvert, stabilize stream banks
1	Reany Creek fords	50,000	Medium	Improve stream crossings/ Construct bridges with higher load restrictions
19	Unnamed Creek Drainage Improvements	200,000	High	Install storm sewers, curb and gutter, and drainage structures to eliminate flashy stormwater flow
9	Exposed culvert, Holyoke Creek	10,000	High	Install new culvert, stabilize banks with rock riprap
4	CR510 Culvert Improvements, Midway Creek	25,000	High	Stabilize sedimentation, fix railing supports, create water diversions
8	Wright Street erosion, Badger Creek	2,000	Low	Stabilize banks with rock riprap
2	US 41/Brickyard Creek site	2,000	Low	Stabilize stream banks
21	Raney Creek residential erosion site	10,000	Medium	Eliminate erosion problems caused by flashy stormwater flow
12	Dead River Falls erosion project	75,000	High	Stabilize undercut banks, work with Longyear Realty to create alternative trail route
13	Vehicle removal, Badger Creek	2,000	Low	Remove vehicle, dredge excess sediment
3	Earthen/residential dams, Brickyard Creek	3,000	Medium	Remove dams
11	Forestville Road erosion site, Wolner Creek	2,500	Low	Extend rock riprap
15	Vehicle removal, Badger Creek	2,000	Low	Removal vehicle, dredge excess sediment
18	White Bear Road sedimentation site, Reany Creek	12,000	High	Install permanent sediment traps, work with White Bear Road Association to create road maintenance guidelines
10	Brookton Road crossing improvements, Badger Creek	15,000	Low	Bank stabilization
17	LS&I perched culvert, Brickyard Creek	10,000	Medium	Create riffle control structure
20	Montgomery Street crossing improvements, Unnamed Creek	25,000	Medium	Replace culvert, stabilize banks
7	Nature trail proposal, Badger Creek	75,000	High	Native plant installation, stairs to eliminate soil compaction/ Information and education component
16	Culvert improvements, Unnamed tributary	10,000	Medium	Create riffle control structure, stabilize banks
22	American Site	150,000	Medium	Eliminate parking lot runoff and pollutants from entering Badger Creek
6	510 erosion site, Reany Creek	50,000	High	Install bottomless arch culvert, stabilize banks
	Estimated Total Cost	**$835,500**		

IDENTIFYING WATERSHED ENHANCEMENT PROJECTS

The Lower Dead River Watershed Council compiled a list of watershed enhancement projects based on the findings of the management plan. In total, they identified twenty-two projects with an estimated value of $835,500 (See Table 6.2). Many of the projects focus on the elimination of excessive storm flows, erosion and sedimentation, and reduction of stream velocities. The council then prioritized each project as "high", "medium", or "low", estimated the cost of each project, and compiled a phasing schedule for each.

Table 6.3 presents a summary of the prioritized expenditures for the Lower Dead River Watershed. Fifty-four percent (54%) of the expenditures are for high priority projects in the watershed. Some of these projects include drainage improvements for Unnamed Creek, installation of a new culvert on Holyoke Creek, bank stabilization on the Dead River Falls trail, and the installation of permanent sediment traps and creation of road maintenance guidelines for the White Bear Road Association. Thirty-one percent (31%) of watershed enhancement expenditures are considered medium priority while fifty-four percent (54%) are considered to be low priority projects.

Based on the priority of each project, a phasing schedule with the forecasted expenditures was created. Each project was ranked "immediate", "near term", or "long term" with anticipated results for all watershed enhancement projects to be completed within ten years. Table 6.4 highlights the phasing schedule and expenditures.

Approximately 30% of the forecasted expenditures are designated as "Immediate" in nature. Projects were almost evenly distributed amongst these categories, with all enhancement projects to be completed within ten years. This phasing strategy will allow various units of government sufficient time to budget for the projects and secure other funding sources.

Table 6.3: Expenditures by Priority

Lower Dead River Watershed

High	Medium	Low	Total
$447,000	$258,000	$130,500	$835,500
54%	*31%*	*54%*	*100%*

Table 6.4: Expenditures by Phasing Schedule

Lower Dead River Watershed

Immediate (1-2 Years)	Near Term (3-5 Years)	Long Term (6-10 Years)	Total
$247,000	$329,000	$259,500	$835,500
30%	*39%*	*31%*	*100%*

EVALUATION PROCESS

The success of the implementation program outlined in the Lower Dead River Watershed Management Plan will be measured by an improvement in water quality. Because this plan included an assessment of stream quality using SWQAS Procedure 51 it would be suggested that this analysis was used as a baseline for future assessments. Conducting a SWQAS Procedure 51 within the same stream reaches on regular intervals (5 years) would provide a measure of how well the implementation plan is progressing, and if the goal of the program is being achieved.

Table 7.1: Assessment of Areas Impacted by the Dead River Flood

Site #	Area of Concern	Linear feet of erosion
Section 3	**From McClure Dam to McClure Power House**	
1a.	Erosion below the McClure Dam, caused by basin overflow	40 ft
2a.	Scoured bank	20 ft
3a.	Rock deposits and eroded bank	160 ft
4a.	Shoreline erosion	180 ft
5a.	Undercut river bank	80 ft
6a.	Longyear bridge washout, damaged shoreline	50 ft
	Total linear feet of erosion in Section 3	**530 feet**
Section 4	**Forestville Dam to upper end of Tourist Park Basin**	
1b.	Bank erosion next to Forestville Dam	250 ft
2b.	Scoured bank	200 ft
3b.	Undercut bank	30 ft
4b.	Large debris pile	
5b.	Low undercut bank	200 ft
6b.	Low undercut bank	200 ft
7b.	Scouring along rip rap and bedrock below dam #1	
8b.	Scouring under wood penstock, bank failure exposing old foundation	15 ft
9b.	Undercut river bank	150 ft
10b.	Large debris pile, stream bank erosion	30 ft
11b.	Large debris pile, stream bank erosion	30 ft
12b.	Bank erosion	50 ft
13b.	Bank erosion	20 ft
14b.	Slumping bank	100 ft
15b.	Bank failure	50 ft
	Total linear feet of erosion in Section 4	**1,325 feet**
Section 5	**From Tourist Park Dam to Mouth of Dead River**	
1c.	East bank below Tourist Park, eroded bank	2,100 ft
2c.	West bank below Tourist Park, eroded bank	2,150 ft
3c.	Railroad bridge, footings washed out, 40 ft wide, 8 ft tall	320 ft
4c.	Vertical bank failure, 40 ft long, 15 ft tall	600 ft
	Total linear feet of erosion in Section 5	**5,170 feet**
	Total linear feet of erosion in the Lower Dead River Watershed	**7,025 feet**

FLOOD UPDATE - IMPACTS & OPPORTUNITIES

The severe damage done by the May flooding along the Lower Dead River serves to highlight the importance of protective measures discussed in the management plan. Rushing waters from an upstream breach in the Silver Lake caused the earthen dam at Tourist Park to give way, resulting in the draining of the Tourist Park Basin. In addition to the Silver Lake breach, immediate effects of the flood damage included:

- Nine bridges either damage or destroyed
- Month-long shutdown of a major coal-fired power plant
- Two parks and three public access sites damaged
- Major river channel scouring and realignment
- Major soil erosion and vegetation loss along stream banks
- Significant amounts of sediment deposited along the river and into Lake Superior
- Damage to Chinook salmon hatchery fish-pens, stressing or killing 130,000 fish
- Limited road access for residents and emergency vehicles north of the river
- Significant economic impacts to dozen of local businesses
- Temporary shut down of two iron-mines, laying off over 1,000 workers

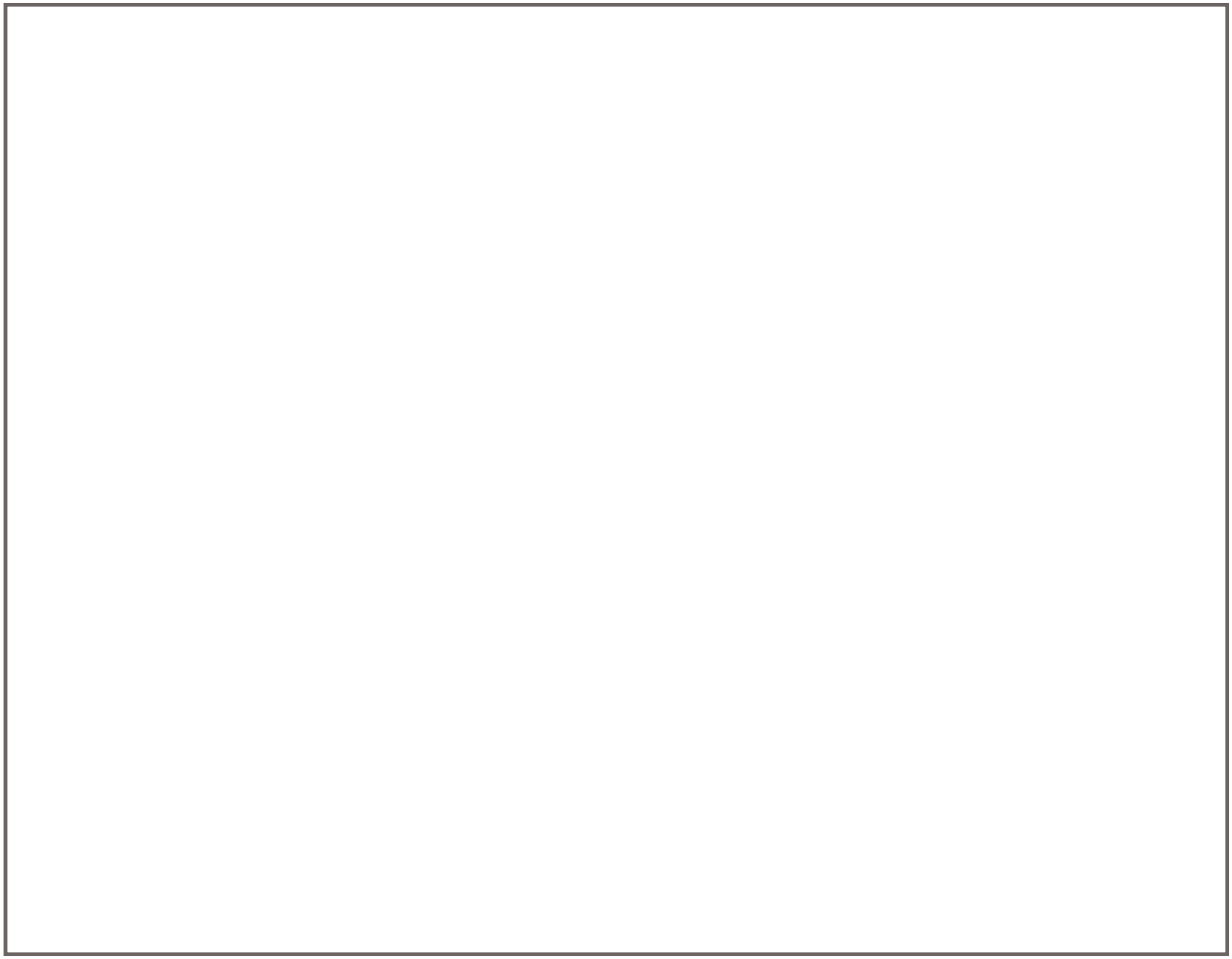
In the weeks immediately following the flood, numerous federal, state, and local officials surveyed and assessed the flood damage by helicopter, boat, and on-ground inventories. The Federal Emergency Management Administration (FEMA) was requested to evaluate the disaster in hope of receiving federal aid and assistance. Though FEMA refused to declare Marquette a disaster area, funds were secured through the Natural Resources Conservation Service 'Emergency Watershed Protection' program to remediate several severe areas of erosion and sedimentation.

To help remediate these damaged areas, banks were regraded and stabilized with rock rip-rap, and both Silver Lake and Tourist Park basin were hydroseeded to prevent further erosion. The status of rebuilding the earthen dike at Silver Lake Basin and the dam at Tourist Park basin remains unknown as options are investigated and analyzed. The affected municipalities continue to work together to seek additional funding sources.

Site of the drained Tourist Park Basin (Source: Peterson 2003)

Tourist Park dam gave way under pressure from floodwaters

Rip-rap and newly seeded grass help prevent erosion



FUNDING SOURCES

The following is a partial list of some grants and funds that can be used to help in the implementation of the Lower Dead River watershed management plan. Funding sources are continually changing and becoming available. Information on new sources of funding can be found through the EPA, Michigan's DNR and DEQ, and through many non-profit organizations dedicated to the protection of natural resources and water quality.

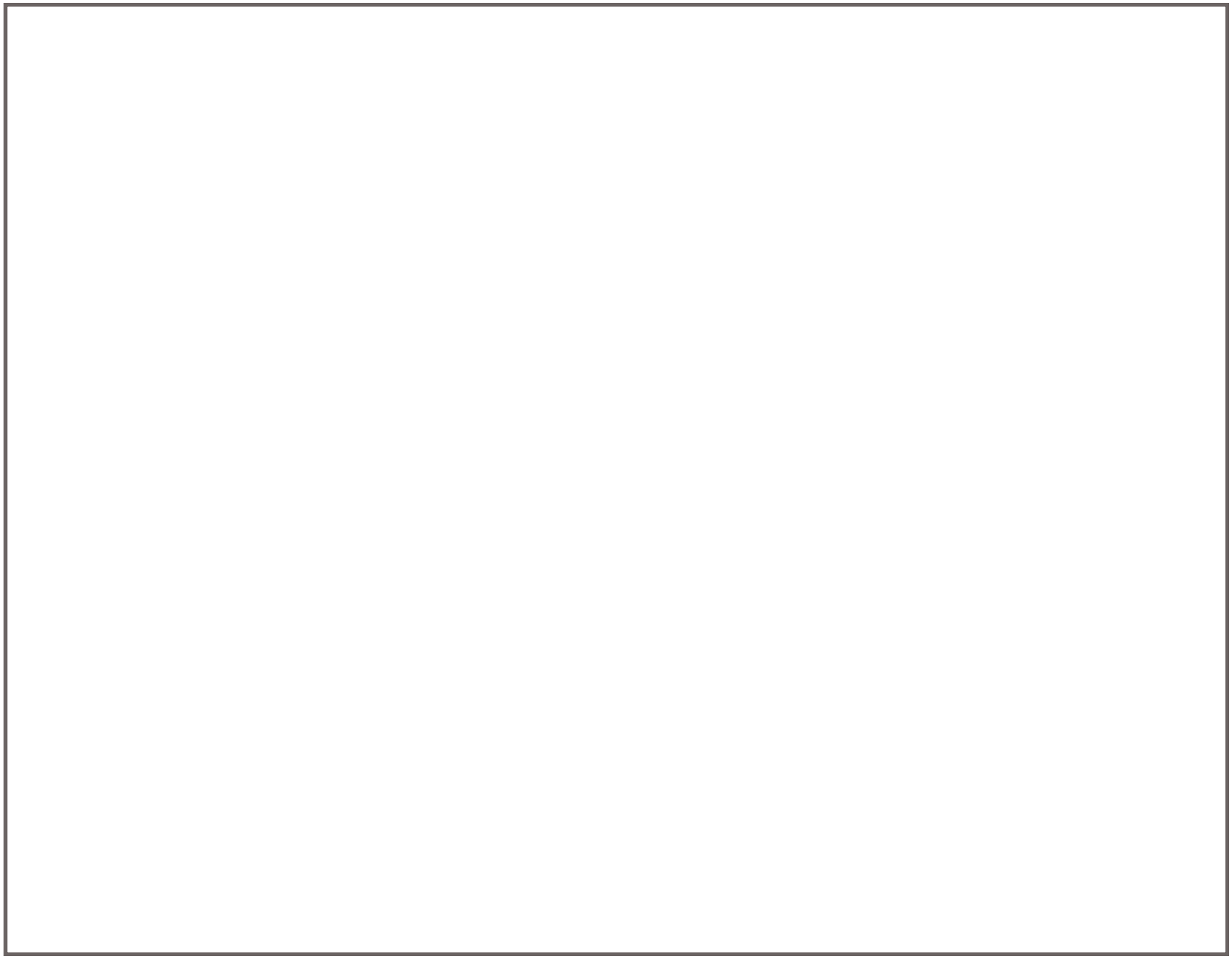
Inland Fisheries Resource Grants (MDNR)
These funds are intended to encourage and enhance inland fishing opportunities and to protect, maintain, or restore inland aquatic environments. Projects might include bank stabilization, piers, erosion control, and access sites. Applicants must demonstrate they can contribute at least 50% of the project's cost as a match to the state-sponsored grant. Contact Todd Grischke, DNR, Fisheries Division, at 517-373-6762 for more application information.

Urban and Community Forestry Program (MDNR)
Funds under this program are used to provide information and technical assistance to municipal governments and volunteer groups for urban and community forest activities. Appropriate projects include tree inventories, land management plans, planting, and other maintenance activities. These funds are specifically set aside for local governments and nonprofit development in local communities. Appropriate projects would include reforestation or revegetation of degraded areas, community education projects that specifically address forestry or reforestation issues, and tree plantings. The deadline for project proposals is May of each year.

Michigan Natural Resources Trust Fund
This fund provides grants to local units of government for acquisition and development of lands and facilities for outdoor recreation or the protection of Michigan's significant natural resources. Appropriate uses include the creation or protection of wildlife or ecological corridors through the connection or buffering of state or local natural areas, forests, or game areas. Applicants must include their community's adopted recreation plan along with their submission. The deadline for application is April 1 of each year.

Coastal Management Program (MDNR)
These funds can be used to create or enhance public access to the great lakes, redevelopment of a deteriorating urban waterfront, protection of sensitive coastal features, erosion/hazard control in coastal areas and restoration of historic coastal features.

Non-Point Source Pollution Control Grant (MDNR)
The purpose of this grant is to implement improvements outlined in approved watershed management plans. These improvements can be used to address sources of non-point source pollution. Applicants must contribute a 25% match to the state-sponsored grant.



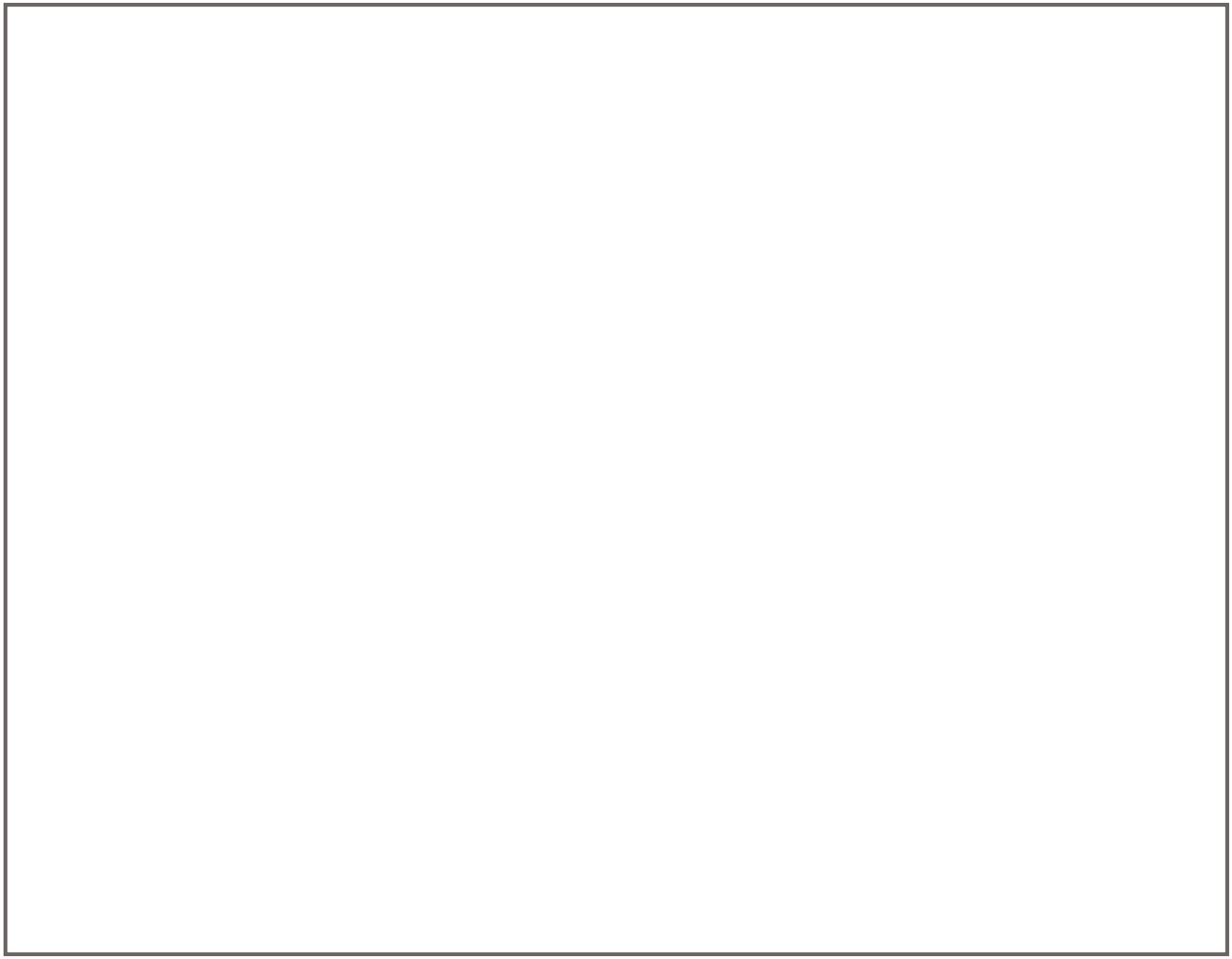
FUNDING SOURCES (CONTINUED)

Great Lakes Protection Fund
This fund seeks and selects projects based on the anticipated benefits to the health of the Great Lakes ecosystem. To be successful, tying the project work into a larger, basin-wide effort would therefore be necessary. Projects should anticipate and prevent impacts to the Great Lakes ecosystem or the specific component (like a developed watershed) of the Great Lakes ecosystem rather than attempt to correct areas already impacted. Applications are accepted at any time.

EPA Grant through Great Lakes National Program Office (EPA)
These funds are distributed to action-oriented, collaborative efforts, leveraged by other funding sources. Like the Great Lakes Protection Fund, this program selects projects based on their contribution to the health of the Great Lakes system.

Watershed Surveys and Planning
This organization provides planning assistance to Federal, State, and local agencies for the development of coordinated water and related land resources programs in watersheds and river basins. Priority will be given to studies which: (1) Contribute to achieving the National Conservation Program high priority objectives; (2) have a high likelihood of being implemented; (3) will be implemented with no or relatively little Federal assistance; (4) have State and local assistance in the study; and (5) are of short duration (2 to 4 years) and (6) low cost. Special priority is given to the objectives of setting priorities in helping to solve problems of upstream rural community flooding, water quality improvement coming from agricultural non-point sources, wetland preservation and drought management for agriculture and rural communities. Special emphasis is given to assisting communities which desire to adopt floodplain management regulations to meet the requirements of the National Flood Insurance Program and State agencies in developing a strategic water resource plan. Types of assistance include provision of specialized services, advisory services and counseling.

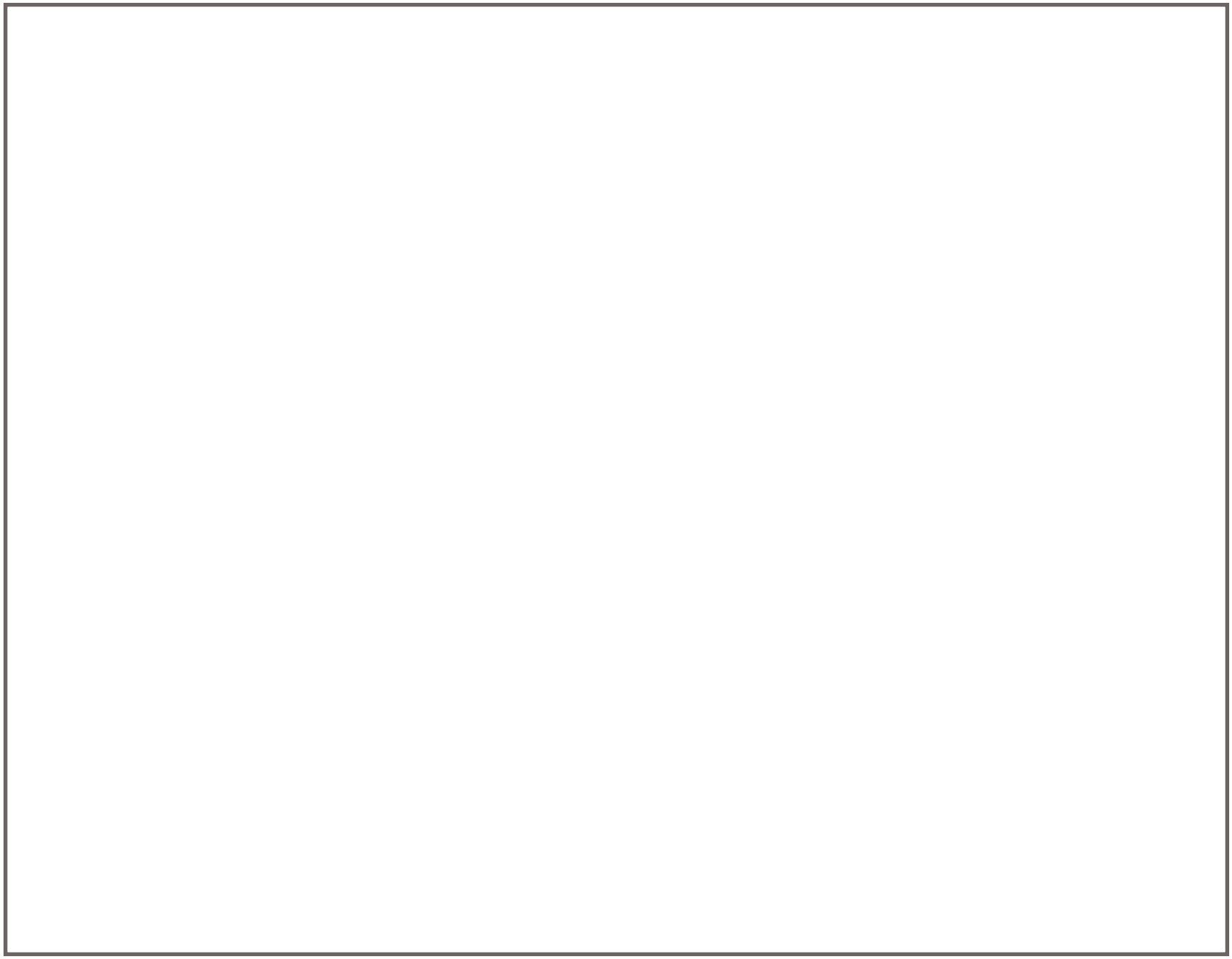
Watershed Protection and Flood Prevention
This group provides technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in small watersheds. Technical assistance is provided in designing, and installing watershed works of improvement. Financial assistance is provided for sharing costs of measures for watershed protection, flood prevention, agricultural water management, sedimentation control, public water-based fish, wildlife, and recreation; and in extending long term credit to help local interests with their share of the costs. Watershed areas must not exceed 250,000 acres. Capacity of a single structure is limited to 25,000 acre-feet of total capacity and 12,500 acre-feet of floodwater detention capacity. Types of assistance include provision of specialized services, advisory services and counseling.



FUNDING SOURCES (CONTINUED)

Conservation Reserve Program
This program's goal is to protect the Nation's long-term capability to produce food and fiber; to reduce soil erosion; to reduce sedimentation; to improve water quality; to create a better habitat for wildlife. Eligible owners or operators may place highly erodible or other environmentally sensitive land into a 10-15 year contract. The participant, in return for annual payments, agrees to implement a conservation plan approved by the local conservation district for converting highly erodible cropland or other environmentally sensitive land to a long-term resource conserving cover i.e., eligible land must be planted with a vegetative cover, such as, perennial grasses, legumes, shrubs, or trees. Financial and technical assistance are available to participants to assist in the establishment of a long-term resource conserving cover.

Anadromous Fish Conservation Act Program
This program assists organizations in the conservation, development, and enhancement of the nation's Anadromous fish stocks and the fish in the Great Lakes that ascend streams to spawn. Funds can be used for spawning area improvement, installment of fishways, data collection, construction of fish protection devices and hatcheries, and research to improve management and increase Anadromous fish resources. Funds cannot be used for law enforcement, public relations, or construction of facilities and vessels, the primary purpose of which is to commercially harvest, handle, and process fishery products.



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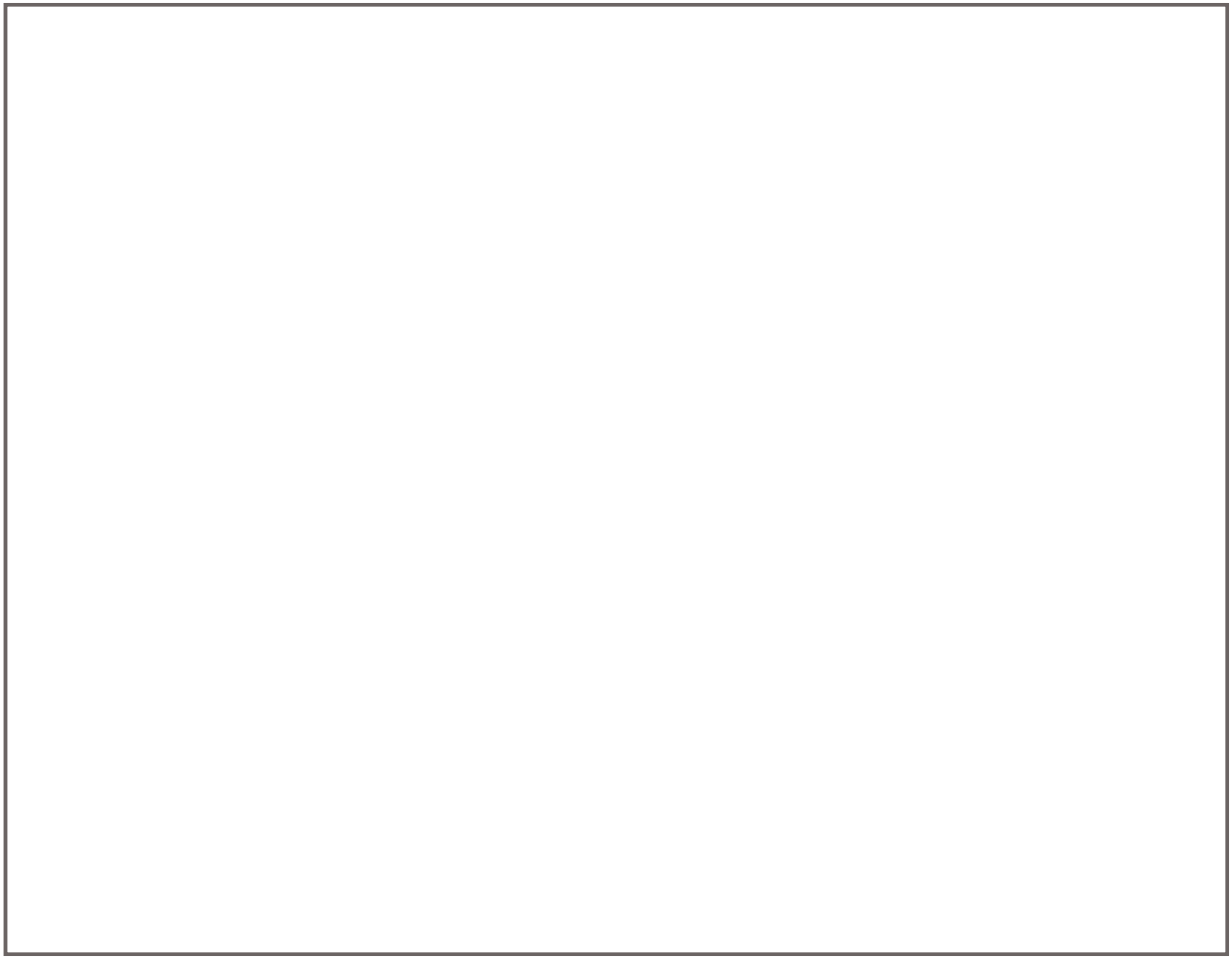

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APPENDIX A - Glossary

Impervious surface[1]
Hard ground cover that prevents or retards the entry of water into the soil and increases runoff, such as asphalt, concrete, or rooftops.

Lacustrine[2]
Relating to, formed in, living in, or growing in lakes.

Riparian[2]
Relating to or located on the bank of a natural watercourse, such as a river, lake, or tidewater.

Stormwater[1]
Precipitation that accumulates in natural and/or constructed storage and stormwater systems during and immediately following a storm event.

[1] Forester Communications, Inc. 2003. *Stormwater* [online]. [cited 21 July 2003]. Available <http://www.forester.net/sw.html>.
[2] Merriam-Webster. 2003. *Merriam-Webster On-line – The Language Dictionary* [online]. [cited 21 July 2003]. Available <http://www.m-w.com/home.htm>

APPENDIX B - Brickyard Creek Hydrologic Study

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INTRODUCTION

The Lower Dead River Watershed Council was formed as one of the watershed groups under the Central Lake Superior Watershed Partnership for the purpose of observing and studying the Dead River and its tributaries from the McClure Dam to Lake Superior. Members of the council include land-owners and other concerned citizens, commercial and industrial representatives, environmental/engineering consultants and student interns.

The council was formed in response to a request from Marquette Township to observe the existing and further potential effects from US 41 corridor development, establish a basis for further study, raise public awareness, and make recommendations for corrective measures through cooperative effort.

For this study, the Marquette County Conservation District issued a Request for Proposals for engineering services to provide hydrologic analyses, observations and recommendations for watershed and stream stabilization for two tributary streams of the lower Dead River watershed. The two streams designated for study were Erie Creek, which is a watershed in Trowbridge Park, and Brickyard Creek. Due to funding limitations, the study was revised to only one watercourse, and because of its proximity to current commercial development, Brickyard Creek was selected as the more critical of the two streams.

This report presents the results of field investigation, hydrologic modelling, conclusions and recommendations.

SUMMARY

In particular, the reach extending from the US 41 crossing upstream to the outlet from the Bishop Pond wetlands was designated as the study area. This reach begins adjacent to the Bishop Woods residential subdivision and flows by culvert through the railroad grade, Northwoods Road, Brickyard Road and US 41. Within this reach, four sites were selected for measuring base flow and design storm flow for the 24 hour 2 year, 10 year and 100 year events. Except for the Bishop Pond wetland outlet, these points are located at the downstream ends of culvert crossings: at the railroad grade, Brickyard Road and US 41.

Base stream flows were taken at these points by direct measurement using channel section/culvert geometry, gradient and stream velocity. Field verification was made to identify any points of "significant discharge" to the stream, with significant discharge defined as any flow greater than 50% of base flow for the stream at that point. Design storm flow rates at these points were calculated using the following sources: USDA Soils Conservation Service Technical Release No 55 (TR-55); the MDEQ Land & Water Management Division publication, "Computing Flood Discharges for Small Ungauged Watersheds" by Richard Sorrell PE, Hydrologic Studies Group, 2000; aerial mapping by Aerometric for Marquette Charter Township; USGS 7.5' Marquette quadrangle; and USDA Soils Conservation Service Atlas for Marquette County, Michigan (sheet 47). Findings, conclusions and recommendations made in this report are based on the above methods and informational sources.

NARRATIVE

While base flows were measured directly from the four designated gauging sites, determination of design storm flows required characterization and modelling of the entire upper watershed. The watershed which is drained by Brickyard Creek may be considered as consisting of two reaches: from the headwaters to Bishop Pond and surrounding wetlands, and from the Bishop Pond wetlands to the Dead River.

In general, the upper watershed is characterized by areas of rock outcrop and intermittent wetland, and is heavily wooded by a mixed hardwood and conifer forest in highland areas and boreal coniferous typical of isolated wetlands in this region. It is approximately 1483 acres and extends south of County Road 492, west to the LS&I trestle at US 41, and east to the Bishop Woods residential subdivision. Elevations in the upper watershed range form 1320 ft in the western highlands to 1100 ft in the Bishop Pond wetlands.

Below 1100 ft, relief of the watershed becomes progressively less pronounced, and makes a transition to an area predominated by open and scrub wetlands which surrounds Bishop Pond. This area, including Bishop Pond is approximately 129 acres in extent. It is in this lower area, elevation 1100 to 1060 ft, that the two tributaries from the western watershed form a confluence at Bishop Pond. As seen in the watershed map (Figure a), the drainage pattern shifts, flowing toward the Dead River in a northwesterly direction. The topography and geomorphology of the southeastern upper watershed area suggests that the area west of Bishop Pond in later Pleistocene times may have served as headwaters for the Badger and Whetstone watershed systems, with Bishop Pond and surrounding wetlands the headwater for Brickyard Creek.

Bishop Woods is a 70 acre residential development located immediately east of Bishop Pond, and is served by paved roads and utilities which include a stormwater collection and conveyance system. Stormwater outfalls from the system do not discharge directly into the Bishop Pond wetlands, but are routed to retention/detention basins constructed with overflow discharge structures. Upon inspection of these basins, it is apparent that they have been designed as "dry" basins, with the floor of the basin situated above the groundwater table. In addition, the overflow structures do not show evidence of flowing water, which would indicate that these basins have thus far operated by retention and infiltration to groundwater.

Locally, the outlet of Bishop Pond is considered to be the headwater/beginning of Brickyard Creek. Base flow was determined to be about 2 to 3 cubic feet per second (cfs). From the outlet, the stream flows through about 1,000 feet of an indeterminate relatively flat system of wetland drainage, and from there begins to drop at an average gradient of about 1% until the gradient again decreases north of US 41.
It is apparent that the Bishop Pond/wetlands area provides a very significant runoff storage factor, and it is this watershed characteristic which in effect separates the upper and lower reaches of the watershed.

As Brickyard Creek flows out of the Bishop Pond wetlands, it forms into a well-defined permanent watercourse. It is at this point in the stream, approximately 1,000 feet downstream of Bishop Pond, that the first gauging point was established. Beginning at the north end of the wetlands, it is evident that the base flow of the creek as it descends is maintained by the hydrogeology of the sand/gravel aquifer driven by the source at the wetlands. The creek flows from the wetlands through an undeveloped area to the railroad grade. This area is heavily wooded with thick undergrowth. The stream channel through this area is 3 to 4 feet in width and 1 foot in depth, with depth of flowing water 3 to 4 inches.

The stream passes through the railroad grade by means of a 4 foot diameter culvert set at a gradient which conducts flow from an upstream pool at a velocity visibly greater than that of the existing stream. Base flow was determined to be about 3 to 4 cfs. This flow discharges from the culvert by free-falling about 3.5 feet to a pool 5 to 6 feet in diameter and 3 to 4 feet deep, which has evidently been scoured from the streambed. Backwater and tailwater conditions suggest that the culvert was set (circa 1910) too high, and velocity suggests that it was set at an excessive gradient relative to the existing streambed. The outfall area has been stabilized by the placement of rock riprap and larger ballast at the toe of the slope and surrounding bank areas.

From this point the stream passes through a relatively flat wetlands floodplain 40 to 50 feet wide, with the stream channel section geometry remaining fairly constant at 3 to 4 feet wide by 1 foot in depth from streambed to overbank. Base flow through this section, which runs from the railroad grade crossing to the Northwoods Road crossing at a depth of 3 to 4 inches, appears to be variable. These observations suggest that the stream channel is of adequate depth to accommodate some amount of stormwater flow, with the wetland/floodplain acting as reserve storage/detention in larger events.

The stream passes through a 3 foot diameter culvert under Northwoods Road, flows for a short distance along the north side of the road in the form of a ditch, then passes under Brickyard Road through another 3 foot diameter culvert. Both the Northwoods Road culvert and the Brickyard Road culverts are well situated, having been set with upstream and downstream inverts at or slightly below the existing streambed.

Base flow measurement at the downstream end of the Brickyard Road culvert indicates a flow of about 3 cfs. This in turn would indicate that there is a degree of loss in volume as the stream flows through the wetlands floodplain area between the railroad grade and Northwoods Road.

The most likely cause for this loss is the groundwater divide (of the Wollner Creek watershed) located immediately east of Brickyard Creek. Terrain elevations only 300 feet east of Brickyard Creek are lower than this section of the stream. It is of interest to note that groundwater from the sand/gravel aquifer in this area was encountered in very significant quantities during the construction of foundations for Menards. An extensive system of foundation and perimeter grade drains was constructed to alleviate the high groundwater levels. The outfall for the Menards subgrade drain system is located at the head of the constructed mitigation wetlands at the northeast corner of the property. This outfall is always flowing.

From Brickyard Road, the stream begins flow in a well-defined ravine with a relatively narrow floodplain. This characteristic section geometry deepens and widens as the stream approaches its confluence with the Dead River. From Brickyard Road to US 41 the stream drops about 30 feet over a flow distance of approximately 1,200 feet at a gradient of about 3%.

At a distance of 35 feet upstream of US 41 are the remnants of a low head dam which impounds a small pool. The backwater discharges through a spillway/low section in the dam and flows to the box culvert under US 41. The box culvert consists of two 6 ft deep by 6 ft wide barrels well situated with respect to the existing streambed. As is typical of tandem box culverts, one side (in this case the west barrel) takes most of the flow while the other becomes partially obstructed with stream sediment. The base flow measurement made at the downstream end of the US 41 culvert indicated that two thirds of the volume flowing through the west barrel and one third flowing through the east barrel, totalling about 3 to 4 cfs.

The above point is the last designated gauging point. Much of the stream from this point downstream to the Dead River is inaccessible, due to property ownership and the considerable physical barrier posed by the floodplain wetlands which widen as the stream approaches its confluence with the Dead River. However, the following observations may be made: 1) north of US 41 and west of the power line service road, the channel deepens, widens and begins to exhibit sinusoidal meandering typical of low gradient and sediment load with tailwater control (at the Dead River); 2) the ravine widens with progression downstream, encompassing increasing areas of floodplain wetlands; 3) the Brickyard Creek/Dead River floodplain confluence is complex and contains a system of cutoff meander ponds and meander scars; 4) the vertical depth of the ravine, from upland edge to water surface ranges from 35 to 40 feet, and 5) the depth of flow in Brickyard Creek increases and the velocity decreases progressively toward the confluence. These observations indicate that the lower reach of Brickyard Creek from the power line service road to confluence with Dead River provides a very significant storage of volume and detention of stormwater flow to the Dead River.

CONCLUSIONS

- The stormwater collection and retention/detention system for Bishop Woods residential development is observed to be designed and maintained adequately. Direct or "significant" flow to the Bishop Pond wetlands is not evident.

- The culvert passing under the railroad grade is set high and at an excessive grade relative to the existing streambed.

- The area west of the stream between the railroad grade and Northwoods Road is the location of a rental storage facility, and it appears as if the gravel parking lot for this facility has displaced some of the floodplain wetlands.

- By direct measurement the stream appears to lose volume as it flows from the railroad grade to the Brickyard Road culvert, probably from exfiltration to the Wollner Creek headwaters aquifer immediately east of Brickyard Creek.

- From the Brickyard Road culvert downstream to the Dead River, the watershed morphology is unusual in that it is relatively very narrow and as a result flow increases very little with progression downstream.

- Runoff from the commercial establishments along Northwoods and Brickyard Roads is in the form of sheet flow which is a non-point discharge, and therefore does not constitute a "significant flow" of any degree.

- The existing small dam immediately south of the highway is in a deteriorated condition and impounds a small backwater.

- Runoff from US 41, although causing some erosion immediately off the shoulder on the south side of the road, is in the form of sheet flow/non-point discharge and does not constitute a significant flow.

- The access to the powerline service road from Brickyard Road north of US 41 is subject to repeated washout, erosion and stream sedimentation.

- West of the powerline service road, the stream enters a deeply incised and increasingly wide wetland floodplain capable of a detaining a considerable volume of storm runoff from immediate discharge to the Dead River.

- The Bishop Pond/wetlands complex acts as a very significant stormwater runoff detention/retention area of the upper watershed.

RECOMMENDATIONS

- Occasionally monitor the Bishop Woods subdivision retention/detention basin discharges.

- Since it would be impractical to replace or adjust the railroad grade culvert, an energy dissipation structure should be designed and constructed to further stabilize the outfall pool area.

- Runoff and erosion from the rental storage facility parking area should be monitored for sedimentation and/or pollutants.

- The gravel shoulders of Northwoods and Brickyard Roads and any commercial or residential establishments adjacent to the creek should be monitored on occasion for erosion.

- Following removal of the deteriorated dam south of US 41, the stream should be restored as nearly as possible to its original condition. In the event of significant upstream development such as the Menards No 3 outlot, this area could be considered for an offset detention/settling basin.

- The eroded bank off the south shoulder of US 41 should be graded and seeded/planted with an appropriate ground cover.

- The access from Brickyard Road north of US 41 to the powerline service road should be graded and stabilized against erosion and sedimentation to the stream. A sedimentation trap downstream of the culvert should be considered in any case.

- In order to more accurately determine the existing storage/detention capacity and groundwater infiltration characteristics of the Bishop Pond/wetlands complex (and proposed design enhancements), a more detailed study of this area in the upper watershed should be undertaken.

Table (a): TR-55 SUMMARY

Flow class	(K) coefficient	(L) Length (ft.)	Elevation Change (ft.)	(s) Slope (%)	v=K(s)exp0.5 velocity (ft/sec)	T= L/v Travel time (hrs)
headwaters						
sheet	0.48	2,000	50	2.5	0.76	0.73
waterway	1.2	200	20	10.0	3.79	0.02
"	"	600	20	3.33	2.19	0.08
"	"	2,600	20	0,77	1.05	0.69
"	"	1,200	20	1.67	1.55	0.21
"	"	1,000	20	2.00	1.70	0.16
"	"	700	20	2.86	2.03	0.10
"	"	1,300	20	1.54	1.49	0.24
"	"	3,000	20	0.67	0.98	0.85
"	"	2,500	20	0.80	1.07	0.65
Tributary	2.1	1,900	2	0.11	0.70	0.75
"	"	160	2	1.25	2.35	0.02
Bishop Pond Outlet		16,620	234	1.44	1.026	4.50
Tributary	2.1	800	18	2.25	3.15	0.07
Railroad grade		17,420	252	1.45	1.059	4.57
Tributary	2.1	560	14	2.50	3.32	0.05
Brickyard Road		17.980	266	1.48	1.081	4.62
Tributary	2.1	1,150	37	3.22	3.37	0.08
U.S.-41		19.130	303	1.58	1.131	4.70

Table (a) - Continue: TR-55 SUMMARY

design storm	P(in)	SRO(in)	F(p)
2 yr	2.39	0.03	0.59
10 yr	3.48	0.24	0.62
100 yr	5.32	0.95	0.65

Gauging point	T© (hrs)	Q(base) (cfs)	Q(u)* (cfs/in/sqmi)	A(m) (sqmi)	Q(2) (cfs)	Q(10) (cfs)	Q(100) (cfs)
Bishop Pond	4.50	3	80.11	2.32	3.29	27.66	114.8
Railroad Grade	4.57	4	79.11	2.39	3.35	28.13	116.7
Brickyard Road	4.62	3	78.42	2.43	3.37	28.36	117.6
US 41	4.70	3	77.34	2.48	3.39	28.54	118.3

*Q(u) = 270.9 (T© exp -0.81), by logarithmic linear regression analysis from "Computing Flood Discharges for Small Ungauged Watersheds" by Richard Sorrell, PE; MDEQ Land & Water Management Division Hydrologic Studies Unit, 2000.

Although a detailed stormwater detention design and analysis are beyond the scope and intent of this report, the following observations and conclusions may be made. The wetlands area immediately upstream of Bishop Pond is about 15 acres in extent and could store approximately 30 acre-feet or more of runoff from a significant event. The relatively small outlet from Bishop Pond appears to accommodate a more or less constant flow. In addition to detention in the wetlands, there is also apparently considerable infiltration to the underlying aquifer. In this analysis, we have used a ponding factor (F(p)) of 0.65 as per the above methods. However, it is suspected that this factor should be less, and design storm flows particularly those for the 100 year event will likely be 30% to 40% less than as given above.

Table (b): BASE FLOW SUMMARY

Gauging Site	Channel	Slope (%)+/-	Observed Velocity (ft/sec)	d/D	q/Q	Q(full) (cfs)	Q (cfs)
Bishop pond	3 ft x 4" depth	-	3	-	-	-	3
Railroad grade	4' dia cmp	2.5	-	0.083	0.020	200	4
Brickyard road	3' dia cmp	1.0	-	0.056	0.030	100	3
US 41	twin 6'x6' box culverts	1.0	-	0.021	0.008	500	3

FIGURE (a) – USGS WATERSHED MAP (see original study for figures)
FIGURE (b) - USDA/SCS SOILS MAP (see original study for figures)

APPENDIX (a) - SCS TR-55 DATA SHEETS (see original study for data sheets)
APPENDIX (b) - USDA SOILS CLASSIFICATION & HYDROLOGIC GROUPS (see below)

Appendix (b) - USDA SOILS CLASSIFICATION & HYDROLOGIC GROUPS

Soils Designation	Description	Hydrologic Group
Upland Soils		
125D	Keweenaw/Kalkaska rock outcrop complex	A
125F	Keweenaw/Kalkaska dissected complex (moraine formation)	A/B
40B	Waiska cobbly/loamy sand	B
13B	Kalkaska sand	A
12B	Rubicon sand (outwash plains & stream terraces)	A
Wetlands Soils		
93	Tawas/Deford Muck/Sand	D/A
57	Carbondale/Tawas Muck/Sand	D/A

APPENDIX C - Riparian Buffer Ordinance (Draft)

Riparian Buffer Ordinance - Outline

The following riparian buffer ordinance was adapted from the EPA's model buffer ordinance and designed to suit the specific needs of Marquette County.

Purpose

The purpose of a riparian buffer ordinance in Marquette County is to ensure the protection of water quality and aquatic habitat within the local stream systems. The protection of the natural vegetation adjacent to waterways is intended to protect the physical integrity of the system, reduce the amount of non-point source pollution entering these systems, and to protect and enhance the aquatic habitat of the region.

Outline of Ordinance

The proposed ordinance includes the following information:

Section I - Intent
Outlines the purpose of the ordinance

Section II - Background
Reviews the benefits such an ordinance would have for the local stream system

Section III - Definitions
Establishes standard definitions to ensure clear communication of the ordinance

Section IV - Design Standards for Riparian Buffers
Describes the detailed design of the riparian buffer including permitted and restricted uses

Section V - Buffer Management and Maintenance
Outlines permitted and restricted activities related to buffer management and maintenance

Section VI - Enforcement Procedures
Reviews the procedures for enforcement of the ordinance

Section IX - Waivers / Variances
Describes the process for obtaining a waiver or variance related to the buffer ordinance

Section I. Intent

The purpose of this ordinance is to establish minimal acceptable requirements for the design of buffers to protect the streams, wetlands, and floodplains of _____ *[jurisdiction]*; to protect the water quality of watercourses, reservoirs, lakes, and other significant water resources within _____*[jurisdiction]*; to protect _____ *'s [Jurisdiction's]* riparian and aquatic ecosystems; and to provide for the environmentally sound use of _____ *'s [jurisdiction's] land resources*.

Section II. Background

Buffers adjacent to stream systems and coastal areas provide numerous environmental protection and resource management benefits that can include the following:

1. Restoring and maintaining the chemical, physical, and biological integrity of the water resources
2. Removing pollutants delivered from urban stormwater
3. Reducing erosion and sediment entering the stream
4. Stabilizing stream banks
5. Providing infiltration of stormwater runoff
6. Maintaining base flow of streams
7. Contributing the organic matter that is a source of food and energy for the aquatic ecosystem
8. Providing tree canopy to shade streams and promote desirable aquatic organisms
9. Providing riparian wildlife habitat
10. Furnishing scenic value and recreational opportunity

It is the desire of the _____*[jurisdiction]* to protect and maintain the native vegetation in riparian and wetland areas by implementing specifications for the establishment, protection, and maintenance of vegetation along all stream systems and/or coastal zones within our jurisdictional authority.

Section III. Definitions

Active Channel

The area of the stream channel that is subject to frequent flows (approximately once per one and a half years) and that includes the portion of the channel below the floodplain.

Best Management Practices (BMPs)

Conservation practices or management measures that control soil loss and reduce water quality degradation caused by nutrients, animal wastes, toxics, sediment, and runoff.

Buffer

A vegetated area, including trees, shrubs, and herbaceous vegetation, that exists or is established to protect a stream system, lake, reservoir, or coastal estuarine area. Alteration of this natural area is strictly limited.

Development
1. The improvement of property for any purpose involving building
2. Subdivision or the division of a tract or parcel of land into two or more parcels
3. The combination of any two or more lots, tracts, or parcels of property for any purpose
4. The preparation of land for any of the above purposes

Nontidal Wetlands
Those areas not influenced by tidal fluctuations that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Nonpoint Source Pollution
Pollution that is generated by various land use activities rather than from an identifiable or discrete source and is conveyed to waterways through natural processes, such as rainfall, stormwater runoff, or groundwater seepage rather than direct discharges.

Pollution
Any contamination or alteration of the physical, chemical, or biological properties of any waters that will render the waters harmful or detrimental to
1. Public health, safety, or welfare
2. Domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses
3. Livestock, wild animals, or birds
4. Fish or other aquatic life

Stream Channel
Part of a watercourse either naturally or artificially created that contains an intermittent or perennial base flow of groundwater origin. Base flows of groundwater origin can be distinguished by any of the following physical indicators:
1. Hydrophytic vegetation, hydric soil, or other hydrologic indicators in the area(s) where groundwater enters the stream channel in the vicinity of the stream headwaters, channel bed, or channel banks
2. Flowing water not directly related to a storm event
3. Historical records of a local high groundwater table, such as well and stream gauge records.

Stream System
A stream channel together with one or both of the following:
1. 100-year floodplain
2. Hydrologically related nontidal wetland

Streams
Perennial and intermittent watercourses identified through site inspection and US Geological Survey (USGS) maps. Perennial streams are those which are depicted on a USGS map with a solid blue line. Intermittent streams are those which are depicted on a USGS map with a dotted blue line.

Water Pollution Hazard
A land use or activity that causes a relatively high risk of potential water pollution.

Section IV. Design Standards for Riparian Buffers

A. A riparian buffer for a stream system shall consist of a forested strip of land extending along both sides of a stream and its adjacent wetlands or steep slopes. The riparian buffer width shall be adjusted to include contiguous sensitive areas, such as steep slopes and wetlands, where development or disturbance may adversely affect water quality, streams, wetlands, or other waterbodies.

B. The riparian buffer shall begin at the edge of the stream bank of the active channel.

C. The riparian buffer shall be composed of two distinct zones, with each zone having its own set of permitted and restricted uses (See Figure 1).

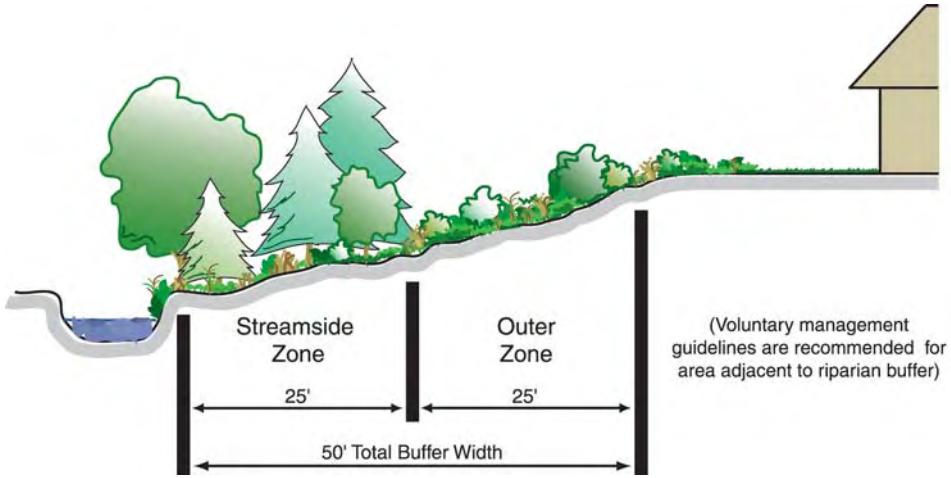

Figure 1: Two-zone Riparian Buffer

1. *Zone 1 - Streamside Zone*
    1. Protects the physical and ecological integrity of the stream ecosystem.
    2. Begins at the edge of the stream bank of the active channel and extends 25 feet from the top of the bank plus any additional buffer width as specified in this section.
    3. Allowable uses within this zone are highly restricted to:
        1. Flood control structures
        2. Utility right of ways
        3. Footpaths
        4. Road crossings, where permitted.
    4. Streamside Zone contains undisturbed natural vegetation.

2. *Zone 2 - Outer Zone*
    1. Protects key components of the stream and provides distance between upland development and the Streamside Zone.
    2. Begins at the outer edge of the Streamside Zone and extends 25 feet.
    3. Allowable uses within the Outer Zone are restricted to
        1. Biking or hiking paths
        2. Stormwater management facilities, with the approval of _____ *[jurisdiction]*.
        3. Recreational uses as approved by _____ *[jurisdiction]*.
        4. Removal of mature tree cover
    4. Middle Zone requires the retention of the shrub layer and herbaceous ground cover to allow infiltration of runoff.

Extensions to Minimum Buffer Width

A. The required width for the Riparian Buffer totals 50 feet (Zone 1 = 25', Zone 2 = 25'). This buffer shall be extended if wetlands or steep slopes are present.

1. Wetlands: When wetlands are present, the width of the Streamside Zone shall be adjusted so that the Zone 1 buffer will consist of the extent of the wetland plus 20-feet beyond the wetland edge.

2. Percent Slope: The riparian buffer width shall be modified if steep slopes are within close proximity to the stream and drain into the stream system. The following extensions will be added to the standard 50' Riparian Buffer in relation to the slope of the stream bank. The extensions are calculated as follows:

Percent Slope	**Buffer Extension**	**Total Width of Riparian Buffer**
15%-17%	add 10 feet	60 feet
18%-20%	add 30 feet	80 feet
21%-23%	add 50 feet	100 feet
24%-25%	add 60 feet	110 feet
> 25%	add 70 feet	120 feet

B. Water Pollution Hazards: The following land uses and/or activities are designated as potential water pollution hazards, and must be set back from any stream or waterbody by the distance indicated below:
    1. Storage of hazardous substances - (150 feet)
    2. Above ground or underground petroleum storage facilities - (150 feet)
    3. Drainfields from onsite sewage disposal and treatment systems (i.e., septic systems) - (100 feet)
    4. Raised septic systems - (250 feet)
    5. Solid waste landfills or junkyards - (300 feet)
    6. Confined animal feedlot operations - (250 feet)
    7. Subsurface discharges from a wastewater treatment plant - (100 feet)
    8. Land application of biosolids - (100 feet)

Section V. Buffer Management and Maintenance

A. The riparian buffer, including wetlands shall be managed to enhance and maximize the unique value of these resources. Management includes specific limitations on alteration of the natural conditions of these resources. The following practices and activities are restricted within both zones of the riparian buffer, except with approval by _____ *[jurisdiction]:*

1. Clearing of existing vegetation (except as noted previously)
2. Soil disturbance by grading, stripping, or other practices
3. Filling or dumping
4. Drainage by ditching, underdrains, or other systems
5. Use, storage, or application of pesticides, except for spot spraying of noxious weeds or non-native species consistent with recommendations of _____ *[jurisdiction]*
6. Housing, grazing, or other maintenance of livestock
7. Storage or operation of motorized vehicles within Zone 1, except for maintenance or emergency use.

B. The following structures, practices, and activities are permitted in the riparian buffer, with specific design or maintenance features, subject to the review of _____ *[jurisdiction]*:

1. Roads, bridges, paths, and utilities:
    1. An analysis needs to be conducted to ensure that no economically feasible alternative is available.
    2. The right-of-way should be the minimum width needed to allow for maintenance access and installation.
    3. The angle of the crossing shall be perpendicular to the stream or buffer in order to minimize clearing requirements.
    4. The minimum number of road crossings should be used within each subdivision, and no more than one fairway crossing is allowed for every 1,000 feet of buffer.

2. Stormwater management:
    1. An analysis needs to be conducted to ensure that no economically feasible alternative is available and that the project is either necessary for flood control, or significantly improves the water quality or habitat in the stream.
    2. In new developments, onsite and nonstructural alternatives will be preferred over larger facilities within the stream buffer.
    3. When constructing stormwater management facilities (i.e., BMPs), the area cleared will be limited to the area required for construction and adequate maintenance access, as outlined in the most recent edition of _____ *[refer to local jurisdiction's stormwater requirements]*.
    4. Material dredged or otherwise removed shall be stored outside the buffer.

3. Stream restoration projects, facilities and activities approved by _____ *[jurisdiction]* are permitted within the riparian buffer.

4. Water quality monitoring and stream gauging are permitted within the riparian buffer, as approved by _____ *[jurisdiction]*.

5. Individual trees within the riparian buffer that are in danger of falling, causing damage to dwellings or other structures, or causing blockage of the stream may be removed.

6. Other timber cutting techniques approved by the agency may be undertaken within the riparian buffer under the advice and guidance of _____ *[jurisdiction]* if necessary to preserve the forest from extensive pest infestation, disease infestation, or threat from fire.

C. All plans prepared for recording and all right-of-way plans shall clearly:
   1. Show the extent of any riparian buffer on the subject property
   2. Label the riparian buffer
   3. Provide a note to reference each zone of the riparian buffer stating: "There shall be no clearing, grading, construction or disturbance of vegetation except as permitted by the agency".
   4. Provide a note to reference any protective covenants governing all riparian buffers areas stating: "Any riparian buffer shown hereon is subject to protective covenants that may be found in the land records and that restrict disturbance and use of these areas."

D. All riparian buffer areas shall be maintained through a declaration of protective covenant, which is required to be submitted for approval by _____ *[jurisdiction]*. The covenant shall be recorded in the land records and shall run with the land and continue in perpetuity.

E. All lease agreements must contain a notation regarding the presence and location of protective covenants for riparian buffer areas and shall contain information on the management and maintenance requirements for the forest buffer for the new property owner.

F An offer of dedication of a riparian buffer area to the agency shall not be interpreted to mean that this automatically conveys to the general public the right of access to this area.

G. _____ *[jurisdiction]* shall inspect the buffer annually and immediately following severe storms for evidence of sediment, deposition, erosion, or concentrated flow channels and corrective actions taken to ensure the integrity and functions of the riparian buffer.

H. Riparian buffer areas may be allowed to grow into their vegetative target state naturally, but methods to enhance the successional process such as active reforestation may be used when deemed necessary by _____ *[jurisdiction]* to ensure the preservation and propagation of the buffer area. Riparian buffer areas may also be enhanced through reforestation or other growth techniques as a form of mitigation for achieving buffer preservation requirements.

Section VI. Enforcement Procedures

A. _____ *[jurisdiction]* is authorized and empowered to enforce the requirements of this ordinance in accordance with the procedures of this section.

B. If, upon inspection or investigation, the _____ *[jurisdiction]* is of the opinion that any person has violated any provision of this ordinance, he/she shall with reasonable promptness issue a correction notice to the person. Each such notice shall be in writing and shall describe the nature of the violation, including a reference to the provision within this ordinance that has been violated. In addition, the notice shall set a reasonable time for the abatement and correction of the violation.

C. Violations of these provisions are subject to the enforcement provisions of _____ *[jurisdiction's]* zoning ordinance.

Section VII. Waivers/Variances

A. This ordinance shall apply to all proposed development except for activities that were completed prior to the effective date of this ordinance and had received the following:
   1. A valid, unexpired permit in accordance with development regulations
   2. A current, executed public works agreement
   3. A valid, unexpired building permit
   4. A waiver in accordance with current development regulations.

B. The _____ *[jurisdiction's]* Zoning Board of Appeals may grant a variance for the following:
   1. Those projects or activities for which it can be demonstrated that strict compliance with the ordinance would result in a practical difficulty.
   2. Those projects or activities serving a public need where no feasible alternative is available.
   3. The repair and maintenance of public improvements where avoidance and minimization of adverse impacts to nontidal wetlands and associated aquatic ecosystems have been addressed.
   4. Those developments which have had buffers applied in conformance with previously issued requirements.

C. Waivers for development may also be granted in two additional forms, if deemed appropriate by the Zoning Board of Appeals:
   1. The buffer width made be reduced at some points as long as the average width of the buffer meets the minimum requirement. This averaging of the buffer may be used to allow for the presence of an existing structure or to recover a lost lot, as long as the Streamside Zone (Zone I) is not disturbed by the reduction and no new structures are built within the 100-year floodplain.
   2. _____ *[jurisdiction]* may offer credit for additional density elsewhere on the site in compensation for the loss of developable land due to the requirements of this ordinance. This compensation may increase the total number of dwelling units on the site up to the amount permitted under the base zoning.

D. The applicant shall submit a written request for a variance to the _____ *[jurisdiction]* . The application shall include specific reasons justifying the variance and any other information necessary to evaluate the proposed variance request. The agency may require an alternative analysis that clearly demonstrates that no other feasible alternatives exist and that minimal impact will occur as a result of the project or development.

E. In granting a request for a variance, the _____ *[jurisdiction]* may require site design, landscape planting, fencing, signs, and water quality best management practices to reduce adverse impacts on water quality, streams, wetlands, and floodplains.

Section VIII. Conflict With Other Regulations

Where the standards and management requirements of this ordinance are in conflict with other laws, regulations, and policies regarding streams, steep slopes, erodible soils, wetlands, floodplains, timber harvesting, land disturbance activities, or other environmental protective measures, the more restrictive shall apply.

Follow-up Information

Additional information on the creation and establishment of riparian corridors can be found at the EPA or the Michigan DEQ websites. Examples such as model ordinances or best management practices for the implementation of riparian buffers are provided.
Visit:
<http://www.epa.gov/owow>
<http://www.michigan.gov/deq>

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