Plaster Creek
Watershed Management Plan

October 2008
Project No. G02408EC

Fishbeck, Thompson, Carr & Huber
engineers • scientists • architects • constructors

PLASTER CREEK

WATERSHED MANAGEMENT PLAN

PREPARED FOR:

GRAND VALLEY METROPOLITAN COUNCIL

OCTOBER 2008
PROJECT NO. G02408EC

Fishbeck, Thompson, Carr & Huber, Inc. Engineers • Scientists • Architects • Constructors
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LIST OF ABBREVIATIONS/ACRONYMS

319 Clean Water Act, Section 319 Funding
BMP Best Management Practice
CEAP Calvin Environmental Assessment Program

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CEE	Channel Erosion Equation
CMI	Clean Michigan Initiative
CPA	Conservation Priority Areas
CRP	Conservation Reserve Program
DO	Dissolved Oxygen
DPW	Department of Public Works
EBI	Environmental Benefits Index
E. coli	*Escherichia Coli (E. coli)*
EPA	U.S. Environmental Protection Agency
FSA	USDA Farm Service Agency
FTC&H	Fishbeck, Thompson, Carr & Huber, Inc.
GEE	Gully Erosion Equation
GVMC	Grand Valley Metropolitan Council
I&E	Information and Education
IDEP	Illicit Discharge Elimination Plan
(k)	known
KCD	Kent Conservation District
KCDC	Kent County Drain Commission
KCRC	Kent County Road Commission
LA	Load Allocations
LGROW	Lower Grand River Organizations of Watersheds
LGRW	Lower Grand River Watershed
LID	Low Impact Development
MDB	Metropolitan Development Blueprint
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/l	milligrams per liter
ml	milliliter
MRI	Michigan Rivers Inventory
MS4	Municipal Separate Storm Sewer System
NAWCA	North America Wetlands Conservation Act
NFI	Natural Features Inventory
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	USDA Natural Resources Conservation Service
NSF	National Science Foundation
ORV	Off Road Vehicle
PRC	Polymerace Chain Reaction
RC&D	Resource Conservation and Development
(s)	suspected
State	State of Michigan
SWPPI	Storm Water Pollution Preventative Initiative
TESC	Threatened, Endangered, or Special Concern
TMDL	Total Maximum Daily Load
TRIAGE	Team Researchers in a GLOBE-al Environment
TSS	Total Suspended Solids
USDA	U.S. Department of Agriculture
VSEC	Valley Segment Ecological Classification
Watershed	Plaster Creek Watershed
WLA	Waste Load Allocations
WMP	Watershed Management Plan
WQI	Water Quality Index
WQS	Water Quality Standard
WRP	Wetland Reserve Program

ACKNOWLEDGEMENT

The Lower Grand River Watershed Implementation Project was initiated and completed through the work of many individuals who participated in the Plaster Creek Steering Committee and the Information and Education Committee. Their contributions to this effort resulted in a realistic document for present and future watershed stakeholders to use in managing their valuable resources.

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EXECUTIVE SUMMARY

Watershed Description

The Plaster Creek Watershed (Watershed) has a drainage area of 58 square miles and is located entirely in Kent County on the south and east sides of the Grand Rapids Metropolitan Area. Plaster Creek's headwaters begin in Gaines Township and flow north and then west to its confluence with the Grand River. A major tributary, Little Plaster Creek, flows from the north, joining Plaster Creek in the City of Kentwood. The Watershed occupies portions of the cities of East Grand Rapids, Grand Rapids, Kentwood, and Wyoming, and Gaines Charter Township, Cascade Township, Grand Rapids Charter Township, Caledonia Township, and Ada Township.

Water Quality Concerns

Previous hydrologic models conducted on Plaster Creek indicated that the watershed's hydrology changed drastically when it transitioned from a natural condition to an active agricultural area in the early 1900s. The watershed is transitioning again to a highly urbanized watershed, spurred recently by the addition of a freeway across the watershed's headwater tributaries. Increased urbanization has continued to increase storm water runoff volumes and peak flows, further challenging the drainage system and increasing channel erosion and flooding.

The Michigan Department of Environmental Quality (MDEQ) conducted a biological assessment of a 12-mile reach of Plaster Creek in 2001. This assessment rated the macroinvertebrate community as minimally acceptable to poor at the four survey stations, while physical habitat conditions were rated as good to fair (moderately impaired). In 2002, the MDEQ included a portion of Plaster Creek, a 12-mile stretch from the Grand River confluence upstream to Dutton Park, on the Section 303(d) non-attainment list due to elevated levels of *Escherichia Coli* (*E. coli)* and poor fish and macroinvertebrate communities (due to excessive sediment loading).

A stream inventory was conducted in 3 subwatersheds of Plaster Creek in 2007 as part of the Lower Grand River Watershed (LGRW) Implementation Project to investigate sites of nonpoint source (NPS) pollution. Sites with observable NPS pollution were classified according to eleven categories: debris/trash/obstructions, stream crossing, gully erosion, livestock access, non-point agricultural source, tile outlet, streambank erosion, construction, urban/residential, rill erosion, and other. There were 84 sites observed to be contributing NPS pollution to surface water. Based on the inventory information, it is estimated that Watershed carries a sediment load of 180.28 tons/year, a phosphorous load of 153.23 lbs/year, and the nitrogen load of 306.47 lbs/year. In addition, a monitoring program was conducted from September 2005 to October 2006 to sample *E. coli* at 13 sites in the Watershed as part of this project. Approximately 80% of the sampling sites sampled during dry weather did not meet the water

quality standard (WQS) for total body contact recreation (300 *E. coli* per 100 milliliter [ml]). None of the sites sampled during wet weather events met the WQS for total body contact recreation or partial body contact recreation (1,000 *E. coli* per 100 ml as a 30-day geometric mean).

Impaired and Threatened Designated Uses

Water quality impairs and threatens several designated uses of the Watershed due to NPS pollution. Three designated uses are impaired, the warm water fishery, indigenous aquatic life and other wildlife, and total body contact recreation (e.g. swimming), while partial body contact recreation (e.g. wading) is threatened.

Warmwater Fishery

Plaster Creek's warm water fishery is impaired by sediment along a 12-mile stretch from the Grand River confluence upstream to Dutton Park. The aquatic life use for Plaster Creek will be considered met when the macroinvertebrate community achieves an acceptable score (i.e. supports designated uses) and the habitat quality score indicates fair conditions, at a minimum. A secondary target is to attain a mean annual Total Suspended Solids (TSS) concentration of 30 milligrams per liter (mg/L). In addition to sediment loading, this use is also impaired by nutrients, while thermal pollution and toxic substances are suspected impairments.

Other Indigenous Aquatic Life and Wildlife

Plaster Creek's indigenous aquatic life and other wildlife are impaired by sediment for the 12-mile stretch mentioned above. By meeting the established TSS macroinvertebrate community and habitat quality targets, this use will be considered met. In addition to sediment loading, this use is also impaired by nutrients, while thermal pollution and toxic substances are suspected impairments.

Total Body Contact Recreation

Total body contact recreation in Plaster Creek is impaired due to *E. coli* levels that exceed water quality standards. According to the MDEQ, all waters of the state protected for total body contact recreation shall not contain more than 130 *E. coli* per 100 milliliters [ml] as a 30-day geometric mean, or more than a maximum of 300 *E. coli* per 100 ml. The degraded portion of Plaster Creek, a 12-mile stretch from the Grand River confluence upstream to Dutton Park, exceeds these water quality standards for *E. coli*.

Partial Body Contact Recreation

Partial body contact recreation, such as fishing, is threatened by *E. coli* contamination in the Plaster Creek Watershed. Currently, *E. coli* levels meet WQS for partial body contact recreation, 1,000 count per

100 ml, as a 30-day geometric mean, but not standards for total body contact recreation, as mentioned above. Therefore, this use is considered threatened due to the potential for future impairment which could elevate *E. coli* counts to levels that exceed the WQS for this use.

Goals and Objectives

To improve and protect the impaired and threatened designated uses of the Watershed, two watershed goals were established. The first goal is to improve and protect habitats for fish and other indigenous aquatic life and wildlife. The second goal is to improve and protect the safety and enjoyment of fishing, public access, and wading. By reducing sediment loading and *E. coli* concentrations to meet WQS in accordance with these goals, the sediment (biota) and *E. coli* Total Maximum Daily Loads (TMDLs) will be met. The short-term objectives to reduce the known (k) and suspected (s) pollutants in the Watershed are listed below.

Prioritized Pollutants	Objectives
1. Sediment (k)	Stabilize stream flows to moderate hydrology and increase base flow
	Minimize impact of drainage systems on streambanks
	Install livestock exclusion fencing
	Reduce sediment input from road/stream crossings
	Implement woody debris management strategies and remove obstructions
	Encourage proper use of off-road vehicles near streambanks
	Treat and manage urban runoff
	Promote conservation tillage practices and cover crops
	Encourage use of erosion and sediment control measures
2. E. coli (k)	Restrict livestock access to waterways
	Encourage proper manure spreading practices
	Encourage feedlot runoff management practices
	Control geese and raccoon populations
	Reduce amount of pet waste entering waterways
	Encourage proper septic system maintenance
	Correct faulty sanitary sewer connections
3. Nutrients (k)	Encourage proper fertilizer management and yard waste disposal
	Restrict livestock access to waterways
	Encourage proper manure spreading practices
	Encourage feedlot runoff management practices
	Control geese and raccoon populations
	Reduce amount of pet waste entering waterways
	Encourage proper septic system maintenance
	Correct faulty sanitary sewer connections
4. Thermal pollution (s)	Reduce imperviousness

Prioritized Pollutants	Objectives
	Plant and protect riparian vegetation
5. Toxic substances (s)	Treat and manage urban runoff
	Encourage proper application of road salt
	Encourage proper application of pesticide
	Reduce illicit dumping

Recommendations

The Best Management Practices (BMPs) selected for the LGRW were reviewed in order to select appropriate BMPs for the Watershed. During the selection process, the impairments and threats to the designated uses, the goals and objectives developed for the Watershed, and the established TMDLs were considered. The recommendations chosen for the Watershed include structural and vegetative BMPs, as well as management and policy BMPs; they are listed below.

BMP Recommendations
Adoption of storm water ordinance
Adoption of wetland and green space protection ordinances
Animal control practices
Annual road/stream crossing inventory
Catch basin cleaning
Corrections to faulty sanitary sewer connections
Fencing
Installation of hydrodynamic separator units
Low impact development applications
Management of woody debris and other obstructions
Pet waste stations
Repair/replace old culverts
Septic system ordinance
Silt fence installation
Soil erosion and sedimentation control practices
Streambank stabilization
Vegetated filter strips
Wetland restoration

As part of any watershed planning project, an Information and Education (I&E) Strategy is developed to create a framework for motivating watershed stakeholders, residents, and other decision makers to take the actions necessary to protect and improve water quality and environmental conditions. The Plaster Creek I&E Strategy will serve as a working document that outlines the major steps and actions needed to successfully improve and maintain water quality and environmental conditions in the Watershed. This I&E

Strategy is based on the larger LGRW I&E Strategy, developed during the LGRW Planning Project, and outlines a similar approach for raising awareness, educating stakeholders, and inspiring action. I&E activities outlined in the strategy are listed in the table below.

Information and Education Activities
Distribute *A Homeowner's Guide to Septic Systems;* Distribute media releases
Distribute fact sheets on Off Road Vehicle use with web link for more information
Distribute fact sheets on pet waste disposal with web link for more information; Distribute media releases
Distribute fact sheets on proper woody debris and obstruction removal practices with web link for more information
Hold field demonstrations on planting buffer strips and rain gardens
Hold field demonstrations on proper feedlot runoff practices
Hold field demonstrations on proper lawn care practices; Distribute media releases
Hold field demonstrations on proper manure spreading practices
Hold field demonstrations on proper pesticide application
Hold storm drain marking or stenciling events; Distribute media releases
Hold targeted training workshop on locating and correcting faulty connections
Hold targeted training workshops on agricultural practices and cost-share opportunities
Hold targeted training workshops on model storm water ordinances and available stream stabilization practices
Hold targeted training workshops on drainage control practices
Hold targeted training workshops on erosion and sediment control practices
Hold targeted training workshops on livestock exclusion and cost-share opportunities
Hold targeted training workshops on locating and correcting faulty connections
Hold targeted training workshops on proper salt application procedures
Hold tours of porous pavement applications and other infiltration practices
Hold tours of road/stream crossings which successfully control erosion and runoff
Hold tours of successful animal control practices
Hold tours of successful urban runoff practices

Evaluation

Measures of success are essential to any project to evaluate and assess the achievements of the project and determine the benefits to water quality and the quality of life that resulted from the implementation of BMPs. The success of the project toward meeting its goals of improving water quality and restoring the designated uses of the Watershed depends on many factors, all of which need to be continuously evaluated. Establishing monitoring targets, against which observed measurements are compared, help determine whether progress is being made toward targets and ultimately the watershed goals. This management plan describes evaluation measures to evaluate implementation of specific BMPs and outlines a water quality monitoring program to evaluate overall changes in watershed conditions.

Sustainability

The LGRW Management Plan is a broad, reference-oriented document that takes a holistic, ecosystem approach to watershed management. This plan recommends structural and vegetative, managerial, and policy BMPs, as well as information and education activities, to address activities that contribute to elevated sediment, nutrient, and pathogen levels. The plan also provides a long range vision for the LGRW, with guidelines and recommendations to achieve that vision. The vision, mission statement, and core values for the LGRW place the LGRW Management Plan initiative in a much larger context for long-term success.

The Plaster Creek Watershed Management Plan (WMP) was developed to assist watershed stakeholders in addressing the sediment, pathogen, and nutrient concerns facing Plaster Creek and its tributaries. The plan provides an implementation strategy designed to meet the Watershed's goals and objectives within the context of the longer range vision of the LGRW Management Plan. Recommendations for the impaired urban areas of the Plaster Creek Watershed can be extrapolated for use and adoption in other urban areas of the LGRW experiencing similar problems. Urban communities in the LGRW can also evaluate the success of the management measures implemented in the Watershed to determine which measures would be best for their particular subwatershed. Coordination between the two WMPs better ensures long term success at meeting the goals and objectives established for both watersheds.

The Lower Grand River Organizations of Watersheds (LGROW) was established in 2007 to provide basin-wide oversight, implement regional or watershed-wide initiatives, and prioritize water quality concerns. The LGROW operates under, and serves as custodian for, the vision, mission, and the strategic direction developed for the LGRW. The current board includes 13 members representing local units of government, existing watershed organizations, environmental organizations, and foundations.

This WMP recommends the formation of a Plaster Creek Steering Committee to implement the recommendations outlined in this plan. The LGROW is available to facilitate the formation of such subwatershed groups. While the LGROW will identify priorities within the Grand River Watershed and facilitate watershed-wide projects that address high priority concerns, subwatershed organizations would manage operations within the subwatersheds, implement subwatershed management plans, and serve as a liaison between local stakeholders and the LGROW.

CHAPTER 1 - INTRODUCTION

1.1 WATERSHED MANAGEMENT PLAN PURPOSE

The quality of Plaster Creek is influenced by many factors, such as human activities within the Plaster Creek Watershed (Watershed), physical and biological characteristics of the natural resources, and the management of those resources. This document provides an overview of these diverse aspects of the Watershed, including detailed information about the sources and causes of watershed pollution, recommendations needed to address impairments, and steps to implement the recommendations.

1.2 PUBLIC PARTICIPATION PROCESS

1.2.1 Steering Committee

A Steering Committee was formed to involve watershed stakeholders in the Lower Grand River Watershed (LGRW) Implementation Project and the development of the Plaster Creek Watershed Management Plan (WMP). Steering Committee members (Table 1.1) were asked to serve on the committee because of their knowledge or interest in the management of the Watershed's natural resources. Members who made specific commitments to the project met at a project kick-off meeting held on May 20, 2005. This meeting was held to review the work plan and timetable in order to begin defining partner roles and assigning tasks required to complete the project.

Steering Committee members participated in meetings and presentations pertinent to the management of the Watershed throughout the project. Steering Committee members attended a stakeholder meeting on May 2, 2006, regarding the Grand River's Total Maximum Daily Load (TMDL) for *Escherichia Coli (E. coli)*. The Michigan Department of Environmental Quality (MDEQ) presented the TMDL report, developed for a one mile stretch of the Grand River, near Johnson Park in the vicinity of Walker. Steering Committee members provided input on MDEQ's report and steps to achieve the TMDL. In addition, Steering Committee members attended a presentation held on April 19, 2007, regarding *E. coli* sampling conducted in the Buck Creek, Coldwater River, and Plaster Creek Watersheds, as part of the LGRW Implementation Project. At this meeting, Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) reported on *E. coli* sampling results, sources contributing to elevated *E. coli* levels, and the best management practices (BMPs) needed to address priority areas. Recommendations for additional sampling efforts were also discussed. Members also participated in a press conference held on July 17, 2007, to promote regular septic system inspections in Kent County.

During the preparation of the Plaster Creek WMP, Steering Committee members were asked to participate in its development and review. Members reviewed and prioritized pollutants and their sources,

ranked impaired and threatened designated uses, and selected desired uses for the watershed during a meeting held on October 30, 2007. Coordination of this project with the future initiatives of the Lower Grand River Organization of Watersheds was also discussed. In December 2007, the Steering Committee reviewed the Plaster Creek WMP draft as whole, paying special attention to the implementation strategy.

1.2.2 Information and Education Committee

The Information and Education (I&E) Committee held 6 meetings between August 2006 and April 2007 to implement an outreach campaign to address *E. coli* contamination in the Buck Creek, Coldwater River, and Plaster Creek Watersheds. Members developed and implemented a number of activities, including classroom presentations, agricultural workshops, distribution of educational material, and a water festival booth, as listed in Table 1.2. The I&E Committee also provided comments on the implementation of BMPs during the project period. Several committee members were directly involved in the installation of 23 pet waste stations within these watersheds.

Table 1.1 - Steering Committee Members

Name	Affiliation	Address
Mr. Kurt Anderson	City of Grand Rapids	1300 Market Avenue, SW, Grand Rapids, MI 49503
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Ms. Janice Tompkins	Michigan Department of Environmental Quality	350 Ottawa Avenue NW, Unit 10, Grand Rapids, MI 49503
Ms. Kim Walton	Barry Conservation District	1611 South Hanover, Suite 105, Hastings, MI 49058
Mr. Shawn Wessell	West Michigan Environmental Action Council	1007 Lake Drive, SE, Grand Rapids MI 49506
Ms. Regina Young	Barry-Eaton District Health Department	330 West Woodlawn, Hastings, MI 49058
Mr. Charlie Ziesemer	City of Kentwood	355 48th Street, SE, Kentwood, MI 49548-4407

1.3 COORDINATION WITH LOWER GRAND RIVER WMP

The Lower Grand River WMP was completed as part of the LGRW Planning Project, administered by the Grand Valley Metropolitan Council between 2002 and 2004. This WMP is a broad, reference-oriented document that builds upon and elevates existing planning efforts in the LGRW. According to residents, local officials, watershed coordinators, and other interested individuals, the greatest concerns in the LGRW are impacts from development, bacteria, storm water, sediment, hydrology, and destruction of wetlands. Goals and desired uses of the LGRW include recreational use, habitat, and educational opportunities. Smart growth techniques, enforcement of existing regulations, use of stream buffers zones, and public education activities were recommended to address existing water quality impairments. This plan takes a holistic, ecosystem approach and provides a vision for the entire LGRW under which to operate, with guidelines and recommendations to follow to achieve that vision.

The Plaster Creek WMP provides recommendations to reach the overall goals and objectives of the Lower Grand River WMP. These recommendations can be used in other urban areas of the LGRW experiencing similar problems. Specifically, recommended practices for impaired urban areas of the Watershed will provide an opportunity for other urban and urbanizing areas in the LGRW to evaluate the management measures used to determine which practices would be best for their subwatershed.

CHAPTER 2 - WATERSHED DESCRIPTION

2.1 GEOGRAPHIC SCOPE

The Plaster Creek Watershed (Watershed) has a drainage area of 58 square miles and is located entirely in Kent County on the south and east sides of the Grand Rapids Metropolitan Area (Figure 1). Plaster Creek's headwaters begin in Gaines Charter Township and flow north and then west to its confluence with the Grand River. A major tributary, Little Plaster Creek, flows from the north, joining Plaster Creek in the City of Kentwood. The Watershed occupies portions of the cities of East Grand Rapids, Grand Rapids, Kentwood, and Wyoming, and Gaines Charter Township, Cascade Charter Township, Grand Rapids Charter Township, Caledonia Township, and Ada Township.

2.2 CLIMATE

The Watershed enjoys a moderate continental climate and annually experiences 155 frost-free growing days, at a latitude approximately midway between the North Pole and the equator. Air masses originating from the Gulf of Mexico, northern Canada, and the north pacific influence day-to-day weather. The presence of Lake Michigan has a slight moderating effect on annual temperatures. The mean January temperature in the Watershed is approximately 22°F, while the mean July temperature is approximately 71°F. The average rainfall throughout the Watershed is approximately 36 inches (USDA SCS 1986). Average snowfall is approximately 78 inches (Michigan Department of Agriculture, Climatology Program 2007).

2.3 TOPOGRAPHY

The topography within the Watershed is influenced by glacial deposition of sediment and the effect of water deposition and drainage over time. Watershed topography is undulating and dissected by water courses with occasional small plains studded with bogs and small lakes. Topography within the Watershed varies. Plaster Creek flows through a steep, walled valley where it joins the entrenched valley of the Grand River.

2.4 GEOLOGY AND SOILS

The Watershed is located in the Regional Landscape Ecosystem Sub-subsection VI.4.1 Lansing. This ecosystem occurs on gently sloping ground moraine, broken by outwash channels and numerous end-moraine ridges. This broad till plain has rich, loamy soils that have been largely converted to agriculture (United States Geologic Service 1998).

The bedrock formations of the Watershed consist primarily of shale, sandstone, limestone, and gypsum (Michigan Department of Natural Resources [MDNR] 1968). These formations formed from sediments that were deposited from 345 to 370 million years ago in seas, which occupied a depression known as the Michigan basin.

The Pleistocene epoch began about one million years ago. Glaciers from Canada moved over the state, picking up fine soil, sand, gravel, and boulders and carrying them great distances before depositing them. At least four major glaciers advanced and retreated over Michigan during the Pleistocene epoch. The physiography of the Watershed owes its development to the last of these glaciers, the Wisconsin stage, which ended approximately 10,000 years ago. As the last glacier retreated, the load of earthen materials incorporated in the ice was deposited, forming several types of glacial features (till plains, end moraines, outwash, and alluvium). Figure 2 shows the surface geology within the Watershed.

The debris deposited by the glaciers forms the parent material for the soils throughout the Watershed. Figure 3 indicates that most soils in the Watershed have low infiltration. Urban soil dominates the western area of the Watershed. Urban soil has been impacted by development activities and no longer has many of the distinctive characteristics of native soils.

Soils in the Watershed primarily fall into the Alfisol soil order. Alfisols have a gray to brown surface horizon resulting from organic material deposited from deciduous trees. The underlying soil is leached and has a low pH. A layer of clay accumulation (i.e., a cambic horizon) is present below the leached horizon.

Histosols are found in poorly drained areas throughout the sub-basin. These soils are composed primarily of organic matter and are known as peat or muck. They are found in scattered areas in swamps, along streams, and in old lake beds that have filled with organic material. They are waterlogged under normal conditions (Bieneman 1999).

2.5 HYDROLOGY

Plaster Creek flows west to its confluence with the Grand River in the City of Grand Rapids. Its drainage area is 58 square miles. In the early 1800s, the predominantly forested watershed naturally absorbed, infiltrated, and evapo-transpirated most of the rainfall, resulting in numerous small wetlands (Figure 4). As the watershed transitioned to agriculture in the late 1800s and early 1900s, an extensive system of county drains was installed throughout the watershed, reducing storm water storage and increasing runoff. Agricultural drains hasten storm water from cultivated fields and other areas, reducing the frequency of flooding in these areas. However, rapidly flowing water is more likely to erode streambeds and carry sediment to the Grand River and its adjacent floodplain. Fields drained with tiles also create a hazard for surface water contamination from pesticides, fertilizer, and *Escherichia Coli* (*E. coli*). The watershed is now transitioning to a highly urban watershed, spurred recently by the addition of a freeway through the

upper portion of the watershed. Urbanization has continued to increase storm water runoff volumes and peak flows, further challenging the drainage system and increasing channel erosion and flooding.

Many previous studies have been conducted on the Plaster Creek Watershed. “Technical Memorandum Number 7 to the Kent County Storm Water Master Plans for Buck Creek and Plaster Creek, Silver Creek Drain Hydraulic Watershed Analysis” was completed by Camp, Dresser & McKee in March 1990. The Silver Creek Drain is an enclosed storm sewer located in the Plaster Creek Watershed. The results of the report indicated that portions of the Silver Creek Drain are undersized, storm water surcharges out of the ground at surface inlets, and surface flooding occurs, especially near Kalamazoo and Ramona, and between Madison and Division on Crofton Street. The computer modeling analysis determined that the Silver Creek Drain does not have sufficient capacity to convey flows greater than the 2-year event without some flooding under existing conditions. The study recommended the construction of approximately five aboveground detention basins at various sites along the drain to lower the peak flows generated in the Watershed, relieve the hydraulic stress, and help prevent future flooding.

“Technical Memorandum Number 10 to the Kent County Storm Water Master Plans for Buck Creek and Plaster Creek, Whiskey Creek Watershed Analysis” was completed by Camp, Dresser & McKee in August 1990. The Whiskey Creek Watershed is located in the Plaster Creek Watershed. A portion of Whiskey Creek is characterized by numerous ponds constructed during development of the area. Results of the study indicated that there is flooding problems within the Watershed during the 25-year and 100-year storm events, specifically high water levels greater than the design levels at the Whiskey Creek detention ponds, North Lake Eastbrook and the Burton Center Ponds, along with localized flooding in several areas directly west of the East Beltline and north of the Woodland Mall. The study recommended replacing a culvert between Lake Eastbrook and North Lake Eastbrook, the construction of two new detention ponds, and flood proofing various areas.

“The Storm Water Management Plan for Buck Creek and Plaster Creek Watersheds” was completed by Camp, Dresser & McKee in January 1991. A few key points of the study are as follows: the existing flooding problems reported along the main stem of the Plaster Creek do not impact a large number of properties; during a 25-year, 24-hour design storm, the majority of the currently identified flooding problems occur on tributaries or are due to undersized enclosed drains; modeling of the future built-out land use conditions, in a 25-year, 24-hour storm event, without the use of extensive storm water controls, results in significant flooding increases on the main stem (inundated area would increase by approximately 31% or 227 acres). Overall, the study indicated detention with a volume of 0.5 acre-feet/acre of developed impervious area and a uniform peak release rate to 0.14 cubic feet per second (cfs)/acres in a 25-year design storm for new developments within the Watershed would allow flood levels along the main stem of Plaster Creek to remain within the current Flood Insurance Study levels during a 100-year storm event. The study recommended using flood proofing or land acquisition to help control flooding on the main stem, not regional detention. Many storm water ordinances developed in

the Plaster Creek Community have incorporated the standards for detention volumes and peak release rates indicated in the plan, such as Cascade Township and the Kent County Drain Commissioner.

"Technical Memorandum Number 11 to the Kent County Storm Water Master Plans for Buck Creek and Plaster Creek, Burton-Breton Watershed Analysis" was completed by Camp, Dresser & McKee in April 1991. The results of the study indicated that flooding occurs at the Annchester crossing and at the Indian Trails Golf Course located just upstream of 28th Street during a 10-year storm event. During a 25-year event, the same areas flood as in the 10-year event, along with flooding at the crossing at Okemos. During the 100-year event, the flooding affects the same areas as indicated above, but a larger number of structures are affected, and both Okemos and Annchester are impassable. The study recommended installing larger culverts, sized to handle the 25-year storm event, at both Okemos and Annchester and to consider flood proofing measures at structures in the vicinity of the flooding which would occur during a 100-year storm event.

A study of the storm water quality in Plaster Creek was conducted by Grand Valley State University (GVSU), Water Resources Institute in October 1992. The purpose of the study was to quantify the impairment of Plaster Creek associated with NPS pollution of storm water runoff from the Watershed. Water quality data was collected at three key locations: Plaster Creek by 52nd Street, a rural part of the Watershed; Burton Street, an urban part of the Watershed; and at Market Avenue, the confluence of the Plaster Creek with the Grand River. The water collected was analyzed for pollutants which are potentially damaging to an aquatic environment and included pH, suspended sediment, total phosphorous, biological oxygen demand, chemical oxygen demand, total and dissolved lead, total and dissolved copper, total and dissolved cadmium, and total and dissolved chromium. A few key points were determined from the study: storm water quality differs substantially from dry weather flow water quality and differs according to the degree of urbanization of the Watershed - the more urbanized, the worse the water quality. Also, there was a rapid response to rainfall at Burton Street, which indicated the lack of storage in the lower part of the Watershed, where there was almost immediate runoff from the impervious areas into the creek. The results of the study showed a deterioration of water quality in Plaster Creek during periods of rain water and pollutant delivery, with the deterioration being more pronounced in parts of the Watershed where the highest percentages of impervious surfaces occur (GVSU, 1992). The information in this study could be used and built upon for future water quality studies in the Watershed.

The Little Plaster Creek WMP was completed by FTC&H in April 1995. Several key results or recommendations from the study are as follows. The use of onsite detention lowers the peak discharge rates in local storm water conveyance ways immediately downstream of the detention sites, but the cumulative effect of increased development, despite onsite detention, is an increase in peak storm water flows in Little Plaster Creek, which is due to an additive effect of an increase in storm water runoff volume released over an extended period of time. Several subdistrict areas contain significant wetlands and lakes, which serve as regional storm water retention areas and have a considerable effect on reducing

peak storm water flows reaching Little Plaster Creek from urban development. The preservation of wetlands and floodplains for storm water quantity control is very important. In general, the study concluded that the carrying capacity of the channel located in the upper half of the study area, located north of Patterson Avenue, is more than adequate; however, floodplain capacity is necessary for a large portion of the channel downstream during the 10-year, 24-hour rainfall event. Excavation of the Little Plaster Creek, between Patterson Avenue and approximately 7,000 feet downstream of 28th Street, was recommended to provide relief from back water and flooding problems.

The majority of the existing hydrology studies for the Watershed are over 10 years old and it is unknown if any of the recommendations from the previous studies have been constructed. It is recommended that new studies be undertaken to get a better handle on the current hydrologic condition of the Watershed.

2.6 NATURAL FEATURES INVENTORY

Ecologically, the Watershed is located at the northern edge of the Carolinian biotic province (also known as the oak-hickory formation). No remnants of virgin forest remain in the Watershed, except perhaps in a few swamps. Woodlands today are restricted to lands that are difficult to till, such as along watercourses, hilly land, and second-growth stands maintained between fields as a windbreak (Grand River Basin Coordinating Committee 1972). Plaster Creek is not designated as a natural river by Michigan's Natural Rivers Program. The MDNR has not designated Plaster Creek or its tributaries as trout streams. Michigan Department of Environmental Quality has designated Plaster Creek as a warm water fishery.

Michigan State University's Natural Features Inventory (NFI) maintains a database of known occurrences of endangered, threatened, and special concern plant and animal species throughout the State of Michigan. An endangered species is any species that is in danger of extinction throughout all or a significant part of its range. A threatened species is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected under Michigan's Endangered Species Act (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act).

Special concern species are not protected under the Endangered Species Act. These species are of concern due to declining or relict populations in the state. If these species continue to decline, they would be recommended for threatened or endangered status. It is important to maintain self-sustaining populations of special concern species in order to prevent them from becoming endangered or threatened species in the future.

The NFI database was reviewed for the Watershed. Figure 5 notes the density of threatened, endangered, and special concern (TESC) species per quarter-quarter section within the Watershed. The highest density of these species has been observed within the Little Plaster Creek Subwatershed. In general, no occurrences of TESC species are noted in the primarily agricultural area present south of

52nd Street. Low densities of TESC species were identified throughout the urbanized central portion of the Watershed.

The NFI notes one endangered species within the Watershed: *Epioblasma triquetra* (the snuffbox mussel). The snuffbox mussel inhabits small and medium-sized rivers. Their preferred habitat usually has a sand, gravel, or cobble substrate with a swift current. Individuals are often found buried deep in the sediment. Eleven threatened and special concern species were identified in the Watershed. The threatened species and their habitat are listed below.

Table 2.1 - Threatened and Special Concern Species

Scientific Name	Common Name	Type	Habitat
Arabis perstellata sensu lato	Rock cress	Plant	Floodplain forest
Diarrhena americana	Beak grass	Plant	Floodplain forest
Draba reptans	Creeping Whitlow-grass	Plant	Oak savanna
Euphorbia commutata	Tinted spurge	Plant	Open, upland forest
Galearis spectabilis	Showy orchid	Plant	Rich, deciduous forest
Geum triflorum	Prairie-smoke	Plant	Dry sand prairie
Mertensia virginica	Virginia bluebells	Plant	Floodplain forest
Morus rubra	Red Mulberry	Plant	Floodplain forest
Panax quinquefolius	Ginseng	Plant	Rich, deciduous forest
Penstemon calycosus	Smooth beard tongue	Plant	Oak barrens or prairie
Valerianella chenopodiifolia	Goosefoot corn-salad	Plant	Floodplain forest

In addition to the NFI, local information has been collected on the biota of the watershed. Under the direction of Dr. Randy Van Dragt, 10 students from Calvin College conducted a vertebrate survey of Plaster Creek and the headwaters of Whiskey Creek, in the vicinity of the Calvin College Ecosystem Preserve. Between April 12, and May 7, 2007, a total of 8 amphibians, 6 reptiles, 53 birds, and 8 mammals were observed. A detailed list of the observed organisms can be found in Appendix 1.

2.7 LAND USE/COVER

The Watershed was almost entirely covered with hardwood forest prior to 1830 (Figure 6). Improved transportation led to a land boom in the 1830s, with the lumbering industry coming into prominence between 1840 and 1870. Deforested land was converted to farmland and farming became a predominant occupation around the turn of the 20th century.

The Grand River supported the development of the region by providing a means of conveying logs to sawmills located on the banks of the Grand River and powered by its flow. Steamboats ferried finished products between Grand Rapids and Grand Haven. Large-scale logging ceased in the 1920s, around the time of rapid industrialization in the City of Grand Rapids. Grand Rapids became a significant manufacturing center, discharging industrial and municipal wastes into the Grand River and, possibly, into the lower reaches of Plaster Creek. Environmental legislation, initiated in the late 1960s, provided the impetus for cleanup of the Grand River and its tributaries.

Currently, most of the land not covered by residences, urban centers, and forests is cultivated. However, urbanization is impacting agricultural land, resulting in significant yearly loss of farmland to residential and commercial development.

As with most aging urban areas, the population in the City of Grand Rapids is stagnant and the surrounding suburbs are growing very rapidly. The majority of the growth has been in agricultural areas. The result of this type of population growth has been an overall reduction in population density (Figure 7). As communities expand away from the urban centers, large lot residential areas, large shopping centers and new roads, parking lots, roof tops, and driveways are produced that increase the Watershed's imperviousness. A study by the Brookings Institute in 2001 found that the greater Grand Rapids area's land use changed 46% while the change in population was only 27%. This produced a change in density of 13% (Orfield 2002).

Figure 8 shows land use and land cover within the Watershed, based upon 1992 data. The total area and percentage of each land use is as follows: agricultural land (38%), developed (high and low density) (38%), forest (16%), open land (5%), water (1%), and wetlands (2%).

CHAPTER 3 - CONDITION OF PLASTER CREEK WATERSHED

This chapter provides an overview of the past and present studies that have evaluated water quality and natural resources of the Plaster Creek Watershed (Watershed). Pollutants have come from a variety of agricultural, industrial, private, and municipal activities, and include both point and nonpoint sources (NPS) of pollution. Point source pollution originates from an easily identifiable source, such as an outfall pipe from an industrial or municipal wastewater treatment plant. NPS pollution originates from indistinguishable sources, such as runoff from lawns, agricultural areas, construction sites, and impervious surfaces, or leaking septic tanks, and atmospheric deposition.

3.1 HISTORICAL CONDITIONS REPORTED IN PREVIOUS STUDIES

3.1.1 Michigan Department of Environmental Quality Biological Surveys

The Michigan Department of Environmental Quality (MDEQ) conducted a biological assessment of a 12-mile reach of Plaster Creek in 2001 (Appendix 2). This assessment rated the macroinvertebrate community as minimally acceptable to poor at the four survey stations, while physical habitat conditions were rated as good to fair (moderately impaired). The primary cause for the decline in habitat quality at the three moderately impaired stations was attributed to increased embeddedness and deposition on colonizable substrate (i.e. logs, gravel, and cobble). The report stated that storm water runoff from agricultural and residential land use in the upper third of the Watershed and impervious surfaces in the lower two-thirds were contributing substantially to an increase in flashy flow conditions. These conditions cause an increase in stream bank erosion, siltation, and sedimentation of desirable habitat and a decrease in water quality.

The MDEQ reported that cattle access contributed substantial loadings of solids to the Plaster Creek near the 68th Street survey location. Runoff from cropland dominated by heavy clay soils and lack of vegetative, buffer-riparian zones are other apparent sources and causes of elevated sedimentation in the upper reaches of the Watershed, all of which cause impairments to the physical habitat conditions. Illicit septic tank drainage to the Plaster Creek in the upper reaches of the Watershed was also evident during the survey which added to decreased water quality.

3.1.2 Total Maximum Daily Loads

Section 303(d) of the Federal Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and instream water quality conditions. TMDLs provide a basis for determining

the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The MDEQ has included most of Plaster Creek, a 12-mile stretch from the Grand River confluence upstream to Dutton Park (Hanna Lake Avenue and 76th Street), on the 2002 Section 303(d) non-attainment list due to elevated levels of *Escherichia Coli (E. coli)* and poor fish and macroinvertebrate communities (due to excessive sediment loading).

PATHOGENS (*E. COLI*)

According to the MDEQ, all waters of the state protected for total body contact recreation shall not contain more than 130 *E. coli* per 100 milliliters [ml] as a 30-day geometric mean, or more than a maximum of 300 *E. coli* per 100 ml as a single reading. Rule 100 of the Michigan WQS requires that water bodies be protected for total body contact recreation from May 1 to October 31. The WQS developed for partial body contact recreation is 1,000 *E. coli* per 100 ml as a 30-day geometric mean.

Because *E. coli* levels in Plaster Creek exceed WQS for total body contact recreation, the MDEQ developed a TMDL report for Plaster Creek in June 2002. The purpose of this TMDL is to identify the allowable levels of *E. coli* that will result in the attainment of the applicable WQS in Plaster Creek.

E. coli is used as an indicator of possible contamination from human sewage and animal waste. Animals (wildlife and domestic) are often a source of elevated *E. coli* levels. The possible pathogen sources for water bodies in the Watershed are typical of urban and agricultural land uses. Point source discharges, storm water discharges, agricultural inputs, and to a lesser degree, illicit discharges are all possible sources of *E. coli* in the Watershed.

The MDEQ found particularly high concentrations of *E. coli* in relation to precipitation events. According to the TMDL report, other possible sources of pathogens to Plaster Creek are agricultural practices, given that the headwaters of the Watershed are dominated by agricultural land use. Surface runoff and field tile drainage are another two possible mechanisms for delivering *E. coli* to water bodies.

The Kent County Health Department has also sampled surface waters in the Watershed for bacteriological quality in accordance with the Michigan Department of Natural Resources, Part 4 WQS, Rule 62.(1), (2), Act 245, P.A. 1929, as amended. Samples were tested to determine the presence of *E. coli*. The number and frequency of samples collected at each station was determined by its designation as "total body contact" (swimming) or "partial body contact" (fishing and canoeing) recreational area. Warning signs were posted on waters which were determined not safe for human contact as a result of the testing.

Data collected in 2001 by the MDEQ is included in Appendix 3 for the ten sampling stations in Plaster Creek. *E. coli* levels in all tests indicated consistent exceedances of WQS for total body contact recreation.

FISH AND MACROINVERTEBRATE COMMUNITIES (BIOTA)

The MDEQ developed a second TMDL report (Appendix 4) for the same 12 mile reach of Plaster Creek in July 2002. This report was written to address the poor state of the fish and macroinvertebrate community. The purpose of this TMDL is to identify an appropriate reduction in sediment loadings from existing sources in the Watershed that will result in WQS attainment.

According to the MDEQ, the fish and macroinvertebrate community in Plaster Creek is impacted through impaired habitat quality due to stream bank erosion, flashy flows, and elevated siltation and sedimentation. The current state of the biota of Plaster Creek indicates that its warm water fishery and indigenous aquatic life and other wildlife uses are impaired. Achievement of WQS is to be demonstrated via assessments of the integrity of the macroinvertebrate community and habitat quality.

The biota TMDL target is to achieve a macroinvertebrate community with an acceptable score (supports designated uses). The macroinvertebrate community scores will be evaluated based on a minimum of two biological assessments conducted in two consecutive years following the implementation of Best Management Practices to minimize sediment loadings to the subject TMDL reach.

A stream habitat quality assessment will also be used to measure WQS for aquatic life. A habitat quality score of fair has been established as the target for the habitat quality, and will be used to represent adequate control of anthropogenic sediment sources so as to improve habitat quality and the biological community.

A numeric target goal for total suspended solids (TSS) was also established to further assess improvements in Plaster Creek. Since the TMDL purpose is to restore the biological community to an acceptable condition and attain WQS, a value of 30 milligrams per liter (mg/l), as a mean annual TSS target, was chosen for Plaster Creek as a secondary target.

3.2 PRESENT CONDITIONS IN THE PLASTER CREEK WATERSHED

3.2.1 National Pollutant Discharge Elimination System Phase I and II Storm Water Regulations

Industrial and municipal point sources are generally well regulated and are no longer a large threat to Plaster Creek. Municipal storm water, however, remains a large pollutant source that has been unregulated in the past, but is currently the focus of new regulations mandated from the EPA. Programs are being implemented in municipalities to remedy municipal storm water pollution, but adequate funding will be critical to ensure consistent and effective long-term enforcement and implementation of these programs.

Portions of the cities of East Grand Rapids, Grand Rapids, Kentwood, and Wyoming, and Gaines Charter Township, Cascade Charter Township, Grand Rapids Charter Township, and Ada Township are included in the Watershed.

These communities have participated in the National Pollutant Discharge Elimination System (NPDES) Phase II program and recognize the importance of monitoring and reducing storm water runoff to the streams and drains in their communities. These communities have initiated an Illicit Discharge Elimination Plan through the Watershed-based Phase II permit. The initial IDEP was implemented in the summer of 2003, completing the investigation of storm water outfalls in Plaster Creek. About 1,100 storm water outfalls were located in the Watershed, 495 of those were identified in the City of Grand Rapids alone. If dry weather flow was present, water quality sampling with field kits was conducted to detect the presence of a pollutant. If intermittent dry-weather flow was suspected, the outfall was flagged for follow-up investigation. The program will continue for the duration of the NPDES Phase II permit, which includes enforcing an Illicit Discharge and Connection Ordinance to prevent future illicit discharges to Plaster Creek and its tributaries.

Under the NPDES Phase II program, only 16 outfalls were suspected of discharging pollutants and have been flagged for follow-up to find the source of the discharge and correct or eliminate the illicit connection. The small number of illicit discharges found in the Watershed is confirmation that Municipal Separate Storm Sewer Systems are not a significant contributor to the water quality problems in Plaster Creek. NPSs, the diffuse runoff from upland and impervious areas, continues to be the most significant contributor of pollution to the surface waters and must be addressed through the holistic watershed management planning effort that is able to identify NPS pollution.

3.2.2 Watershed Inventory

The inventory process, to identify NPS pollution in the Watershed, was developed through input and participation of the Steering Committee. Accurate assessment of the condition of the Watershed is best done by field observations. The watershed inventory consisted primarily of walking portions of Plaster Creek and its tributaries. Three of the most representative subwatersheds were inventoried, characterizing the rural, developing, and urban characteristics of the Watershed. Subwatershed 0 is located in the headwater region of the Watershed, Subwatershed 3 is located along a portion of the main branch within the City of Kentwood, and Subwatershed 11 is located along the main branch and tributaries near the mouth of Plaster Creek. Figures 9 through 11 illustrate the NPS sites and areas of water quality impairments in the Watershed.

The inventory was completed by staff from the Kent Conservation District, West Michigan Environmental Action Council, and Fishbeck, Thompson, Carr & Huber, Inc. in the summer of 2007. Data sheets were filled out at each site where NPS pollution was evident. An example data sheet is included in Appendix 5.

Sites with observable NPS pollution were classified according to 11 categories: debris/trash/obstructions, stream crossing, gully erosion, livestock access, non-point agricultural source, tile outlet, streambank erosion, construction, urban/residential, rill erosion, and other. The location of each NPS site was recorded geographically with a Global Positioning System unit. A photograph was also taken at each site to document the "before" condition.

The sites of NPS pollution identified in the Watershed during the inventory are summarized in Appendix 6. The most abundant sources of pollution or impairments to the Watershed were debris/trash/obstructions. The majority of the debris/trash/obstruction sites were log jams, which can alter stream hydrology and cause streambank erosion, as well as sedimentation problems. Urban/residential pollutant sources were the second most abundant and included locations of yard waste dumping. The runoff from residential lawns and the organic input of yard waste adds nutrients and other possible sources of contamination to the stream. The third most abundant source, streambank erosion source, was observed at many outfall pipe locations along Plaster Creek. This non-point source inventory did not include sites where streambank erosion was caused by natural hydrology. Several stream crossings also resulted in streambank erosion, but were listed as a separate source.

The construction sites noted during the inventory were due to the construction of a bike trail, which resulted in faulty silt fences located on the streambank. The silt fences have since been corrected and are no longer causing sedimentation to the creek. There were two sites identified as non-point agricultural pollutant sources. At these sites, livestock were located next to the stream without proper filter strips to reduce nutrients and pathogens. There were also two tile outlet sites identified that had caused significant erosion along the streambank. Gully erosion, which delivers sediment to the streams, was present at only one site. There were no livestock access or rill erosion sites identified during the inventory. The "other" category included sites where recreational activity had occurred on the streambank or across the river by off road vehicles. This activity degrades riparian and stream vegetation and habitat, as well as erodes streambanks, introducing more sediment into the system.

3.2.3 Pathogen Monitoring

Pathogens, specifically *E. coli* bacteria, have been measured at levels exceeding WQS in reaches of Plaster Creek. The WQS for the Plaster Creek Watershed is 130 *E. coli* per 100 ml as a 30-day geometric mean, and 300 *E. coli* per 100 ml as a daily geometric mean for total body contact recreation. In the document titled "*Total Maximum Daily Load for Escherichia Coli in Plaster Creek, Kent County*, *Michigan*" developed by MDEQ in June 2002, the data indicated that exceedances of the WQS were observed during both wet and dry weather events. Through the Lower Grand River Watershed (LGRW) Implementation Project additional sampling was conducted at 13 sites in the Watershed (Figure 12).The data generated from monthly dry weather sampling is presented in Table 3.1. These monthly samples ranged from 96 *E. coli* per 100 ml to >24,200 *E. coli* per 100 ml. Approximately 20% of the monthly sampling sites met the WQS for total body contact recreation (300 *E. coli* per 100 ml). Samples of *E. coli*

collected during wet weather events are presented in Table 3.2, and monthly samples ranged from 1,700 *E. coli* per 100 ml to 104,620 *E. coli* per 100 ml. There were no sites that met the WQS for total body contact recreation or partial body contact recreation (1,000 *E. coli* per 100 ml as a 30-day geometric mean) during wet weather sampling.

The wet weather sampling, or high flow stage sampling, resulted in a significant increase in stream *E. coli* concentrations, most probably due to surface runoff. During wet weather events, there was a rapid rise in stream elevation on Plaster Creek indicating that surface runoff is particularly a problem in the Watershed. The sites with higher *E. coli* concentrations during the wet weather sampling typically had higher concentrations during the monthly dry weather sampling as well. However, only 4 of the 13 sites were sampled during wet weather. According to Tables 3.1 and 3.2, it is evident that the results at individual sampling locations can vary greatly. Sites PC-09 and PC-10 had the highest average *E. coli* readings during the monthly dry weather sampling. According to Figure 12, these sites are located only about 1 mile apart and both sites are on the main branch of Plaster Creek. Potential pollutant sources include failing septic systems, high numbers of wildlife and waterfowl, and agricultural runoff and field tile drainage.

Additional work will be required to identify actual pollutant sources. Molecular markers can be used to help determine sources of fecal contamination. Certain strains of Bacteriodes and Enterococcus bacteria are found only in human sewage. Other strains of Bacteriodes are found in ruminants, such as cattle, but not in humans. Michigan State University has recently used the polymerase chain reaction method to detect DNA sequences from these strains of Bacteriodes and Enterococcus in other subwatersheds in the LGRW.

Table 3.1 - Dry Weather *E. coli* Analytical Results - Plaster Creek Watershed September 2005 to October 2006

Station ID	9/13/2005	10/17/2005	5/9/2006	6/13/2006	7/11/2006	8/8/2006	9/12/2006	10/10/2006	Site Average
PC01	281	124	172	687	365	345	1300	201	**434**
PC04	461	150	435	921	727	326	1733	411	**646**
PC05	1203	326	272	727	579	921	2420	687	**892**
PC06	345	111	192	1203	148	727	1733	1733	**774**
PC07	96	299	365	613	727	816	>2420	1120	**807**
PC09	488	435	2420	2420	1414	>2420	>2420	1203	**1653**
PC10	>2420	>2420	>2420	3650	>24200	>2420	19860	2420	**7476**
PC14	118	196	411	687	260	921	>2420	1414	**572**
PC15	1733	129	387	517	770	345	1733	488	**763**
PC16	980	276	326	770	921	687	2420	2420	**1100**
PC17	152	154	866	1120	127	517	1046	488	**559**
PC18	166	517	921	770	1046	>2420	2420	866	**1141**
PC19	816	225	365	579	980	291	345	1414	**627**

Table 3.2 - Wet Weather *E. coli* Analytical Results - Plaster Creek Watershed May 2006 to October 2006

Station ID	5/11/2006 PM	5/12/2006 AM	5/12/2006 PM	7/12/2006 AM	7/12/2006 PM	7/13/2006 AM	10/2/2006 PM	10/3/2006 AM	10/3/2006 PM	Site Average
PC01	60000	16500	19500	95500	22500	4400	7701	3873	41060	**30115**
PC04	22000	7500	14000	59000	12500	2900	15531	4352	27230	**18335**
PC06	35500	20000	16000	40500	5000	1700	9208	38730	51720	**24262**
PC09	34500	5500	12000	82000	29500	4900	51720	104620	14136	**37653**

CHAPTER 4 - DESIGNATED AND DESIRED USES

4.1 DESIGNATED USES OF WATER BODIES

The State of Michigan has developed water quality standards (WQS) under Part 4 of the Administrative Rules issued pursuant to Part 31 of the Natural Resources and Environmental Protection Act (1994 PA451, as amended). Rule 100 (R323.1100) of the WQS states that all surface waters of the Sate are designated for, and shall be protected for, eight uses (Table 4.1).

Table 4.1 - Designated Uses for Surfaces Waters in the State of Michigan

Designated Use	General Definition
Agriculture	Livestock watering, irrigation, and crop spraying
Navigation	Navigation of inland waters
Warmwater or coldwater fishery	Supports warm water or cold water species
Other Indigenous aquatic life and wildlife	Supports other indigenous animals, plants, and macroinvertebrates
Partial body contact recreation	Supports boating, wading, and fishing activities
Total body contact recreation	Supports swimming activities between May 1 to October 31
Public water supply	Surface waters meet human cancer and non-cancer values set for drinking water
Industrial water supply	Water utilized in industrial or commercial applications

4.2 DESIGNATED USES BEING MET, IMPAIRED, OR THREATENED

The status of a designated use in a watershed can be met, impaired, threatened, or under review/unknown. The use is unimpaired if the available physical and analytical data indicates that all applicable WQS are being consistently met. If the available physical and analytical data indicates that WQS are not being consistently met, then the designated use is considered to be impaired. A threatened status occurs when a watershed is currently unimpaired but could become impaired due to: 1) actual and/or projected land use changes and/or, 2) declining water quality trends, as shown by physical or analytical data. A use that is designated as under review or unknown means there is insufficient physical or analytical data available to determine a status for the use, and additional studies are necessary.

4.2.1 Warm Water Fishery

A warmwater fishery is generally considered to have summer temperatures between 60°F and 70°F and is capable of supporting warm water species, such as largemouth and smallmouth bass, on a year-round basis. Plaster Creek's warm water fishery is impaired by sediment along a 12-mile stretch from the Grand River confluence upstream to Dutton Park (MDEQ 2002b). The aquatic life use for Plaster Creek will be

considered met when the macroinvertebrate community achieves an acceptable score (i.e. supports designated uses) and the habitat quality score indicates fair conditions, at a minimum (MDEQ 2002b). A secondary target is to attain a mean annual Total Suspended Solids (TSS) concentration of 30 milligrams per liter (mg/l).

4.2.2 Other Indigenous Aquatic Life and Wildlife

The considerations for other indigenous aquatic life and wildlife are similar to those for a warm water fishery, but include broader concerns of surrounding habitats (e.g. floodplains and forests). Large contiguous areas of forest, wetlands, and prairies are important for many species. Fragmentation of habitats divides wildlife areas into smaller less suitable tracts of land. Plaster Creek's indigenous aquatic life and other wildlife are impaired by sediment for the 12-mile stretch mentioned above (MDEQ 2002b). By meeting the established TSS, macroinvertebrate community, and habitat quality targets, this use will be considered met.

4.2.3 Total Body Contact Recreation

According to the MDEQ (MDEQ 2002a), a 12-mile reach of Plaster Creek is impaired for total body contact recreation. Total body contact recreation refers to any activity that will result in the submersion of the head (e.g. swimming). Safety concerns arise when the eyes and nose are submerged and the possibility of ingesting the water exists. WQS for total contact body recreation must be met between May 1 and October 31. During this time, *E. coli* must be below 130 count per 100 ml, as a 30-day geometric mean.

4.2.4 Partial Body Contact Recreation

Partial body contact recreation includes activities, such as fishing, where some skin contact is made with the water, but generally the body is not submerged. Water quality must meet minimum standards for health and safety, which for partial body contact recreation is below 1,000 count per 100 ml, as a 30-day geometric mean. Plaster Creek currently meets WQS for partial body contact, but not for total body contact. Because further degradation is possible that could result in impairment to this use, it is considered threatened by *E. coli* contamination.

4.2.5 Other Designated Uses

Currently, Plaster Creek and its tributaries are not being used for navigation, an industrial water supply, or as a public water supply. Surface water is being used for agriculture and it is considered a consistent and safe source for irrigation and livestock watering. Therefore, the agricultural use of the Plaster Creek

Watershed (Watershed) is considered met at this time. The Steering Committee should evaluate uses as they emerge or change to determine the potential for impairment or threat.

4.3 PRIORITIZATION OF DESIGNATED USES

The Steering Committee prioritized the designated uses of the Watershed after reviewing the impairments and threats (Table 4.2). Committee members evaluated the resources of the Watershed according to their perceived value and the members' local knowledge of their importance. The members also evaluated the feasibility of restoring each designated use. Restoring the indigenous aquatic life and other wildlife use and warm water fishery use, by reducing sediment loading, was considered the most feasible and attainable goal. Reducing *E. coli* concentrations to restore the partial and total body contact uses will therefore be the second goal for the Watershed.

Table 4.2 - Status and Priority of Designated Uses for the Plaster Creek Watershed

Level of Priority	Designated Use	Status of Designated Use
1	Other Indigenous aquatic life and wildlife	Impaired
2	Warm water fishery	Impaired
3	Partial body contact recreation	Threatened
4	Total body contact recreation	Impaired
5	Agriculture	Met
6	Public water supply	Not a current use
7	Industrial water supply	Not a current use
8	Navigation	Not a current use

4.4 IDENTIFICATION AND PRIORITIZATION OF POLLUTANTS TO BE CONTROLLED

The Steering Committee identified and prioritized the pollutants affecting the designated uses in the Watershed. Past and current studies, input from watershed stakeholders, and field observations were considered in order to determine each pollutant's degree of degradation to surface waters. Pollutants were then prioritized based on the degree of impairment and the feasibility of reducing the pollutant to desirable levels. This prioritization will help narrow the focus on the pollutants causing the greatest impairment to each designated use. The pollutant prioritization is outlined in Table 4.3. Pollutants that were known (k) were given a higher priority than pollutants that were suspected (s). *E. coli* and sediment are considered the highest priority pollutants in the Watershed based on their impact on designated uses.

Nutrients, thermal pollution, and toxic substances were also identified as either known or suspected pollutants in the Watershed.

4.4.1 Pathogens

The presence of coliforms, *E. coli* or fecal coliform, within a water body indicates the possible presence of microbial pathogen contamination. Coliforms are mostly harmless bacteria that live in soil, water, and the intestinal tracts of humans and warm-blooded animals. Pathogens are microbes that cause disease and include several types of bacteria, viruses, protozoa, and other organisms. The extent to which total coliforms are present in surface waters can indicate general water quality and the likelihood that the water is contaminated with microbial pathogens. Improperly installed, operated, or maintained septic systems and faulty sanitary sewer connections can contribute pathogens from humans to surface waters, posing a potential health risk to recreational users. Runoff from animal pastures, improper disposal of pet waste, and wildlife can also contribute animal pathogens to nearby water bodies.

4.4.2 Sediment

Inorganic fine sediments are naturally present to some extent in all streams, but are considered pollutants at excessive levels. Precipitation, including secondary events such as floods and melting snow packs, will transport sediment from eroded uplands to nearby water bodies. In addition, channel movement will scour stream banks and streambeds and contribute additional amounts of inorganic sediment. Because storm events increase stream velocity, more sediment is added by channel movement during rainfall events. Sediment can be suspended, causing turbidity, or deposited on the streambed, causing a loss of benthic productivity and fish habitat. The deposit of an excessive amount of sediment in a stream will cover spawning habitat, clog fish gills, and generally degrade the aquatic habitat of fish and macroinvertebrate species. Human activities related to agriculture, forestry, mining, and urban development contribute excessive amounts of sediment that often overwhelms the “assimilative capacity” of a stream (Cairns 1977) and affects aquatic life.

4.4.3 Nutrients

Nutrients are rated as the second most important factor, next to siltation, adversely affecting the nation’s fishery habitat (Judy et al. 1984). Excessive nutrients, carried by storm water runoff, can cause dense algal growths known as an algal bloom. After the elevated nutrient source has been depleted, the algal bloom will die and decompose, reducing dissolved oxygen (DO) levels. If DO levels reach levels intolerant to fish species, a fish kill may result. If DO levels are consistently low, a shift toward more tolerant aquatic species will arise, reducing species diversity within the stream. Nitrogen and phosphorus have been

identified as the two most common nutrients to enter surface waters. Polluted runoff can result from a variety of sources related to agricultural and urban land use practices.

4.4.4 Thermal Pollution

Thermal pollution can result from the input of heated liquids from industrial discharges or hot impervious surfaces such as parking lots, roads, or rooftops. A lack of streamside vegetation and ditching practices will also lead to thermal pollution due to direct exposure of surface waters to the sun. A significant reduction in water levels from water withdrawals will also cause a stream to be more easily heated by the sun. Dark sediment particles absorb heat, increasing the temperature of surface water as well. Thermal pollution is harmful to cold water species (such as brook trout) because warm water holds less dissolved oxygen than coldwater, which may lower the dissolved oxygen level beyond the species' tolerance level.

4.4.5 Toxic Substances

The MDEQ defines toxic substances as "a substance, except for heat, that is present in sufficient concentration or quantity that is or may be harmful to plant life, animal life, or designated uses" (R 323.1044 1100 of Part 4, Part 31 of PA 451, 1994, revised April 2, 1999). Toxic substances can affect the reproductive health of aquatic life and may pose a health risk to recreational users who use a water body for partial/total body contact recreational uses or consume its fish. Toxic substances can include, but are not limited to: synthetic organic contaminants, such as pesticides, herbicides, and volatile organic contaminants (e.g. xylenes, toluene, and benzene). Hydrocarbons are also considered toxic substances and are defined as organic compounds (as acetylene or butane) containing only carbon and hydrogen and often occurring in petroleum, natural gas, coal, and bitumens (asphalt and tar are the most common forms of bitumen). The presence of hydrocarbons in a waterbody can result from the input of urban runoff containing automotive petroleum products, illicit dumping of used motor oil into storm drains, or discharges from agricultural sites.

4.5 IDENTIFICATION AND PRIORITIZATION OF POLLUTANT SOURCES AND CAUSES

The Steering Committee identified and ranked pollutant sources according to the degree in which they were believed to contribute pollutants to the water bodies of the Watershed (Table 4.3). The magnitude of the sources and how readily the pollutant moves from its source to surface water was considered. Causes of each source were also identified and should be considered first when addressing a pollutant source. For example, when addressing streambank erosion (a source), flashy flows and the other identified causes should be resolved first before attempting to stabilize impacted streambanks.

Table 4.3 - Sources and Causes of Pollutants

Impacted Designated Uses	Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes
Warm water fishery and other indigenous aquatic life and wildlife	1. Sediment (k)	1. Streambank erosion (k)	Flashy flows (k)
			Storm water outfalls and tile outlets (k)
			Livestock access (k)
			Road/stream crossings (k)
			Log jams (k)
			Off Road Vehicle use (k)
		2. Urban runoff (k)	Untreated urban runoff (k)
		3. Agricultural runoff (k)	Rill and gully erosion (k)
		4. Construction sites (k)	Improper erosion and sediment control measures (k)
Total body contact recreation and partial body contact recreation	*2. E. coli* (k)	1.Animal waste (k)	Livestock access (k)
			Manure spreading (s)
			Feedlot runoff (s)
			Wildlife (s)
			Pet waste (s)
		2. Septic systems (s)	Improper septic system maintenance (s)
		3. Sanitary sewer connections (s)	Faulty connections (s)
Warm water fishery and other indigenous aquatic life and wildlife	3. Nutrients (k)	1. Lawn inputs (s)	Improper fertilizer management and yard waste disposal (s)
		2. Animal waste (k)	Livestock access (k)
			Manure spreading (s)
			Feedlot runoff (s)
			Wildlife (s)
			Pet waste (s)
		3. Septic systems (s)	Improper septic system maintenance (s)
		4. Sanitary sewer connections (s)	Faulty connections (s)
Warm water fishery and other indigenous aquatic life and wildlife	4. Thermal pollution (s)	1. Urban runoff (k)	Impervious surfaces (k)
		2. Lack of riparian vegetation (k)	Removal of riparian vegetation (k)
Warm water fishery and other indigenous aquatic life and wildlife	5. Toxic substances (s)	1. Urban runoff (k)	Untreated urban runoff (k)
			Excessive application of road salt (s)
		2. Agricultural runoff (s)	Improper application of pesticides (s)
		3. Storm sewer (s)	Illicit dumping (s)

(k) = known; (s) = suspected

4.6 DESIRED USES

Desired uses are based on factors important to the watershed community and do not necessarily relate to water quality. Desired uses for the Watershed were discussed at a Steering Committee meeting held on October 30, 2007. Committee members evaluated four potential categories that described desired uses and potential tools. These categories included planning and development, ecosystem, education, and recreation. Each committee member selected his or her top 5 desired uses for the Watershed. A summary of the 15 returned questionnaires is presented in Table 4.4. Overall, the planning and development category was the most popular grouping of desired uses, followed by the ecosystem, education, and recreation categories. Planning and development emphasizes the need for smart growth to protect natural resources, while maintaining economic viability. Ecosystem priorities relate to wildlife and aquatic habitat, aesthetics, and riparian corridor establishment. The need for education and recreation, especially for citizen awareness and stewardship and public access, were also considered important desired uses.

Table 4.4 - Prioritized Desired Uses

Planning and Development	**Number of Nominations**
Smart Growth	6
Conservation Easements	4
Flood Control	4
Wetland Protection	4
Storm Water Drainage	4
Continued Agriculture	3
Purchase Development Rights	2
Incentives for Good Planning	1
Planning and Development Total	**28**
Ecosystem	**Number of Nominations**
Wildlife and Aquatic Habitat	7
Aesthetics	7
Riparian Corridor Establishment	6
Stream Morphology	1
Ecosystem Total	**21**
Education	**Number of Nominations**
Citizen Awareness and Stewardship	8
Agricultural Practices	4
Municipal/Township Practices	1
Student Education	1
Education Total	**14**
Recreation	**Number of Nominations**
Public Access	7
Wading	3
Fishing	2
Recreation Total	**12**

CHAPTER 5 - GOALS AND OBJECTIVES

5.1 GOALS OF WATERSHED

The goals for the Plaster Creek Watershed (Watershed) are based on improving or restoring the designated uses of the Watershed and attaining compliance with the Total Maximum Daily Loads (TMDLs) established for Plaster Creek for *Escherichia Coli (E. coli)* and Biota. The goals have been developed on a watershed-wide basis and have been prioritized based on their relationship with the prioritized designated uses and pollutants. Table 5.1 outlines the goals established for the Watershed.

Table 5.1 - Watershed Goals

Impaired and Threatened Designated Uses	Goals
Warm water fishery (impaired) and other indigenous aquatic life and wildlife (impaired)	1. Improve and protect habitats for fish and other indigenous aquatic life and wildlife
Total body contact recreation (impaired) and partial body contact recreation (threatened)	2. Improve and protect the safety and enjoyment of fishing, public access, and wading

5.2 OBJECTIVES OF WATERSHED

The objectives required to meet the goals are based on addressing the identified causes of the sources of nonpoint source pollution in the Watershed. The goals and objectives for the Watershed are defined in Table 5.2.

Table 5.2 - Watershed Objectives

Impacted Designated Uses	Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes	Objectives
Warm water fishery (impaired) and other indigenous aquatic life and wildlife (impaired)	1. Sediment (k)	1. Stream bank erosion (k)	Flashy flows (k) (8 sites *)	Stabilize stream flows to moderate hydrology and increase base flow
			Storm water outfalls and tile outlets (k) (2 sites *)	Minimize impact of drainage systems on stream banks
			Livestock access (k) **	Install livestock exclusion fencing
			Road/stream crossings (k) (6 sites *)	Reduce sediment input from road/stream crossings
			Log jams (k) (41 sites *)	Implement woody debris management strategies and remove obstructions
			ORV use (k) (2 sites *)	Encourage proper use of off-road vehicles (ORVs) near stream banks
		2. Urban runoff (k)	Untreated urban runoff (k) (16 sites *)	Treat and manage urban runoff
		3. Agricultural runoff (k)	Rill and gully erosion (k) (1 site *)	Promote conservation tillage practices and cover crops
		4. Construction sites (k)	Improper erosion and sediment control measures (k) (6 sites *)	Encourage use of erosion and sediment control measures
Total body contact recreation (impaired) and partial body contact recreation (threatened)	*2. E. coli* (k)	1.Animal waste (k)	Livestock access (k) **	Restrict livestock access to waterways
			Manure spreading (s)	Encourage proper manure spreading practices
			Feedlot runoff (s)	Encourage feedlot runoff management practices
			Wildlife (s)	Control geese and raccoon populations
			Pet waste (s)	Reduce amount of pet waste entering waterways
		2. Septic systems (s)	Improper septic system maintenance (s)	Encourage proper septic system maintenance
		3. Sanitary sewer connections (s)	Faulty connections (s)	Correct faulty sanitary sewer connections
Warm water fishery (impaired) and other indigenous aquatic life and wildlife (impaired)	3. Nutrients (k)	1. Lawn inputs (s)	Improper fertilizer management and yard waste disposal (s)	Encourage proper fertilizer management and yard waste disposal
		2. Animal waste (k)	Livestock access (k) **	Restrict livestock access to waterways
			Manure spreading (s)	Encourage proper manure spreading practices
			Feedlot runoff (s)	Encourage feedlot runoff management practices
			Wildlife (s)	Control geese and raccoon populations
			Pet waste (s)	Reduce amount of pet waste entering waterways
		3. Septic systems (s)	Improper septic system maintenance (s)	Encourage proper septic system maintenance
		4. Sanitary sewer connections (s)	Faulty connections (s)	Correct faulty sanitary sewer connections
Warm water fishery (impaired) and other indigenous aquatic life and wildlife (impaired)	4. Thermal pollution (s)	1. Urban runoff (k)	Impervious surfaces (k) (14,106 acres)	Reduce imperviousness
		2. Lack of riparian vegetation (k)	Removal of riparian vegetation (k) (areas identified, not quantified)	Plant and protect riparian vegetation
Warm water fishery (impaired) and other indigenous aquatic life and wildlife (impaired)	5. Toxic substances (s)	1. Urban runoff (k)	Untreated urban runoff (k) (16 sites *)	Treat and manage urban runoff
			Excessive application of road salt (s)	Encourage proper application of road salt
		2. Agricultural runoff (s)	Improper application of pesticides (s)	Encourage proper application of pesticide
		3. Storm sewer (s)	Illicit dumping (s)	Reduce illicit dumping

(k) = known
(s) = suspected
* = Sites identified by NPS inventory conducted in three representative subwatersheds.
** = Sites observed by MDEQ as noted in the “Biological Assessment of Plaster Creek” (2001).

5.3 CRITICAL AREAS

5.3.1 Lower Grand River Watershed

During the development of the Lower Grand River Watershed (LGRW) Management Plan, the subwatersheds of the LGRW, including the Plaster Creek Watershed, were analyzed to determine critical subwatersheds of the LGRW. Each subwatershed of the LGRW was assessed based on its estimated water quality degradation from flow, sediment, and temperature pollution. Five factors were used to make this assessment: 1) land use, 2) impervious area, 3) in-stream temperature fluctuation, 4) storm water runoff, and 5) population density. From the information available, these factors were weighted to reflect the sensitivity of these subwatersheds of the LGRW in terms of urban issues. The information below details how each of the subwatersheds in the LGRW, including the Plaster Creek Watershed, were ranked based on these five factors and how a total ranking for each subwatershed of the LGRW was determined.

5.3.1.1 LAND USE RANKING

This ranking identifies subwatersheds of the LGRW with high percentages of urban and agricultural land. Data for this analysis came from the 1978 MIRIS Land Use/Cover data for Allegan, Barry, Clinton, Eaton, Ionia, Mecosta, Montcalm, and Newaygo Counties. For Kent and Ottawa Counties, updated 1992 Land Use/Cover data collected by AWRI was used. Updated 1998 Land Use/Cover data collected by the AWRI was used for Muskegon County. Each subwatershed of the LGRW received a numerical rank based on the percentage of urban/agricultural land: 0% to 25% = 1, 26% to 50% = 2, 51% to 80% = 3, and 81% to 100% = 4. A score between 1 and 2 was classified as a slightly critical area, a score of 3 was classified as moderately critical, and a score of 4 was classified as severely critical.

5.3.1.2 IMPERVIOUS AREA RANKING

This ranking identifies subwatersheds of the LGRW with high percentages of impervious land. The total amount of impervious acreage for each subwatershed of the LGRW was calculated using an average percent impervious number for each land use (Table 5.3) (Halley et al. 1998). The acreage of impervious land in each subwatershed of the LGRW was then divided by the total acreage of land to achieve an impervious area percentage. All subwatersheds of the LGRW received a numerical rank based upon the percentage of impervious land: 0% to 25% = 1, 26% to 50% = 2, 51% to 80% = 3, and 81% to 100% = 4. A score between 1 and 2 was classified as slightly critical, a score of 3 was classified as moderately critical, and a score of 4 was classified as severely critical. Subwatersheds of the LGRW received a score of 0 if information was not available.

Table 5.3 - Average Percent Imperviousness of Typical Land Uses

Description	Average % Impervious	Typical Land Uses
Residential (High Density)	65	Multi-Family Apartments, Condos, Trailer Parks
Residential (Med. Density)	30	Single Family, Lot Size 1/4 to 1 acre
Residential (Low Density)	15	Single-Family, Lot Size 1 acre and Greater
Commercial	79	Strip Commercial, Shopping Centers
Industrial	79	Schools, Prisons, Treatment Plants, Light Industrial
Disturbed/Transitional	5	Gravel Parking, Quarries
Agricultural	5	Cultivated Land, Row Crops
Open Land	5	Parks, Golf Courses, Greenways
Meadow	5	Hay Fields, Tall Grass
Forest	5	Forest Litter, Woods/Grass combination, Tree Farms
Water	0	Water Bodies, Lakes, Ponds, Wetlands

5.3.1.3 IN-STREAM TEMPERATURE FLUCTUATION RANKING

This ranking used Valley Segment Ecological Classification (VSEC) data, developed through the Michigan Rivers Inventory (MRI), to determine the percentage of streams in each subwatershed of the LGRW with a high degree of in-stream temperature fluctuation. Researchers involved in the MRI determined temperature averages and fluctuations based on catchment hydrology and size, upstream lake and shading effects, latitude, impacts from upstream land cover patterns, presence of upstream lakes, and downstream temperature conditions (Seelbach et al., 1997). The length of cold or cool water streams, with either a moderate or high diurnal (daily) temperature fluctuation, based on the MRI, was calculated for each subwatershed of the LGRW and then divided by the total stream length to reach a total percentage. Subwatersheds of the LGRW received a numerical rank based on the percentage of cold or cool water streams with a moderate to high in-stream temperature fluctuation: < 25% = 1, 25% to 50% = 2, 50.01% to 75% = 3, and > 75% = 4. A score between 1 and 2 was classified as slightly critical, a score of 3 was classified as moderately critical, and a score of 4 was classified as severely critical. Subwatersheds of the LGRW received a score of 0 if VSEC data was not available for the area.

5.3.1.4 STORM WATER RUNOFF RANKING

This ranking also used VSEC data to determine the percentage of streams in each subwatershed of the LGRW with the majority of their hydrological input coming from surface runoff. Researcher involved in the MRI determined discharge patterns by examining the composition of catchment topography, surficial geology, land cover, and neighboring stream segments (Seelbach et al. 1997). The length of these type of streams was calculated for each subwatershed of the LGRW and then divided by the total stream length to achieve a total percentage. Subwatersheds of the LGRW received a numerical rank based on the percentage of runoff driven streams: < 25% = 1, 25% to 50% = 2, 50.01% to 75% = 3, > 75% = 4. A score between 1 and 2 was classified as slightly critical, a score of 3 was classified as moderately critical, and a score of 4 was classified as severely critical. Subwatersheds of the LGRW received a score of 0 if VSEC data was not available for the area.

5.3.1.5 POPULATION DENSITY RANKING

The population density for each subwatershed of the LGRW was determined using the 2000 U.S. Census. Subwatersheds of the LGRW received a numerical rank based on the population density: no information = 0, < 40 people/square mile = 1, 41 to 115 = 2, 116 to 299 = 3, and > 300 = 4. A score between 1 and 2 was classified as slightly critical, a score of 3 was classified as moderately critical, and a score of 4 was classified as severely critical.

5.3.1.6 TOTAL RANKING

The total ranking added the individual rankings from each of the five categories measured for the critical subwatershed analysis. The subwatersheds of the LGRW receiving higher rankings are the critical subwatersheds most sensitive to changes within the LGRW. A total ranking between 8 and 12 was classified as slightly critical, a ranking of 13 to 14 was classified as moderately critical, and a ranking at or above 15 was classified as severely critical.

During the critical assessment of the LGRW, the Plaster Creek Watershed was divided into a northern portion (Plaster Creek at mouth) and a southern portion (Plaster Creek above Little Plaster Creek). Table 5.4 indicates the rankings for both of these areas. Both the northern and southern portions of the Watershed were ranked as moderately to severely critical for stream temperature fluctuation, land use, population, and imperviousness. Storm water runoff data indicated that water quality degradation by this pollutant source was only slightly critical. The total rankings indicate that overall the Plaster Creek Watershed is a severely critical subwatershed of the LGRW.

Table 5.4 - Critical Subwatershed Ranking

Subwatershed	Identification Number	Stream Temperature Fluctuation Ranking	Storm Water Runoff Ranking	Land Use Ranking	Population Ranking	Impervious Ranking	Total Ranking
Plaster Creek at Mouth	14 91	4	1	4	4	4	17
Plaster Creek above Little Plaster Creek	14 90	4	1	3	4	3	15

5.3.2 Plaster Creek Watershed

The Plaster Creek Watershed has been categorized as severely critical by the LGRW Management Plan. Critical areas within the Watershed, however, need to be identified in order to locate high priority areas for remediation. Critical areas of the Watershed are those areas having specific nonpoint source pollution concerns that need to be addressed with appropriate BMPs.

In order to determine critical areas within the Watershed, its 12 subwatersheds (Figure 13) were ranked based on septic system usage, urban and agricultural acreage, number of TMDL reach miles, and dry weather *E.coli* monitoring data (Table 5.5). The subrankings for each category were added together to establish a final ranking for the Watershed. Future watershed efforts should begin by targeting the pollution sources identified in the subwatersheds targeted by watershed managers.

Table 5.5 - Critical Areas
Septic System Usage Subranking

Subbasin No.	Total Acreage	Areage with Sanitary Sewer	Acreage with Septic Systems	Acreage with Septic Systems (% of total)	Subranking
0	2825.26	0	2825.26	100%	4
1	3713.01	458.65	3254.236	88%	3
2	5349.74	1309.45	4040.29	76%	3
3	783.4	243.56	539.84	69%	2
4	2963.38	2251.45	711.93	24%	1
5	996	996	0	0%	0
6	8202.08	8202.08	0	0%	0
7	163.27	0	163.27	100%	4
8	2040.1	2040.1	0	0%	0
9	2507.25	2507.25	0	0%	0
10	4100.41	4100.41	0	0%	0
11	2801.87	2801.87	0	0%	0

* Septic system areas were obtained from the USGS National Land Cover Data, 1992.
Each subwatershed received a numerical rank based on the percentage of land area with septic systems (i.e. area without storm sewer): 0-25% = 1, 26-50% = 2, 51-75% = 3, and 76-100% = 4.

Urban and Agricultural Area Subranking

Subbasin No.	Total Acreage	Commercial Acreage	Industrial Acreage	Multi-Family Acreage	Residential Acreage	Transportation Acreage	Total Urban Acreage	Total Agricultural Acreage	Total Urban and Agricultural Acreage	Total Urban and Agricultural Acreage (% of total)	Subranking
0	2825.26	0	0	0	2095.2	0	2095.2	730.06	2825.26	100%	4
1	3713.01	2.46	0	0	3372.91	0	3375.37	337.64	3713.01	100%	4
2	5349.74	755.82	1074.25	0	3492.41	15.13	5337.61	12.13	5349.74	100%	4
3	783.4	0	0	0	724.9	0	724.9	58.5	783.4	100%	4
4	2963.38	98.16	1565.23	0	553.81	617.21	2834.41	0	2834.41	96%	4
5	996	4.22	234.07	76.68	655.14	0	970.11	0	970.11	97%	4
6	8202.08	1531.94	1063.92	202.85	5027.83	306.34	8132.88	0	8132.88	99%	4
7	163.27	0	87.39	2.94	72.94	0	163.27	0	163.27	100%	4
8	2040.1	252.61	207.29	131.87	1448.33	0	2040.1	0	2040.1	100%	4
9	2507.25	280.32	126.82	0	2100.11	0	2507.25	0	2507.25	100%	4
10	4100.41	162.34	737.71	373.68	2799.17	27.51	4100.41	0	4100.41	100%	4
11	2801.87	346.97	576.18	224.95	1560.94	92.83	2801.87	0	2801.87	100%	4

* Land use information obtained from the USGS National Land Cover Data, 1992.
Each subwatershed received a numerical rank based on the percentage of urban/agricultural land: 0-25% = 1, 26-50% = 2, 51-75% = 3, and 76-100% = 4.

Total Maximum Daily Load (TMDL) Reach Subranking

Subbasin No.	Total Stream Miles	TMDL Reach Miles	TMDL Reach Miles (% of total)	Subranking
0	7.02	0	0%	1
1	10.17	1.42	14%	1
2	16.92	1.43	8%	1
3	3.71	2.4	65%	3
4	12.11	3.63	30%	2
5	4.01	2.28	57%	3
6	28.76	0	0%	1
7	1.41	1.08	77%	4
8	9.44	5.35	57%	3
9	6.84	2	29%	2
10	3.5	1.87	53%	3
11	3.9	2.47	63%	3

* TMDL reach miles determined by GIS and MDEQ's 2002 Biota and *E.coli* TMDL Reports for Plaster Creek.
Each subwatershed received a numerical rank based on the percentage of TMDL reach miles: 0-25% = 1, 26-50% = 2, 51-75% = 3, and 76-100% = 4.

***E.coli* Concentration Subranking**

Subbasin No.	Monitoring Sites	Dry Weather Site Average (*E.coli*/100 mL)	Subranking
0	PC19	627	4
1	PC10	7476	12
2	PC18	1141	11
2	PC09	1653	11
3	PC14	572	3
4	PC07	807	8
5	PC06	774	7
6	PC17	559	2
7	PC05	892	9
8	PC16	1100	10
9	PC04	646	5
10	PC01	434	1
11	PC15	763	6

* *E.coli* concentrations were determined through the water quality monitoring program implemented as part of the project. Each subwatershed was ranked based on the average *E.coli* concentration for its corresponding monitoring site(s).

Sediment, Phosphorus, and Nitrogen Load Subranking

Subbasin No.	Total Acreage	Total Sediment Load (tons/year)	Total P Load (tons/year)	Total N Load (tons/year)	Subranking
0	2825.26	3.73	3.17	6.33	3
1	3713.01	18.37	15.61	31.22	8
2	5349.74	26.46	22.49	44.98	10
3	783.4	0.63	0.53	1.07	1
4	2963.38	14.66	12.46	24.92	7
5	996	4.93	4.19	8.38	4
6	8202.08	40.58	34.48	68.97	12
7	163.27	0.81	0.69	1.37	2
8	2040.1	10.09	8.58	17.15	5
9	2507.25	12.40	10.54	21.08	6
10	4100.41	20.28	17.24	34.48	9
11	2801.87	27.35	23.25	46.5	11

* Sediment, phosphorus, and nitrogen loadings were determined based on the stream inventory conducted as part of the project. Each subwatershed was ranked based on the pollutant load values.

Critical Area Ranking

Subbasin No.	Septic System Usage Subranking	Urban and Agricultural Area Subranking	TMDL Reach Subranking	*E.coli* Concentration Subranking	Sediment, Phosphorus, and Nitrogen Load Subranking	Subranking Total	Final Ranking	
2	3	4	1	11	10	29	1	Most Critical
1	3	4	1	12	8	28	2	
11	0	4	3	6	11	24	3	
7	4	4	4	9	2	23	4	
4	1	4	2	8	7	22	5	
8	0	4	3	10	5	22	6	
6	0	4	1	2	12	19	7	
5	0	4	3	7	4	18	8	
9	0	4	2	5	6	17	9	
10	0	4	3	1	9	17	10	
0	4	4	1	4	3	16	11	
3	2	4	3	3	1	13	12	Least Critical

* Subrankings were added together to determine the subanking total. Higher numbers indicate greater impairment.

5.4 WATER QUALITY SUMMARY

Water quality impairs and threatens several designated uses of the Watershed due to nonpoint source pollution. Three designated uses are impaired, the warm water fishery, indigenous aquatic life and other wildlife, and total body contact recreation (e.g. swimming), while partial body contact recreation (e.g. wading) is threatened.

5.4.1 Project Goals

To improve and protect the impaired and threatened designated uses of the Watershed, two watershed goals were established. The first goal is to improve and protect habitats for fish and other indigenous aquatic life and wildlife. The second goal is to improve and protect the safety and enjoyment of fishing, public access, and wading. By reducing sediment loading and *E. coli* concentrations to meet water quality standards in accordance with these goals, the sediment (biota) and *E. coli* TMDLs established for Plaster Creek will be met.

5.4.2 Warm Water Fishery

Plaster Creek's warm water fishery is impaired by sediment along a 12-mile stretch from the Grand River confluence upstream to Dutton Park (MDEQ 2002b). The aquatic life use for Plaster Creek will be considered met when the macroinvertebrate community achieves an acceptable score (i.e. supports designated uses) and the habitat quality score indicates fair conditions, at a minimum (MDEQ 2002b). A secondary target is to attain a mean annual Total Suspended Solids (TSS) concentration of 30 milligrams per liter (mg/l). In addition to sediment loading, this use is also impaired by nutrients, while thermal pollution and toxic substances are suspected impairments.

5.4.3 Other Indigenous Aquatic Life and Wildlife

Plaster Creek's indigenous aquatic life and other wildlife are impaired by sediment for the 12-mile stretch mentioned above (MDEQ 2002b). By meeting the established TSS, macroinvertebrate community, and habitat quality targets, this use will be considered met. In addition to sediment loading, this use is also impaired by nutrients, while thermal pollution and toxic substances are suspected impairments.

5.4.4 Total Body Contact Recreation

Total body contact recreation in Plaster Creek is impaired due to *E. coli* levels that exceed water quality standards. According to the Michigan Department of Environment Quality, all waters of the state protected for total body contact recreation shall not contain more than 130 *E. coli* per 100 milliliters [ml] as a 30-day geometric mean, or more than a maximum of 300 *E. coli* per 100 ml. The degraded portion of

Plaster Creek, a 12-mile stretch from the Grand River confluence upstream to Dutton Park, exceeds these water quality standards for *E. coli* (MDEQ 2002a).

5.4.5 Partial Body Contact Recreation

Partial body contact recreation, such as fishing, is threatened by *E. coli* contamination in the Plaster Creek Watershed. Currently, *E. coli* levels meet water quality standards for partial body contact recreation, 1,000 count per 100 ml, as a 30-day geometric mean, but not standards for total body contact recreation, as mentioned above. Therefore, this use is considered threatened due to the potential for future impairment which could elevate *E. coli* counts to levels that exceed the water quality standard for this use.

CHAPTER 6 - PROPOSED IMPLEMENTATION ACTIVITIES

6.1 MANAGEMENT STRATEGIES

Best management practices (BMPs) were selected for the Lower Grand River Watershed (LGRW) by the LGRW Steering Committee during the LGRW Planning Project. Recommendations were selected for the purpose of treating, preventing, and reducing watershed pollutants. BMPs included structural and vegetative BMPs, management and policy BMPs, and information and education activities. Structural and vegetative BMPs incorporated the categories of pretreatment; vegetated treatment; infiltration and filtration; agricultural BMPs; and detention and retention. Managerial BMPs included the categories of agricultural; zoning ordinances and land use policies; recycling and composting; turf management; operations and maintenance; and municipal operations.

The Plaster Creek Watershed Steering Committee reviewed the BMPs selected for the LGRW in order to select appropriate BMPs for the Plaster Creek Watershed (Watershed). During the selection process, the impairments and threats to the designated uses, the goals and objectives developed for the Watershed, and the established Total Maximum Daily Loads (TMDLs) were considered. The recommendations chosen for the Watershed include structural and vegetative BMPs as well as managerial BMPs (Table 6.1). Information and education (I&E) activities were also identified for each pollutant cause and are described in Chapter 9. These I&E activities are noted in Table 6.1 for only those pollutant causes not being addressed by another BMP.

6.2 SCHEDULE OF ACTIVITIES

How the various BMPs will be phased in or scheduled in relation to one another over time is a key question when planning to implement BMPs to address the water quality concerns. The most efficient system of BMPs requires careful examination of what the BMPs are to accomplish and what needs to take place first. The causes or the sources of the impairments need to be addressed before the actual site specific problem can be solved in most cases.

BMPs for the Watershed are defined as short-term (one to five years) or long-term (five to ten years) activities (Table 6.1). These time lines are recommendations of how BMP implementation can be organized, however, many variables exist in the real world and adjustments to the schedule and the sequence of BMP implementation should surely occur.

Short-term BMPs are those actions that require minimal to moderate costs and planning. Examples include fencing for cattle exclusion, installation of pet waste stations, and catch basin cleaning. This category of BMPs is recommended to be implemented in one to five years.

Long-term BMPs are those actions that require greater costs and planning and may need to build on the success of other BMPs to support a sustainable program. Examples include ordinance adoption, the installation of hydrodynamic separator units, and wetland restoration. These long-term BMPs are expected to be in progress within five to ten years.

I&E activities are recommended for an annual or semiannual schedule of implementation. More detail on the complete list of I&E activities and the I&E strategy can be found in Chapter 9.

6.3 ESTIMATION OF COSTS AND TECHNICAL AND FINANCIAL ASSISTANCE

6.3.1 Cost Estimates

Committing to BMPs without understanding the cost involved can cause problems when it comes time for implementation. For this reason, costs have been estimated for the proposed watershed-wide BMPs in Table 6.1 to help watershed stakeholders determine what can be feasibility implemented based on the available budget. Actual costs for BMP implementation will vary according to site conditions. Generally, costs will be lower when multiple BMPs are installed simultaneously. Specific costs for BMP implementation, based on sites identified by the nonpoint source inventory (Appendix 6), are included in Table 6.3.

6.3.2 Technical and Financial Assistance Needed

Technical and financial assistance is needed to successfully implement the recommendations of the Watershed Management Plan. Funding sources can include state and federal grant awards, such as the Clean Michigan Initiative program and Section 319 of the Clean Water Act, as well as local organizations and agencies. Several local and state agencies and organizations are on hand to provide technical and/or financial assistance for many of the recommendations listed in the WMP. Table 6.1 recommends specific partners and funding programs that may be able to assist with the implementation of particular BMPs.

Table 6.1 - Recommended Watershed-Wide Implementation Activities

Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes	Objectives	BMP Recommendations	Technical Assistance	Financial Assistance	Estimated Cost	Implementation Schedule
1. Sediment (k)	1. Streambank erosion (k)	Flashy flows (k)	Stabilize stream flows to moderate hydrology and increase base flow	Adoption of storm water ordinance	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
				Conduct hydrologic study	MDEQ	319 grants	$15,000	Short-Term (1-5 years)
				Low impact development applications	Developers	319 and CMI grants, developers	Porous asphalt: $0.50-$1/square foot Rain garden: $15/square ft Green roof: Variable	Long-Term (5-10 years)
				Wetland restoration	NRCS, FSA	319 and CMI grants, NAWCA grants, private landowners	$2,350/acre	Long-Term (5-10 years)
				Adoption of wetland and green space protection ordinances	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
		Storm water outfalls and tile outlets (k)	Minimize impact of drainage systems on stream banks	Streambank stabilization	DPWs KCD, KCRC, NRCS, Timberland RC&D	USDA farm bill programs, 319 and CMI grants, private landowners	Plants and Mulch: $6/square foot Riprap: $35/square foot	Short-Term (1-5 years)
		Livestock access (k)	Install livestock exclusion fencing	Fencing	KCD, NRCS	USDA farm bill programs, private landowners	$1.90/foot	Short-Term (1-5 years)
		Road/stream crossings (k)	Reduce sediment input from road/stream crossings	Annual road/stream crossing inventory	DPWs, KCRC	KCRC and DPW general funds	$60/day for volunteer mobilization	Short-Term (1-5 years)
				Streambank stabilization	DPWs, KCRC	KCRC and DPW general funds	Plants and Mulch: $6/square foot Riprap: $35/square foot	Short-Term (1-5 years)
				Repair/replace old culverts	DPWs, KCRC	KCRC and DPW general funds	Variable	Short-Term (1-5 years)
		Log jams (k)	Implement woody debris management strategies and remove obstructions	Management of woody debris and other obstructions	KCDC, MDEQ, MDNR, Timberland RC&D	Drain assessments, MDNR grants	Obstruction removal: $10/foot	Short-Term (1-5 years)
		ORV use (k)	Encourage proper use of ORVs near streambanks	Fact sheets on ORV use with web link for more information (See Chapter 9: I&E Strategy)	LGROW and Plaster Creek Steering Committee	EPA education and 319 grants, local units of government	12 staff hours and $200 for reproduction per set of fact sheets	Annually

Table 6.1 - Recommended Watershed-Wide Implementation Activities

Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes	Objectives	BMP Recommendations	Technical Assistance	Financial Assistance	Estimated Cost	Implementation Schedule
	2. Urban runoff (k)	Untreated urban runoff (k)	Treat and manage urban runoff	Adoption of storm water ordinance	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
				Low impact development applications	Developers	319 and CMI grants, developers	Porous asphalt: $0.5-1/square foot Rain garden: $15/square foot Green roof: Variable	Long-Term (5-10 years)
				Installation of hydrodynamic separator units	Local units of government	319 and CMI grants	$15,000/acre of impervious surface	Long-Term (5-10 years)
				Catch basin cleaning	Local units of government	319 and CMI grants	$96/annually	Short-Term (1-5 years)
				Wetland restoration	FSA, NRCS	319 and CMI grants, NAWCA grants, private landowners	$2,350/acre	Long-Term (5-10 years)
				Adoption of wetland and green space protection ordinances	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
	3. Agricultural runoff (k)	Rill and gully erosion (k)	Promote conservation tillage practices and cover crops	Targeted training workshop on agricultural practices and cost-share opportunities (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	16 staff hours and $100 for materials	Semiannually
				Vegetated filter strips	DPWs, KCRC	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	$4-$10/linear foot	Short-Term (1-5 years)
	4. Construction sites (k)	Improper erosion and sediment control measures (k)	Encourage use of erosion and sediment control measures	Silt fence installation	Storm Water Operators	Developers	$2/linear foot	Short-Term (1-5 years)
				Soil erosion and sedimentation control practices	Storm Water Operators	Developers	$100/site	Short-Term (1-5 years)
2. E. coli (k)	1.Animal waste (k)	Livestock access (k)	Restrict livestock access to waterways	Fencing	KCD, NRCS	USDA farm bill programs, private landowners	$1.90/foot	Short-Term (1-5 years)
		Manure spreading (s)	Encourage proper manure spreading practices	Field demonstrations on proper manure spreading practices (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Annually
		Feedlot runoff (s)	Encourage feedlot runoff management practices	Field demonstrations on proper feedlot runoff practices (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Annually

Table 6.1 - Recommended Watershed-Wide Implementation Activities

Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes	Objectives	BMP Recommendations	Technical Assistance	Financial Assistance	Estimated Cost	Implementation Schedule
		Wildlife (s)	Control geese and raccoon populations	Animal control practices	Park and recreation departments, Local units of government, private landowners	319 and CMI grants, private landowners	Variable	Long-Term (5-10 years)
				Vegetated filter strips	DPWs, KCRC	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	$4-$10/linear foot	Long-Term (5-10 years)
		Pet waste (s)	Reduce amount of pet waste entering waterways	Pet waste stations	Park and recreation departments	319 and CMI grants	$115/station	Short-Term (1-5 years)
	2. Septic systems (s)	Improper septic system maintenance (s)	Encourage proper septic system maintenance	Septic system ordinance	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
	3. Sanitary sewer connections (s)	Faulty connections (s)	Correct faulty sanitary sewer connections	Corrections to faulty sanitary sewer connections	Local units of government	319 and CMI grants	Variable	Long-Term (5-10 years)
3. Nutrients (k)	1. Lawn inputs (s)	Improper fertilizer management and yard waste disposal (s)	Encourage proper fertilizer management and yard waste disposal	Field demonstrations on proper lawn care practices; Media releases (See Chapter 9: I&E Strategy)	West Michigan Environmental Action Council	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Semiannually
	2. Animal waste (k)	Livestock access (k)	Restrict livestock access to waterways	Fencing	KCD, NRCS	USDA farm bill programs, private landowners	$1.90/foot	Short-Term (1-5 years)
		Manure spreading (s)	Encourage proper manure spreading practices	Field demonstrations on proper manure spreading practices (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Annually
		Feedlot runoff (s)	Encourage feedlot runoff management practices	Field demonstrations on proper feedlot runoff practices (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Annually
		Wildlife (s)	Control geese and raccoon populations	Animal control practices	Park and Recreation Departments, Local units of government, Private landowners	319 and CMI grants, private landowners	Variable	Short-Term (1-5 years)
				Vegetated filter strips	DPWs, KCRC	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	$4-$10/linear foot	Short-Term (1-5 years)
		Pet waste (s)	Reduce amount of pet waste entering waterways	Pet waste stations	Park and Recreation Departments	319 and CMI grants	$115/station	Short-Term (1-5 years)
	3. Septic systems (s)	Improper septic system maintenance (s)	Encourage proper septic system maintenance	Septic system ordinance	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)

Table 6.1 - Recommended Watershed-Wide Implementation Activities

Prioritized Pollutants	Prioritized Pollutant Sources	Pollutant Causes	Objectives	BMP Recommendations	Technical Assistance	Financial Assistance	Estimated Cost	Implementation Schedule
	4. Sanitary sewer connections (s)	Faulty connections (s)	Correct faulty sanitary sewer connections	Corrections to faulty sanitary sewer connections	Local units of government	319 and CMI grants	Variable	Long-Term (5-10 years)
4. Thermal pollution (s)	1. Urban runoff (k)	Impervious surfaces (k)	Reduce imperviousness	Low impact development applications	Developers	319 and CMI grants, developers	Porous asphalt: $0.5-1/square foot Rain garden: $15/square foot Green roof: Variable	Long-Term (5-10 years)
	2. Lack of riparian vegetation (k)	Removal of riparian vegetation (k)	Plant and protect riparian vegetation	Vegetated filter strips	DPWs, KCRC	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	$4-$10/linear foot	Short-Term (1-5 years)
5. Toxic substances (s)	1. Urban runoff (k)	Untreated urban runoff (k)	Treat and manage urban runoff	Adoption of storm water ordinance	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
				Low impact development applications	Developers	319 and CMI grants, developers	Porous asphalt: $0.5-1/square foot Rain garden: $15/square foot Green roof: Variable	Long-Term (5-10 years)
				Installation of hydrodynamic separator units	Local units of government	319 and CMI grants	$15,000/acre of impervious surface	Long-Term (5-10 years)
				Catch basin cleaning	Local units of government	319 and CMI grants	$96/annually	Short-Term (1-5 years)
				Wetland restoration	NRCS, FSA	319 and CMI grants, NAWCA grants, private landowners	$2,350/acre	Long-Term (5-10 years)
				Adoption of wetland and green space protection ordinances	Local units of government	319 and CMI grants	$2,000/ordinance	Long-Term (5-10 years)
		Excessive application of road salt (s)	Encourage proper application of road salt	Targeted training workshops on proper salt application procedures (See Chapter 9: I&E Strategy)	DPWs, KCRC,	EPA education and 319 grants, local units of government	16 staff hours and $100 for materials per workshop	Annually
	2. Agricultural runoff (s)	Improper application of pesticides (s)	Encourage proper application of pesticide	Field demonstrations on proper pesticide application (See Chapter 9: I&E Strategy)	KCD, NRCS	EPA education and 319 grants, local units of government	20 staff hours and $100 for materials per demonstration	Semiannually
	3. Storm sewer (s)	Illicit dumping (s)	Reduce illicit dumping	Storm drain marking or stenciling events; Media releases (See Chapter 9: I&E Strategy)	LGROW and Plaster Creek Steering Committee	EPA education and 319 grants, local units of government	24 staff hours per event and $5 per marker or $20 per stencil template	Annually

Notes:
319 – Clean Water Act, Section 319 Funding
CMI – Clean Michigan Initiative
DPWs – Departments of Public Works
FSA – Farm Service Agency
KCD – Kent Conservation District
KCDC – Kent County Drain Commissioner
KCRC – Kent County Road Commission
EPA – U.S. Environmental Protection Agency
LGROW – Lower Grand River Organization of Watersheds
USDA – U.S. Department of Agriculture
ORV – Off Road Vehicle
MDEQ – Michigan Department of Environmental Quality
MDNR – Michigan Department of Natural Resources
I&E – Information and Education
RC&D – Resource, Conservation, and Development
NRCS – Natural Resource Conservation Service
NAWCA – North American Wetlands Conservation Act

6.4 ESTIMATE OF POLLUTANT LOADINGS

6.4.1 Modeling Pollutant Loadings From Nonpoint Source Sites

As described in Section 3.1.2, an inventory of Plaster Creek and its tributaries was completed in the summer of 2007. A total of 84 sites (Table 6.2) were identified as contributing nonpoint source (NPS) pollution to surface waters of the Watershed. These sites were identified in three of the most representative subwatersheds (Figures 9 through 11), characterizing the rural, developing, and urban characteristics of the Watershed. The Michigan Department of Environment Quality's (MDEQ's) "*Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual"* (MDEQ 1999) was used to provide estimates of sediment and nutrient (phosphorus and nitrogen) loadings from NPS sites impacted by erosion from road/stream crossings, gullies, tile outlets, urban/residential sources, and stream banks. The Gully Erosion Equation (GEE) and the Channel Erosion Equation (CEE) were used to calculate sediment loads for these sites undergoing erosion. Nutrient loading was determined by calculating total erosion at each NPS site, and then estimating the amount of nutrients attached to the sediment.

Table 6.2 - Summary of NPS Watershed Inventory

Pollutant source	Extensive Sites	Large Sites	Moderate Sites	Small Sites	Total Sites	Sediment loads (tons/yr)	P loads (lbs/yr)	N loads (lbs/yr)
Construction	1	1	3	1	6	--	--	--
Debris/Trash/ Obstructions	14	10	14	3	41	--	--	--
Gully erosion	0	0	1	0	1	1.10	.93	1.87
Livestock Access	0	0	0	0	0			
Non-point Agricultural Source	0	0	2	0	2	--	--	--
Other*	0	2	2	0	4	--	--	--
Rill Erosion	0	0	0	0	0	--	--	--
Stream Crossings	1	0	4	1	6	15.80	13.43	26.86
Streambank Erosion	3	2	2	1	8	13.51	11.48	22.96
Tile Outlets	1	0	0	1	2	.15	.12	.25
Urban/ Residential	5	3	4	2	14	1.16	.98	1.96
Total Sites	25	18	32	9	84			
Total Loads						31.71	26.95	53.9

** Off Road Vehicle Trails, other recreation, and vertical stream bank erosion*

The pollutant loadings for the inventoried subwatersheds were then used to estimate loadings for the entire Watershed (Appendix 7). The following equation was used: (Watershed Acreage/Inventoried Acreage) x (Loading). It is estimated that the Watershed carries a sediment load of 180.28 tons/year, a phosphorus load of 153.23 lbs/year, and a nitrogen load of 306.47 lbs/year.

For those NPS sites impacted by a pollutant source other than erosion, a pollutant load was not calculated using MDEQ's "*Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual."* These sites include locations impacted by debris/trash/obstructions, nonpoint agricultural sources, construction, urban/residential sources, or other identified pollutant sources. The number of these types of NPS sites for the inventoried subwatersheds was then used to estimate the number of sites for the entire Watershed The following equation was used: (Watershed Acreage/Inventoried Acreage) x (Number of NPS Sites). (Appendix 7). It is estimated that the Watershed contains 233 debris/trash/obstruction sites, 11 nonpoint agricultural source sites, 34 construction sites, 80 urban/residential source sites, and 23 other pollutant source sites.

6.4.2 Pathogen Contamination

As described in Section 3.1.2, *Escherichia Coli* (*E. coli)* bacteria have been measured at levels exceeding water quality standards (WQS) in reaches of Plaster Creek during both wet and dry weather events (MDEQ 2002a). During the implementation of this project, a monitoring program was conducted from September 2005 to October 2006 to sample *E. coli* at 13 sites in the Watershed (Figure 12). Data was collected to supplement the existing data collected by the MDEQ in order to determine pollutant sources. Monthly samples collected during dry weather ranged from 96 *E. coli* per 100 ml to >24,200 *E. coli* per 100 ml (Table 3.1). Approximately 20% of the monthly sampling sites met the water quality standard for total body contact recreation (300 *E. coli* per 100 ml). Monthly samples of *E. coli* collected during wet weather events ranged from 1700 *E. coli* per 100 ml to 104,620 *E. coli* per 100 ml (Table 3.2). There were no sites that met the WQS for total body contact recreation or partial body contact recreation (1,000 *E. coli* per 100 ml as a 30-day geometric mean) during wet weather sampling.

6.5 MANAGEMENT MEASURES TO REDUCE POLLUTANT LOADINGS

To control and reduce pollutant loading at the non-point source sites in the Watershed, several BMPs have been recommended. Table 6.3 prioritizes specific BMPs that will need to be implemented on the identified nonpoint source sites to reduce the pollutant loadings described in the previous section. Table 6.3 also includes recommended management measures based on *E. coli* monitoring completed in 2005-2006. Information on technical and financial assistance needs, costs, and scheduling is also provided to assist in implementation efforts.

Because MDEQ's "*Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual"* does not provide information on the amount of each BMP needed to achieve pollutant removal efficiencies, pollutant reduction goals should be considered during BMP implementation in order to achieve long-term pollutant reduction goals for the Watershed. For example, the pollutant reduction goal for sediment (i.e. total suspended solids) is 25%; therefore, BMPs selected to address sediment at a particular site should be at least 25% efficient. By reducing sediment by 25%, or greater, at each known pollutant source in the Watershed, this pollutant reduction goal will eventually be met. Additional pollutant reduction goals are outlined in Chapter 7.

Many combinations of BMPs can be implemented to realize pollutant reduction goals. The most effective combination will be the one that is most feasible for the stakeholders based on cost, acceptability, and sustainability. Local and national efforts are continuing to identify pollutant removal effectiveness of BMPs and estimated pollutant reductions expected.

Table 6.3 - BMP Implementation Detail and Schedule for NPS Sites

Pollutant Source	BMP	Technical Assistance	Unit Cost	Number of Affected Sites	Total Cost	Financial Assistance	Schedule
Streambank erosion	Streambank stabilization	KCD, KCRC, NRCS, Timberland RC&D	Plants and Mulch: $6/square foot Riprap: $35/square foot	Erosion by drainage networks (8 sites or 730 square feet)	Plants and mulch for 730 sq. ft. (total area) = $4,380 Rip rap for 250 sq. ft. (toe area) = $8,750	USDA farm bill programs, 319 and CMI grants, private landowners	Short-term (1-5 years)
Gully erosion	Vegetated filter strips	KCD, NRCS	$4-$10/linear foot	Agricultural runoff (1 site or 30 linear feet)	$300	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	Short-term (1-5 years)
Tile outlet	Streambank stabilization	KCD, NRCS	Plants and Mulch: $6/square foot Riprap: $35/square foot	Streambank erosion (2 sites or 33 square feet)	Plants and mulch for 33 sq. ft. = $198 Riprap for 33 sq. ft. = $1,155	USDA farm bill programs, 319 and CMI grants, private landowners	Short-term (1-5 years)
Stream crossings	Streambank stabilization	KCRC, DPW staff	Riprap: $35/square foot	Streambank erosion (5 sites or 1,519 square feet)	Riprap for 1,519 sq. ft/ = $53,165	KCRC and DPW general funds	Short-term (1-5 years)
	Repair/replace old culvert	KCRC, DPW staff	Variable	Misaligned culvert (1 sites)	Estimated at $5,000, variable	KCRC and DPW general funds	Short-term (1-5 years)
Urban/Residential	Vegetated filter strips	Consulting engineers, DPW staff	$4-$10/linear foot	Insufficient stream buffer (8 sites)	Estimate 80ft/site at $10/linear ft. = $6,400	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	Short-term (1-5 years)
	Field demonstration on proper lawn care practices; Distribute media releases (See Chapter 9: I&E Strategy)	West Michigan Environmental Action Council	20 staff hours and $100 for materials/ demonstration	Yard waste piles (4 sites)	Hold two meetings per year, total of 20 staff hours at $20/hr (including prep time) and materials = $1,000	EPA education and 319 grants, local units of government	Semiannually

Table 6.3 - BMP Implementation Detail and Schedule for NPS Sites

Pollutant Source	BMP	Technical Assistance	Unit Cost	Number of Affected Sites	Total Cost	Financial Assistance	Schedule
	Streambank stabilization	KCD, KCRC, NRCS, Timberland RC&D	Plants and Mulch: $6/square foot	Storm water outlet erosion (2 sites, or estimated 400 square feet)	Plants and mulch for 400 sq. ft. = $2,000	319 and CMI grants, private landowners	Short-term (1-5 years)
Debris, trash, obstructions	Manage woody debris and obstructions	KCDC, KCRC, MDEQ, MDNR Timberland RC&D	Obstruction removal: $10/linear foot	Log jams and obstructions (41 sites, estimated 50 linear feet/site)	$20,500	Drain assessments, MDNR grants	Short-term (1-5 years)
Construction	Soil erosion and sediment control practices	Storm water operators	$100/site	Bike path construction – sediment spilling over silt fence (4 sites)	$400	Developers	Completed
	Silt fence installation	Storm water operators	$2/linear foot	Bike path construction – missing silt fence (2 sites or 75 linear feet)	$150	Developers	Completed
Animal waste	Fencing to restrict livestock access to waterway	KCD, NRCS	$1.90/foot	Identified at monitoring sites (DEQ03)	500 ft. of fencing/site = $950	USDA farm bill programs, 319 grants, private landowners	Short-term (1-5 years)
	Field demonstrations on proper manure spreading practices	KCD, NRCS	$20/staff hour and $100 for materials per demonstration	13,847 acres of ag land approximately 3,462 (25%) acres available for spreading	Hold one meeting per year, total of 20 hours (including prep time) and materials = $500	EPA education and 319 grants, local units of government	Annually
	Field demonstrations on proper feedlot runoff practices	KCD, NRCS	$20/staff hour and $100 for materials per demonstration	All farms in watershed	Hold one meeting per year, total of 20 hours (including prep time) and materials = $500	EPA education and 319 grants, local units of government	Annually
	Control geese and raccoon populations using animal control practices and vegetated filter strips	Park and recreation department, local units of government, private landowners, DPWs, KCRC	Animal practices variable, $4-$10/event	Entire watershed	Animal practices ($150/event for 4 events/summer) = $600/year	319 and CMI grants, private landowners, drain assessments, USDA farm bill programs	Long-term (5-10 years)

Table 6.3 - BMP Implementation Detail and Schedule for NPS Sites

Pollutant Source	BMP	Technical Assistance	Unit Cost	Number of Affected Sites	Total Cost	Financial Assistance	Schedule
Septic systems	Septic system ordinance	Local units of government	$2,000/ordinance	11,532 acres with septic systems, average 0.5 septic systems/acre = 5,766 septic systems	1 ordinance per township or community = 6 x $2,000 = $12,000	319 and CMI grants	Long-term (5-10 years)
Sanitary sewer connections	Corrections to faulty sanitary sewer connections	Local units of government	Variable	Miles of sanitary sewer unknown	Estimated $100,000, variable	319 and CMI grants	Long-term (5-10 years)
Nonpoint agricultural source	Vegetated filter strips	KCD, NRCS	$4-$10/linear foot	Nutrient and pathogen loading (2 sites, estimated 80 linear fee/site)	Estimate 80ft/site at $10/linear foot = $1,600	319 and CMI grants, drain assessments, private landowners, USDA farm bill programs	Long-term (5-10 years)
					TOTAL COST: $219,548		

Notes:
319 – Clean Water Act Section 319
CMI – State of Michigan's Clean Michigan Initiative
DPW – Department of Public Works
KCD – Kent Conservation District
KCDC – Kent County Drain Commissioner
KCRC – Kent County Road Commission
MDEQ – Michigan Department of Environmental Quality
MDNR – Michigan Department of Natural Resources
NRCS – USDA Natural Resources Conservation Service
Timberland RC&D – Timberland Resources Conservation and Development
USDA – U.S. Department of Agriculture
I&E – Information and Education

6.6 ESTIMATE OF POLLUTANT REDUCTIONS

6.6.1 Modeling Pollutant Reductions From Nonpoint Source Sites

Using MDEQ's "*Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual,"* estimates of pollutant load reductions following BMP implementation were calculated (Appendix 7). As described in the training manual, BMPs are assumed to control 100% of the erosion at sites of NPS pollution, thus reducing the pollutants by 100%. The reductions are therefore the same amounts as the loadings (Table 6.2). Pollutant reductions for phosphorus and nitrogen are based on the amount of sediment delivered, thus the calculations are dependent on the accuracy of the data collected at the site pertaining to soil loss. These estimates are based on limited field measurements, due to time and financial constraints. The results, therefore, are purely estimates of the pollutant removal capability of the actions and BMPs implemented.

6.6.2 Pathogen Contamination

The Plaster Creek TMDL establishes allowable loadings of pollutants to meet WQS based on the relationship between pollution sources and in-stream water quality conditions. The TMDL allows stakeholders to develop controls to reduce pollution and restore the quality of the resource. TMDLs identify the allowable levels of *Escherichia Coli (E. coli)* that will result in the attainment of the applicable WQS. The TMDL is comprised of the sum of individual waste load allocations (WLAs) for point sources, load allocation (Las) for nonpoint sources and natural background levels, and a margin of safety, as expressed in the following equation: TMDL = ∑WLAs + ∑Las + MOS.

WLA is equal to 130 count (ct)/100 milliliter (ml) (as a 30-day geometric mean) or 300 *E. coli* ct/100 ml (daily maximum during the same sampling event), since that is the WQS. An illicit connection WLA is 0, since it is illegal. Because the TMDL is concentration based, the LA is equal to 130, since all land should be required to meet the lowest standard, regardless of use.

The reductions, therefore, at each site must be enough to reduce the load to reach 130 ct/100 ml (as a 30-day geometric mean). Consistent exceedances of WQS have been observed in the sampling programs, thus many sites would be nearing 100% reduction to meet water quality standards. As pollutant load reductions approach 100%, costs escalate exponentially. Many existing load allocations, such as those for pathogens in Michigan, call for nearly 100% pollution reduction without concern for implementation cost.

CHAPTER 7 - METHODS OF MEASURING PROGRESS

Measures of success are essential to any project to evaluate the achievements of the project and determine the benefits to water quality and the quality of life that resulted from the implementation of Best Management Practices (BMPs). The success of the project toward meeting its goals of improving water quality and restoring the designated uses of the Plaster Creek Watershed (Watershed) depends on many factors, all of which need to be continuously evaluated. Establishing monitoring targets, against which observed measurements are compared, help determine whether progress is being made toward targets and ultimately the watershed goals. Section 7.1 below describes evaluation measures to evaluate implementation of specific BMPs, while Section 7.2 outlines a water quality monitoring program to evaluate overall changes in watershed conditions.

7.1 SPECIFIC MONITORING COMPONENTS FOR RECOMMENDED BMPS

7.1.1 Monitoring Components

Table 7.1 identifies the monitoring components to measure the effectiveness and success of the specific structural and vegetative BMPs as well as management and policy BMPs outlined in Chapter 6. Evaluation measures for Information and Education activities can be found in Chapter 9. The following paragraphs describe each recommended monitoring component.

7.1.1.1 ORDINANCE STATUS

Ordinances are necessary to balance the demand for growth with environmental protection. The development, adoption, and enforcement of ordinances in the Watershed will be assessed to evaluate the effectiveness of these policies at meeting the goals and objectives established for the Watershed. Model ordinances developed for local units of government in Michigan are available and should be consulted prior to ordinance development to avoid “reinventing the wheel.”

7.1.1.2 REPORT SUMMARIES

As implementation efforts are completed in the Watershed, it is recommended that these efforts be recorded by Departments of Public Works, the Kent County Road Commission, local units of government, the Michigan Department of Environmental Quality (MDEQ), Michigan Department of Natural Resources (MDNR), and the Natural Resource Conservation Service to track the number of sites addressed in the Watershed. The Plaster Creek Steering Committee can use these records to determine the ratio of nonpoint source pollution (NPS) sites addressed to the remaining unaddressed sites in order to track implementation progress.

7.1.1.3 PORTFOLIO OF BEFORE AND AFTER PHOTOGRAPHS

The inventory of the Watershed includes photographs of major pollution sources and nonpoint source sites in the Watershed. Pictures should be taken after BMPs have been installed at these sites to provide visual documentation of water quality improvements in the Watershed. In addition, as new problem areas are identified in the Watershed, photographs of their initial condition should be added to the photograph portfolio for future reference.

7.1.1.4 POLLUTANT REDUCTION CALCULATIONS

The MDEQ provides documents that explain how to calculate pollutant load reductions resulting from BMP implementation. These calculations measure the amount of sediment, phosphorus, and nitrogen that are prevented from entering surface water when a BMP is installed at that site. These reductions will be calculated and recorded throughout the project to enable pollution reduction efforts to be quantified.

7.1.1.5 WATER QUALITY MONITORING

To determine reductions in thermal loadings, toxic substance concentrations, and *E. coli* concentrations resulting from BMP implementation, water quality monitoring is recommended. Digital temperature loggers are relatively inexpensive and would be an excellent tool for measuring in-stream water temperature changes as a result of replanting the riparian zone. Water grab samples should be analyzed in an analytical laboratory to determine accurate toxic substance and *Escherichia coli* (*E. coli)* concentrations.

7.1.2 Interim, Measurable Milestones

The evaluation process is organized by matching a monitoring component to each recommended BMP and then describing the milestones for determining whether management measures are being implemented in an effective process. Short-term (within 5 years) and long-term (within 10 years) milestones have been developed to evaluate the progress of BMP implementation and in meeting the watershed goals. The parties responsible for monitoring and evaluating the achievement of the milestones are also included in Table 7.1. The task of measuring progress is a necessary component of creating a dynamic and effective management plan.

7.1.3 Watershed Management Plan Evaluation Criteria

A set of criteria (Table 7.1) was established to determine whether loading reductions are being achieved over time, if progress is being made towards attaining water quality standards, and whether the management plan or current Total Maximum Daily Loads (TMDL) needs revision. The water quality

criteria include pollutant reduction goals for each watershed pollutant. For example, a 25% reduction goal was established for sediment. Because phosphorus and nitrogen are attached to sediment in ratios of 20/25 and 40/25, 20% and 40% reduction goals were established for these pollutants, respectively.

It these pollutant reductions goals are not being reached or future BMP implementation is not adequately meeting the defined short-term and long-term milestones, revisions to this management plan would be necessary. If additional watershed concerns are discovered, the BMPs and milestones would also need to be updated. The measurable goals included in Table 7.2 should be used, in addition to the set of criteria listed in Table 7.1, to evaluate the effectiveness of the implementation efforts over time, as compared to current conditions.

Table 7.1 - Monitoring Components for BMP Implementation

BMP Recommendations	Monitoring Components	Units of Measurement	Criteria	Short-Term Milestone 1-5 Years	Long-Term Milestone 5-10 Years	Evaluation Schedule	Responsible Partners
Adoption of storm water ordinance	Ordinance status	Number of ordinances adopted	100% of communities adopt ordinances	Draft ordinances	Adopt and implement ordinances	Annually	Local units of government
Adoption of wetland and green space protection ordinances	Ordinance status	Number of ordinances adopted	100% of communities adopt ordinances	Draft ordinances	Adopt and implement ordinances	Annually	Local units of government
Animal control practices	Local units of government reports; before and after photographs; pollutant reduction calculations; water quality monitoring	Number of BMPs implemented to address open areas contributing pollutants; pounds of phosphorus and nitrogen; concentration of *E. coli*	Reduction in number of areas contributing pollutants; 20% phosphorus and 40% nitrogen reduction; meet WQS for *E. coli*	Address 75% of existing problem areas through BMP implementation	Identify and address 75% of new problem areas through BMP implementation	Annually	Local units of government
Annual road/stream crossing inventory	RC and DPW reports; before and after photographs; pollutant reduction calculations	Number of BMPs implemented to address road/stream crossings contributing sediment; tons of sediment	Reduction in number of crossings contributing sediment; 25% TSS reduction	Address 30% of existing problem areas through BMP implementation	Address 75% of existing problem areas through BMP implementation	Annually	KCRC and DPWs
Conduct hydrologic study	Status of hydrologic study	Completion of a hydrologic study for the watershed	Update hydrologic study with new data for the entire watershed	Complete hydrologic study for watershed	Implement recommendations from hydrologic study	Once every 5 years	MDEQ, consultants, local units of government
Corrections to faulty sanitary sewer connections	Local units of government reports; pollutant reduction calculations; water quality monitoring	Number of sanitary sewer connections corrected to address pollutants; pounds of phosphorus and nitrogen; *E. coli* concentrations	Reduction in number of connections contributing pollutants; 20% phosphorus and 40% nitrogen reduction; meet WQS for *E. coli*	Address 30% of existing faulty connections through BMP implementation	Address 75% of existing faulty connections through BMP implementation	Annually	Local units of government
Fencing	USDA NRCS yearly status reviews; before and after photographs; pollutant reduction calculations; water quality monitoring	Number of BMPs implemented to address livestock access areas contributing pollutants; tons of sediment; pounds of phosphorus and nitrogen; concentration of *E. coli*	Reduction in number of areas contributing pollutants; 25% TSS, 20% phosphorus, and 40% nitrogen reduction; meet WQS for *E. coli*	Address 75% of existing problem areas through BMP implementation	Identify and address 75% of new problem areas through BMP implementation	Annually	NRCS
Low impact development applications	LID site inspection reports; before and after photographs for retrofits; pollutant reduction calculations; water quality monitoring	Number of BMPs implemented to address urban runoff; storm water volume, tons of sediment, instream temperature, and concentration of toxic substances	30% storm water; 25% TSS reduction; toxic substances not to exceed wildlife values and human cancer values; maintain instream temperature between 60°F – 70°F	Increase overall infiltration by 15% through BMP implementation	Increase overall infiltration by 30% through BMP implementation	Annually	Local units of government, developers
Installation of hydrodynamic separator units	KCRC and DPW reports, before and after photographs, water quality monitoring	Number of BMPs implemented to address impervious areas contributing pollutants, tons of sediment	Reduction in number of catch basins contributing pollutants, 25% TSS reduction	Address 30% of existing problem areas through BMP implementation	Identify and address 75% of existing and 100% new problem areas	Annually	KCRC and DPWs
Management of woody debris and other obstructions	MDNR reports, before and after photographs	Number of BMPs implemented to address streambank erosion; amount of woody debris; number and location of obstructions	Amount of woody debris and other obstructions removed	Establish management plan for woody debris and organize stream clean-ups annually. Manage wood debris and reduce obstructions by 75% at existing problem areas	Identify and address 75% of new problem areas through BMP implementation	Spring/Fall	MDNR
Pet waste stations	Park and recreation department reports; pollutant reduction calculations; water quality monitoring	Number of BMPs implemented to address park areas contributing pollutants; pounds of phosphorus and nitrogen; concentration of *E. coli*	Reduction in number of sites contributing pollutants; 20% phosphorus and 40% nitrogen reduction; meet WQS for *E. coli*	Address 75% of existing problem areas through BMP implementation	Identify and address 75% of new problem areas through BMP implementation	Annually	Park and recreation departments
Repair/replace old culverts	KCRC and DPW reports; before and after photographs; pollutant reduction calculations	Number of BMPs implemented to address road/stream crossings contributing sediment; tons of sediment	Reduction in number of crossings contributing sediment, 25% TSS reduction	Address 30% of existing critical crossings through BMP implementation	Address 75% of existing critical crossings through BMP implementation	Annually	KCRC and DPWs
Septic system ordinance	Ordinance status	Number of ordinances adopted	100% of communities or Kent County adopt ordinances	Draft ordinances	Adopt and implement ordinances	Annually	Local units of government
Silt fence installation	Soil erosion and sedimentation control reports; pollutant reduction calculations	Number of construction areas contributing sediment; tons of sediment	Reduction in number of construction areas contributing sediment, 25% TSS reduction	Reduce in the number of construction sites contributing pollutants by 60% through BMP implementation	Reduce in the number of construction sites contributing pollutants by 90% through BMP implementation	Annually	County enforcing agent, Municipal enforcing agencies
Soil erosion and sedimentation control practices	Soil erosion and sedimentation control reports; pollutant reduction calculations	Number of construction areas contributing sediment; tons of sediment	Reduction in number of construction areas contributing sediment; 25% TSS reduction	Reduce in the number of construction sites contributing pollutants by 60% through BMP implementation	Reduce in the number of construction sites contributing pollutants by 90% through BMP implementation	Annually	County enforcing agent, Municipal enforcing agencies

Table 7.1 - Monitoring Components for BMP Implementation

BMP Recommendations	Monitoring Components	Units of Measurement	Criteria	Short-Term Milestone 1-5 Years	Long-Term Milestone 5-10 Years	Evaluation Schedule	Responsible Partners
Streambank stabilization	KCRC and DPW reports; before and after photographs; pollutant reduction calculations	Number of BMPs implemented to address stream banks contributing sediment; tons of sediment	Reduction in number of stream banks contributing sediment; 25% TSS reduction	Address 30% of existing problem areas through BMP implementation	Address 75% of existing problem areas through BMP implementation	Annually	KCRC, DPWs, landowners
Vegetated filter strips	USDA NRCS yearly status reviews; before and after photographs; pollutant reduction calculations; water quality monitoring	Number of BMPs implemented to address riparian areas contributing pollutants; tons of sediment; pounds of phosphorus and nitrogen; in-stream temperature; concentration of *E. coli*	Reduction in number of riparian areas contributing pollutants; 25% TSS, 20% phosphorus, and 40% nitrogen reduction; maintain instream temperature between 60°F – 70°F; meet WQS for *E. coli*	Address 75% of existing problem areas through BMP implementation	Identify and address 75% of new problem areas through BMP implementation	Annually	NRCS, Ducks Unlimited, US Fish and Wildlife Service
Wetland restoration	MDEQ wetland status reports; before and after photographs; pollutant reduction calculations; water quality monitoring	Net gain of wetland acreage; tons of sediment; concentration of toxic substances	Increased wetland acres in alignment with State goals; 25% TSS reduction; toxic substances not to exceed wildlife values and human cancer values	Restore 5 critical wetland areas through BMP implementation	Restore 20 critical wetland areas through BMP implementation	Annually	NRCS, Ducks Unlimited, US Fish and Wildlife Service

Notes:
KCRC – Kent County Road Commission
DPW – Department of Public Works
USDA – U.S. Department of Agriculture (USDA)
NRCS – USDA Natural Resources Conservation Service
LID – Low Impact Development
E. coli – Escherichia Coli
BMP – Best Management Practice
TSS – Total Suspended Solids
WQS – Water Quality Standards
MDEQ – Michigan Department of Environment Quality

Table 7.2 - Evaluation Techniques for Implementation Phase

Pollutant	Monitoring Components	Units of Measurement	Current Conditions	Measurable Goal
Sediment	Status of hydrologic study	Completion of a approvable hydrologic study	Studies including a hydrology component have been completed for portions of the watershed as well as for the entire watershed in 1990, 1991, 1992, and 1995	Update hydrologic study for entire watershed by 2013
	Ordinance status	Adoption of ordinances	Storm water ordinance: 7/9 townships/ municipalities have adopted Wetland ordinance: 0/9 townships/ municipalities have adopted Green space ordinances: Status unknown	Six of 9 possible townships/ municipalities adopt ordinances
	Report Summaries	Number of BMPs implemented	Minimal	Implement BMPs on all identified NPS sites of sediment loading
	Photographs of BMPs installed	Before and after photographs	Current conditions of NPS sites were documented during the watershed inventory	Portfolio of photographs with supporting documentation
	Pollutant Reduction Calculations	Tons of sediment	180.28 tons/year	Prevent 45 tons/year of sediment from entering surface waters
E. coli	Ordinance status	Adoption of ordinances	Kent County has not adopted a septic system ordinance	Kent County adopts septic system ordinance
	Report Summaries	Number of BMPs implemented	None	Implement BMPs on all identified NPS sites contributing *E. coli*
	Photographs of BMPs installed	Before and after photographs	Current conditions of NPS sites were documented during the watershed inventory	Portfolio of photographs with supporting documentation
	Monitoring	Concentration of *E. coli*	96 to 104,620 *E. Coli* per 100 ml	Meet water quality standards for total body contact recreation (300 *E. coli* per 100 ml)
Nutrients	Ordinance status	Adoption of ordinances	Kent County has not adopted a septic system ordinance	Kent County adopts septic system ordinance
	Report Summaries	Number of BMPs implemented	None	Implement BMPs on all identified NPS sites of nutrient loading
	Photographs of BMPs installed	Before and after photographs	Current conditions documented in watershed inventory	Photographs of past and future conditions documented in a portfolio with supporting documentation
	Pollutant Reduction Calculations	Pounds of phosphorus and nitrogen	Phosphorus: 153.23 lbs/year Nitrogen: 306.47 lbs/year	Prevent 30.65 lbs/year of phosphorus and 122.29 lbs/year of nitrogen from entering surface water
Temperature	Report Summaries	Number of BMPs implemented	None	Implement BMPs on all identified NPS sites of thermal loading
	Photographs of BMPs installed	Before and after photographs	Current conditions of NPS sites were documented during the watershed	Portfolio of photographs with supporting documentation

Table 7.2 - Evaluation Techniques for Implementation Phase

Pollutant	Monitoring Components	Units of Measurement	Current Conditions	Measurable Goal
			inventory	
	Monitoring	Instream temperature	Unknown	60°F to 70°F
Toxic Substances	Ordinance status	Adoption of ordinances	Storm water ordinance: 7/9 townships/ municipalities have adopted Wetland ordinance: 0/9 townships/ municipalities have adopted Green space ordinances: Status unknown	Six of 9 possible townships/ municipalities adopt ordinances
	Report Summaries	Number of BMPs implemented	None	Implement BMPs on all identified NPS sites contributing toxic substances
	Photographs of BMPs installed	Before and after photographs	Current conditions of NPS sites were documented during the watershed inventory	Portfolio of photographs with supporting documentation
	Monitoring	Concentration of toxic substances	Unknown	Toxic substances should not exceed wildlife values and human cancer values (MDEQ 1999)

7.2 INDICATORS OF OVERALL WATER QUALITY

While the previous section described methods for evaluating the implementation of specific BMPs, this section outlines a water quality monitoring program to evaluate the effectiveness of the cumulative implementation efforts over time by assessing changes in watershed conditions.

7.2.1 Quantitative Measurements

Quantitative measurements are used in this evaluation to determine the level and rate of water quality improvements, focusing on areas of physical, chemical, and biological improvements. Methods of evaluation will be used to monitor the success of the project, both immediately following implementation and for continual monitoring of the water quality.

Quantitative measurements are further defined by categories of indirect indicators and direct environmental indicators. Indirect indicators are those that are measurements of practices and activities that could indicate water quality improvements but do not actually measure the water quality itself. For example, estimating the pollutant reduction that a practice will achieve is stating that a certain amount of that pollutant will be prevented from entering the stream. Another indirect indicator would be the miles of vegetated filter strips installed as a percentage of the total miles of riparian areas without buffers. This percentage of installation could be compared to the goals of Watershed and the success could be measured.

Direct environmental indicators would measure the quality of the water through scientific investigation. Sediment load and nutrient load reductions could be measured through biological and chemical analysis of the water. Macroinvertebrate surveys are also direct environmental indicators of water quality since some insects are very sensitive to changes in a stream's health.

Quantitative measurements will be used to determine whether the pollutant load reduction goals are being met. Pollutant reduction criteria have been established for the known and suspected pollutants of the Watershed as described below.

7.2.1.1 SEDIMENT

Although all streams carry a natural amount of bed load sediment, excessive additions of sediment from uplands can degrade stream habitat. To restore the biological community to an acceptable condition and attain water quality standards (WQS), this plan recommends that sediment load carried by Plaster Creek be reduced by 25%.

7.2.1.2 *E. COLI*

The criteria for *E. coli* will be based on WQS and attaining designated uses. *E. coli* concentrations must meet WQS established for total and partial body contact recreation. Total body contact recreation standards, set by the State, are 130 count *E. coli* per 100 milliliter (ml) as a 30-day geometric mean from May 1 to October 31. Partial body contact recreation standards are 1,000 count *E. coli* as a 30-day geometric mean all year. Plaster Creek currently meets partial body contact recreation criteria, but not total body contact recreation criteria.

7.2.1.3 NUTRIENTS

Nuisance algae and aquatic plant growth are usually caused by excessive amounts of phosphorus and nitrogen entering the surface water. The State requires that "nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the waters of the State." The qualitative measurements for nutrients are similar to those of sediment, since the sources of loadings of these pollutants have comparable paths. The qualitative measurements will be conducted through acroinvertebrate and biological surveys, using orthophosphate, total phosphorus, nitrite, nitrate plus nitrite, and Kjeldahl nitrogen as the nutrient parameters. Levels of <0.05 milligrams per liter (mg/l) of total phosphorus is considered a normal level adequate for plant and algal growth. The amount of Kjeldahl nitrogen normally present in surface water is <3.0 mg/l. Elevated levels usually indicate recent, nearby pollution entering the surface water.

7.2.1.4 THERMAL POLLUTION

Impervious surfaces and a lack of sufficient riparian vegetation can cause increases in instream water temperature. These sources are suspected of raising the surface water temperature of the Watershed. To support the warmwater fish species of Plaster Creek and its tributaries, instream temperature should fall between 60°F to 70°F, the typical temperature range for a warm water fishery.

7.2.1.5 TOXIC SUBSTANCES

Urban runoff can carry many toxic and dangerous materials into the waterways. Toxic substances include synthetic organic contaminants (e.g. pesticides, herbicides) and volatile organic contaminants (e.g. xylenes, toluene, and benzene). Hydrocarbons are also considered toxic substances and often occur in petroleum, natural gas, coal, and bitumens (asphalt and tar are the most common forms of bitumen). The presence of hydrocarbons in a waterbody can result from the input of urban runoff containing automotive petroleum products, illicit dumping of used motor oil into storm drains, or discharges from agricultural sites. Plaster Creek and its tributaries should be monitored to determine if

toxic substances are present at levels which exceed established wildlife values and human cancer values (MDEQ 1999).

7.2.1.6 BIOLOGICAL

In addition to assessing stream pollutants, this plan recommends conducting biological assessment of the Watershed to evaluate stream health. The MDEQ has developed a system, Procedure 51, to estimate stream condition based on the diversity and abundance of the benthic acroinvertebrate community. Freshwater benthic acroinvertebrate are animals without backbones that are larger than 0.5 millimeter (the size of a pencil dot). Macroinvertebrates include crustaceans, such as crayfish, mollusks (such as clams and snails), aquatic worms, and immature forms of aquatic insects, such as stonefly and mayfly nymphs. These animals live on rocks, logs, sediment, debris, and aquatic plants during some period in their life. When these acroinvertebrate are found in diverse communities, which include species sensitive to pollution (i.e. stoneflies, mayflies, and caddisflies), the stream is generally classified as having "fair" or "excellent" water quality. Streams with large inputs of organic matter, and therefore low dissolved oxygen concentrations, will typically how low acroinvertebrate diversity and will include an abundance of pollution tolerant species, such as worms and midges. These streams are classified as having "poor" water quality.

For Plaster Creek, the MDEQ established a biota TMDL target to achieve a acroinvertebrate community with an acceptable score (i.e. a score that supports designated uses) (MDEQ, 2002b). The acroinvertebrate community scores will be evaluated by the MDEQ based on a minimum of two biological assessments conducted in two consecutive years following the implementation of BMPs to minimize sediment loadings to the subject TMDL reach. A stream habitat quality assessment will also be used to measure water quality standards for aquatic life. A habitat quality score of fair has been established as the target for the habitat quality, and will be used to represent adequate control of anthropogenic sediment sources so as to improve habitat quality and the biological community.

7.2.2 Watershed Monitoring Efforts

Physical assessments of water quality will be conducted through field investigations, which will include measurements of water quality parameters, such as *E. coli*, Total Suspended Solids (TSS), and assessments of macroinvertebrate assemblages and habitat conditions. Table 7.3 describes the watershed monitoring and evaluation plan in terms of the agency or organization responsible for conducting the monitoring, parameters and locations of the monitoring, and status of the monitoring programs. The site locations listed in Table 7.3 that have been recently monitored are included in Figure 12. The water quality monitoring programs listed in Table 7.3 are described below.

7.2.2.1 WATER QUALITY MONITORING

The City of Grand Rapids (City) monitors temperature, dissolved oxygen, TSS, and sodium chloride at 2 locations in the Watershed, Plaster Creek at Burton Street and Silver Creek at Croften and Roy. The City uses these parameters to determine a water quality index number. The water quality index (WQI) is a statistic designed to closely approximate state and national WQI's. The usual factors that enter into its calculation are the percent saturation of dissolved oxygen, the change in temperature from a reference temperature (usually the most upstream from heat sources), pH, biochemical oxygen demand, total solids, Fecal coliform counts, phosphate, nitrate, and turbidity. For each parameter, a Q-statistic is calculated on a scale of 0 to 100, 100 being best. The Q statistic is subject to exponentially weighted averaging to produce the WQI. Not all of the standard WQI tests are performed by the City. Total solids are not measured. However, total suspended solids and chloride are measured. The sum of the total suspended solids and the chloride values, as sodium chloride, give the City a reasonably close approximation of the total solids. This sum is then used in place of the total solids value in the WQI. Turbidity is also not measured since there is not a way to approximate it from the other collected data. This measurement has therefore been omitted and the weighting factors have been adjusted to cover this omission. WQI values are reported to the public online at:

www.ci.grand-rapids.mi.us/index.pl?page_id=1958.

In 2001, the MDEQ monitored *E. coli* at ten locations along Plaster Creek and its tributaries. The MDEQ has noted in their TMDL report (2002a) that additional sampling will be conducted by the MDEQ from May to September in the future to determine if surface water is meeting water quality standards for total and partial body contact recreation.

The Plaster Creek Steering Committee will be responsible for conducting additional water quality monitoring in the Watershed to supplement existing efforts. A program for monitoring TSS and *E. coli* should be implemented to determine pollutant load reductions following BMP implementation. The Kent County Health Department and Grand Rapids Wastewater Treatment Plant would assist with the lab analysis. It is recommended that samples be collected from sites previously monitored by the MDEQ in order to have baseline line data for comparison and to complement any existing monitoring efforts of the MDEQ.

7.2.2.2 BIOLOGICAL ASSESSMENTS

The MDEQ conducts biological sampling using the Procedure 51 sampling protocol typically every five years in major watersheds. This assessment includes a survey of the benthic acroinvertebrate community. The MDEQ conducted such an assessment of the Watershed in 2001. Comparing future

results to the most recent survey will show whether the installation of BMPs has actually improved water quality.

The West Michigan Environmental Action Council (WMEAC) administers Stream Search, a project that uses volunteers to check the health of streams in Kent County. Volunteer groups trained by WMEAC conduct biological and habitat assessments using the Procedure 51 protocol developed by the MDEQ. Stream searches have been conducted on reaches of Plaster Creek through this program and future investigations are planned.

7.2.2.3 STORM WATER OUTFALL SCREENING

As part of the National Pollutant Discharge Elimination System Phase II Storm Water Program, local units of government in the Watershed with Municipal Separate Storm Sewer System (MS4) permits are implementing an illicit discharge elimination plan to identify and correct illicit discharges and connections to the MS4. As part of this plan, a reconnaissance of the urbanized areas of the Watershed was conducted during the summer of 2004. The location of all observed storm water outfalls was documented and the outfall discharge was tested, if flow was present. The information recorded for each outfall included outfall size and material, amount of flow, odor, color, floatables, deposits, abnormal vegetation, conductivity, pH, ammonia, copper, nitrate, nitrite, phosphorus, surfactants, surrounding land use, and any field comments. Each site was prioritized and flagged for immediate attention or a follow-up visit, if appropriate. Local units of government have begun to address outfalls suspected of having an illicit discharge or connections based on the initial screening process. Beginning in 2010, outfalls will be screened a second time and this process will continue every five years to identify and address future illicit discharges and connections.

Table 7.3 - Monitoring and Evaluation

Organization	Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
City of Grand Rapids	Plaster Creek at Burton St. **(GR01)*** Silver Creek at Croften **(GR02)**	Temperature (°C)	Temperature (°C)	Hand-held Temperature probe	1985 – Present	Quarterly	City of Grand Rapids
		Dissolved Oxygen (%)	Dissolved Oxygen (%)	Standard Methods 18th Ed., SM 4500G			
		pH	pH	SM 4500B			
		Biochemical Oxygen Demand (BOD) (mg/L)	BOD (mg/L)	SM 5210B			
		TSS (mg/L)	TSS (mg/L)	SM 2540D			
		Fecal Coliform	Fecal Coliform	SM 9222D			
		Sodium Chloride (mg/L)	Sodium Chloride (mg/L)	SM 4500E			
		Phosphorus (mg/L)	Phosphorus (mg/L)	SM 4500E B5			
		Nitrate (mg/L)	Nitrate (mg/L)	SM 4500E			
		Nitrite (mg/L)	Nitrite (mg/L)	SM 4500B			
WMEAC	Plaster Creek at Division **(WM01)** Plaster Creek Family Park **(WM02)**	Macroinvertebrate diversity and abundance	Macroinvertebrate Survey	MDEQ Protocol/Procedure 51	2000 – Present / Fair to Good ranking	Once/Year	WMEAC volunteers
MDEQ – Surface Water Quality Division	Plaster Creek at Godfrey Ave. **(DEQ01)** Eastern Ave. **(DEQ02)** 68th St. **(DEQ03)** East Paris Ave. **(DEQ04)**	Macroinvertebrate diversity and abundance	Macroinvertebrate Survey	MDEQ Protocol/Procedure 51	2002	Once/5 Years	MDEQ
		Substrate, vegetation, flow and bank stability, temperature, and velocity (as part of hydrologic study)	Stream Habitat Assessment				
MDEQ – Surface Water Quality Division	Plaster Creek at Market St. **(DEQ05)** Godfrey St., 28th St. **(DEQ06)** Schaffer St. **(DEQ07 and DEQ08)** 44th St. **(DEQ09)** 60th St. **(DEQ10)** 68th St. tributary at 28th St **(DEQ11)** 60th St. **(DEQ12)**	Pathogens (*E. coli* count/100 ml)	Pathogens (*E. coli* count/100 ml)	MDEQ Protocol	2002	Once/5 Years	MDEQ
Municipal Separate Storm Sewer System Permittees	Outfalls throughout the Plaster Creek Watershed (see NPDES Phase II IDEP for Grand Rapids, Kentwood, Wyoming, Cascade Township, Grand Rapids Township)	Pathogens (*E. coli* count/100 ml)	Pathogens (*E. coli* count/100 ml)	MDEQ Protocol	2004	Once/5 Years	Kent County Health Department
		Temperature (°C)	Temperature (°C)	Hand-held Temperature probe			FTC&H
		Conductivity (Microsemens)	Conductivity (Microsemens)	Hand-held Conductivity probe			
		pH	pH	Hand-held pH probe			
		Ammonia (mg/L)	Ammonia (mg/L)	Test strips			
		Copper (mg/L)	Copper (mg/L)	Test strips			
		Nitrate (mg/L)	Nitrate (mg/L)	Test strips			
		Nitrite (mg/L)	Nitrite (mg/L)	Test strips			
		Phosphorus (mg/L)	Phosphorus (mg/L)	Test strips/HACH kit			
		Surfactants (presence/absence)	Surfactants (presence/absence)	Jar/glass			

Table 7.3 - Monitoring and Evaluation

Organization	Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Plaster Creek Steering Committee	Plaster Creek at Market St., Godfrey St., 28th St., Schaffer St., 44th St., 60th St., and 68th St. Tributary at 28th St. and 60th St.	Pathogens (*E. coli* count/100 ml)	Pathogens (*E. coli* count/100 ml)	MDEQ Protocol	No current data	Monthly wet and dry weather sampling	Kent County Health Department and Grand Rapids Clean Water Plant
	Plaster Creek at Mouth at Market Ave. **(PC01)** 28th St. between Eastern & Madison **(PC04)** Shaffer (south of Wing) **(PC05)** Shaffer (north of 36th St.) **(PC06)** 44th St. and Meadow Lawn **(PC07)** 60th St. and Hanna Lake Rd. **(PC09)** 68th St. and Glen Hollow **(PC10)** 52nd St. between Wing & East Paris **(PC14)** Burton (east of Clyde Park) **(PC15)** 32nd St. (east of Kalamazoo) **(PC16)** Broadmoor (north of 36th) **(PC17)** 60th St. and Hanna Lake Rd. **(PC18)** Hanna Lake Rd. (south of 68th) **(PC19)**	Pathogens (*E. coli* count/100 ml)	Pathogens (*E. coli* count/100 ml)	MDEQ Protocol	Sampling data collected as part of the Lower Grand River Watershed *E. coli* Implementation Project	Monthly wet and dry weather sampling	Kent County Health Department
	Plaster Creek at Godfrey Ave., Eastern Ave., 68th St., and East Paris Ave.	TSS (mg/L)	TSS (mg/L)	MDEQ Protocol	No current data	Monthly	Grand Rapids Clean Water Plant

* Site locations indicated on Figure 12

CHAPTER 8 - SUSTAINABILITY

8.1 LOWER GRAND RIVER WATERSHED MANAGEMENT PLAN

The Grand Valley Metropolitan Council (GVMC) and the Lower Grand River Watershed (LGRW) Steering Committee completed a watershed management plan (WMP) for the LGRW in September 2004, during the LGRW Planning Project, The LGRW Management Plan is a broad, reference-oriented document that takes a holistic, ecosystem approach to watershed management. This plan recommends structural and vegetative, managerial, and policy best management practices, as well as information and education activities, to address activities that contribute to elevated sediment, nutrient, and pathogen levels. The plan also provides a long range vision for the LGRW, with guidelines and recommendations to achieve that vision. The vision, mission statement, and core values for the LGRW place the LGRW Management Plan initiative in a much larger context for long-term success.

LGRW Vision: Connecting water with life: swimming, drinking, fishing, and enjoying all the waters of our Grand River Watershed.

LGRW Mission Statement: "Discover and value all water resources and celebrate our shared water legacy throughout our entire Grand River Watershed community."

LGRW Core Values:

- Activities will be diverse, inclusive and collaborative
- Efforts are sustainable and high quality
- Images and messages create a widely shared sense of legacy and heritage
- Methods and products are holistic and employ a systems approach
- The organization and program offers incentives, evaluates progress, and rewards success

8.2 PLASTER CREEK WMP

The Plaster Creek WMP was developed to assist watershed stakeholders in addressing the sediment, pathogen, and nutrient concerns facing Plaster Creek and its tributaries. The plan provides an implementation strategy designed to meet the Watershed's goals and objectives within the context of the longer range vision of the LGRW Management Plan. Recommendations for the impaired urban areas of the Plaster Creek Watershed can be extrapolated for use and adoption in other urban areas of the LGRW experiencing similar problems. Urban communities in the LGRW can also evaluate the success of the management measures implemented in the Watershed to determine which measures would be best for

their particular subwatershed. Coordination between the two WMPs better ensures long term success at meeting the goals and objectives established for both watersheds.

8.3 LOWER GRAND RIVER ORGANIZATION OF WATERSHEDS

The GVMC established the Lower Grand River Organization of Watersheds (LGROW) in 2007 to provide basin-wide oversight, implement regional or watershed-wide initiatives, and prioritize water quality concerns. The LGROW operates under, and serves as custodian for, the vision, mission, and the strategic direction developed for the LGRW. The current board includes 13 members representing local units of government, existing watershed organizations, environmental organizations, and foundations.

According to their strategic plan, the LGROW will serve as an umbrella organization under which subwatershed organizations of the LGRW can operate. The LGROW will provide the opportunity for subwatershed groups to work together and share information and resources to collectively reach the overall goals and objectives of the LGRW. LGROW will also facilitate the formation of subwatershed groups that would be capable of creating subwatershed management plans and grassroots level opportunities for local governments and residents. While the LGROW will identify priorities within the Grand River Watershed and facilitate watershed-wide projects that address high priority concerns, the subwatershed organizations would manage operations within the subwatersheds, implement subwatershed management plans, and serve as a liaison between local stakeholders and the LGROW.

8.4 PLASTER CREEK WATERSHED ORGANIZATION

Michigan is home to a number of watershed organizations that have successfully leveraged community support to continue efforts to cleanup and beautify their rivers, lakes, and streams. Some of these watershed organizations are found within the LGRW. The Rogue River Watershed Council, the Sand Creek Watershed Partners, and the Coldwater River Watershed Council are examples of subwatershed organizations that are operating individually within the LGRW.

The initiative behind the LGRW is municipally driven. Municipally driven projects tend to have greater stability for funding, as long as the watershed organization provides a service to local governments. However, stability and government services alone will not meet the LGRW Mission Statement of engaging the public to value water as a resource. A grassroots component involving the public and local governments is needed in the Plaster Creek Watershed (Watershed) to capture the core values outlined in the LGRW Mission Statement.

Creating a grassroots watershed organization in small watersheds can be difficult. Holding meetings, mailing correspondence, setting up tax-exempt status, and organizing stakeholders may be tasks too large to overcome by small grassroots efforts without grant monies or a government interest. However,

the LGROW has made itself available to provide technical assistance for fledgling watershed organizations and grassroots efforts. Once a subwatershed organization is established, the LGROW can serve as a facilitator until the group is capable of sustainable independence.

8.5 LOCAL EFFORTS

8.5.1 NPDES Phase II Communities

Communities within the Watershed have been identified by the United States Environmental Protection Agency (EPA) as having urbanized areas requiring a National Pollutant Discharge Elimination System (NPDES) storm water discharge permit. These communities include the cites of East Grand Rapids, Grand Rapids, Kentwood, and Wyoming, and Gaines Charter Township, Cascade Charter Township, and Grand Rapids Charter Township. These cities and townships have been required by the EPA to develop a Storm Water Pollution Prevention Initiative (SWPPI) in accordance with NPDES Phase II Storm Water Regulations. These communities have worked together to develop a watershed-based strategy to pursue compliance with these regulations. Caledonia Township and Ada Township are no longer required to have NPDES Phase II permits since MDEQ determined that they do not own or operate a municipal separate storm sewer system (MS4).

The SWPPI component of the NPDES Phase II Storm Water Regulations requires each jurisdiction to identify significant sources of storm water pollution and to develop an action oriented strategy to address each pollutant. The SWPPIs are designed to reduce the discharge of pollutants to the maximum extent practicable with guidance from the goals and objectives set forth in a WMP. SWPPIs developed for communities in the LGRW were submitted to the Michigan Department of Environment Quality (MDEQ) in April 2006. These SWPPIs will be used to evaluate each community's actions toward mitigating impairments caused by storm water pollution.

8.5.2 Metropolitan Development Blueprint

The GVMC was organized as a response to decades of ineffective efforts to coordinate the scores of governmental entities each acting independently, yet each striving for ways to better collaborate. Though now nearly a decade old, the Metropolitan Development Blueprint (MDB) was developed as a tool for governments to achieve that collaboration. The MDB defined what the metropolitan region looked like and offered a chance for communities to act in a more consistent, well organized manner.

The GVMC began a process which enlisted hundreds of interested regional citizens in four subject groups: Land Use, Transportation, Utilities and Environment/Natural Resources. After a year long effort, which led to 23 visions supported by 53 individual strategies, the MDB Steering Committee condensed

the final report into 3 central themes and 7 broad initial strategies. These were adopted by GVMC in their effort to "change business as usual."

8.5.2.1 THEMES

1. A network of open lands and greenways should be developed and preserved,
2. The creation of compact centers of regional economic activity, and
3. Promote compact livable communities.

8.5.2.2 STRATEGIES

1. Create a Blueprint Commission.
2. Complete an inventory of natural assets.
3. Design a transit system based on Blueprint themes.
4. Define regional employment and activity centers.
5. Review region-wide water and sewer utility systems in relation to land use.
6. Convene a collaboration of public and private planners to encourage compact livable communities.
7. Create and encourage sub-regional planning alliances.

A newly established Blueprint Committee declared a set of guiding principles spelling out its beliefs pertaining to shared regional interests. These principles were adopted by GVMC in September 2000 and were used as one of many important guides in the remaining process. These principals added significantly to the central themes and initial strategies of the MDB and gave a much clearer picture of future directions for metropolitan planning.

The GVMC Planning Department soon determined that the best way to accomplish nearly all the remaining strategies, and to do so living within the spirit of both the original MDB and the Blueprint Principles, was develop a type of regional "plan" would be necessary for the Greater Grand Rapids metropolitan area. This plan would not be like a local land use plan in that it would cover development patterns and regional infrastructure in a much broader way. Over a two-year period, GVMC staff devised and proposed a methodology which established a process for planning the metropolitan region.

After discussions with local officials throughout the metro area, it was concluded that the best way to gain a single regional perspective on growth was to group the 50 or so governing entities of the metro area into logical divisions. The "logic" in this case applies to a particular regional perspective shared by many local governments in a particular portion of the metro region. For example, on the north end of the metro region, 14 communities within the Rogue River Watershed believed a Watershed Council was the most appropriate regional role for them. Ten communities in the southern part of the metro region saw their greatest regional role to be related to the newly forming M-6 Southbelt freeway. In all, GVMC staff helped

establish seven such “subregional entities” through which joint planning could be conducted through a single metro-wide perspective. The opportunity exists for the communities involved in the M-6 Southbelt freeway subregional entity to also form a Watershed Council to incorporate the water quality concerns within the Buck and Plaster Creek Watersheds.

8.5.3 Calvin College

During the summer of 2004, the Plaster Creek Working Group, representing Calvin College, the West Michigan Environmental Action Council, and the Christian Reformed Church (Grand Rapids Classis East) began to gather information on Plaster Creek, map the watershed, and identify partners and ways to be involved, using existing resources and programs. The following initiatives were identified.

1. Calvin Environmental Assessment Program (CEAP) involves faculty who dedicate regular lab sessions or course projects to collecting data that contribute to an overall assessment of the environment of the campus and surroundings areas. CEAP is increasingly focused on the Watershed.

2. The science education program at Calvin is directly involved in community K-12 science education on many levels, helping teachers develop a coherent science curriculum for their schools that is inquiry-based, infused with technology, and aligned with state standards. Faculty regularly provides professional development to area teachers. A new direction on the part of Calvin College science education is to use the Plaster Creek watershed as the context for community K-12 science education initiatives.

3. Calvin’s Office of Community Engagement serves as a catalyst for Calvin’s efforts in engaged scholarship and brings oversight to the growing numbers of college programs and partnerships with community agencies, schools, and organizations. This office’s strategic plan identifies environment as one of four key focus areas.

4. The Calvin College Ecosystem Preserve provides educational programs to over 1,000 elementary school aged children each year. The preserve was awarded two grants to design a watershed unit for children in grades 3 to 5 to complement other outdoor education programs at its new Bunker Interpretive Center. Calvin is developing an interactive display for the center designed to help visitors understand how they are connected to a local watershed.

Calvin College also plans to partner closely with two new complimentary programs at Calvin. Professor Ken Bergwerff received a grant from the EPA to improve environmental education at local schools by providing professional development to area high school teachers. With a focus on Plaster Creek, teachers will learn about watershed issues and be introduced to existing curricula, activity books, and tools. They will work together to create educational units that encourage students to use scientific

inquiry to formulate, design, gather, analyze, and present information on the physical, biological, and chemical water quality of the Watershed. A second program is the National Science Foundation (NSF) funded Team Researchers in a GLOBE-al Environment (TRIAGE), designed to help middle school students develop authentic scientific research skills and thinking as part of a comprehensive focus on environmental sustainability. Calvin's Bunker Interpretive Center will connect over 100 students to various research projects in the community. Students will be invited to participate in restoration activities, including starting their own Adopt-A-Stream group, and create a number of rain-gardens within the Watershed.

8.6 OPPORTUNITIES AND FUNDING SOURCES

8.6.1 GVMC

The GVMC participated extensively with planning efforts to complete this WMP. Support for future planning efforts could be provided by GVMC through grant provisions like local match and in-kind services.

8.6.2 Kent County Administration

Kent County Administration has provided support through local match and in-kind services during the LGRW Planning Project. Institutionalizing the WMP recommendations could be accomplished by the Kent County Administration through the Planning Commission, Department of Public Works, and Parks and Recreation.

8.6.3 Kent County Drain Commissioner

The Kent County Drain Commissioner has designated waterways in the Watershed as county drains. These county drains have established drainage districts. Residents living in a drainage district are assessed for modifications to the drain that improve storm water drainage and reduce flooding. Recommendations in this WMP could be implemented through a special assessment for water quality improvements in the drainage district.

8.6.4 Kent County Road Commission

Road stream crossings are often a source of nonpoint source pollution, including excessive sediment input. Any road stream crossing identified for improvements in the Watershed could be completed by the Kent County Road Commission in accordance with recommendations in this WMP.

8.6.5 U.S. Department of Agriculture (USDA)

The USDA Farm Services Agency (FSA) and Natural Resources Conservation Service (NRCS) provide technical and financial assistance to landowners to address resource concerns of soil, water, air, plants, and animals. The agencies offer cost-share opportunities through many federal programs and coordinate with state and local programs to maximize benefits. More information can be obtained at http://www.mi.nrcs.usda.gov/.

8.6.6 Conservation Reserve Program

The Conservation Reserve Program (CRP) was created in 1985 as part of the Food Security Act. A farmer may enter into a long-term contract to set aside land and establish a permanent cover. In return, the farmer receives an annual per-acre rent and up to half the cost of establishing cover on land that has recently been farmed and is highly erodible or environmentally sensitive. In the first five years of the program, 33.9 million acres were enrolled in the CRP. Additional Acts in 1990 and 1996 have allowed continued enrollment and expanded the scope from reducing soil erosion to include habitat conservation. Participants may sign up at any time to perform the following practices on their land:

- Filter Strips
- Riparian Buffers
- Shelterbelts, Field Windbreaks, and Living Snow Fences
- Grass Waterways
- Shallow Water Areas for Wildlife
- Salt-Tolerant Vegetation
- Certain Approved Public Wellhead Protection Areas

8.6.7 Wetland Reserve Program

The Wetland Reserve Program (WRP) receives technical assistance through NRCS. The landowner controls access to the land and may use it for recreational activities such as hunting and fishing. There are three options for the WRP.

1. Ten-year Cost Share Agreement: This agreement is a cost share program where the NRCS pays 75% of the restoration costs and the landowner signs an agreement to keep the wetland in place for 10 years. This option is very similar to the United States Fish and Wildlife Service's Partners for Wildlife Program.

2. Thirty-Year Easement Option: The NRCS "purchases" a 30-year conservation easement over the property. The NRCS will pay 75% of all restoration costs and pay the landowner 75% of the appraised agricultural value of the property under the easement.

3. Permanent Easement Option: The NRCS "purchases" a permanent conservation easement over the property. The NRCS will pay 100% of all restoration costs and pay the landowner 100% of the appraised agricultural value of the property under the easement.

Today, the Environmental Benefits Index (EBI) is used to prioritize land offered for enrollment. Scores are based on a cost factor, plus six environmental factors, as follows:

- Wildlife
- Water Quality
- Erosion
- Enduring Benefits
- Air Quality Benefits from Reduced Wind Erosion
- State or National Conservation Priority Areas (CPAs). The Great Lakes, along with Long Island Sound, the Chesapeake Bay, the Longleaf Pine region, and the Prairie Pothole region comprise the national CPAs.

8.6.8 Funding Sources

Typically, WMP implementation is funded through federal and state grants. Because these grant sources are highly competitive, they can be an unreliable source of funding. However, self-sustaining funds from endowments and revenues generated by community services are a more reliable approach to funding watershed implementation activities. Examples of these funding sources include, but are not limited to, the following:

- Membership dues
- Fund drives
- Charity events (e.g. angler competition, dinners, auctions)
- Educational services
- Government services (e.g. storm water regulation administration, ordinance development, streambank stabilization)

8.7 RESOURCES

Materials, data sources, and publications used to complete this WMP are listed in a resource library created during the LGRW Planning Project. This library can be found online at www.lowergrandriver.org.

Future watershed projects in the LGRW can access this library to find useful publications for completing a WMP.

CHAPTER 9 - INFORMATION AND EDUCATION STRATEGY

9.1 INTRODUCTION

As part of any watershed planning project, an Information & Education (I&E) Strategy is developed to create a framework for motivating watershed stakeholders, residents, and other decision makers to take the actions necessary to protect and improve water quality and environmental conditions. The Plaster Creek Watershed I&E Strategy will serve as a working document that outlines the major steps and actions needed to successfully improve and maintain water quality and environmental conditions in the Plaster Creek Watershed (Watershed). This I&E Strategy is based on the larger Lower Grand River Watershed (LGRW) I&E Strategy, developed during the LGRW Planning Project, and outlines a similar approach for raising awareness, educating stakeholders, and inspiring action.

9.2 STRATEGY COMPONENTS

The primary goals of the Plaster Creek Watershed Management Plan (WMP) are to 1) improve and protect habitats for fish and other indigenous aquatic life and wildlife, and 2) improve and protect the safety and enjoyment of fishing, public access, and wading. The I&E efforts outlined in this I&E Strategy will achieve the watershed management goals by increasing the involvement of the community in watershed improvement activities through awareness, education, and action. To move target audiences through the phases of outreach from awareness to education and finally to action, three specific I&E objectives have been developed to achieve the Watershed goals. The activities and delivery mechanisms outlined in Table 9.1 should be designed and implemented to meet objectives 1 through 3 in order to raise awareness, educate target audiences, and inspire action.

Objective 1 - Awareness: Make the target audience aware that they live in a watershed with unique resources and that their day-to-day activities affect the quality of those resources.

Objective 2 - Education: Educate target audiences on the link between urban development, agricultural activities, and water quality impacts, and highlight what actions can be taken to reduce impacts.

Objective 3 - Action: Motivate the audience to adopt and implement practices that will result in water quality improvements. These practices may include homeowner activities such as reducing fertilizer application, maintaining septic systems, purchasing properties with low-impact design elements, maintaining stream buffers on their properties, or supporting land use planning practices in the Watershed.

9.2.1 Target Audiences

Key target audiences, whose support is needed to achieve the watershed management goals, have been identified (Table 9.1). The following target audiences include groups known to impact, or be impacted by, water quality:

- Agricultural landowners
- Developers
- Departments of Public Works
- Engineers
- Golf courses
- Kent County Road Commission
- Lawn care companies
- Local units of government
- Michigan Department of Transportation
- Off road vehicle (ORV) users
- Pet owners
- Riparian landowners
- Septic system owners
- Storm water operators
- Urban residents
- Faith-based organizations

Characterizing each target audience is an important part of implementing an I&E strategy. Collecting demographic information will help define the socioeconomic structure of each target audience. Information on existing knowledge of watershed issues, current attitudes and beliefs, and existing communications channels will also be relevant and should be determined before initiating an education campaign. This information will ensure that appropriate messages are reaching the designated target audiences using effective formats and distribution methods.

9.2.2 Developing Messages

Implementation of the I&E strategy will need to effectively communicate with the wide range of audiences that make up the community. Specific messages will need to be developed that raise awareness, educate individuals on the problems and solutions, and inspire action. These messages should be repeated frequently to be effective. Each audience will respond differently to the information presented, and it is critical that the information be tailored to each audience. Each target audience must have a clear understanding of the watershed problems being addressed and how the project is addressing these problems before any behavioral changes are to take place. Some key messages include, but are not limited to, the following:

- We all live in a watershed. Your watershed is a unique resource in which everyone can enjoy and take pride.
- Protecting our watershed also protects your pocketbook.
- Take part in shaping your future.
- Water quality of lakes and streams is greatly affected by your everyday activities. Changes in simple activities can protect your watershed.

An effective activity to first increase awareness of Plaster Creek as a unique resource is to collect and disseminate local historical knowledge of the Watershed. Old newspaper stories, photographs, oral histories, and previous studies can all contribute to establishing a sense of place and pride for a watershed. This activity should be initiated before the implementation of the strategy to address specific concerns.

9.2.3 Formats and Distribution

Because the collective target audience is broad, multiple formats will be necessary to reach each audience and to reinforce messages over time. Formats should be phased in as each audience moves from awareness to education and finally to action. Initially, efforts should largely focus on media outlets and printed materials to raise awareness and educate audiences on water quality issues. During these awareness and education phases, materials could include media releases, fact sheets, and guidebooks. Formats that focus on solutions and actions should be developed as the audiences become more aware of the existing water quality concerns. These formats could include targeted training workshop, field demonstrations, tours, and other events.

Formats should be distributed through a variety of delivery mechanisms (Table 9.1). One of the most effective means of distributing information is to piggyback with existing material distributions already received by the target audience. This approach helps to leverage resources, and materials are more likely to be seen by the audience since they are already familiar with the format.

9.2.4 Evaluation

Evaluation of the education campaign provides a feedback mechanism for continuous improvement of the I&E Strategy. Evaluation tools should be built into the strategy at the beginning to ensure that accurate feedback is generated.

In regard to specific I&E tasks, the purpose, theme, and objective (learning, behavioral, and emotional) of each delivery mechanism should be defined prior to implementation. An I&E worksheet developed for

completing such an assessment was created during the LGRW Planning Phase and is provided in Appendix 8 defining each activity during its initial development results in more fine-tuned product and one that can be more easily evaluated based on its initial purpose and objectives. Table 9.1 recommends evaluation methods to assess the success of each delivery mechanism, in accordance with the I&E worksheet.

Although evaluation of specific components within the I&E Strategy will occur continuously, the I&E Strategy should be will be periodically reviewed and adjusted as necessary. Questions that should be considered during implementation of the I&E Strategy are listed below.

- Are the planned activities being implemented according to the schedule?
- Is additional support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated sufficient to carry out the tasks?
- Are all of the target audiences being reached?
- What feedback has been received, and how does it affect the I&E strategy program?
- How do the Best Management Practice (BMP) implementation activities correspond to the I&E strategy?

9.3 STRATEGY IMPLEMENTATION AND ADMINISTRATION

9.3.1 Organizing Strategy Administration

The I&E Strategy will primarily be administered by the Plaster Creek Steering Committee and the Lower Grand River Organization of Watersheds (LGROW). The associated tasks, responsible parties, timeline, and estimated costs to implement the delivery mechanisms of the I&E strategy are included in Table 9.2. The Plaster Creek Steering Committee will be responsible for administering the strategy and coordinating activities with project partners such as Kent County Health Department, Kent County Road Commission, Parks and Recreation Departments, West Michigan Environmental Action Council, Natural Resources Conservation Service, Timberland Resource, Conservation, & Development (RC&D), and Kent Conservation District. The Plaster Creek Steering Committee will prioritize the I&E activities based on the critical areas identified in Table 5.5 and Table 9.1. The responsibilities of the Plaster Creek Steering Committee, with guidance from LGROW, will include the following:

- Oversight of the project
- Obtaining grants or appropriations
- Establishing strategy development milestones and tracking progress
- Obtaining volunteer support

- Advertising the strategy
- Participating in activities

9.3.2 Project Priorities

Project priorities need to be established to direct resources to the areas that will realize the greatest benefits. The LGROW has designated the following public education activities as high-priority activities in terms of resource allocation:

- Activities that build on existing efforts: These activities include watershed programs in adjacent areas, land use planning efforts, and statewide programs.

- Activities that consider future regulatory requirements, such as National Pollutant Discharge Elimination System Phase II Storm Water Regulations, and Total Maximum Daily Load actions.

- Activities that must be conducted to lay the foundation for future efforts, such as awareness campaigns in the local press to bring the major watershed issues to the forefront.

- Activities that strengthen relationships or form partnerships within the Watershed.

- Activities that leverage external funding sources (such as grants).

9.3.3 Resources

This I&E strategy is based on the LGRW I&E Strategy and the *LGRW Project I&E Guidebook,* both developed during the LGRW Planning Project. These resources are available online at www.lowergrandriver.org. While the LGRW I&E Strategy defines an outreach campaign for the entire LGRW, the I&E Guidebook was developed for subwatersheds of the LGRW wishing to implement a campaign based on the larger LGRW I&E strategy. Both documents should be reviewed before implementing the I&E strategy for this watershed.

Table 9.1 - Information and Education Strategy

Causes	Objectives	Target audiences	Activities and delivery mechanisms	Evaluation methods	Critical Areas To Target
Flashy flows (k)	Stabilize stream flows to moderate hydrology and increase base flow	Local units of government; engineers; developers	Hold targeted training workshops on the model storm water ordinance and available stream stabilization practices	Follow-up questionnaire; track number of new ordinances adopted and stream stabilization practices	Entire watershed
Storm water outfalls and tile outlets (k)	Minimize impact of drainage systems on streambanks	Local units of government; engineers; developers	Hold targeted training workshops on drainage control practices	Follow-up questionnaire; track number of new drainage control practices	Entire watershed until specifically identified and prioritized
Livestock access (k)	Install livestock exclusion fencing	Agricultural landowners	Hold targeted training workshops on livestock exclusion and cost-share opportunities	Follow-up questionnaire; track the number of miles of new exclusion fencing	Subbasins 0, 1, 2, and 3
Road/stream crossings (k)	Reduce sediment input from road/stream crossings	Kent county road commission	Hold tours of road/stream crossings which successfully control erosion and runoff	Follow-up questionnaire; track the number of improved road/stream crossings	Entire watershed
Log jams (k)	Implement woody debris management strategies and remove obstructions	Riparian landowners	Distribute fact sheets on proper woody debris and obstruction removal practices with web link for more information	Number of website hits and number of stream miles undergoing woody debris management or obstruction removal	Entire watershed until specifically identified and prioritized
ORV use (k)	Encourage proper use of ORVs near stream banks	ORV users	Distribute fact sheets on ORV use with web link for more information	Number of website hits and users properly using ORV's to reduce stream pollution	Subbasins 0, 1, 2, 3, 4, 5, and 6
Untreated urban runoff (k)	Treat and manage urban runoff	Local units of government; engineers; developers, faith-based organizations	Hold tours of successful urban runoff practices	Follow-up questionnaire; track number of new urban runoff practices	Entire watershed
Rill and gully erosion (k)	Promote conservation tillage practices and cover crops	Agricultural landowners	Hold targeted training workshops on agricultural practices and cost-share opportunities	Follow-up questionnaire; track the number of new agricultural practices	Subbasins 0, 1, 2, and 3
Improper erosion and sediment control measures (k)	Encourage use of erosion and sediment control measures	Storm water operators	Hold targeted training workshops on erosion and sediment control practices	Follow-up questionnaire; track number of new erosion and sediment control practices	Entire watershed
Livestock access (k)	Restrict livestock access to waterways	Agricultural landowners	Hold targeted training workshops on livestock exclusion and cost-share opportunities	Follow-up questionnaire; track the number of miles of new exclusion fencing	Subbasins 0, 1, 2, and 3
Manure spreading (s)	Encourage proper manure spreading practices	Agricultural landowners	Hold field demonstrations on proper manure spreading practices	Follow-up questionnaire; track number of new manure spreading practices	Subbasins 0, 1, 2, and 3
Feedlot runoff (s)	Encourage feedlot runoff management practices	Agricultural landowners	Hold field demonstrations on proper feedlot runoff practices	Follow-up questionnaire; track number of miles of new feedlot runoff practices	Subbasins 0, 1, 2, and 3
Wildlife (s)	Control geese and raccoon populations	Riparian landowners; local units of government	Hold tours of successful animal control practices	Follow-up questionnaire; track number of new animal control practices	Entire watershed
Pet waste (s)	Reduce amount of pet waste entering waterways	Pet owners	Distribute fact sheets on pet waste disposal with web link for more information; distribute media releases	Track the number of website hits and new owners properly disposing of pet waste	Entire watershed
Improper septic system maintenance (s)	Encourage proper septic system maintenance	Septic system owners	Distribute *a homeowner's guide to septic systems;* distribute media releases	Follow-up questionnaire; track number of new septic system maintenance practices	Subbasins 0, 1, 2, 3, 4, and 7
Faulty connections (s)	Correct faulty sanitary sewer connections	Local units of government	Hold targeted training workshops on locating and correcting faulty connections	Follow-up questionnaire; track number of corrected connections	Entire watershed, except subbasins 0 and 7
Improper fertilizer management and yard waste disposal (s)	Encourage proper fertilizer management and yard waste disposal	Riparian landowners; lawn care companies; golf courses	Hold field demonstrations on proper lawn care practices; distribute media releases	Follow-up questionnaire; track number of new lawn care practices	Entire watershed until specifically identified and prioritized
Impervious surfaces (k)	Reduce imperviousness	Local units of government; engineers; developers, faith-based organizations	Hold tours of porous pavement applications and other infiltration practices	Follow-up questionnaire; number of new sites infiltrating storm water	Entire watershed
Removal of riparian vegetation (k)	Plant and protect riparian vegetation	Riparian landowners	Hold field demonstrations on planting buffer strips and rain gardens	Follow-up questionnaire; track number of miles of newly planted riparian vegetation	Entire watershed
Excessive application of road salt (s)	Encourage proper application of road salt	MDOT; Kent County Road Commission; DPWs	Hold targeted training workshops on proper salt application procedures	Follow-up questionnaire; track number of new salt application practices	Entire watershed
Improper application of pesticides (s)	Encourage proper application of pesticide	Agricultural landowners	Hold field demonstrations on proper pesticide application	Follow-up questionnaire; track number of new pesticide practices	Subbasins 0, 1, 2, and 3
Illicit dumping (s)	Reduce illicit dumping	Urban residents	Hold storm drain marking or stenciling events; distribute media releases	Follow-up questionnaire; track number of markers installed or stencils painted	Entire watershed

Table 9.2 - Information and Education Tasks

Delivery Mechanism	Tasks	Priority	Responsible Organization	Timeline	Unit Costs	Total Costs
Hold targeted training workshops on model storm water ordinance and available stream stabilization practices	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	High	Kent County Drain Commissioner and Water Resource consultants	Annually	16 staff hours and $100 for materials ($50/staff hr)	$900
Hold targeted training workshops on drainage control practices	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	High	LGROW and Plaster Creek Steering Committee	Annually	16 staff hours and $100 for materials ($25/staff hr)	$500
Hold targeted training workshops on livestock exclusion and cost-share opportunities	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	High	NRCS; Kent Conservation District	Semiannually	16 staff hours and $100 for materials ($25/staff hr)	$500
Hold tours of road/stream crossings which successfully control erosion and runoff	Designate tour sites, contact landowners, develop invitation list and materials, hold tour, and conduct evaluation	High	LGROW and Plaster Creek Steering Committee	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Distribute fact sheets on proper woody debris and obstruction removal practices with web link for more information	Develop distribution program, collect information, develop draft, complete review, finalize and distribute final copies, and conduct evaluation	Low	Timberland RC&D	Annually	12 staff hours and $200 for reproduction ($25/staff hr)	$400
Distribute fact sheets on ORV use with web link for more information	Develop distribution program, collect information, develop draft, complete review, finalize and distribute final copies, and conduct evaluation	Low	LGROW and Plaster Creek Steering Committee	Annually	12 staff hours and $200 for reproduction ($25/staff hr)	$400
Hold tours of successful urban runoff practices	Designate tour sites, contact landowners, develop invitation list and materials, hold tour, and conduct evaluation	High	LGROW and Plaster Creek Steering Committee	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold targeted training workshops on agricultural practices and cost-share opportunities	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	Medium	NRCS; Kent Conservation District	Semiannually	16 staff hours and $100 for materials ($25/staff hr)	$500
Hold targeted training workshops on erosion and sediment control practices	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	High	LGROW and Plaster Creek Steering Committee	Annually	16 staff hours and $100 for materials ($25/staff hr)	$500
Hold field demonstrations on proper manure spreading practices	Identify demonstration location, develop hands on program and invitation list, hold demonstration, and conduct evaluation	Medium	NRCS; Kent Conservation District	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold field demonstrations on proper feedlot runoff practices	Identify demonstration location, develop hands on program and invitation list, hold demonstration, and conduct evaluation	Medium	NRCS; Kent Conservation District	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold tours of successful animal control practices	Designate tour sites, contact landowners, develop invitation list and materials, hold tour, and conduct evaluation	Medium	LGROW and Plaster Creek Steering Committee	Biannually	20 staff hours and $100 for materials ($25/staff hr)	$600
Distribute fact sheets on pet waste disposal with web link for more information; Distribute media releases	Develop distribution program, collect information, develop draft, complete review, finalize and distribute final copies, and conduct evaluation	Low	Park and Recreation Departments	Semiannually	12 staff hours and $200 for reproduction ($25/staff hr)	$400
Distribute *A Homeowner's Guide to Septic Systems;* Distribute media releases	Develop distribution program, print copies, distribute guidebook, conduct evaluation	Medium	Kent County Health Department	Annually	4 staff hours and $200 for reproduction ($25/staff hr)	$300
Hold targeted training workshops on locating and correcting faulty connections	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	Low	LGROW and Plaster Creek Steering Committee	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold field demonstrations on proper lawn care practices; Distribute media releases	Identify demonstration location, develop hands on program and invitation list, hold demonstration, and conduct evaluation	Medium	West Michigan Environmental Action Council	Semiannually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold tours of porous pavement applications and other infiltration practices	Designate tour sites, contact landowners, develop invitation list and materials, hold tour, and conduct evaluation	High	LGROW and Plaster Creek Steering Committee	Annually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold field demonstrations on planting buffer strips and rain gardens	Identify demonstration location, develop hands on program and invitation list, hold demonstration, and conduct evaluation	Medium	West Michigan Environmental Action Council	Semiannually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold targeted training workshops on proper salt application procedures	Develop invitation list, collect presentation materials, hold workshop, and conduct evaluation	Low	Kent County Road Commission; Departments of Public Works	Annually	16 staff hours and $100 for materials ($25/staff hr)	$500
Hold field demonstrations on proper pesticide application	Identify demonstration location, develop hands on program and invitation list, hold demonstration, and conduct evaluation	Low	NRCS; Kent Conservation District	Semiannually	20 staff hours and $100 for materials ($25/staff hr)	$600
Hold storm drain marking or stenciling events; Distribute media releases	Organize volunteers, collect materials, hold event, and conduct evaluation	Low	LGROW and Plaster Creek Steering Committee	Annually	24 staff hours and up to $5 per marker (100 markers) and $20 per stencil template (50 stencil templates) ($25/staff hr)	$2100
					TOTAL COST	**$13,000**

REFERENCES

Bieneman, P. M. *Michigan: A Physical Perspective.* 1999. Aquinas College. Grand Rapids, Michigan.

Cairns, J., Jr. Aquatic Ecosystem Assimilative Capacity. 1977. Fisheries. 2(2): 5 - 7, 24.

Grand River Basin Coordinating Committee. *Grand River Basin, Michigan, Comprehensive Water Resources Study. Volume II, Appendix B - Basin Description.* 1972. Grand Rapids, Michigan.

Halley, M.C., White, S.O., and Watkins, E.W. Arcview GIS Extension for Estimating Curve Numbers. http://gis.esri.com/library/userconf/professional/papers/pad6571/p657/htm.

Judy, R.D., Seeley, P.N., Murray, T.M., Svirsky, S.C., Whitworth, M.R., and Ischinger, L.S. 1984. 1982 National Fisheries Survey, Volume 1. Technical Report: Initial Findings. U.S. Fish and Wildlife Service. FWS-OBS-84/06.

Michigan Department of Agriculture, Climatology Program. 2007. http://climate.geo.msu.edu

Michigan Department of Environmental Quality, Nonpoint Source Unit, Surface Water Quality Division. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. 1999. Lansing, Michigan.

Michigan Department of Environmental Quality, Surface Water Quality Division. A Biological Assessment of Plaster Creek, Kent County, Michigan. 2001. Lansing, Michigan.

Michigan Department of Environmental Quality, Surface Water Quality Division. Administrative Rules, Part 4. Water Quality Standards, Promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. 1999. Lansing, Michigan.

Michigan Department of Environmental Quality. Total Maximum Daily Load for *Esherichia Coli* in Plaster Creek, Kent County, Michigan. 2002a. Lansing, Michigan.

Michigan Department of Environmental Quality. Total Maximum Daily Load for Biota for Plaster Creek, Kent County, Michigan. 2002b. Lansing, Michigan.

Michigan Department of Natural Resources, Water Resources Commission. *Water Resource Conditions and Uses in the Lower Grand River Basin.* 1968. Lansing, Michigan.

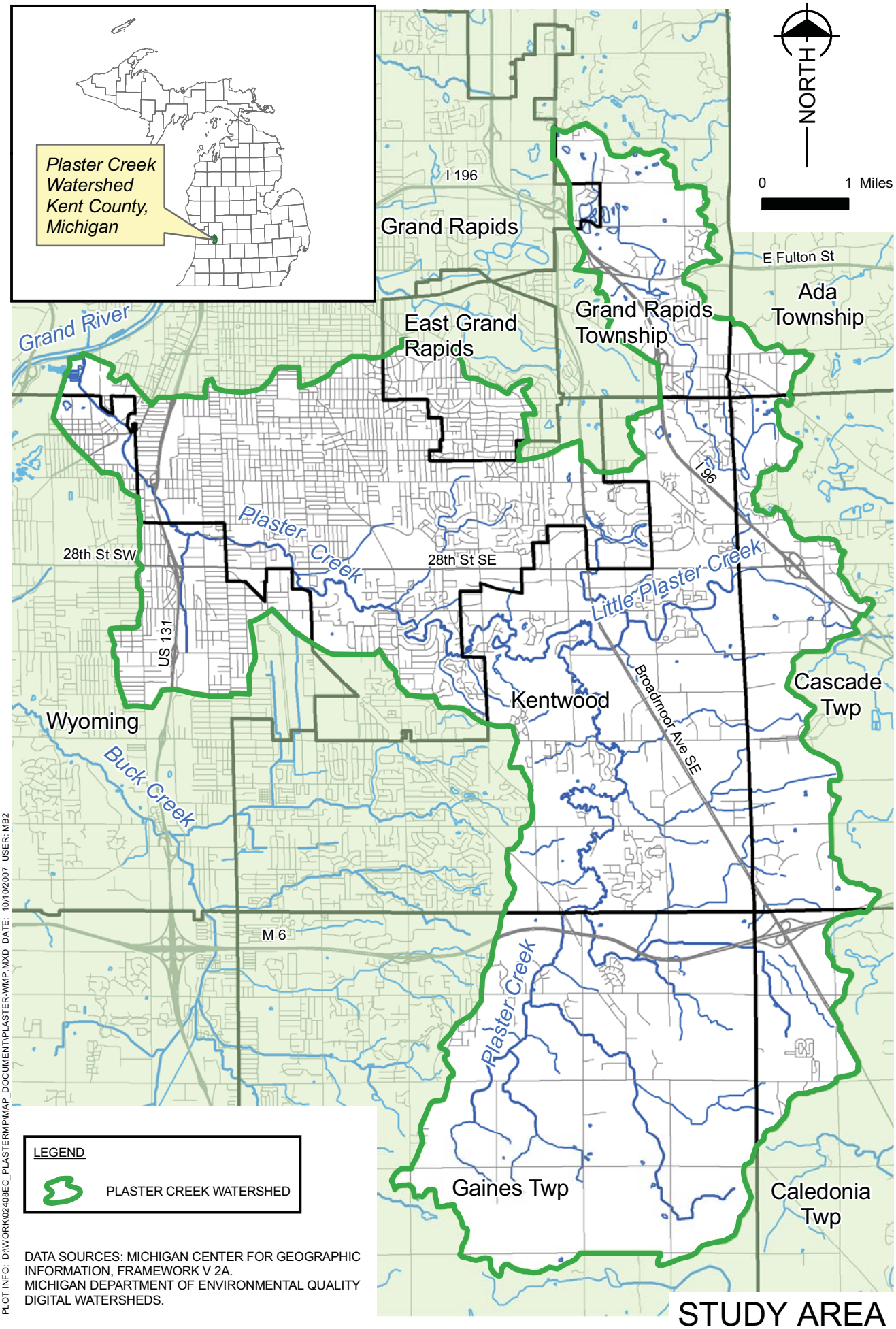
Orfield, M. American Metropolitics: The New Suburban Reality. 2002. Brookings Institution Press.

Seelbach, P.W., Wiley, M.J., Kotanchik, J.C., and Baker, M.E. A Landscape-based ecological classification system for river valley segments in Lower Michigan. 1997. Fisheries Research Report No. 2036. Michigan Department of Natural Resources, Ann Arbor, MI.

United States Department of Agriculture, Soil Conservation Service. Soil Survey for Kent County, Michigan. 1986. U.S. Government Printing Office, Washington, DC.

United States Geologic Service. *Regional Landscape Ecosystems of Michigan, Minnesota, and Wisconsin.* 1998. http://www.npwrc.usgs.gov/resource/1998/rlandscp/michmap1.htm

Figures



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
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STUDY AREA

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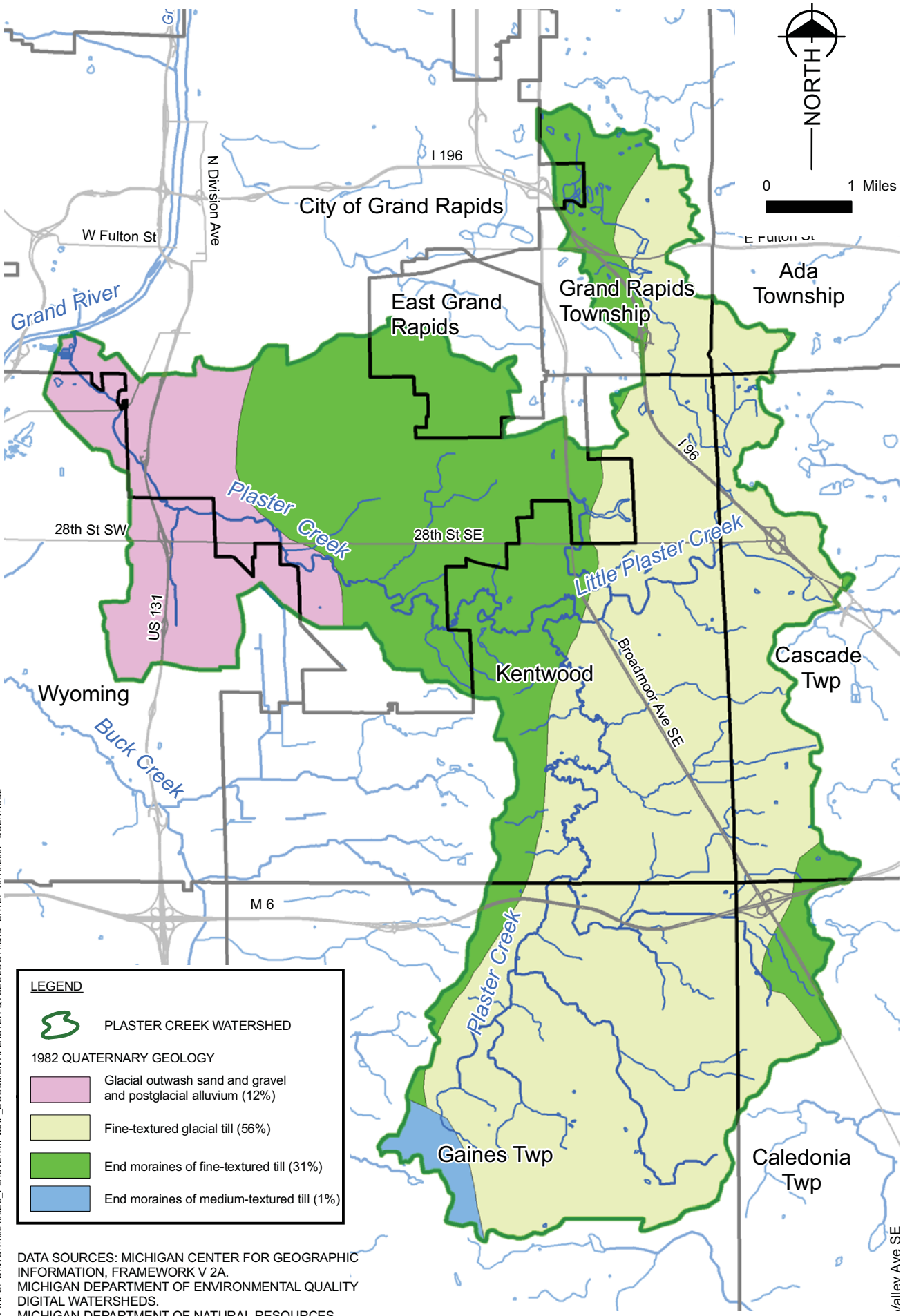

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
MICHIGAN DEPARTMENT OF NATURAL RESOURCES, MIRIS 1982 QUARTERLY GEOLOGY.

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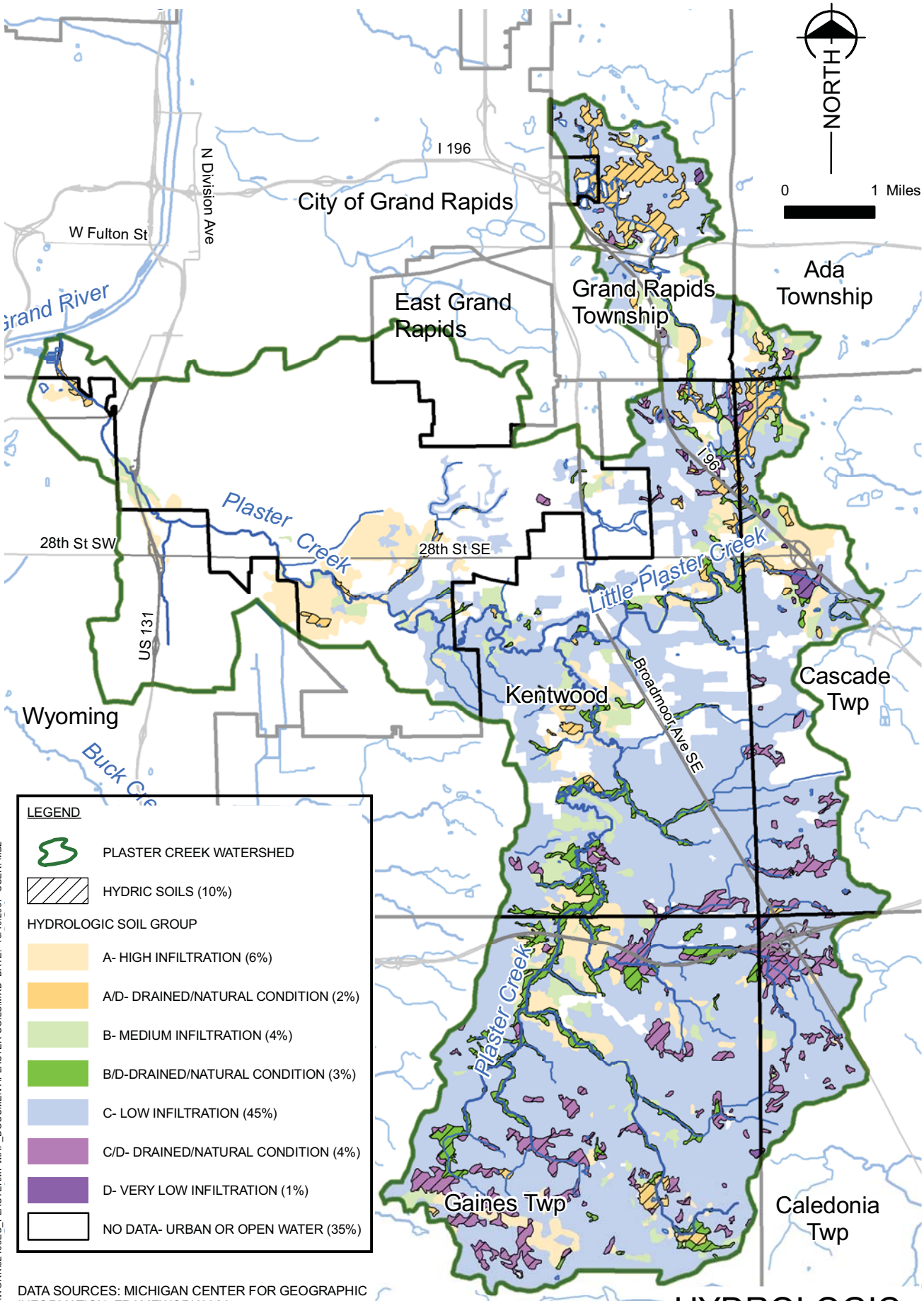

DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
USDA NATURAL RESOURCES CONSERVATION SERVICE, SSURGO SOILS, KENT COUNTY 1986.

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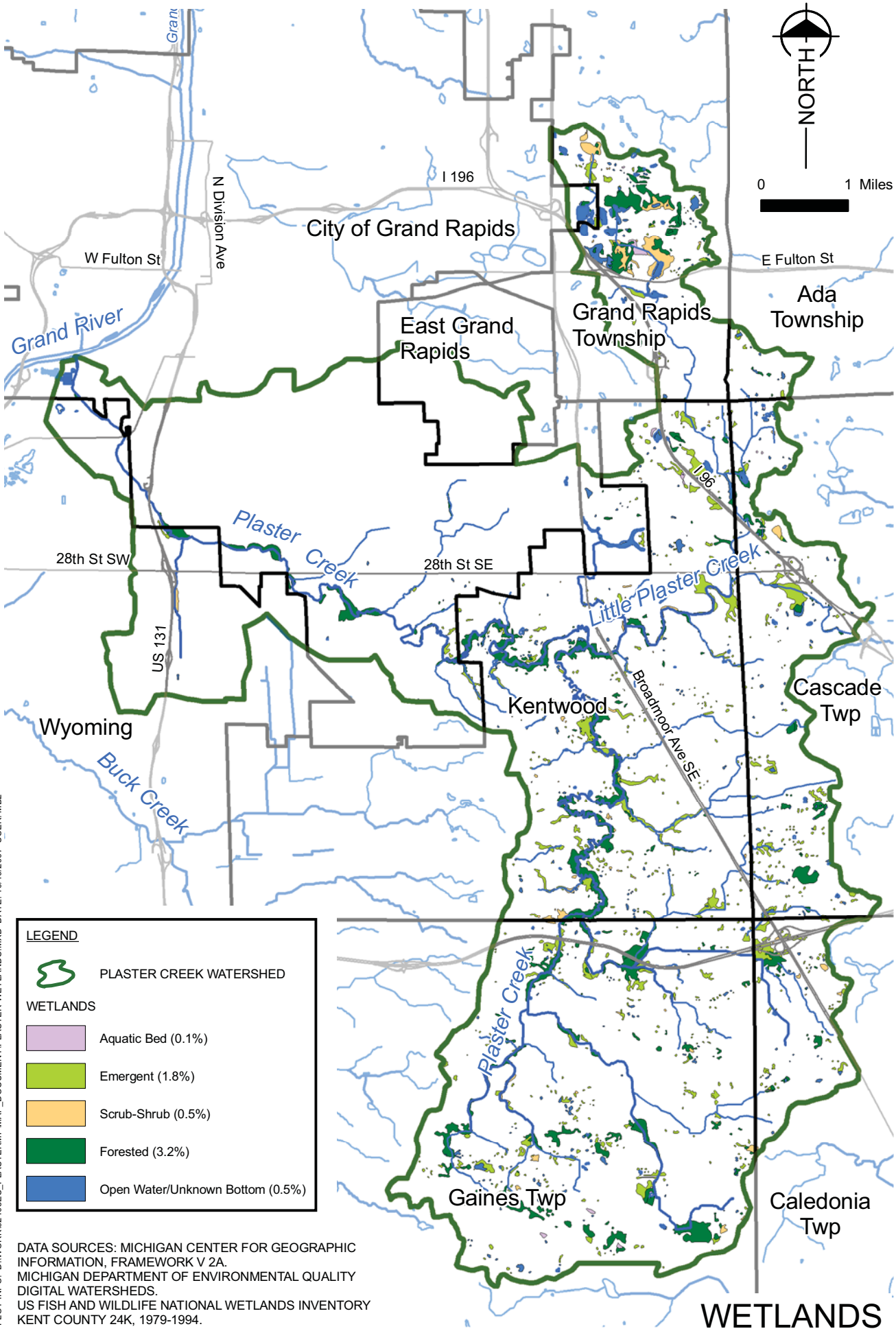
HYDROLOGIC SOIL GROUPS



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
US FISH AND WILDLIFE NATIONAL WETLANDS INVENTORY KENT COUNTY 24K, 1979-1994.

WETLANDS

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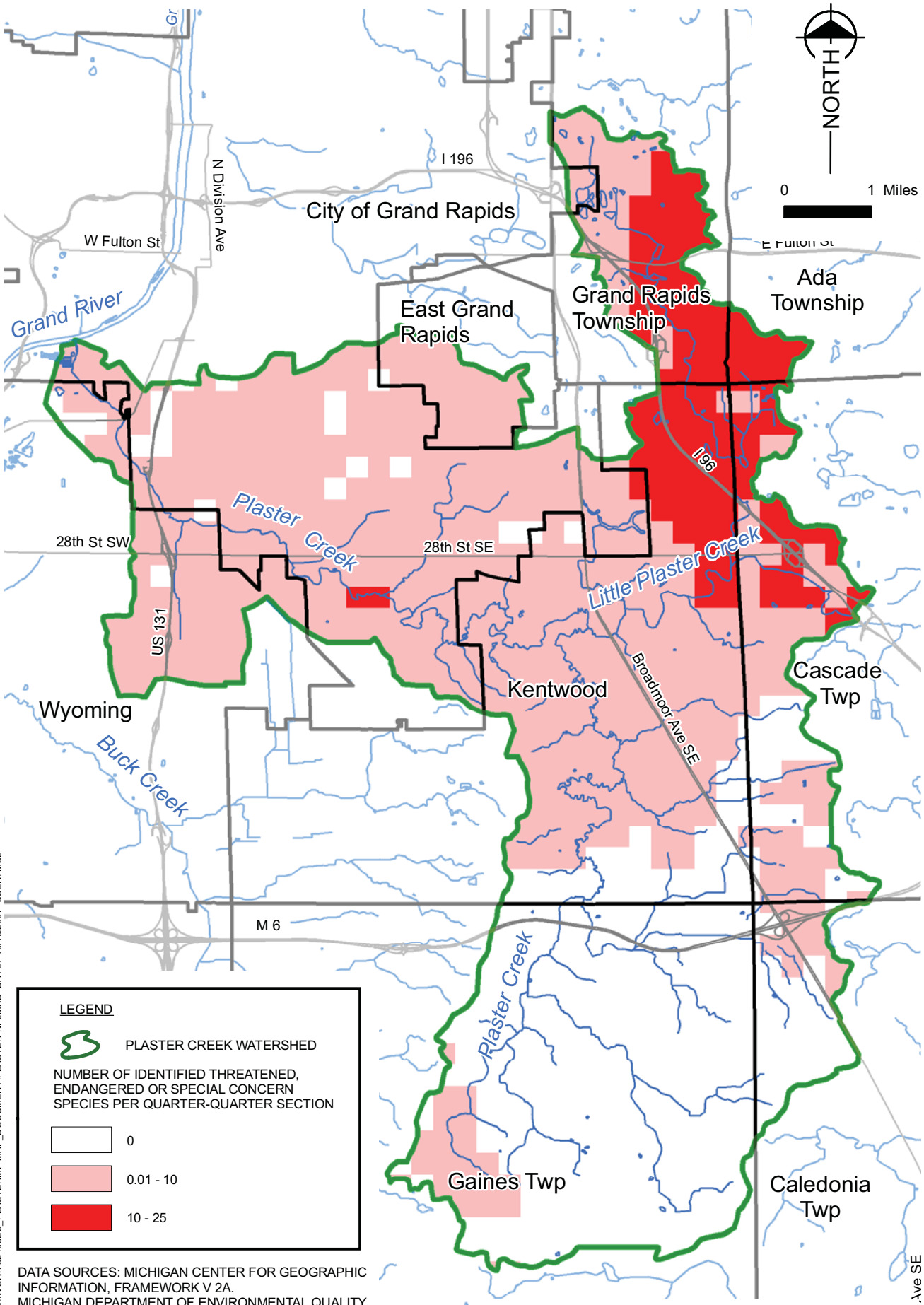

DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
SUBWATERSHED DELINEATION, FTC&H, 2007.MICHIGAN NATURAL FEATURES INVENTORY, MICHIGAN STATE UNIVERSITY EXTENSION, 2006.

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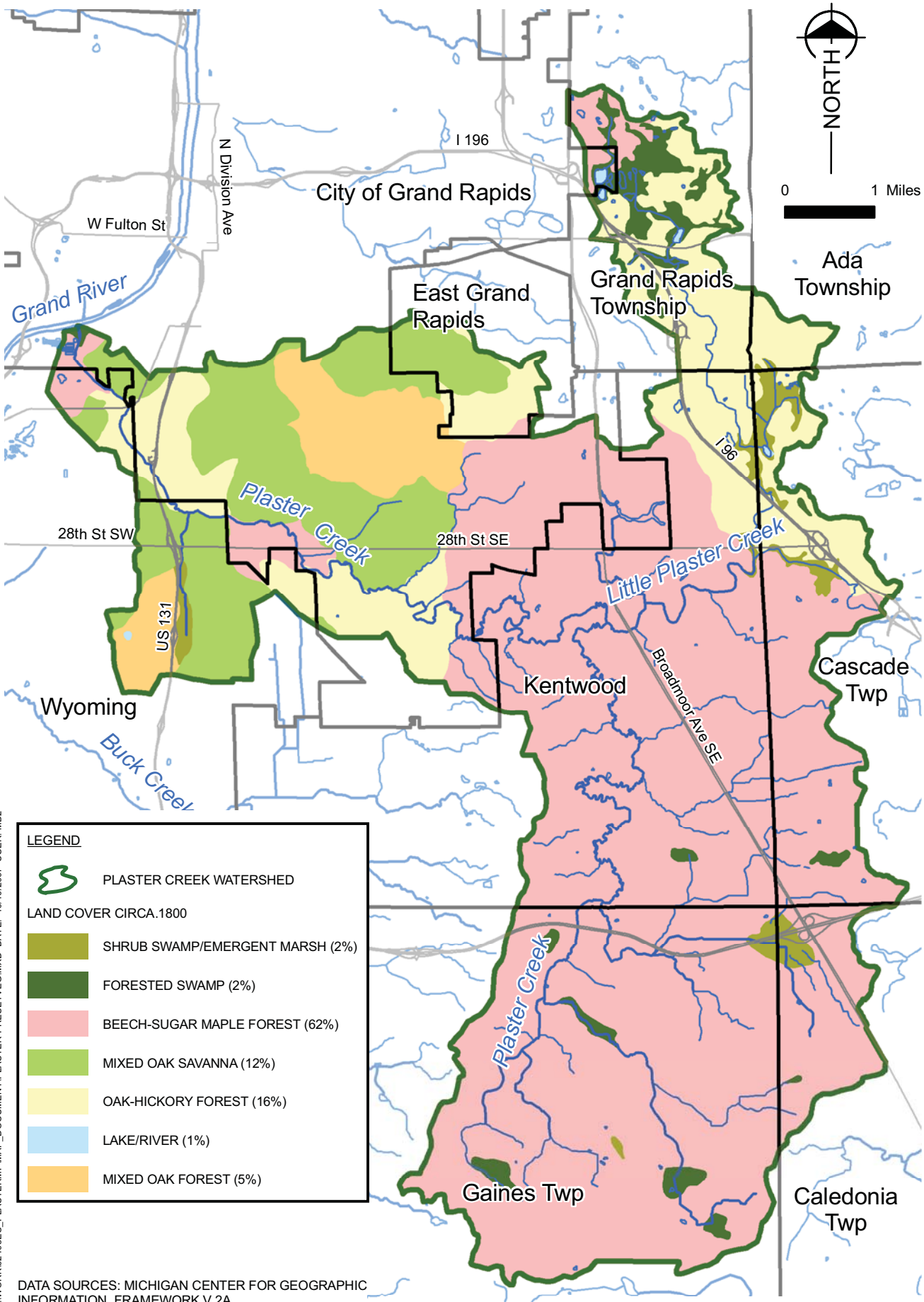

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PRESETTLEMENT VEGETATION

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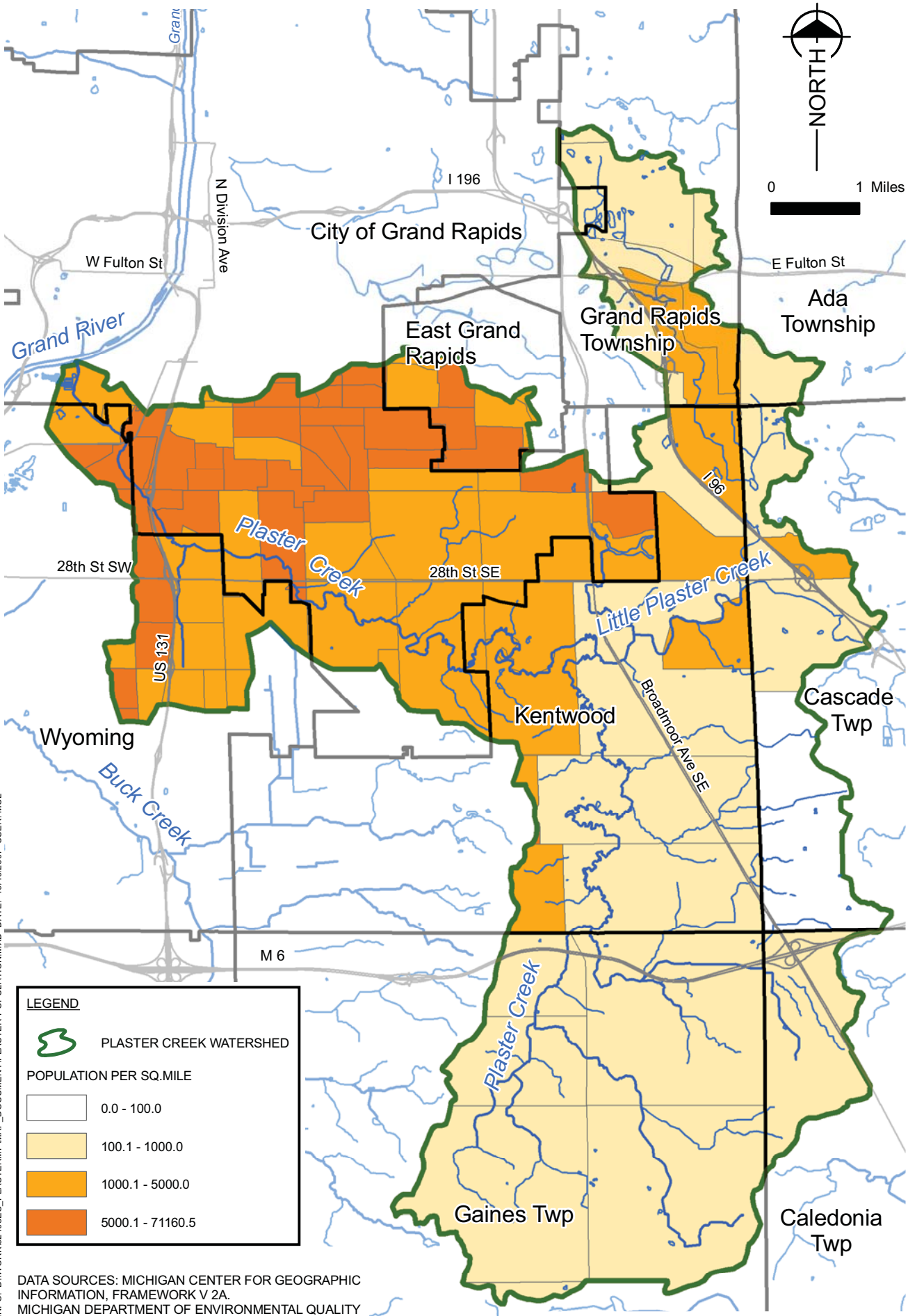

DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
US CENSUS BUREAU, 2000.

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FIGURE NO.
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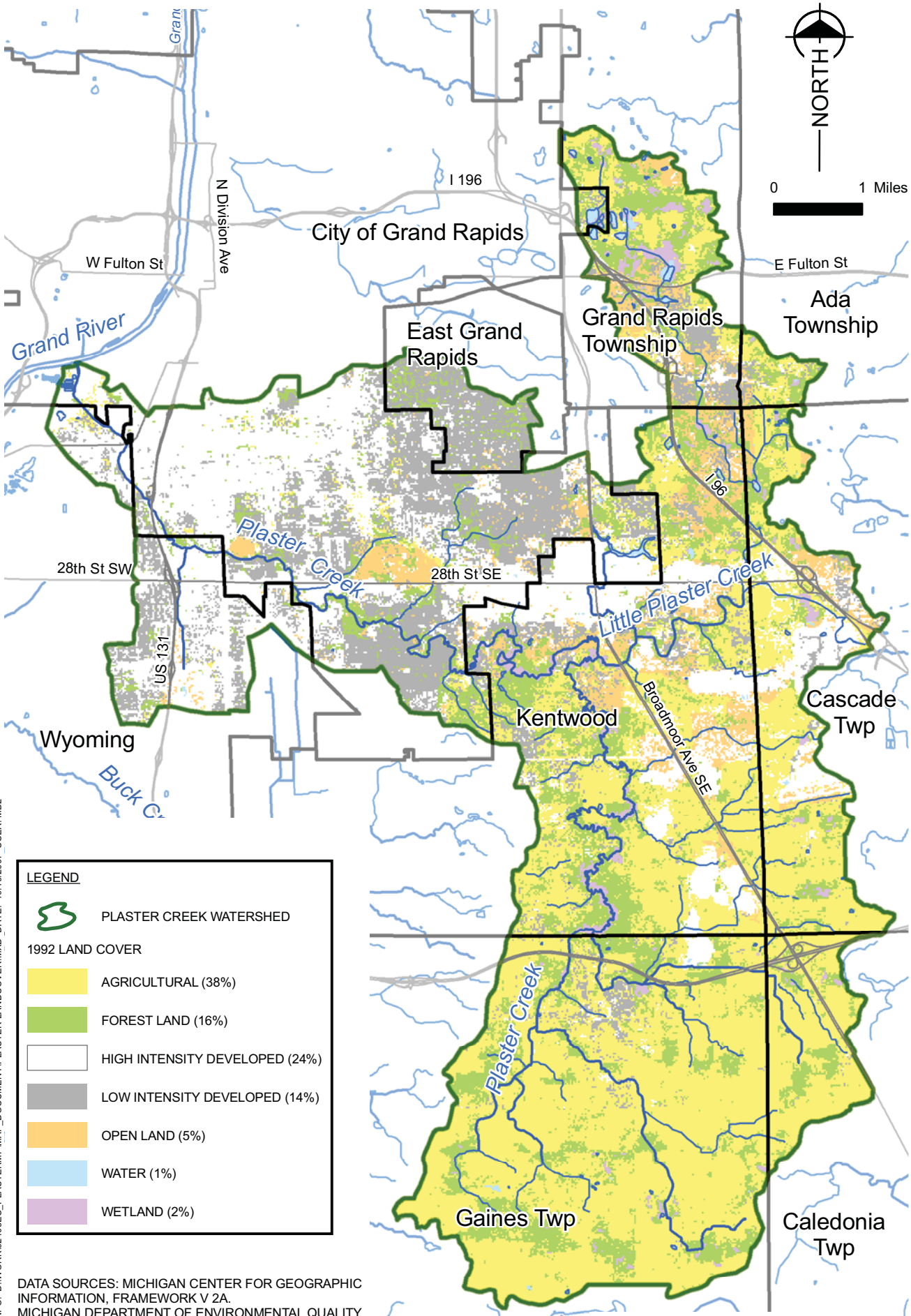

DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
USGS NATIONAL LAND COVER DATA, 1992.

LAND USE/COVER

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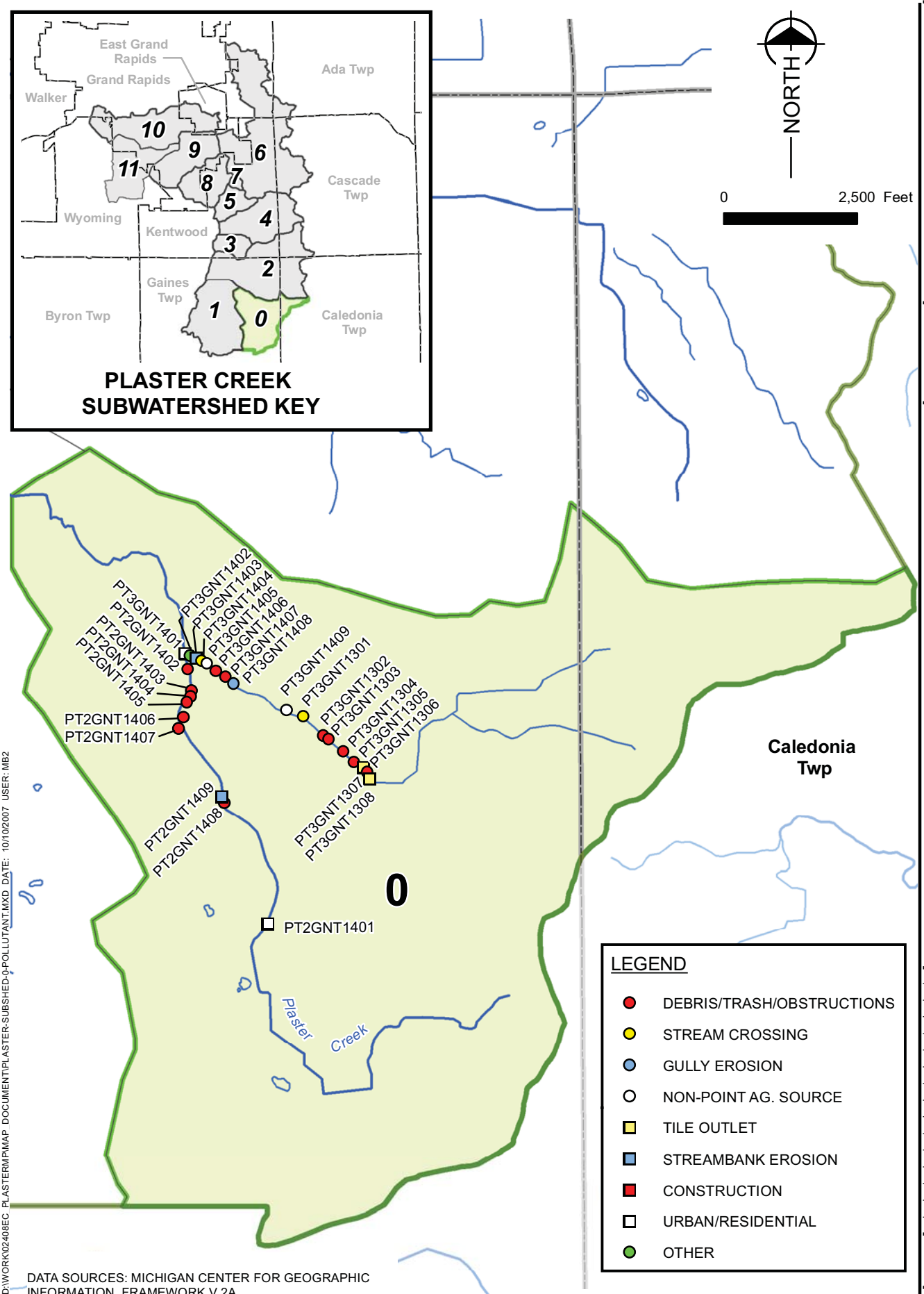
FIGURE NO.
8



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIGITAL WATERSHEDS.
SUBWATERSHED DELINEATION, FTC&H, 2007.

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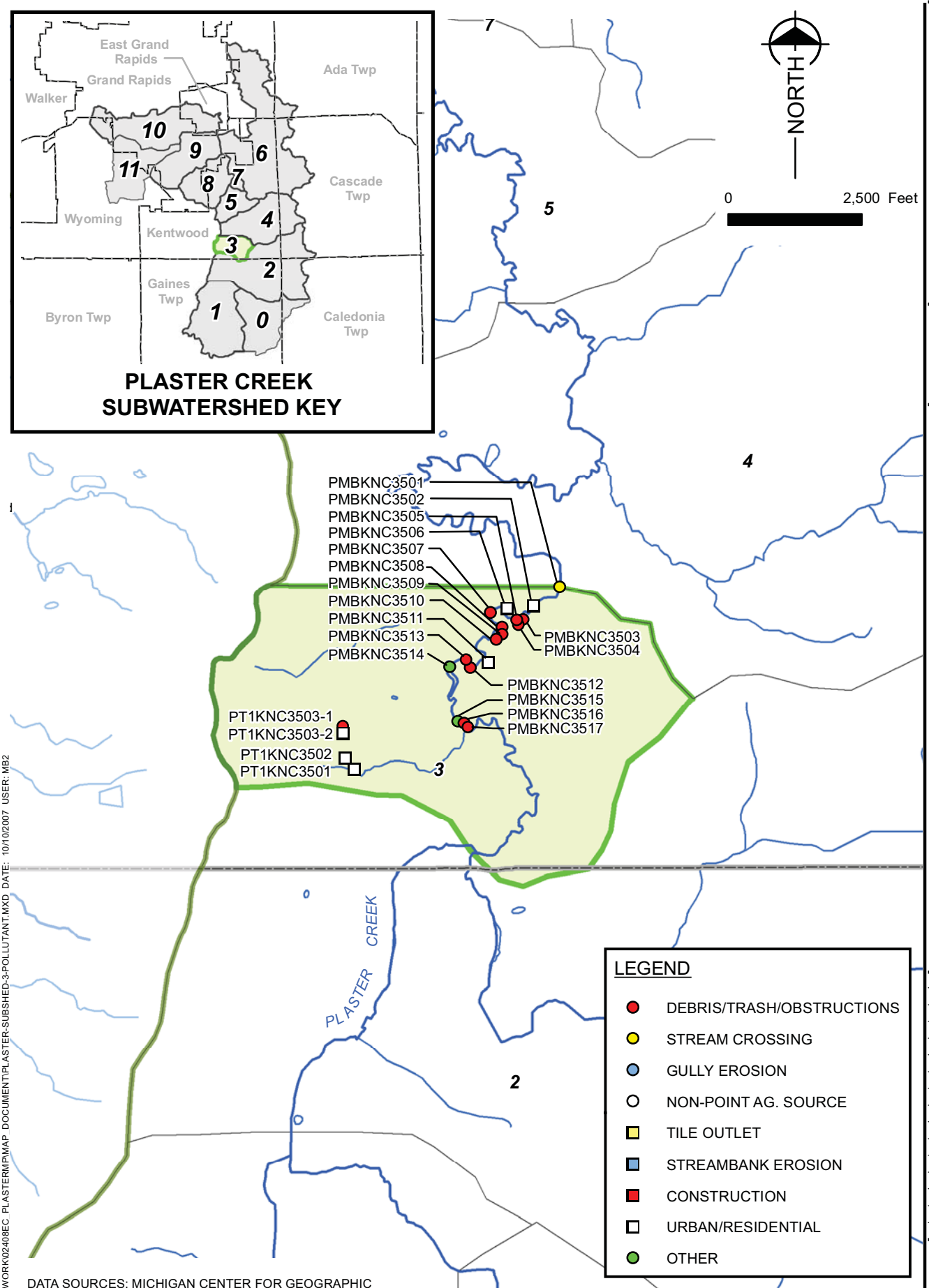
FIGURE NO.
9



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
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INVENTORY SITES IN SUBWATERSHED 3

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PROJECT NO.
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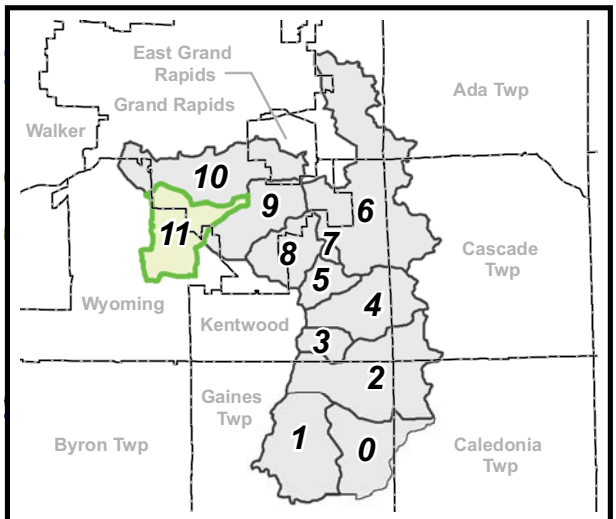
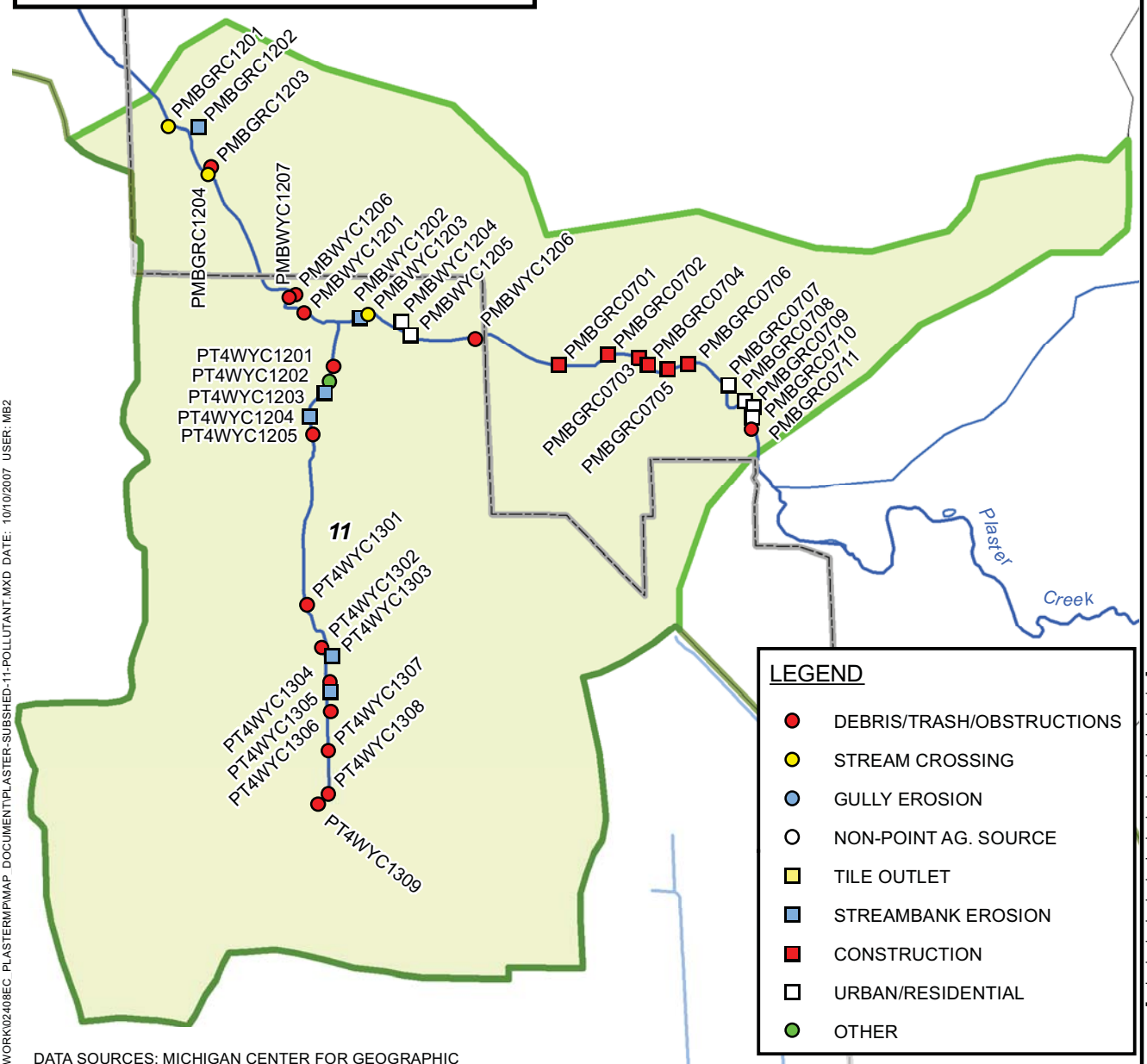
FIGURE NO.
10



PLASTER CREEK SUBWATERSHED KEY

NORTH

0 2,500 Feet



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
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INVENTORY SITES IN SUBWATERSHED 11

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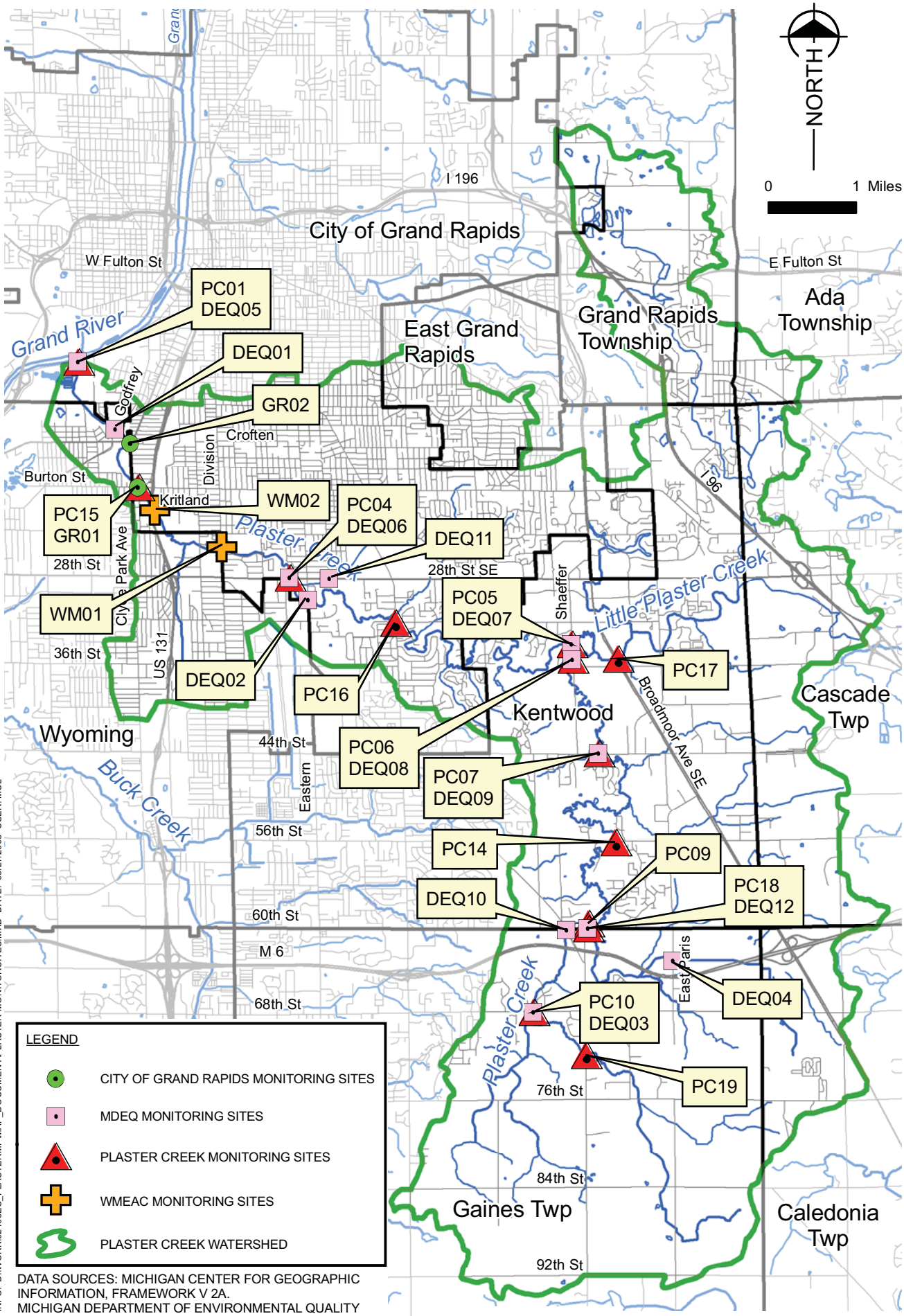
FIGURE NO.
11



DATA SOURCES: MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION, FRAMEWORK V 2A.
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MONITORING SITES

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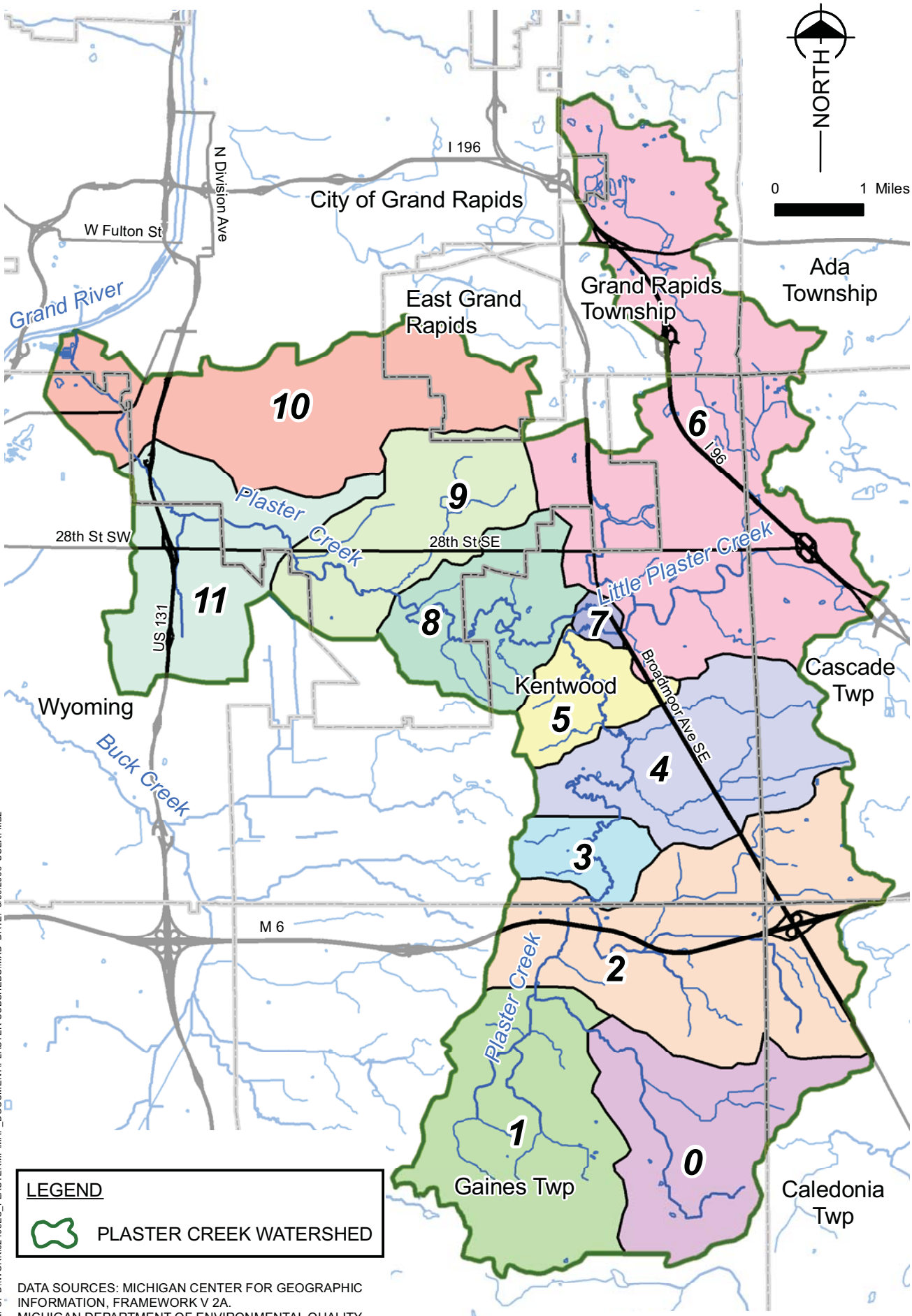
FIGURE NO.
12



LEGEND

PLASTER CREEK WATERSHED

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SUBWATERSHEDS

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Kent County, Michigan

Plaster Creek Watershed Management Plan

PROJECT NO.
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FIGURE NO.
13

Appendix 1

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)
Background

This survey is the result of repeated visits by student pairs from the 2007 Vertebrate Biology class to Plaster and the headwaters of Whiskey Creek in the Calvin College Ecosystem Preserve. An attempt was made to Plaster Creek at contrasting points along its course from Dutton Park to Ken-O-Sha Park. The students survey were:

Dutton Park: Aren Phillips and Jon Dozeman
Paris Park: Scott Warsen and Dan Engel
Wingate Apartments: Rob Roos and Julianna Gallup
Ken-O-Sha Park: Anneke Leunk and Perry-David van Dillen
Calvin College Ecosystem Preserve: Robert and Andrew Harrer

For this survey students established specific routes in the area bounding their reach of the stream. The route was laid out such that it could be traveled in approximately 1.5 hr with reasonable time dedicated to observing and identifying animals. Within the time frame for this project students were allowed to establish their own schedules visiting the sites with the provisions that they complete one full circuit of their sampling route per outing and that distribute their sampling outings to include the full daylight period during the study. The minimum number of was 5 for the Leunk-van Dillen team and nine for the Haarer brothers team. Animals and animal signs were as they were encountered along the sampling routes.

A total of 8 amphibians (7 anurans), 6 reptiles (4 turtles, 2 snakes), 53 birds and 8 mammals were observed. The variation seen among the species lists reflects several variables which are hard to disentangle at this point in time:
1. different stream order and character of bounding habitats,
2. specific sampling times (students were allowed to select sampling periods within the overal date frame),
3. different abilities and aggressiveness of the students in observing and identifying vertebrates in their section of stream.

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)
Amphibians

Common Name	Scientific Name	Location				
		Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Blue-spotted Salamander	Ambystoma laterale	X				
American Toad	*Bufo americanus*			X	X	
Gray Treefrog	*Hyla versicolor*	X				
Spring Peeper	*Pseudacris crucifer*	X			X	
Green Frog	*Rana clamitans*	X	X	X	X	X
Northern Leopard Frog	*Rana pipiens*			X	X	
Pickerel Frog	*Rana palustris*				X	
Wood Frog	*Rana sylvatica*	X		X		
Total		5	1	4	5	1

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)
Reptiles

Common Name	Scientific Name	Location				
		Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Snapping Turtle	*Chelydra serpentina*				X	
Blanding's Turtle	*Emydoidea blandingi*	X			X	
Common Map Turtle	*Graptemys geographica*					X
Midland Painted Turtle	*Chrysemys picta*	X				
Eastern Garter Snake	*Thamnophis sirtalis*	X	X	X	X	
Ribbon Snake	*Thamnophis sauritus*			X		X
Total		3	1	2	3	2

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)
Birds

Common Name	Scientific Name	Ecosystem Preserve	Dutton Park	Location Paris Park	Wingate Apartments	Ken-O-Sha Park
Great Blue Heron	*Ardea herodias*	X				
Canada Goose	*Branta canadensis*	X	X	X	X	
Mallard	*Anas platyrhynchos*	X	X	X	X	X
Wood Duck	*Aix sponsa*	X		X		
Killdeer	*Charadrius vociferous*		X			
Turkey Vulture	*Cathartes aura*	X	X	X	X	
Cooper's Hawk	*Accipiter cooperii*		X			X
Red-tailed Hawk	*Buteo jamaicensis*	X	X	X	X	
Wild Turkey	*Meleagris gallopavo*	X			X	X
Mourning Dove	*Zenaida macroura*		X	X	X	
Great Horned Owl	*Bubo virginianus*	X				
Belted Kingfisher	*Ceryle alcyon*					X
Yellow-shafted Flicker	*Colaptes auratus*	X	X	X	X	X
Red-bellied Woodpecker	*Melanerpes carolinianus*	X		X	X	X
Yellow-bellied Sapsucker	*Sphyrapicus varius*			X	X	
Downy Woodpecker	*Picoides pubescens*	X	X	X		
Hairy woodpecker	*Picoides villosus*	X	X	X	X	X
Pileated Woodpecker	*Drycopus pileatus*			X		
Eastern Wood Pewee	*Contopis virens*			X		
Eastern Phoebe	*Sayornis phoebe*			X		
Blue Jay	*Cyanocitta cristata*	X	X	X	X	X
American Crow	*Corvus brachyrhynchos*	X	X	X	X	
Black-capped Chickadee	*Parus atricapillus*	X	X	X	X	X
Tufted Titmouse	*Parus bicolor*		X	X		X
White-breasted Nuthatch	*Sitta canadensis*	X		X		X
Red-breasted Nuthatch	*Sitta carolinensis*		X			
Brown Creeper	*Certhia americana*	X	X	X	X	X
Golden-crowned Kinglet	*Regulus satrapa*	X		X	X	X
Ruby-crowned Kinglet	*Regulus calendula*			X	X	X
Blue-gray Gnatcatcher	*Polioptila caerulea*			X		X
Hermit Thrush	*Catharus guttatus*			X		
American Robin	*Turdus migratorius*	X	X	X	X	X
Gray Catbird	*Dumatella carolinensis*				X	
Cedar Waxwing	*Bombycilla cedrorum*	X				
European Starling	*Sturnus vulgaris*		X	X	X	
Black-and-White Warbler	*Mniotilta varia*	X				X
Yellow-rumped Warbler	*Dendroica coronata*	X		X	X	X
Black-throated Green Warbler	*Dendroica virens*				X	X
Palm Warbler	*Dendroica palmara*				X	X
Yellow Warbler	*Dendroica petechia*				X	
House Sparrow	*Passer domesticus*		X	X	X	
Red-winged Blackbird	*Agelaius phoeniceus*	X	X	X	X	
Baltimore Oriole	*Icterus galbula*		X	X		
Rusty Blackbird	*Euphagus carolinus*			X		
Common Grackle	*Quiscalus quiscula*	X	X	X	X	
Brown-headed Cowbird	*Molothrus ater*		X	X	X	
Scarlet Tanager	*Piranga olivacea*			X		
Northern Cardinal	*Cardinalis cardinalis*	X	X	X	X	X
House Finch	*Carpodacus mexicanus*				X	
American Goldfinch	*Carduelis tristis*	X	X	X	X	
Northern Junco	*Junco hyemalis*	X	X	X		
White-throated Sparrow	*Zonotrichia leucophrys*	X	X	X		
Song Sparrow	*Melospiza melodia*	X		X	X	
Total		29	27	39	31	21

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)
Mammals

Common Name	Scientific Name	Location				
		Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Raccoon	*Procyon lotor*	X	X	X	X	X
Muskrat	*Ondatra zibethicus*	X				
Eastern Chipmunk	*Tamias striatus*	X			X	X
Red Squirrel	*Tamiasciurus hudsonicus*				X	
Eastern Fox Squirrel	*Sciurus niger*	X	X	X	X	X
Woodchuck	*Marmota monax*	X		X	X	
Eastern Cottontail	*Sylvilagus floridanus*	X			X	
White-tailed Deer	*Odocoileus virginianus*	X		X	X	X
Total		7	2	4	7	4

Plaster Creek Vertebrate Survey
Spring 2007 (4/12/07 -- 5/7/07)

Amphibians

Common Name	Scientific Name	Location: Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Blue-spotted Salamander	Ambystoma laterale	X				
American Toad	*Bufo americanus*			X	X	
Gray Treefrog	*Hyla versicolor*	X				
Spring Peeper	*Pseudacris crucifer*	X			X	
Green Frog	*Rana clamitans*	X	X	X	X	X
Northern Leopard Frog	*Rana pipiens*			X	X	
Pickerel Frog	*Rana palustris*				X	
Wood Frog	*Rana sylvatica*	X		X		
Total		5	1	4	5	1

Reptiles

Common Name	Scientific Name	Location: Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Snapping Turtle	*Chelydra serpentina*				X	
Blanding's Turtle	*Emydoidea blandingi*	X			X	
Common Map Turtle	*Graptemys geographica*					X
Midland Painted Turtle	*Chrysemys picta*	X				
Eastern Garter Snake	*Thamnophis sirtalis*	X	X	X	X	
Ribbon Snake	*Thamnophis sauritus*			X		X
Total		3	1	2	3	2

Mammals

Common Name	Scientific Name	Location: Ecosystem Preserve	Dutton Park	Paris Park	Wingate Apartments	Ken-O-Sha Park
Raccoon	*Procyon lotor*	X	X	X	X	X
Muskrat	*Ondatra zibethicus*	X				
Eastern Chipmunk	*Tamias striatus*	X			X	X
Red Squirrel	*Tamiasciurus hudsonicus*				X	
Eastern Fox Squirrel	*Sciurus niger*	X	X	X	X	X
Woodchuck	*Marmota monax*	X		X	X	
Eastern Cottontail	*Sylvilagus floridanus*	X			X	
White-tailed Deer	*Odocoileus virginianus*	X		X	X	X
Total		7	2	4	7	4

Appendix 2

MI/DEQ/SWQ-01/107

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
SURFACE WATER QUALITY DIVISION
APRIL 2002

STAFF REPORT

A BIOLOGICAL ASSESSMENT OF PLASTER CREEK, KENT COUNTY, MICHIGAN
JUNE 29, 2001

Introduction

A biological assessment of Plaster Creek, using the Michigan Department of Environmental Quality's (MDEQ's) Procedure 51, was made on June 29, 2001, to assess the quality of its macroinvertebrate community and physical habitat. A 12-mile reach of Plaster Creek that extends from the Grand River confluence upstream to 76th Street (vicinity of Dutton) was listed in Michigan's Years 2000 and 2002 Section 303(d) reports as needing a Total Maximum Daily Load (TMDL) (Creal and Wuycheck, 2000 and 2002) because of a degraded macroinvertebrate community impaired by excessive sedimentation.

Summary

Qualitative macroinvertebrate community and physical habitat assessments were conducted at four locations on the Plaster Creek watershed. Survey stations were located upstream from Godfrey Avenue, Eastern Avenue, and 68th Street on Plaster Creek with one station located upstream of East Paris Avenue on Little Plaster Creek (Figure 1). Numerous stream crossings were visited during the course of the assessment to better determine where the biological and habitat assessments were to be made. Digital photographs taken during the June 2001 survey are maintained in the MDEQ's Plaster Creek stream assessment file as a Microsoft PowerPoint presentation and are available upon request.

The macroinvertebrate community assessment results for the three Plaster Creek stations indicated "poor" rated macroinvertebrate communities at Godfrey Avenue and 68th Street with a minimally acceptable community at Eastern Avenue (Tables 1A and 1B). The macroinvertebrate community scores ranged from -7 at 68th Street, -5 at Godfrey Avenue, to -4 at Eastern Avenue. Little Plaster Creek's macroinvertebrate community scored -4 (minimally acceptable) at East Paris Avenue. A Procedure 51 score range of (-4 to +4) is considered acceptable (supports designated uses) with an increasing negative number of -4 being minimally acceptable but with degraded conditions. A score of $\geq$-5 (-5 to -9) indicates a "poor" rating and is considered not to be supporting designated uses as defined by Michigan's Water Quality Standards.

The physical habitat score of 81 (out of a total possible score of 135) at Godfrey Avenue indicated the presence of "good" physical conditions (Table 2). The Eastern Avenue, 68th Street, and East Paris Avenue habitat scores (43, 38, and 48, respectively) indicated fair (moderately impaired) habitat. The primary cause for the decline in habitat quality at the latter three sites is attributable to increased embeddedness and deposition on colonizable substrate.

There are numerous permitted discharges to the stream throughout the Plaster Creek watershed (Figure 2). Of the 113 discharge points depicted, 4 are associated with facilities that have individual National Pollutant Discharge Elimination System (NPDES) permits, 6 facilities have general discharge permit, with the majority of the discharges are storm water discharge

permits primarily from industrial related sources. Runoff from substantial area of impervious surfaces throughout the watershed also increase the flashy flow conditions characteristic of Plaster Creek. The design discharge total volume for the four individual NPDES permitted is 1.06 million gallons per day (mgd) (0.65 cubic feet per second (cfs)), which is not expected to cause flashy flow extremes in Plaster Creek. This is because the 0.65 cfs represents a relatively low input rate into a stream with a low monthly 95% exceedance flow of 4.3 mgd (2.8 cfs) from points of discharge that are well distributed throughout the watershed. The flashy characteristics of Plaster Creek appear to be related to storm water runoff events and excessive runoff rates from agricultural and residential land use in the upper third of the watershed and impervious surfaces in the lower two-thirds of the watershed.

The severely impaired macroinvertebrate community at Godfrey Avenue, despite good rated physical habitat, appears to be attributable to the cumulative affects of reduced water quality at this location. Silver Creek Drain, located upstream of Godfrey Avenue, needs to be assessed as a potential source of pollutants due to possible effects from combined storm sewer overflows and industrial storm sewer discharges located on this tributary to Plaster Creek. The impaired biological community at 68th Street is attributable to cattle access in the immediate reach upstream that has contributed substantial loadings of solids to the reach. Eroded, broken down stream banks are evident in this area as a result of unrestricted cattle access. Runoff from cropland, dominated with heavy clay soils and the lack of a vegetative, buffer-riparian zone are also and apparent sources and causes of elevated sedimentation in the upper reaches of Plaster Creek.

Illicit septic tank drainage to Plaster Creek in this upper reach was also evident during this survey. This information has been reported to the Surface Water Quality Division's Grand Rapids District Office and forwarded onto the Kent County Health Department.

Field Work: Dan Rockafellow, Aquatic Biologist
John Wuycheck, Aquatic Biologist

Report By: John Wuycheck, Aquatic Biologist
Great Lakes and Environmental Assessment Section
Surface Water Quality Division

References:

Creal, W. and J. Wuycheck. 2000. Federal Clean Water Act Section 303(d) List – Michigan Submittal for Year 2000. MDEQ Report #MI/DEQ/SWQ-00/018.

Creal, W. and J. Wuycheck. 2002. Federal Clean Water Act Section 303(d) List – Michigan Submittal for Year 2000. MDEQ Report #MI/DEQ/SWQ-02/013 (available at the following website address: http://www.deq.state.mi.us/documents/deq-swq-gleas-303_d_Rpt2002b.pdf).

MDEQ. 1997. GLEAS Procedure 51. Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers. Report #MI/DEQ/SWQ-96/068 as Revised May 1998.

Sylvester, S. 1978. Biological Survey of Plaster Creek. July-September 1977. Michigan Department of Natural Resources. Publication No. 4833-5160 (0022980), 25 pp.

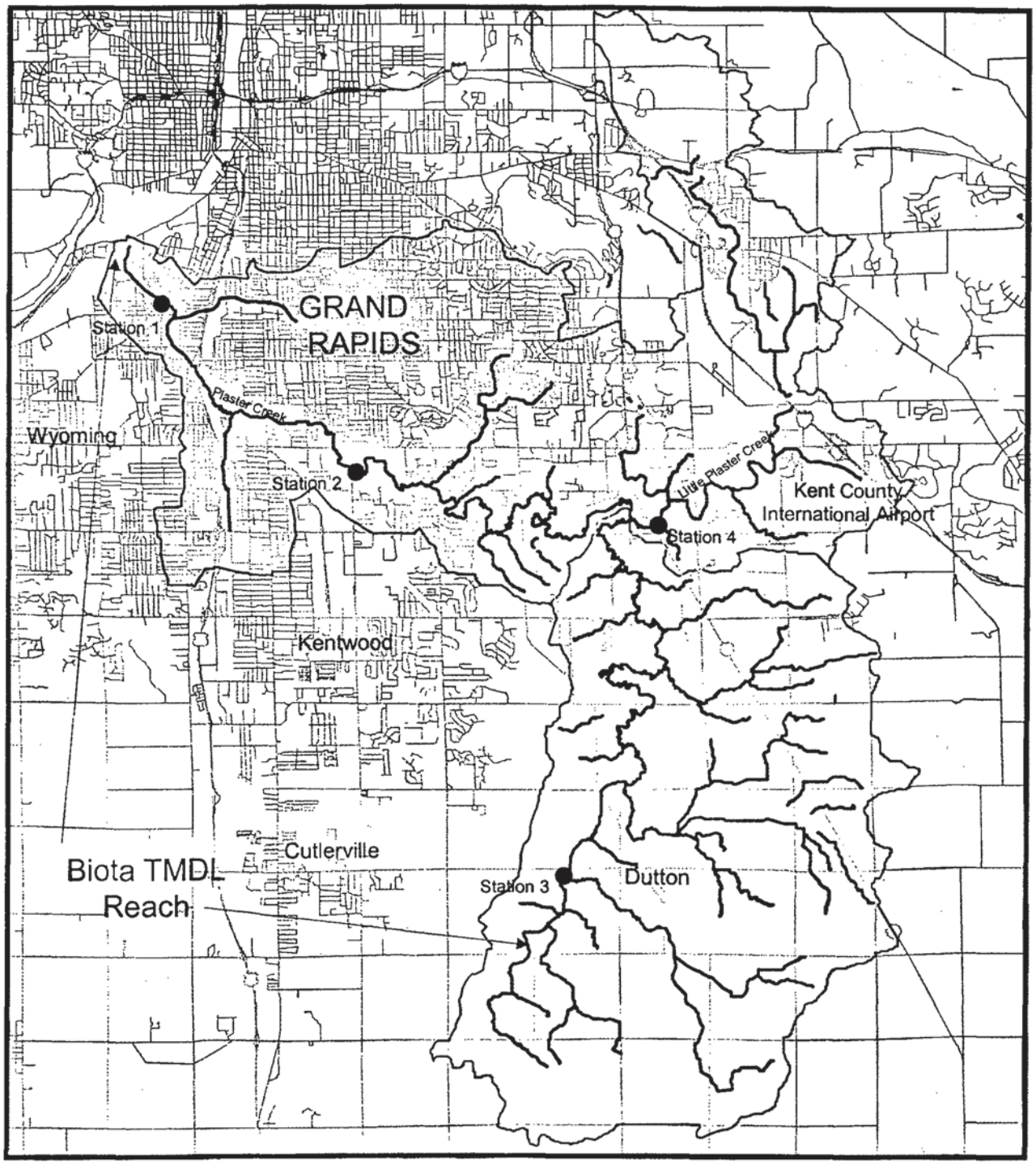

Figure 1. Biological community assessment sites during the June 6, 2002 survey of the Plaster Creek Watershed, Kent County, Michigan.
Note: Biota TMDL reach.

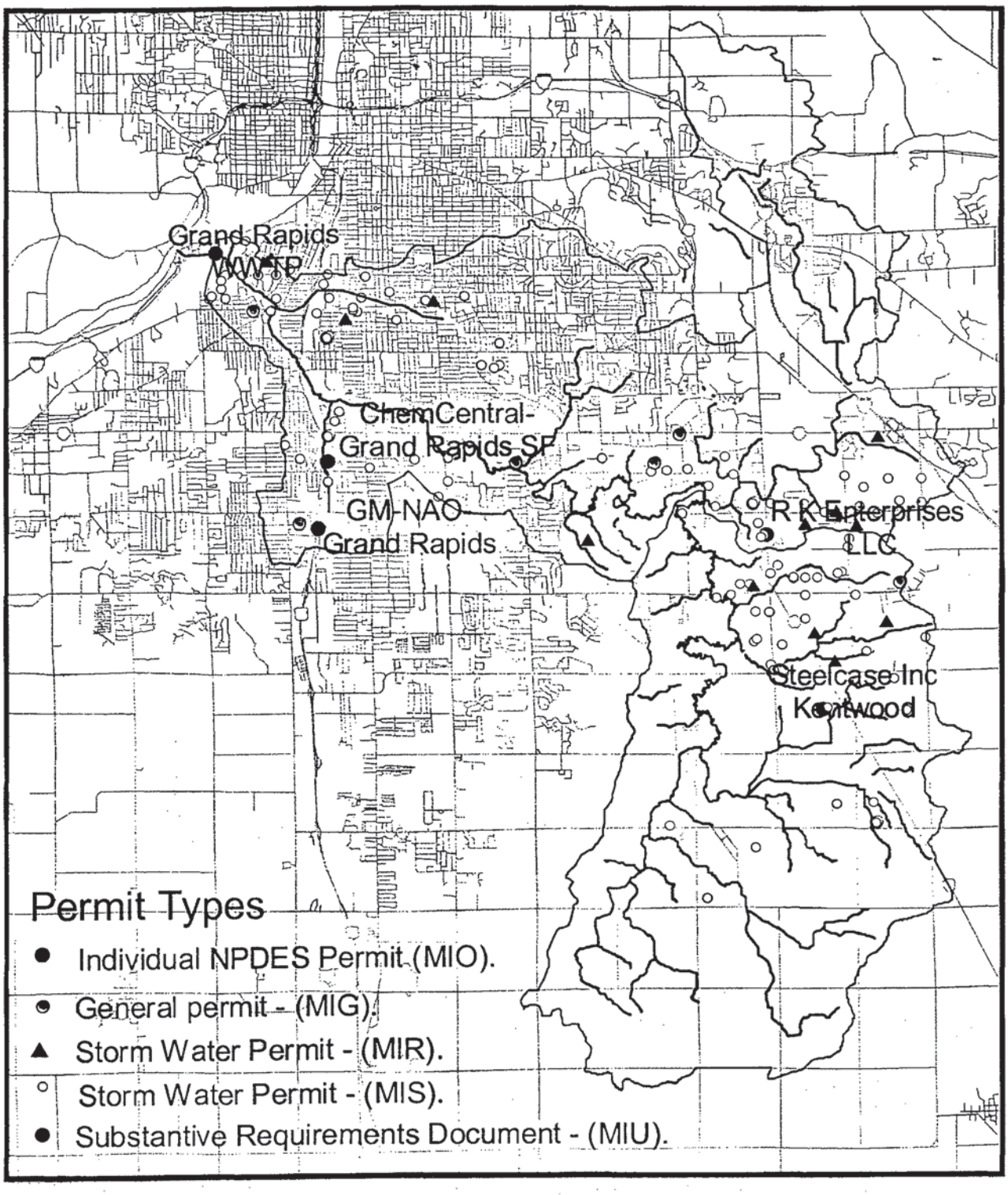

Figure 2. Permitted outfalls in the Plaster Creek watershed.

Table 1A. Qualitative macroinvertebrate sampling results for Plaster Creek survey of June 29, 2001 Kent County, Michigan.

TAXA	Plaster Cr. u/s Godfrey Ave 6/29/2001 STATION 1	Plaster Cr. u/s Eastern Ave 6/29/2001 STATION 2	Plaster Cr. 68th St 6/28/2001 STATION 3	Little Plaster Cr. East Paris 6/28/2001 STATION 4
PORIFERA (sponges)				1
PLATYHELMINTHES (flatworms)				
Turbellaria				1
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1			1
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	30	30	2	75
Decapoda (crayfish)	1		20	5
Isopoda (sowbugs)	20	30	20	5
Insecta				
Ephemeroptera (mayflies)				
Baetidae				5
Heptageniidae		5		
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1		
Zygoptera (damselflies)				
Calopterygidae		2		
Hemiptera (true bugs)				
Corixidae		2	1	
Gerridae				1
Neuroptera (spongilla flies)				
Sisyridae				1
Trichoptera (caddisflies)				
Hydropsychidae	20	20	2	1
Coleoptera (beetles)				
Elmidae			1	
Diptera (flies)				
Chironomidae	20	20	30	5
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)				
Physidae	1	2		
Pelecypoda (bivalves)				
Pisidiidae				5
Sphaeriidae (clams)		2		5
TOTAL INDIVIDUALS	93	114	76	111

Table 1B. Macroinvertebrate metric evaluation of Plaster Creek, June 29, 2001.

METRIC	STATION 1 Value	STATION 1 Score	STATION 2 Value	STATION 2 Score	STATION 3 Value	STATION 3 Score	STATION 4 Value	STATION 4 Score
TOTAL NUMBER OF TAXA	7	-1	10	-1	7	-1	13	0
NUMBER OF MAYFLY TAXA	0	-1	1	-1	0	-1	1	-1
NUMBER OF CADDISFLY TAXA	1	-1	1	-1	1	-1	1	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	0.00	-1	4.39	0	0.00	-1	4.50	0
PERCENT CADDISFLY COMP.	21.51	0	17.54	0	2.63	-1	0.90	-1
PERCENT CONTR. DOM. TAXON	32.26	0	26.32	0	39.47	-1	67.57	-1
PERCENT ISOPOD, SNAIL, LEECH	23.66	-1	28.07	-1	26.32	-1	5.41	0
PERCENT SURF. AIR BREATHERS	0.00	1	1.75	1	1.32	1	0.90	1
TOTAL SCORE		-5		-4		-7		-4
MACROINV. COMMUNITY RATING		POOR		ACCEPT.		POOR		ACCEPT.

Table 2. Stream habitat evaluations within the Plaster Creek watershed on June 29, 2001, Kent County, Michigan.

HABITAT METRIC (MAXIMUM SCORE)	Plaster Cr. u/s Godfrey Ave. STATION 1	Plaster Cr. u/s Eastern Ave. STATION 2	Plaster Cr. 68th St STATION 3	Little Plaster Creek East Paris Ave. STATION 4
Avail. Cover (20):	15	5	6	5
Embeddedness (20):	6	5	0	6
Velocity:Depth (20):	11	6	5	6
Flow Stability (15):	8	7	8	8
Bottom Depos. (15):	12	3	2	2
Runs-Bends (15):	15	4	2	4
Bank Stability (10):	2	2	3	5
Stability (10):	6	3	6	6
Stream Cover (10):	6	8	6	6
TOTAL SCORE (135):	81	43	38	48
HABITAT RATING:	**GOOD**	**FAIR**	**FAIR**	**FAIR**
Date:	6/29/2001	6/29/2001	6/28/2001	6/28/2001
Weather:	Sunny	Sunny	Sunny	Sunny
Air Temperature (Deg. F)	76	80	85	80
Water Temperature (Deg. F):	67	70	74	69
Ave. Stream Width (Feet):	20	25	20	12
Ave. Stream Depth (Feet):	1	2	1	0.5
Surface Velocity (Ft./Sec.):	1	0.5	0.5	0.5
Estimated Flow (CFS):	20	25	10	3
Stream Modifications:			cattle access	
Nuisance Plants (Y/N):	0	0	0	0
Report Number: MI/DEQ/SWQ-01/107				
STORET No.:	410628	410629	410631	410630
County Code:	41	41	41	41
County Name:	Kent	Kent	Kent	Kent
TRS:	06N12W02	06N11W17	05N11W10	06N11W13
Latitude (dd):	42.9359	42.90936	42.84102	42.9006
Longitude (dd):	-85.68748	-85.64674	-85.59678	-85.56
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4050006	4050006	4050006	4050006
USGS Basin Name:	Lower Grand R.	Lower Grand R.	Lower Grand R.	Lower Grand R.

Comments:

Plaster Creek is impaired due to excessive solids and runoff loadings from a variety of sources including agriculture in the upper reaches, suburban development in the upper/middle reaches and urbanization in the lower reaches. Major WQ problems are related to elevated E.coli, suspended solids and extremes in flow regimes (highs and lows) that also impair the biota of Plaster Creek.

Appendix 3

Michigan Department of Environmental Quality
Surface Water Quality Division
June 2002

Total Maximum Daily Load for *Escherichia Coli* in Plaster Creek, Kent County, Michigan

INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable levels of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore then maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli*) that will result in the attainment of the applicable WQS in Plaster Creek, a tributary to the Grand River, located in Kent County.

PROBLEM STATEMENT

This TMDL addresses approximately 12 miles of Plaster Creek in the greater Grand Rapids area where recreational uses are impaired by elevated levels of pathogens. Michigan's Section 303(d) list (Creal and Wuycheck, 2000) cites the Grand River confluence upstream to Dutton Park (Hanna Lake Avenue and 76th Street) as the affected reach. The TMDL reach (Figure 1) is on the Section 303(d) list as:

Waterbody: **Plaster Creek** WBID#: **082806H**
County: Kent RF3RchID: 4050006 10 Size: 12 M
Location: Grand River confluence upstream to Dutton Park (Hanna Lake Avenue and 76th Street).
Status: **2** Problem: **Fish and macroinvertebrate communities rated poor; Pathogens (Rule 100).**
TMDL YEAR(s): 2001

Plaster Creek was placed on the Section 303(d) list due to impairment of recreational uses by the presence of elevated levels of *E. coli*. Historical data collected by the Kent County Health Department documented elevated levels of *E. coli* in 1997. Monitoring data (Appendix 1) collected in 2001 by the Michigan Department of Environmental Quality (MDEQ) documented exceedances of the WQS, in both Plaster Creek and the two tributaries sampled (Table 1). In addition, seasonal geometric means for the 2001 sampling season exhibited elevated levels throughout the 12-mile reach of the creek. Monthly geometric mean *E. coli* concentrations in Plaster Creek for 2001 ranged from 216 *E. coli* per 100 milliliters (ml) in June at 28th Street to 4,340 *E. coli* per 100 ml in August at 60th Street (Table 1). Sampling associated with rain events (Appendix 1) yielded substantially higher *E. coli* concentrations in Plaster Creek and the tributaries.

Monthly geometric mean *E. coli* concentrations for the Plaster Creek tributaries ranged from 481 *E. coli* per 100 ml in June at 28th Street to 6,903 *E. coli* per 100 ml in September at 60th Street (Table 1). Overall, the highest *E. coli* data collected for Plaster Creek came from the

tributary at 60th Street (Figure 2). The lowest monthly geometric mean at this station was 2,043 *E. coli* per 100 ml in July and the highest was 6,903 *E. coli* per 100 ml in September (Table 1). The 2001 data collected indicate that the upper end of the Plaster Creek Watershed, specifically in the area of 60th Street, may be a substantial source of *E. coli* to Plaster Creek.

In addition, the Kent County Health Department has sampled Plaster Creek at three locations in both the cities of Grand Rapids and Kentwood. In general, these data agree with the MDEQ 2001 data indicating consistent exceedances of WQS for *E. coli* in Plaster Creek. These data can be found at http://www.accesskent.com/living/environhealth.

NUMERIC TARGETS

The impaired designated use for Plaster Creek at this location is total body contact. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

> R 323.1062 Microorganisms.
> Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli (E. coli)* per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

In addition, sanitary wastewater from point sources have an additional target as follows:

> Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 milliliters, based on the on the geometric mean of all of 3 or more samples taken during any period of discharge not to exceed 7 days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliform per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source discharge is meeting their limit of 200 fecal coliform per 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent.

For this TMDL, the WQS of 130 *E. coli* per 100 ml as a 30-day geometric mean is the target level for the TMDL reach from May 1 to October 31. As previously stated, 2001 monitoring data indicated consistent exceedances of WQS at all ten stations sampled. Storm water runoff

appears to be a major contributor of *E. coli* to Plaster Creek, as indicated by two high sampling events on August 10, 2001 and September 7, 2001. Despite the runoff inputs to Plaster Creek, the consistent *E. coli* exceedances throughout the sampling season seem to indicate a constant source of *E. coli* to Plaster Creek and the tributaries.

SOURCE ASSESSMENT

The Plaster Creek Watershed is located in Kent County. The listed TMDL reach is the Grand River confluence upstream to Dutton Park (Hanna Lake Avenue and 76th Street) (Figure 1). Municipalities in the watershed include the cities of Grand Rapids, Wyoming, Kentwood, and East Grand Rapids, and the townships of Gaines, Caledonia, Cascade, Ada, and Grand Rapids (Figure 3). Table 2 shows the distribution of land in the Plaster Creek Watershed for each municipality.

Potential pathogen sources for this waterbody include those typically associated with urban and suburban runoff, as well as illicit connections. As previously discussed, sampling that coincided with rain events showed substantial increases in *E. coli* concentrations in both Plaster Creek and the tributaries. There are 106 storm water permits in the Plaster Creek Watershed (Table 3). Another possible source could be agricultural inputs, as the headwaters of Plaster Creek are heavily influenced by this type of land use.

There are 16 permitted discharges to the Plaster Creek Watershed (Table 3, Figure 4). Eleven are covered by general permits, of which seven are wastewaters associated with gasoline and/or related petroleum products and the remaining four are noncontact cooling water discharges. In addition, there are five individual NPDES permits in the Plaster Creek Watershed for the following facilities: R & K Enterprises LLC (MI0002861), Steelcase Inc. – Kentwood (MI0043061), GM-NAO-Grand Rapids (MI0043877), Delphi Automotive Systems LLC (MI0001236), and the Grand Rapids Waste Water Treatment Plant (WWTP) (MI0026069). With exception to the Grand Rapids WWTP, these other four discharges generally consist of mine dewatering, noncontact cooling water, and coal pile runoff. These four discharges are not considered to contain treated or untreated human sewage; therefore, these discharges are not a source of *E. coli* to Plaster Creek and the requirements of Rule 62(3) do not apply.

The city of Grand Rapids has five outfalls, four combined sewer overflows (CSOs) and one WWTP emergency bypass, to the Plaster Creek Watershed. The city of Grand Rapids has a combined sewer overflow system and is authorized to discharge combined sewer overflows at four locations on Silver Creek Drain, a highly modified tributary of Plaster Creek (Table 3, Figure 4). Section A.6.a. of the Grand Rapids WWTP NPDES permit (MI0026069) authorizes combined sewer overflows in response to rainfall or snowmelt conditions when total available transportation and treatment capabilities are exceeded. Following the approved Phase III plan outlined in the Grand Rapids WWTP NPDES permit, two outfalls are scheduled for complete elimination by December 31, 2006, with the remaining two eliminated by December 31, 2019. The Grand Rapids WWTP also maintains an emergency bypass, outfall 002, to Plaster Creek at the downstream end, between Godfrey and Market Street. This bypass has occurred once in the last ten years, in June 1996, and discharges only in cases of extreme circumstances. Due to the infrequent discharge from this outfall and the future elimination of the combined sewage system overflows, these outfalls are not considered a source of *E. coli* for this TMDL.

LINKAGE ANALYSIS

The link between the *E. coli* concentration in Plaster Creek and the potential sources is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. This provides the basis for

estimating the total assimilative capacity of the creek and any needed load reductions. For this TMDL, the primary loading of pathogens appears to enter Plaster Creek by both wet and dry weather conditions.

Based on 2001 monitoring data, every location sampled on Plaster Creek and the tributaries were exceeding WQS. Compliance with the numeric pathogen target in Plaster Creek depends on the removal of illicit connections, eliminations of combined sewer overflows, control of *E. coli* in storm water, and control of agricultural inputs. This concept was the guiding water quality management principle used to develop the TMDL. If the *E. coli* inputs can be controlled, then total body contact recreation in Plaster Creek will be protected.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving WQS. As indicated in the Numeric Targets section, the target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1090. In general, the lowest monthly 95% exceedance flow for streams is used as a design condition for point source discharges. However, *E. coli* sources to Plaster Creek arise from a mixture of dry and wet weather-driven sources, and there is no single critical condition that is protective for all other conditions. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli* indicators, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL is equal to the target concentration of 130 *E. coli* per 100 ml for each month of the recreational season (May through October).

In addition, an allocation strategy for nonpoint sources has been selected that assumes equal bacteria loads per unit area for all lands within the watershed. Consistent with the allocation strategy, Table 4 shows the TMDL or allowable concentrations for *E. coli* by applicable month in the Plaster Creek Watershed.

ALLOCATIONS

TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a Margin of Safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. As previously indicated, this pathogen TMDL will not be expressed on a mass loading basis and is concentration-based consistent with USEPA regulations at 40 CFR, Section 130.2(i).

WLAs

As mentioned previously, there are 16 permitted point source discharges to Plaster Creek or its tributaries. Eleven discharges are covered by general permits and are not known to contain treated or untreated human sewage. Four discharges are covered by individual NPDES permits and due to the nature of the discharges -- mine dewatering, noncontact cooling water, and coal pile runoff, Rule 62(3) does not apply. These discharges are not considered sources of *E. coli* to Plaster Creek so the WLA is equal to zero.

The remaining outfall is the Grand Rapids WWTP emergency bypass to Plaster Creek. This bypass has occurred once in the last ten years and only functions under extreme circumstances. Due to the infrequent discharge from this outfall, it is not given a WLA. In addition, the city of Grand Rapids has a permitted combined sewer overflow system. Four outfalls discharge to Silver Creek Drain, a modified tributary of Plaster Creek. This combined sewer overflow system is scheduled for complete elimination, with two outfalls eliminated by the end of 2006 and the other two by December 31, 2019. Due to the future elimination of the combined system overflows, the WLA remains equal to zero.

LAs

This TMDL is concentration-based; therefore, the LA is equal to 130 *E. coli* per 100 ml. The assumption used in the allocation strategy is that there are equal bacteria loads per unit area for all lands within the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction of the various local units of government within the watershed. Table 2 gives the relative land in the watershed for each of the local units of governments. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated uses to Plaster Creek.

The government entities with the largest percent land area in the Plaster Creek Watershed are the city of Grand Rapids (26%), Gaines Township (26%), and the city of Kentwood (23%). These three entities make up 75% of the Plaster Creek Watershed. The remaining 25% of the watershed is made up by the city of Wyoming (7%), Grand Rapids Township (7%), Cascade Township (6%), the city of East Grand Rapids (3%), Ada Township (1%), and Caledonia Township (1%).

The LA incorporates the pathogen sources for this waterbody, including those typically associated with urban and suburban runoff, as well as illicit connections. This includes the 106 storm water permits in the Plaster Creek Watershed (Table 3), as well as agricultural inputs.

MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis thorough conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay was used.

SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by Rule 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. In addition, because this is a concentration-based TMDL, WQS will be met regardless of flow conditions in the applicable season.

MONITORING

In 2001, pathogens were monitored at ten stations from May to September (Figure 1). Subsequent weekly sampling will begin at appropriate stations in May 2002, and conclude in September 2002. If sampling in 2002 indicates WQS are exceeded, sampling will be oriented toward source identification. If these results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

In future years, assuming WQS are not met immediately, additional sampling will be conducted from May to September at appropriate stations. Sampling will be adjusted as needed to assist in continued source identification and elimination. When these results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

REASONABLE ASSURANCE ACTIVITIES

Storm water inputs, agricultural inputs, and illicit discharges are likely the dominant source of *E. coli* to Plaster Creek, given the wide variety of land uses in the watershed. Implementation activities to meet the TMDL require measures to reduce *E. coli* sources. Efforts to reduce *E. coli* sources are currently in place. The city of Grand Rapids has implemented their Phase I storm water permit (MI0053872). This permit includes the preparation and implementation of a storm water management plan (approved September 8, 1998), public education and outreach, and an illicit discharge elimination program. To further reduce the input of *E. coli* in Plaster Creek, the city of Grand Rapids has begun locating and eliminating illicit discharges within the city since the plan was approved. In addition, all known outfalls in the city of Grand Rapids drainage system have been cataloged.

The city of Grand Rapids has also been awarded a Clean Michigan Initiative (CMI) grant of about $75,000 to aid in the investigation of approximately 270 outfalls of various origin within the city limits that discharge to Plaster Creek and tributaries (CMI, 2001). Overall, the city has a proactive approach to monitoring water quality. The city began water quality monitoring in 1969 and created an Environmental Protection Services Department in 1995. This department is responsible for wastewater collection and treatment, storm water management, and addresses other environmental issues that face urban areas.

The remaining municipalities of Wyoming, Kentwood, East Grand Rapids, Gaines Township, Caledonia Township, Ada Township, Grand Rapids Township, and Cascade Township will likely be subject to the Phase II storm water permits. These permits will require activities that reduce *E. coli* inputs through the public education, storm water management plan, and illicit connection identification and elimination requirements.

Plaster Creek has an MDEQ approved (November 23, 1999) watershed management plan in accordance with the requirements of the CMI Nonpoint Source Pollution Control Grants Program (KCDC, 1999). A CMI grant (tracking code number 1999-0039) was approved by the

MDEQ for two storm water detention basin retrofit construction projects located in the Plaster Creek Watershed: the Wyoming Department of Public Works and the Laraway-Brooklyn detention basins. The contract end date for the retrofitting projects is July 2002. The CMI grant amount was for $386,100 with a local match of $128,700 for a project total of $514,800.

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Michigan Department of Environmental Quality
June 19, 2002

REFERENCES

American Public Health Association. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition.

CMI. 2001. Grant TC:2001-0042.

Creal, W. and J. Wuycheck. 2000. Federal Clean Water Act Section 303(d) List – Michigan's Submittal for Year 2000. Michigan Department of Environmental Quality, Surface Water Quality Division, Report Number MI/DEQ/SWQ-00/018.

KCDC – Kent County Drain Commissioners Office. July 1999. Amendment to the "Plaster Creek Nonpoint Watershed Project" – December 1987, as amended in 1989. Project No. F99037. Prepared by: Kent County Drain Commissioner and Fishbeck, Thompson, Carr and Huber, Inc.

Personal communication, Richard L. Whitman. United States Geological Survey, October 2001.

USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

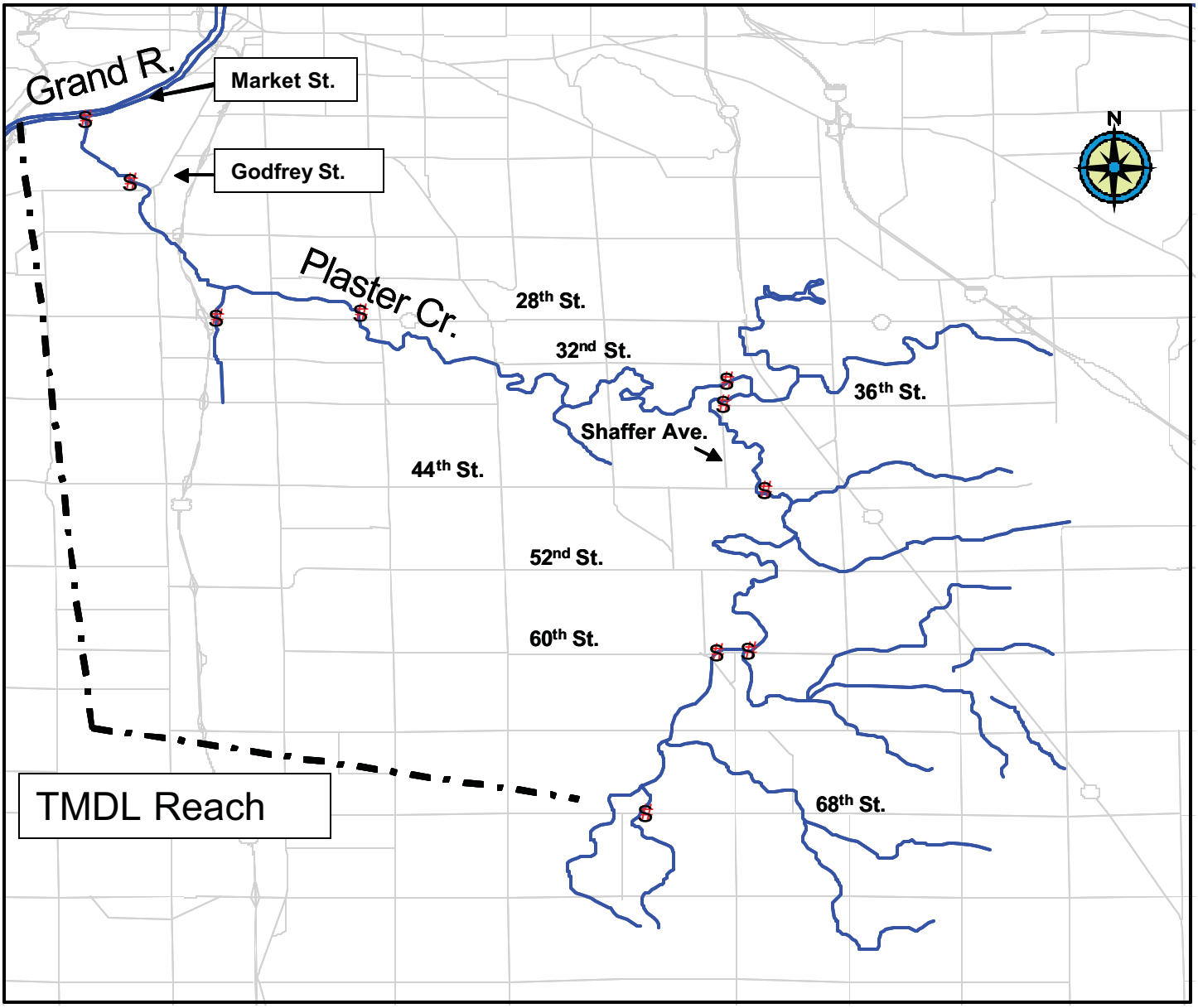

Figure 1. Sampling locations for Plaster Creek and selected tributaries, May through September 2001, Kent County, Michigan.

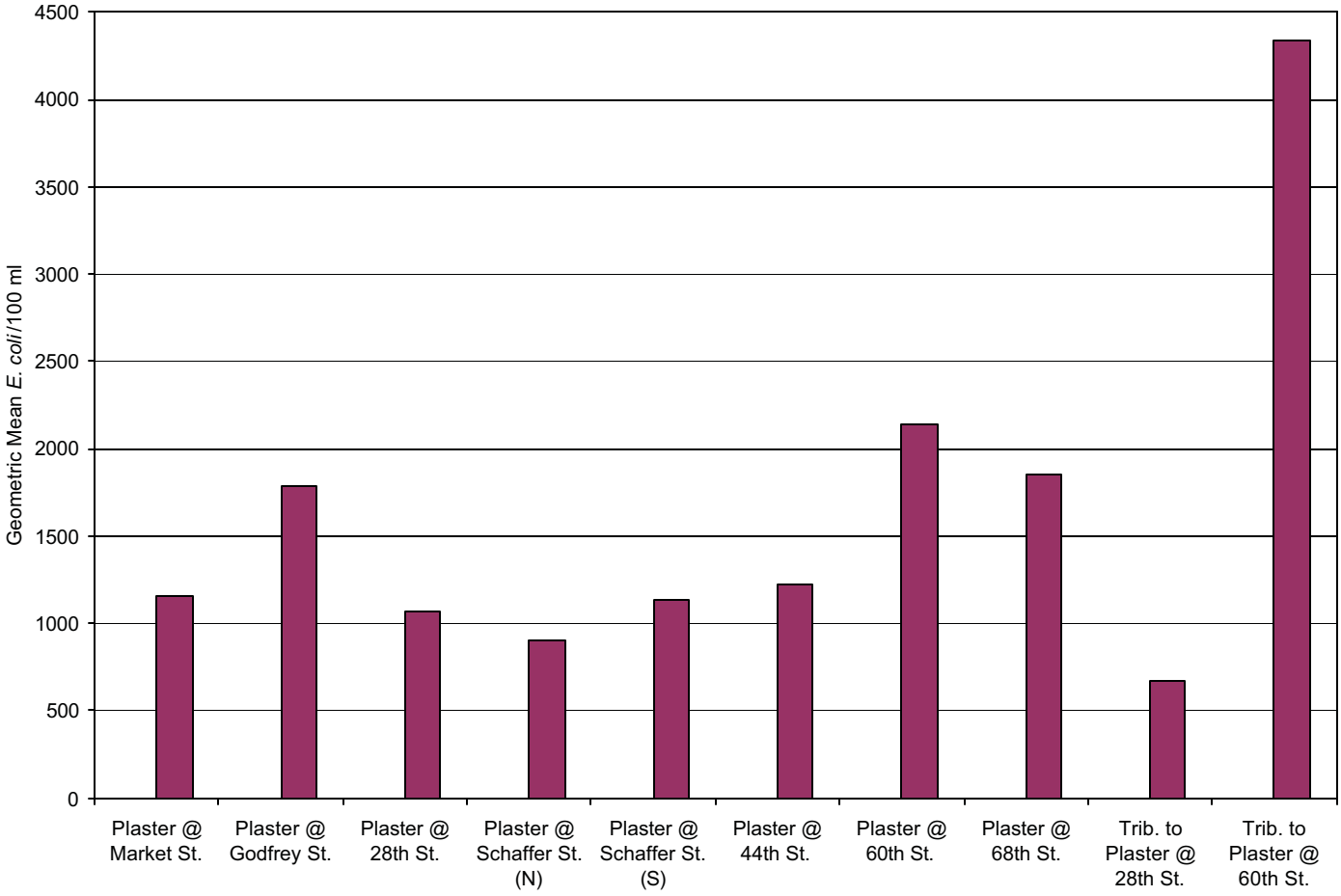

Figure 2. Seasonal geometric mean *E. coli* results for Plaster Creek and selected tributaries, Kent County, Michigan, May through September 2001. Data are presented downstream to upstream, followed by tributaries.

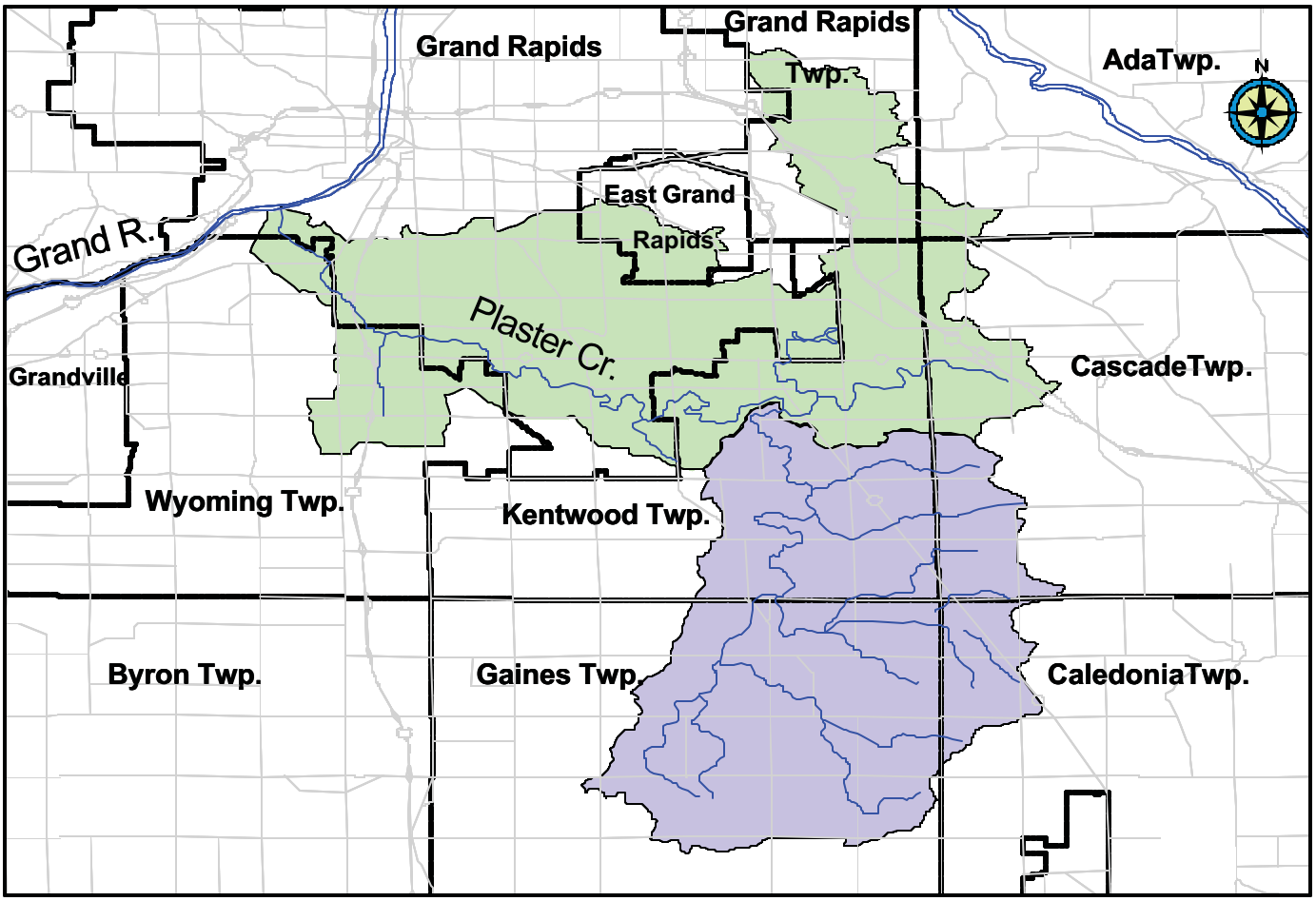

Figure 3. Municipalities in the Plaster Creek Watershed.

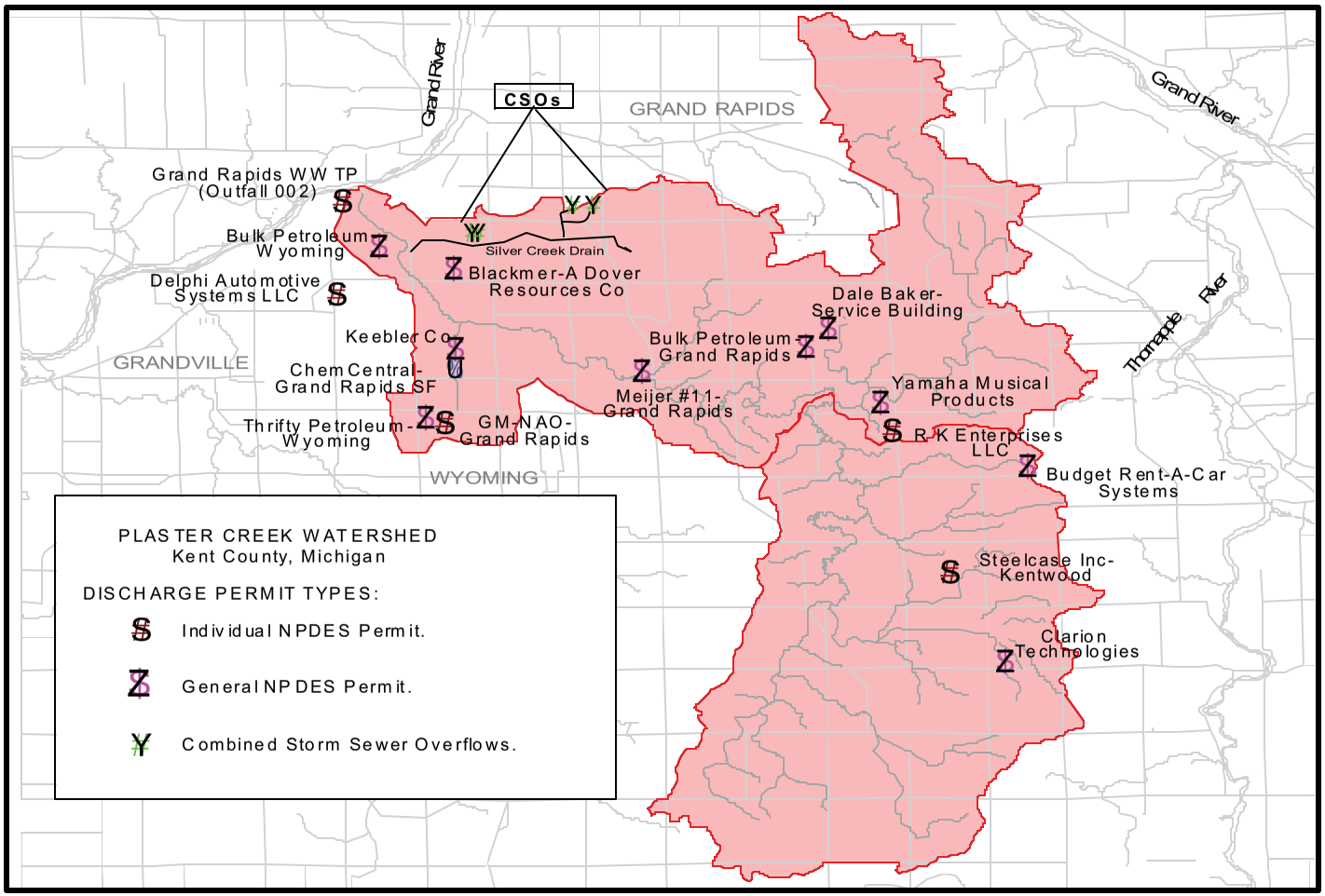

Figure 4. NPDES permitted outfalls in the Plaster Creek Watershed, excluding storm water permits.

Table 1. MDEQ *E. coli* data for Plaster Creek in the greater Grand Rapids area, Kent County Michigan, 2001.

Sample Location	Month	Minimum	Geometric Mean	Maximum	# of results
Plaster Creek @ Market St.	May	360	433	580	3
	June	370	663	1,800	12
	July	290	580	860	12
	August	400	3,197	560,000	18
	September	230	1,149	9,000	24
Plaster Creek @ Godfrey St.	May	3,500	4,138	4,500	3
	June	300	500	870	12
	July	360	629	940	12
	August	590	3,561	37,000	18
	September	600	3,058	86,000	24
Plaster Creek @ 28th St.	May	340	465	590	3
	June	10	216	860	12
	July	160	707	3,270	12
	August	390	2,243	23,300	18
	September	510	1,853	58,000	24
Plaster Creek @ Schaffer Ave. (N)	May	550	769	1,400	3
	June	380	542	810	12
	July	190	359	580	12
	August	290	1,650	19,900	18
	September	380	1,189	6,200	24
Plaster Creek @ Schaffer Ave. (S)	May	650	798	900	3
	June	420	738	1,500	12
	July	150	465	1,000	12
	August	420	1,871	32,100	18
	September	460	1,583	8,100	24
Plaster Creek @ 44th St.	May	610	807	980	3
	June	510	680	1,000	12
	July	240	661	4,700	12
	August	350	1,953	22,600	18
	September	440	1,656	5,660	24
Plaster Creek @ 60th St.	May	580	706	810	3
	June	280	938	1,800	12
	July	620	1,788	6,200	12
	August	490	4,340	600,000	18
	September	500	2,378	720,000	24
Plaster Creek @ 68th St.	May	400	467	580	3
	June	620	1,454	3,100	12
	July	540	1,758	6,910	12
	August	460	2,515	30,000	18
	September	480	2,016	72,000	24

Table 1 continued.

Sample Location	Month	minimum	geometric mean	maximum	# of results
Tributary to Plaster Creek @ 28th St.	May	430	499	590	3
	June	310	481	710	12
	July	390	872	2,600	12
	August	300	1,048	29,200	18
	September	30	513	15,000	24
Tributary to Plaster Creek @ 60th St.	May	5,700	5,995	6,300	3
	June	1,760	2,945	4,700	12
	July	890	2,043	4,700	12
	August	1,000	4,713	26,900	18
	September	880	6,903	4,700,000	24

Table 2. Distribution of land for each municipality in the Plaster Creek Watershed.

Municipality	Square Miles	Percent
City of Grand Rapids	17.6	26
Gaines Township	18.0	26
Kentwood	16.0	23
Wyoming	4.9	7
Grand Rapids Township	4.8	7
Cascade Township	4.4	6
East Grand Rapids	1.8	3
Ada Township	0.6	1
Caledonia Township	0.6	1
TOTAL	**68.7**	**100**

Table 3. Permitted outfall s in the Plaster Creek Watershed.

PERMIT NO.	FACILITY NAME	RECEIVING WATERS
Individual NPDES Permits:		
MI0001236	Delphi Automotive Systems LLC	Plaster Creek
MI0002861	R K Enterprises LLC	Plaster Creek
MI0043061	Steelcase Inc-Kentwood	Plaster Creek
MI0043877	GM-NAO-Grand Rapids	Cole Drain
MI0026069	Grand Rapids WWTP	Plaster Creek
	CSO - Ionia Avenue and Stevens Street	Silver Creek Drain
	CSO - Alexander Street and Cooper Avenue	Silver Creek Drain
	CSO - Alexander Street and Kalamazoo Avenue	Silver Creek Drain
	CSO - Stevens Street at Railroad Crossing	Silver Creek Drain
General Permits:		
MIG080036	Thrifty Petroleum-Wyoming	Plaster Creek
MIG080083	Meijer #11-Grand Rapids	Ken-O-Sha Creek
MIG080115	Bulk Petroleum-Wyoming	Plaster Creek
MIG080172	J & H Oil Co-Wyoming	Plaster Creek
MIG080422	Budget Rent-A-Car Systems	unnamed trib to Plaster Creek
MIG080985	Bulk Petroleum-Grand Rapids	Whiskey Creek
MIG081003	Dale Baker-Service Building	Whiskey Creek
MIG250151	Keebler Co	Plaster Creek
MIG250152	Blackmer-A Dover Resources Co	Plaster Creek
MIG250156	Clarion Technologies	Plaster Creek
MIG250271	Yamaha Musical Products	Little Plaster Creek
Substantive Requirements Document:		
MIU990004	ChemCentral-Grand Rapids SF	Cole Drain
Storm Water Permits:		
MIR20G102	River City Metal Products	Plaster Creek
MI0053937	MDOT - Grand Rapids - MS4	Plaster Creek
MI0053872	Grand Rapids - MS4	Plaster Creek
MIS110038	Burton St Recycling-Supply Co	Plaster Creek
MIS110041	Midwest Bumper Co	Silver Creek
MIS110042	Grand Rapids Plastics-4220 RBC	Plaster Creek
MIS110052	Thompson-McCully Co-Market Co	Plaster Creek
MIS110057	Kentwood Packaging-Powder	Plaster Creek
MIS110118	Mitco Inc	Plaster Creek
MIS110129	P & K Steel Service Inc	Plaster Creek
MIS110137	Grand Rapids Carvers Inc	Plaster Creek
MIS110283	Wamar Products Inc	Plaster Creek
MIS110294	Tabletting Inc	Plaster Creek
MIS110296	Starcade Inc	Plaster Creek
MIS110297	State Heat Treat-Grand Rapids	Plaster Creek
MIS110299	Stagood-Metal Components Inc	Plaster Creek
MIS110347	USPS-Wyoming	Plaster Creek
MIS110352	Stephenson & Lawyer-GR	Plaster Creek
MIS110365	Schupan & Sons Inc-Recycling	Plaster Creek
MIS110366	Conway Central Express-Kentwood	Plaster Creek
MIS110486	Riviera Tool Company	Plaster Creek

Table 3 continued.

PERMIT NO.	FACILITY NAME	RECEIVING WATERS
MIS110487	Reliance Finishing Co	Plaster Creek
MIS110488	Rapid Die & Engineering	Plaster Creek
MIS110491	Price Industries Inc	Plaster Creek
MIS110497	Lacks-Brockton Mold	Plaster Creek
MIS110504	Michigan Packaging Co	Little Plaster Creek
MIS110505	Michigan Colprovia	Plaster Creek
MIS110506	Mich Cert Con-Grand Rapids	Plaster Creek
MIS110508	Consolidated Rail Corporation	Plaster Creek
MIS110515	Lake Mich Packaging Products	Plaster Creek
MIS110526	Lily Products of Mich	Plaster Creek
MIS110527	Knoll Inc-Grand Rapids	Plaster Creek
MIS110529	Kentwood Manufacturing Co	Plaster Creek
MIS110530	Key Plastics Inc-GR	Plaster Creek
MIS110538	Hill Machinery Co Inc	Plaster Creek
MIS110553	BF Goodrich Avionics Sys Inc	Plaster Creek
MIS110563	Christopher Metal Fabricating	Plaster Creek
MIS110568	Die Dimensions Corp	Plaster Creek
MIS110569	Blackmer-A Dover Resources Co	Plaster Creek
MIS110570	Cascade Engineering 5141-36	Little Plaster Creek
MIS110572	Helen Inc-Envir Coatings	Plaster Creek
MIS110573	Country Fresh Inc	Plaster Creek
MIS110574	Dyna Plate Inc	Plaster Creek
MIS110577	Hi Tec Laser Die-J-Tec Prod	Plaster Creek
MIS110578	Imperial Sheet Metal	Plaster Creek
MIS110581	Keebler Co	Plaster Creek
MIS110583	Consolidated Metal Prdts Inc	Silver Creek Drain
MIS110585	Consumers Concrete-15	Plaster Creek
MIS110586	CSX Transport-Wyoming Yard	Plaster Creek
MIS110591	Lacks Ent-Plastic Plate 2	Plaster Creek
MIS110592	Lacks Ent-52nd-Paint East	Plaster Creek
MIS110593	Lacks Ent-52nd-Paint West	Plaster Creek
MIS110594	Lacks Ent-Barden Assembly	Plaster Creek
MIS110595	Lacks Ent-52nd Mold	Plaster Creek
MIS110596	Lacks Ent-Airlane Plant	Plaster Creek
MIS110597	Lacks Ent-Distribution Center	Plaster Creek
MIS110599	Interface AR-32nd Street	Whiskey Creek
MIS110601	Meridian Auto-GR-Plt 1	Plaster Creek
MIS110602	Meridian Auto-GR-Plt 4 & 5	Plaster Creek
MIS110603	Meridian Auto-GR-Plt 7	Plaster Creek
MIS110607	Allied Finishing Inc	Plaster Creek
MIS110613	American Litho-Inc	Plaster Creek
MIS110616	Adac Plastics Inc-GR	Plaster Creek
MIS110618	Autocam Corporation	Plaster Creek
MIS110621	Advance Packaging Corp	Plaster Creek
MIS110626	Amerikam	Plaster Creek
MIS110630	A & K Finishing-Danvers	Plaster Creek
MIS110631	A & K Finishing-Donker	Plaster Creek
MIS110658	Electro Chem Finish Co-44th	Plaster Creek
MIS110660	Detroit Diesel Remanufacturing	Plaster Creek
MIS110673	Smith Industries Inc-Patterson	Plaster Creek

Table 3 continued.

PERMIT NO.	FACILITY NAME	RECEIVING WATERS
MIS110703	MC Van Kampen Trucking	Plaster Creek
MIS110707	Modular Transportation-Mart	Plaster Creek
MIS110709	Lacks Ent-Airwest Mold	Plaster Creek
MIS110751	Venture Grand Rapids	Plaster Creek
MIS110778	Reliance Plastisol Coating Co	Plaster Creek
MIS110802	Diecraft-GR	Plaster Creek
MIS110818	Paladin Ind Inc	Plaster Creek
MIS110820	Parker Motor Freight Inc	Plaster Creek
MIS110823	Team Industries	Plaster Creek
MIS110825	Fki Indust-Keeler Die Cast	Silver Creek Drain
MIS110827	Plastic Mold Technology Inc	Plaster Creek
MIS110829	Yamaha Musical Products	Little Plaster Creek
MIS110840	M & E Manufacturing	Plaster Creek
MIS110848	Grand Rapids Plastics-4050 RBC	Plaster Creek
MIS110850	MacDonalds Ind-44th St	Plaster Creek
MIS110894	American Metal & Plastics	Plaster Creek
MIS110945	Master Finish Company	Plaster Creek
MIS111015	Development-GR	Plaster Creek
MIS111017	Dieline-GR	Plaster Creek
MIS111028	Magic Finishing Company	Plaster Creek
MIS111048	Bishop Distributing Co	Plaster Creek
MIS111058	Eerdmans Printing Co	Plaster Creek
MIS111078	Steeltech Ltd	Silver Creek Drain
MIS111080	Davidson Plyforms Inc	Plaster Creek
MIS111104	Towne Air Freight Inc	Plaster Creek
MIS111105	Beverlin Manufacturing Corp	Plaster Creek
MIS111106	Cascade Engineering 4950-37	Little Plaster Creek
MIS111110	Magna-Lakeland	Plaster Creek
MIS111111	CSX Transport-BIDS GR	Plaster Creek
MIS111119	Federal Express-GRRA	Plaster Creek
MIS111137	Michigan Wheel Corp	Plaster Creek
MIS111190	Lacks Airlane Campus	Plaster Creek
MIS111191	Lacks Brockton Campus	Plaster Creek
MIS111192	Lacks 52nd Campus	Plaster Creek
MIS111193	Lacks Barden Campus	Plaster Creek

Table 4. Allowable *E. coli* concentrations by month in the Plaster Creek Watershed.

May	June	July	August	September	October
130	130	130	130	130	130

Table 5. Plaster Creek average flows (cfs) at the confluence with the Grand River.

May	June	July	August	September	October
39	27	21	18	18	22

Appendix 1. MDEQ *E. coli* monitoring data for Plaster Creek, greater Grand Rapids area, 2001. Data are presented downstream to upstream, followed by tributaries.

Plaster Creek @ Market St. PC-1A	Plaster Creek @ Godfrey St. PC-2A	Plaster Creek @ 28th St. PC-4A	Plaster Creek @ Schaffer Ave. (N) PC-5A	Plaster Creek @ Schaffer Ave. (S) PC-6A	Weather data
5/31/2001	**5/31/2001**	**5/31/2001**	**5/31/2001**	**5/31/2001**	Sunny, cool
390	4500	590	1400	650	
580	3500	340	550	900	
360	4500	500	590	870	
6/7/2001	**6/7/2001**	**6/7/2001**	**6/7/2001**	**6/7/2001**	Partly sunny, mild
530	550	380	380	420	
720	480	50	460	530	
960	520	270	380	720	
6/14/2001	**6/14/2001**	**6/14/2001**	**6/14/2001**	**6/14/2001**	Partly cloudy, hot, humid
430	300	490	570	690	
370	450	390	810	620	
600	430	330	590	580	
6/21/2001	**6/21/2001**	**6/21/2001**	**6/21/2001**	**6/21/2001**	Partly cloudy, cool, mild
460	410	10	590	730	
410	310	510	450	560	
390	510	560	700	690	
6/27/2001	**6/27/2001**	**6/27/2001**	**6/27/2001**	**6/27/2001**	Partly cloudy, mild
1800	780	<10	530	1300	
1300	700	1300	560	1200	
1200	870	860	640	1500	
7/6/2001	**7/6/2001**	**7/6/2001**	**7/6/2001**	**7/6/2001**	Clear and cool
710	600	2400	350	470	
860	600	2600	400	460	
790	380	160	450	470	
7/13/2001	**7/13/2001**	**7/13/2001**	**7/13/2001**	**7/13/2001**	Clear, mild
290	380	440	260	1000	
310	360	880	330	990	
430	410	110	440	980	
7/20/2001	**7/20/2001**	**7/20/2001**	**7/20/2001**	**7/20/2001**	Partly cloudy, warm and humid
720	880	3270	190	170	
590	820	380	250	150	
680	940	2660	230	240	
7/27/2001	**7/27/2001**	**7/27/2001**	**7/27/2001**	**7/27/2001**	Sunny, 65° F
660	880	290	580	670	
630	920	530	540	450	
650	910	720	560	560	
8/3/2001	**8/3/2001**	**8/3/2001**	**8/3/2001**	**8/3/2001**	sunny, clear, 80° F
400	4000	1100	450	420	
500	4500	700	470	450	
580	4500	500	290	440	
8/10/2001	**8/10/2001**	**8/10/2001**	**8/10/2001**	**8/10/2001**	Partly cloudy, mild heavy rain last night
500000	15100	23300	18900	32100	
560000	37000	19600	19900	22700	
31900	36400	16000	19700	24800	
8/17/2001	**8/17/2001**	**8/17/2001**	**8/17/2001**	**8/17/2001**	Mostly cloudy, mild
700	650	810	530	490	
630	590	800	510	590	
600	620	780	500	520	
8/24/2001	**8/24/2001**	**8/24/2001**	**8/24/2001**	**8/24/2001**	Overcast, mild
5100	4700	3800	3500	3600	
4600	4600	4200	3400	3500	
4200	4300	3700	2800	3800	
8/29/2001	**8/29/2001**	**8/29/2001**	**8/29/2001**	**8/29/2001**	Clear, mild
600	910	400	350	500	
490	900	390	440	550	
470	880	410	390	520	
8/31/2001	**8/31/2001**	**8/31/2001**	**8/31/2001**	**8/31/2001**	Partly cloudy, mild
6500	6500	7400	4200	4100	
7500	7400	7400	3900	3900	
6700	6700	7000	4100	3200	

Appendix 1 continued.

Plaster Creek @ Market St. PC-1A	Plaster Creek @ Godfrey St. PC-2A	Plaster Creek @ 28th St. PC-4A	Plaster Creek @ Schaffer Ave. (N) PC-5A	Plaster Creek @ Schaffer Ave. (S) PC-6A	Weather data
9/5/2001	**9/5/2001**	**9/5/2001**	**9/5/2001**	**9/5/2001**	Clear, mild
420	1000	1500	1100	900	
600	980	770	900	900	
480	810	780	1100	900	
9/7/2001	**9/7/2001**	**9/7/2001**	**9/7/2001**	**9/7/2001**	Overcast, warm, rain
8700	86000	58000	6200	8100	
2880	59000	26000	5590	6380	
9000	60000	32000	5060	5160	
9/11/2001	**9/11/2001**	**9/11/2001**	**9/11/2001**	**9/11/2001**	Clear, 62° F
7900	7500	4000	3400	7600	
7300	7100	3900	2300	3300	
7400	8000	6200	4200	3200	
9/14/2001	**9/14/2001**	**9/14/2001**	**9/14/2001**	**9/14/2001**	Clear, cool
440	790	560	400	550	
400	820	510	420	500	
390	840	550	410	460	
9/18/2001	**9/18/2001**	**9/18/2001**	**9/18/2001**	**9/18/2001**	Clear, mild
280	4400	810	400	920	
290	4400	560	380	920	
230	3300	800	410	910	
9/20/2001	**9/20/2001**	**9/20/2001**	**9/20/2001**	**9/20/2001**	Overcast, cool
880	1300	990	910	900	
900	1450	970	920	890	
920	1400	960	910	930	
9/26/2001	**9/26/2001**	**9/26/2001**	**9/26/2001**	**9/26/2001**	Overcast, rainy, mild
2700	5000	2300	1900	2400	
3000	5000	2400	1000	2200	
2300	6000	2300	700	2200	
9/28/2001	**9/28/2001**	**9/28/2001**	**9/28/2001**	**9/28/2001**	Overcast, cool
430	600	900	1600	1700	
570	650	1070	1400	2300	
570	810	1000	1040	1200	

Appendix 1 continued.

Plaster Creek @ 44th St. PC-7A	Plaster Creek @ 60th St. PC-9A	Plaster Creek @ 68th St. PC-10A	Trib. to Plaster Creek @ 28th St. PC-3A	Trib. to Plaster Creek @ 60th St. PC-8A	Weather data
5/31/2001	**5/31/2001**	**5/31/2001**	**5/31/2001**	**5/31/2001**	Sunny, cool
980	810	580	430	5700	
610	750	440	590	6000	
880	580	400	490	6300	
6/7/2001	**6/7/2001**	**6/7/2001**	**6/7/2001**	**6/7/2001**	Partly sunny, mild
510	460	730	530	3600	
600	640	970	600	4500	
580	610	620	540	4300	
6/14/2001	**6/14/2001**	**6/14/2001**	**6/14/2001**	**6/14/2001**	Partly cloudy, hot, humid
680	1250	2220	570	2150	
640	1330	2550	460	2210	
590	1020	2400	310	2250	
6/21/2001	**6/21/2001**	**6/21/2001**	**6/21/2001**	**6/21/2001**	Partly cloudy, cool, mild
810	1170	1140	320	1800	
670	280	1470	330	1900	
680	1110	800	340	1760	
6/27/2001	**6/27/2001**	**6/27/2001**	**6/27/2001**	**6/27/2001**	Partly cloudy, mild
770	1300	3100	650	4700	
750	1800	2000	670	4700	
1000	1800	1800	710	4300	
7/6/2001	**7/6/2001**	**7/6/2001**	**7/6/2001**	**7/6/2001**	Clear and cool
2610	3000	3700	2600	4500	
1130	3000	3700	1500	4570	
4700	3520	3500	2400	4700	
7/13/2001	**7/13/2001**	**7/13/2001**	**7/13/2001**	**7/13/2001**	Clear, mild
320	810	680	400	900	
280	790	700	390	890	
240	880	650	420	900	
7/20/2001	**7/20/2001**	**7/20/2001**	**7/20/2001**	**7/20/2001**	Partly cloudy, warm and humid
610	6200	6910	1560	2800	
470	4930	6840	1490	3240	
450	5840	6860	1520	2930	
7/27/2001	**7/27/2001**	**7/27/2001**	**7/27/2001**	**7/27/2001**	Sunny, 65° F
530	620	590	430	1280	
610	710	540	450	1360	
560	760	570	460	1640	
8/3/2001	**8/3/2001**	**8/3/2001**	**8/3/2001**	**8/3/2001**	Sunny, clear, 80° F
680	1200	1300	450	1700	
1000	800	1300	500	1700	
1200	900	2400	300	1500	
8/10/2001	**8/10/2001**	**8/10/2001**	**8/10/2001**	**8/10/2001**	Partly cloudy, mild heavy rain last night
17000	400000	13600	29200	26900	
20700	430000	19200	11600	21800	
22600	600000	12100	11800	25700	
8/17/2001	**8/17/2001**	**8/17/2001**	**8/17/2001**	**8/17/2001**	Mostly cloudy, mild
600	900	880	500	1200	
560	960	920	450	1100	
700	990	900	350	1000	
8/24/2001	**8/24/2001**	**8/24/2001**	**8/24/2001**	**8/24/2001**	Overcast, mild
3400	1240	1030	510	4400	
3700	1270	990	460	4700	
3500	1160	970	490	4500	
8/29/2001	**8/29/2001**	**8/29/2001**	**8/29/2001**	**8/29/2001**	Clear, mild
470	490	460	380	2300	
520	620	530	420	2420	
350	590	600	370	2400	
8/31/2001	**8/31/2001**	**8/31/2001**	**8/31/2001**	**8/31/2001**	Partly cloudy, mild
3100	19000	21000	2500	19000	
3100	30000	30000	2600	25000	
3100	21000	19000	2500	25800	

Appendix 1 continued.

Plaster Creek @ 44th St. PC-7A	Plaster Creek @ 60th St. PC-9A	Plaster Creek @ 68th St. PC-10A	Trib. to Plaster Creek @ 28th St. PC-3A	Trib. to Plaster Creek @ 60th St. PC-8A	Weather data
9/5/2001	**9/5/2001**	**9/5/2001**	**9/5/2001**	**9/5/2001**	Clear, mild
830	1730	3300	310	2900	
900	1100	3000	300	2500	
930	1100	3800	260	2100	
9/7/2001	**9/7/2001**	**9/7/2001**	**9/7/2001**	**9/7/2001**	Overcast, warm, rain
5270	51000	23000	10600	4300000	
3990	720000	65000	15000	3800000	
5660	530000	72000	1900	4700000	
9/11/2001	**9/11/2001**	**9/11/2001**	**9/11/2001**	**9/11/2001**	Clear, 62° F
3300	3400	610	360	6300	
4200	2300	600	280	6500	
4300	4100	590	220	6600	
9/14/2001	**9/14/2001**	**9/14/2001**	**9/14/2001**	**9/14/2001**	Clear, cool
440	520	510	230	880	
500	500	480	250	900	
520	510	490	330	920	
9/18/2001	**9/18/2001**	**9/18/2001**	**9/18/2001**	**9/18/2001**	Clear, mild
1010	660	560	180	4500	
1010	640	500	210	4400	
910	620	450	30	4500	
9/20/2001	**9/20/2001**	**9/20/2001**	**9/20/2001**	**9/20/2001**	Overcast, cool
2410	2220	1010	950	2600	
2350	1980	990	910	2300	
3110	2110	1000	890	990	
9/26/2001	**9/26/2001**	**9/26/2001**	**9/26/2001**	**9/26/2001**	Overcast, rainy, mild
2400	1600	3500	1900	1600	
1800	2400	3500	1600	2100	
1800	2100	7200	2300	2300	
9/28/2001	**9/28/2001**	**9/28/2001**	**9/28/2001**	**9/28/2001**	Overcast, cool
1400	690	2600	280	5400	
1000	680	2300	130	5000	
1800	670	2900	160	5400	

Appendix 4

Michigan Department of Environmental Quality
Surface Water Quality Division
July 2002

Total Maximum Daily Load for Biota for Plaster Creek Kent County, Michigan

Introduction: Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of a pollutant to a waterbody based on the relationship between pollutant sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reduction necessary from both point and/or nonpoint sources to maintain and/or restore the quality of their water resources. The purpose of this TMDL is to identify an appropriate reduction in sediment loadings from existing sources in the Plaster Creek Watershed that will result in WQS attainment.

Problem Statement: The TMDL reach of the Plaster Creek, a warmwater designated waterbody, is located in Kent County and extends from the Grand River confluence at Market Street upstream to its headwaters located upstream of the community of Dutton (Figure 1). The TMDL reach is about 12 miles in length. It is identified in the year 2002 Section 303(d) report (Creal, W. and J. Wuycheck, 2002) as follows:

PLASTER CREEK WBID# **082806H**
County: KENT HUC: 4050006 Size: 12 M
Location: Grand River confluence u/s to Dutton Park (Hanna Lake Avenue and 76th Street).
Problem: **Fish and macroinvertebrate communities rated poor; Pathogens (Rule 100).**
TMDL Year(s): 2002 RF3RchID: 4050006 10

The pathogen problem has been addressed in a separate TMDL (Thelen, 2002).

The impaired designated uses include aquatic life. Biological assessments of Plaster Creek, since 1977 (Sylvester, 1978), have indicated poor biological communities downstream of Breton Avenue (Figure 1). Using the Great Lakes and Environmental Assessment Section's Procedure 51 (Michigan Department of Environmental Quality (MDEQ), 1997 and 1998), a biological community and habitat quality assessment was conducted during a June 29, 2001 survey of Plaster Creek (Wuycheck, 2002). The macroinvertebrate community continued to be characterized as poor based on scores of -7 and -5 at 68th Street and Godfrey Avenue, respectively.

The low scores observed were attributable to impaired habitat quality as affected by elevated siltation and sedimentation that coated and obscured surfaces of larger substrate (e.g., logs, gravel, and cobble) suitable for macroinvertebrate colonization. This condition is commonly referred to as "embeddedness."

Excessive erosion and runoff contribute to elevated runoff volumes and runoff rates resulting in flashy flow conditions. These factors result in stream bank erosion, siltation, and sedimentation of desirable habitat. The June 2001 habitat assessment scores ranged from 38 (fair) at

68th Street to 81 (good) at Godfrey Avenue. A habitat score range of 35 to 70 defines a fair rating; however, habitat with scores in the lower end of this range will not support acceptable macroinvertebrate communities. Expectations are that with continued, excessive sediment additions and hydrologic loadings, the impaired reach will continue to not support its warmwater aquatic life designated use. Reductions in runoff rates and sediment loads from controllable upland sources and reduced stream bank erosion are necessary to reduce impacts on the aquatic life.

Numeric Targets: The impaired designated use for Plaster Creek is aquatic life. Michigan's WQS require, as a minimum, the protection of a variety of designated uses, including aquatic life (Rule 100 (1)(f) - Other indigenous aquatic life and wildlife). Since the biota in Plaster Creek are impacted due to habitat loss by excessive sedimentation, achievement of WQS for the aquatic life designated use is to be demonstrated via assessments of the integrity of the macroinvertebrate community and habitat quality.

The "primary" numeric targets involve the use of Michigan's biological community and habitat quality assessment Procedure 51. The biota TMDL target is to achieve a macroinvertebrate community with an acceptable, reproducible score equal to or greater than -4. The macroinvertebrate community scores will be evaluated based on a minimum of two Procedure 51 biological assessments conducted in two consecutive years following the implementation of Best Management Practices (BMPs) to minimize sediment loadings to the subject TMDL reach.

A stream habitat quality assessment will also be used. A habitat quality score of 65 (approaching the upper end of the fair habitat score range of 35 to 70) has been established as the target for the habitat quality. This represents a 70% increase over the June 2001 survey's lowest score of 38, which approaches the lower end of the fair habitat score range. The habitat assessment target score of 65 will be used to represent adequate control of anthropogenic sediment sources so as to improve habitat quality and the biological community. This targeted score is closely associated with macroinvertebrate community scores of -3 or greater, providing results better than a minimally acceptable value of -4. This level of conservation is appropriately high enough to minimize both temporal and spatial variability within the watershed and buffer variability within the macroinvertebrate and habitat assessment protocol itself.

A "secondary" numeric target for total suspended solids (TSS) will be used to further assess improvements in Plaster Creek. The secondary target goal is represented by a mean annual, in-stream TSS concentration of 30 milligrams per liter (mg/l). This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated. Achievement of the secondary numeric target will help guide proper control over nonpoint sources of excessive suspended solids loadings from runoff, as well as the runoff discharge rates and instantaneous runoff volumes that affect increased stream flow instability, stream bank erosion, and increased suspended solids concentrations.

The mean annual target concentration of 30 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS. Vohs et al. (1993) indicated that chemically inert suspended solids of 100 mg/l appears to separate those streams with a fish population from those without. The European Inland Fisheries Advisory Commission (EFIAC) stated that, in the absence of other pollution, a fishery would not be harmed at suspended solids concentrations less than 25 mg/l. Good to moderate fisheries can be found at 25 to 80 mg/l suspended solids, good fisheries were unlikely to be found at 80 to 400 mg/l, while only poor fisheries would be found at 400 mg/l (Alabaster, 1972). Decreases were demonstrated in the standing crop of both fish and macroinvertebrates in an area receiving suspended solids loadings of no more than 40 mg/l (Gammon, 1970).

Water quality criteria for suspended solids (finely divided solids) may be represented by the following categories:

Optimum	= ≤ 25 mg/l
Good to Moderate	= >25 to 80 mg/l
Less than moderate	= >80 to 400 mg/l
Poor	= >400 mg/l

Based on the available TSS data for Plaster Creek, the TSS annual mean is generally 40 to 50 mg/l. This level is associated with poor biota. Since the TMDL purpose is to restore the biological community to an acceptable condition and attain WQS, a value of 30 mg/l, as a mean annual TSS target, was chosen for Plaster Creek.

Overall, the secondary target of 30 mg/l TSS (as a mean annual value) is intended to evaluate solids loading effects and assist in orienting and focusing corrective actions for source reductions. Additional TSS targets, based on flow related considerations, may be developed as additional data on Plaster Creek becomes available.

Source Assessment: A source characterization survey of the subject reach was conducted during the June 29, 2001 biological assessment to better define and document soil erosion sites throughout the riparian zone of the TMDL reach. Visual assessments were made in portions of the 12-mile river reach that extends from the Grand River confluence upstream to 76th Street.

From the Grand River confluence, progressing upstream residential, industrial, commercial, and suburban development and, ultimately, agricultural land use dominate the landscape (Figure 2). Development within a watershed alters its hydrologic characteristics (Fonger and Fulcher, 2001). Typically, such development and associated land use modification practices increase rapid precipitation runoff and suspended solids loads to surface waters in a watershed. Substantive reductions in vegetative riparian zones in the upper watershed of Plaster Creek and the extensive use of structural features, including paved impervious surface areas (e.g., roads and parking lots), curb and gutter, and numerous direct storm sewer discharges, dominate portions of the landscape and contribute to rapid precipitation runoff rates to Plaster Creek. This condition fosters stream bank erosion, unstable flow conditions, and sedimentation of desirable habitat in Plaster Creek. Therefore, the nonpoint sources of sediment loadings to Plaster Creek are primarily attributable to periodic erosion and runoff from urban, residential, industrial, commercial, suburban, and farmland dominated land uses in the watershed.

Table 1 provides available information that was used to characterize and estimate Plaster Creek loadings of TSS from nonpoint sources at a point just upstream from the Grand River confluence (Market Street). An estimated TSS loading of about 3,352,525 pounds/year is based on a grand mean TSS concentration of 50 mg/l and a grand mean monthly flow of 22 million gallons per day (mgd) (33 cfs).

Of the permitted sources of TSS to Plaster Creek, 5 are for facilities with individual National Pollutant Discharge Elimination System (NPDES) permits (one of which includes several combined sewer overflows (CSOs)); 11 facilities are covered by general permits; and numerous (104) storm water permits are associated, primarily, with facilities involving industries (Table 2).

Collectively, the 5 facilities with individual NPDES permits have a combined daily maximum allowable discharge volume (design flows) of over 3.5 mgd. Two of the facilities (R.K. Enterprises - MI0002861 and SteelCase Inc./Kentwood - MI0043061) have daily maximum TSS limits of 30 and 50 mg/l, respectively. A worst-case estimate of TSS loadings for these 5 facilities (excluding the Grand Rapids WWTP emergency release Outfall 002) was made

assuming a TSS monthly average concentration of 30 mg/l for all of the facilities (Table 3). The loadings estimate for the R.K. Enterprises facility was estimated using an assumed worst-case discharge of 0.25 mgd since they are authorized to discharge an unspecified volume of discharge. The estimated annual total loading from the 4 facilities is 421,593 pounds.

The 11 facilities with general discharge permits are not required to measure TSS. However, an estimate with an assumed monthly mean of 30 mg/l TSS and a total design discharge (for the 11 facilities) of about 1.17 mgd equals 293 pounds/day or 106,976 pounds/year (Table 3). The sum of estimated TSS loadings from the facilities with the individual NPDES permits and general permits represents 528,560 pounds/year. When compared to nonpoint source loadings, the solids loadings from the individual NPDES permitted sources are a minor source of solids to Plaster Creek. The overall TSS loadings effect on stream conditions from these point sources are lessened also because the discharges are widely distributed throughout the watershed (Figure 3).

Four CSO discharges to Silver Creek Drain (tributary to Plaster Creek) are scheduled to be eliminated as part of the Grand Rapids Phase 1 Municipal Storm Sewer Separation program by the year 2019 and are not considered into the total loadings estimate. The Silver Creek confluence with Plaster Creek is located about 1.25 miles upstream from the Grand River confluence.

In summary, excessive sedimentation of Plaster Creek is primarily associated with elevated levels of soil erosion from land development activities and stream bank erosion due to the erosive effects of excessive runoff rates. Upland development has disrupted the “natural” hydrology of Plaster Creek throughout the watershed resulting in erosive, flashy flows following precipitation/runoff events. These alterations to the Plaster Creek Watershed have destabilized stream banks, increased sediment loadings, and reduced or eliminated desirable fish and macroinvertebrate habitat.

Linkage Analysis: A suitable method used to develop a TMDL that addresses the severity of the impacts of sedimentation to a biological community is to measure sediment impacts on stable, colonizable substrates in the stream channel and the associated changes in the biological community.

Increased siltation and embeddedness of colonizable substrates resulting from excessive sedimentation has been demonstrated to impair the biological integrity of rivers (Waters, 1995) by obscuring or reducing the suitability of colonizable or useable substrate by stream biota. With a reduction in sedimentation, the macroinvertebrate community typically responds with an increase in species diversity and an increase in the number of individuals of each species. This commonly results from increased habitat diversity as sedimentation rates decline. As a result, the Procedure 51 assessment scores and ratings for quality of the macroinvertebrate community and habitat are expected to increase as sedimentation rates decline, embeddedness decreases, and habitat diversity increases. These latter characteristics will serve to demonstrate improvement in habitat conditions, WQS attainment, and overall stream quality, as expressed through an acceptably rated biological community.

TMDL Development: The TMDL represents the maximum loading that can be assimilated by a waterbody while still achieving WQS. Because the biotic community has been impaired by excessive sedimentation and flow instability, this TMDL will be based on the response of the macroinvertebrate community to the reduction of sedimentation. The TMDL is based on reducing sediment loads throughout the watershed to a level that supports a biological community of the stream that meets WQS. Using the metrics from Procedure 51, a numeric score of -4 for a macroinvertebrate community and a habitat score of 65 will serve as the primary targets for this biota TMDL.

Concurrent with the selection of numeric endpoints, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Some TMDLs are designed around the concept of "critical condition." A "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other important conditions. For example, the critical conditions for the control of point sources in Michigan are provided in R 323.1082 and 323.1090 of Michigan's WQS. In general, the lowest monthly 95% exceedance flow for a stream is used to establish effluent limits for point sources. However, the primary sediment inputs to Plaster Creek are attributable to wet weather driven nonpoint source discharges. As such, there are is no single condition that is protective for all conditions. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed. For this TMDL, the monthly mean flows for Plaster Creek were used to develop secondary TSS allocations.

The secondary target of 30 mg/l TSS was used to develop a secondary TMDL loading goal for TSS. Based on this TSS target for Plaster Creek at Market Street and the monthly mean flows and facility flows given in Tables 1 and 3, the secondary TMDL for TSS is 2,540,075 pounds/year.

Allocations: TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. A margin of safety (MOS), either implicit or explicit, is also a component and accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving waters. Conceptually, this relationship is defined by the equation:

$$TMDL = \sum^{WLAs} + \sum^{LAs} + MOS$$

The acronym TMDL refers to a maximum loading of a pollutant or stressor that can be discharged to a receiving water and still meet WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS.

WLA: The permitted point source loading of TSS to Plaster Creek is estimated at 528,560 pounds/year. This represents approximately 21% of the TSS TMDL for Plaster Creek. This level of loading from the point sources was considered acceptable and was established as the WLA. For point sources, the receiving stream design flow equals the lowest 95% exceedance flow. However, it is proposed that any TSS limits in NPDES permits be established at the target of 30 mg/l, which then makes it unnecessary to consider mixing zone scenarios. The WLA is considered controllable through the existing NPDES permit requirements.

LA: The LA defines the loading capacity for a pollutant that is nonpoint in origin, including natural background sources and storm sewers. The nonpoint sources of sediment loadings to Plaster Creek are attributable to erosion and runoff from urban, residential, industrial, commercial, suburban, and farmland dominated land uses in the watershed.

As given above, the TSS TMDL for Plaster Creek equates to 2,540,075 pounds/year. If 21% (528,560 pounds/year) is allocated as the WLA, then 2,011,515 pounds/year is available for the LA. To achieve the LA, a 40% reduction in nonpoint source sediment loading is necessary.

MOS: The MOS in a TMDL is used, in part, to account for variability of source inputs to the system and is either implicit or explicit. An MOS is implicit for a biota TMDL because the quality of the biological community, its integrity, and overall composition represent an integration of the effects of the spatial and temporal variability in sediment loadings in the aquatic environment. For comparison of survey assessment results experienced in June 2001, follow-up biological

and habitat assessments will be conducted during the June through August timeframe, during stable flow conditions. The results collected will best reflect an MOS that is implicit and express an integration of the effects of the variability in sediment loadings in the aquatic environment and minimize seasonal variability.

Seasonality: Seasonality is addressed in the TMDL in terms of sampling periods for macroinvertebrates. To minimize temporal variability in the biological community, sampling will be conducted during the June through August period each year during stable flow conditions.

Monitoring Plan: Monitoring will be conducted by the MDEQ to assess progress towards meeting the biota TMDL targets, following implementation of applicable BMPs and control measures. Subsequently, annual sampling of the macroinvertebrate community and habitat quality at Godfrey Avenue, Eastern Avenue, and 68th Street, as a minimum, will be conducted until assessment results from two consecutive years demonstrate attainment of TMDL targets at these sites. For best comparative purposes, follow-up biological and habitat assessments will be conducted in a June to August timeframe, during stable flow conditions. Every effort will be made to sample during similar stream conditions and assess the same sampling locations.

Once the BMPs are in place to minimize the effects of runoff and flashy conditions that exist in Plaster Creek, stream flow and suspended solids sampling can be implemented so as to measure progress towards the secondary numeric target of 30 mg/l as a mean annual TSS value. Multiple sampling during critical high flow events, as well as low flow events, needs to be assessed to better estimate TSS loads in Plaster Creek.

Reasonable Assurance: The focus of the actions to protect Plaster Creek is directed towards installing BMPs and other control measures to reduce and minimize nonpoint source sediment loadings and excessive runoff discharge rates to the TMDL reach of Plaster Creek. The former action is to reduce sedimentation impacts, the latter to minimize the erosive effects to the stream. Overall, control measures include: CSO elimination, individual and general NPDES permit limits, storm water permits that include BMPs, and BMPS for areas not under any permit.

For the WLA, existing NPDES permit requirements will be adequate to meet the target.

Storm water permits, pursuant to the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, require the collective units of government within a watershed to development a watershed management plan that includes the detailing of short- and long-term goals and attainment actions; public education plans; illicit discharge elimination plans; and the development, by each local unit of government within the Plaster Creek Watershed, of their individual storm water prevention plans.

Plaster Creek has an MDEQ approved (November 23, 1999) watershed management plan in accordance with the requirements of the Clean Michigan Initiative (CMI) Nonpoint Source Pollution Control Grants Program (KCDC, 1999). A CMI grant was approved by the MDEQ for two storm water detention basin retrofit construction projects located in the Plaster Creek Watershed: the Wyoming Department of Public Works and the Laraway-Brooklyn detention basins. The contract end date for the retrofitting projects is July 2002. The CMI grant amount was for $386,100 with local match of $128,700 ($514,800 total).

MDEQ district staff will continue to work with and assist interest groups in the Plaster Creek Watershed. The purpose is to assist in defining and designing approvable actions and programs that assess, develop, plan, and implement BMPs and control measures that best minimize or prevent soil erosion and excessive runoff rates to the Plaster Creek Watershed.

The MDEQ's Guidebook of BMPs for Michigan Watersheds (Peterson et al., 1993, as modified) can be used to develop BMP elements that should include:

- Upgrade and maintain the current vegetative riparian zone to reduce soil erosion and loadings to the Plaster Creek from farmland, subdivision, and urban sources. BMPs need to be employed within the riparian zone adjacent to the farmland to minimize the loss, through erosion and direct runoff, thereby minimizing habitat impairment of the Plaster Creek and preserving farmland soils.

- Implementation of BMPs in the storm water permits program that reduce sediment loadings and moderate runoff release rates and excessive runoff to the Plaster Creek Watershed are expected to improve and protect designated use support throughout the watershed. The goals are for reduced solids loadings and greater flow stability throughout the watershed so that WQS are restored and protected. Recent guidance regarding runoff detention and stream protection is provided by Fongers and Fulcher, 2001.

MDEQ approval of BMPs and implementation plans will be required prior to implementation of proposed structural improvements.

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July 23, 2002

References:

Alabaster, J. S. 1972. Suspended solids and fisheries. Proceedings of the Royal Society of London, Series B 180:395-406.

Creal, W. and J. Wuycheck. 2002. Clean Water Act Section 303(d) List - Michigan Submittal for Year 2002. MDEQ Report #MI/DEQ/SWQ-02/013.

Fongers, D. and J. Fulcher. 2001. Hydrologic Impacts Due to Development: The Need for Adequate Runoff Detention and Stream Protection. MDEQ, Land and Water Management Division. 20 pp.

Gammon, J. R. 1970. The effect of inorganic sediment on stream biota. Water Pollut. Contr. Research Series. Water Quality 18050 DWC12/70. U.S. EPA printing office. 145 pp.

KCDC - Kent County Drain Commissioners Office. July 1999. Amendment to the "Plaster Creek Nonpoint Watershed Project" - December 1987, as amended in 1989. Project No. F99037. Prepared by: Kent County Drain Commissioner and Fishbeck, Thompson, Carr and Huber, Inc.

MDEQ. January 1997 Revision. GLEAS Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers.

MDEQ. May 1998 Revision. Update of GLEAS Procedure 51 - Metric Scoring and Interpretation. MDEQ Report #MI/DEQ/SWQ-96/068.

Peterson, A., R. Reznick, S. Hedin, M. Hendges, and D. Dunlap. 1993. Guidebook of Best Management Practices for Michigan Watersheds. MDEQ, SWQD.

Sylvester, S. 1978. Biological Survey of Plaster Creek - July-September 1977. Michigan Department of Natural Resources. Publication No. 4833-5160 (002980), 25 pp.

Thelen, C. 2002. Total Maximum Daily Load for *E. coli* for Plaster Creek, Kent County, Michigan. MDEQ.

Vohs, P., I. Moore, and J. Ramsey. 1993. A Critical Review of the Effects of Turbidity on Aquatic Organisms in Large Rivers. Report by Iowa State University, Ames, Iowa, for the U.S. Fish and Wildlife Service, Environmental management Technical Center, Onalaska, Wisconsin. EMTC 93-s002. 139 pp.

Waters, T. 1995. SEDIMENT IN STREAMS - Sources, Biological Effects and Control. American Fisheries Society Monograph 7, American Fisheries Society, Bethesda, MD.

Wuycheck, J. 2002. Biological Assessment of Plaster Creek, Kent County, Michigan, June 29, 2001. MDEQ Report # MI/DEQ/SWQ-01/107

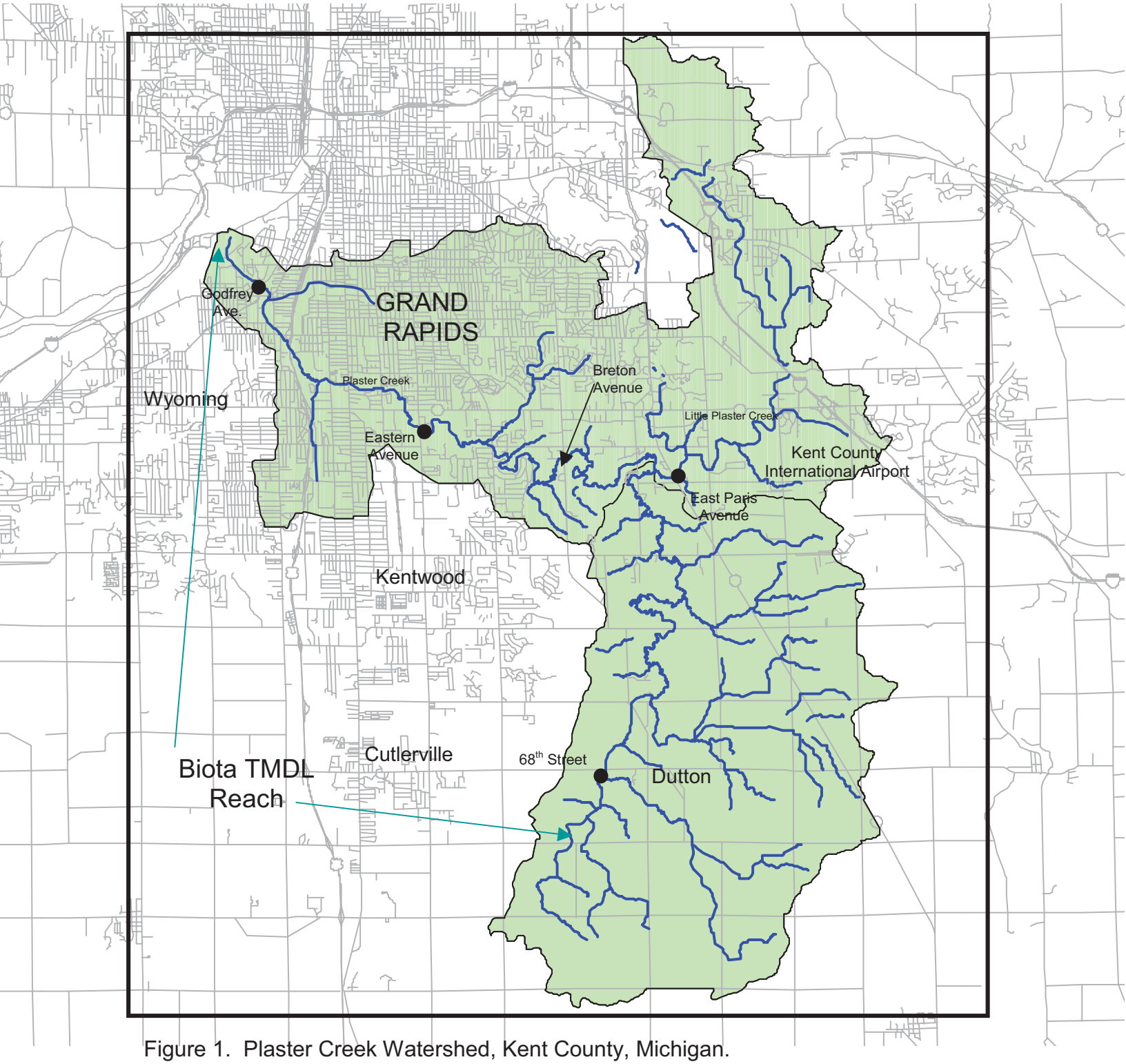

Figure 1. Plaster Creek Watershed, Kent County, Michigan.

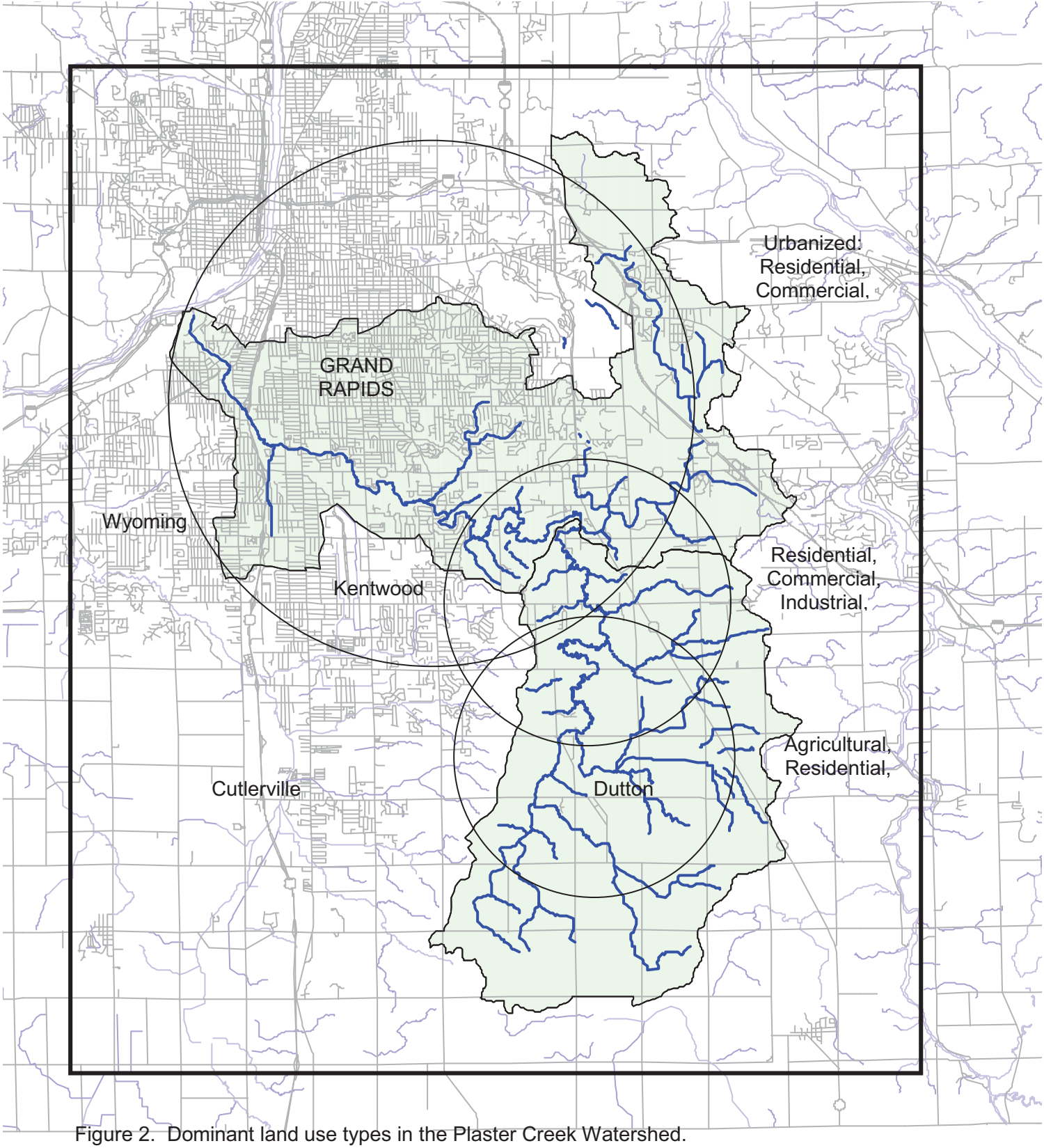

Figure 2. Dominant land use types in the Plaster Creek Watershed.

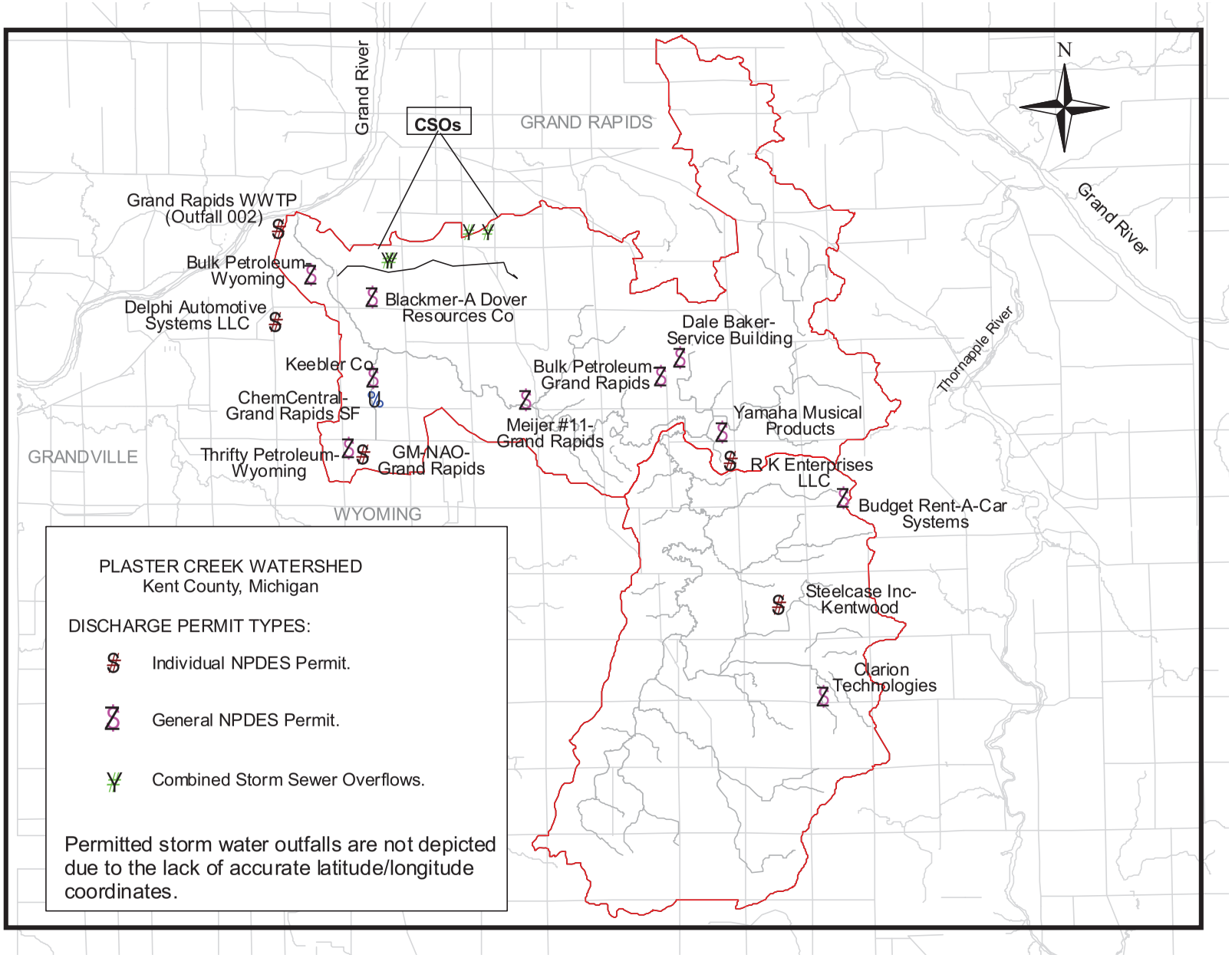

Figure 3. Permitted outfalls in the Plaster Creek Watershed.

Table 1. Plaster Creek suspended solids loadings estimate at Market Avenue (STORET Station 410121).

Month/Year	Monitoring Years/Total Suspended Solids (as mg/l) 1970	1973	1974	1975	1979	1980	1992	Mean TSS (mg/l)	Mean Monthly Flow (cfs)	(mgd)	Grand Mean Annual Estimate (Pounds)
Jan			12	23				18	33	21	
Feb			35	8				18	34	22	
Mar			30				144	87	63	41	
Apr		7					6	7	62	40	
May		10	364				12	129	39	25	
Jun		16	37				7	20	27	17	
Jul		20	186				76	94	21	14	
Aug	19		8				4	10	18	12	
Sep		32	6			2	9	12	18	12	
Oct		11	103		10			41	22	14	
Nov		5	26					16	29	19	
Dec		148						148	35	23	
							Grand Mean:	50		22	3,352,525*

* 50 mg/l x 22 mgd x the factor of 8.35 to convert to pounds.

Table 2. Permitted Outfalls to the Plaster Creek Watershed.

Source: MDEQ/SWQD's NPDES Permit Management System (NMS).

PERMIT NUMBER	FACILITY NAME	RECEIVING WATERS
Individual NPDES Permits:		
MI0001236	Delphi Automotive Systems LLC	Plaster Creek
MI0002861	R K Enterprises LLC	Plaster Creek
MI0043061	SteelCase Inc-Kentwood	Plaster Creek
MI0043877	GM-NAO-Grand Rapids	Cole Drain
MI0026069	Grand Rapids WWTP (Emergency Outfall 002)	Plaster Creek/Silver Creek Drain
	Ionia Avenue and Stevens Street CSO	Silver Creek Drain
	Alexander Street and Cooper Avenue CSO	Silver Creek Drain
	Alexander Street and Kalamazoo Avenue CSO	Silver Creek Drain
	Stevens Street at Railroad Crossing CSO	Silver Creek Drain
General Permits:		
MIG080036	Thrifty Petroleum-Wyoming	Plaster Creek
MIG080083	Meijer #11-Grand Rapids	Ken-O-Sha Creek
MIG080115	Bulk Petroleum-Wyoming	Plaster Creek
MIG080172	J & H Oil Co-Wyoming	Plaster Creek
MIG080422	Budget Rent-A-Car Systems	unnamed tributary to Plaster Creek
MIG080985	Bulk Petroleum-Grand Rapids	Whiskey Creek
MIG081003	Dale Baker-Service Building	Whiskey Creek
MIG250151	Keebler Co	Plaster Creek
MIG250152	Blackmer-A Dover Resources Co	Plaster Creek
MIG250156	Clarion Technologies	Plaster Creek
MIG250271	Yamaha Musical Products	Little Plaster Creek
Substantive Requirements Document:		
MIU990004	ChemCentral-Grand Rapids SF	Cole Drain
Storm Water Permits:		
MIR20G102	River City Metal Products	Plaster Creek
MI0053937	MDOT - Grand Rapids - MS4	Plaster Creek
MI0053872	Grand Rapids - MS4	Plaster Creek
MIS110038	Burton St Recycling-Supply Co	Plaster Creek
MIS110041	Midwest Bumper Co	Silver Creek
MIS110042	Grand Rapids Plastics-4220 RBC	Plaster Creek
MIS110052	Thompson-McCully Co-Market Co	Plaster Creek
MIS110057	Kentwood Packaging-Powder	Plaster Creek
MIS110118	Mitco Inc	Plaster Creek
MIS110129	P & K Steel Service Inc	Plaster Creek
MIS110137	Grand Rapids Carvers Inc	Plaster Creek
MIS110283	Wamar Products Inc	Plaster Creek
MIS110294	Tabletting Inc	Plaster Creek
MIS110296	Starcade Inc	Plaster Creek
MIS110297	State Heat Treat-Grand Rapids	Plaster Creek
MIS110299	Stagood-Metal Components Inc	Plaster Creek
MIS110347	USPS-Wyoming	Plaster Creek
MIS110352	Stephenson & Lawyer-GR	Plaster Creek
MIS110365	Schupan & Sons Inc-Recycling	Plaster Creek
MIS110366	Conway Central Express-Kentwood	Plaster Creek
MIS110486	Riviera Tool Company	Plaster Creek
MIS110487	Reliance Finishing Co	Plaster Creek

Table 2 (continued).

PERMIT NUMBER	FACILITY NAME	RECEIVING WATERS
MIS110488	Rapid Die & Engineering	Plaster Creek
MIS110491	Price Industries Inc	Plaster Creek
MIS110497	Lacks-Brockton Mold	Plaster Creek
MIS110504	Michigan Packaging Co	Little Plaster Creek
MIS110505	Michigan Colprovia	Plaster Creek
MIS110506	Mich Cert Con-Grand Rapids	Plaster Creek
MIS110508	Consolidated Rail Corporation	Plaster Creek
MIS110515	Lake Mich Packaging Products	Plaster Creek
MIS110526	Lily Products of Mich	Plaster Creek
MIS110527	Knoll Inc-Grand Rapids	Plaster Creek
MIS110529	Kentwood Manufacturing Co	Plaster Creek
MIS110530	Key Plastics Inc-GR	Plaster Creek
MIS110538	Hill Machinery Co Inc	Plaster Creek
MIS110553	BF Goodrich Avionics Sys Inc	Plaster Creek
MIS110563	Christopher Metal Fabricating	Plaster Creek
MIS110568	Die Dimensions Corp	Plaster Creek
MIS110569	Blackmer-A Dover Resources Co	Plaster Creek
MIS110570	Cascade Engineering 5141-36	Little Plaster Creek
MIS110572	Helen Inc-Envir Coatings	Plaster Creek
MIS110573	Country Fresh Inc	Plaster Creek
MIS110574	Dyna Plate Inc	Plaster Creek
MIS110577	Hi Tec Laser Die-J-Tec Prod	Plaster Creek
MIS110578	Imperial Sheet Metal	Plaster Creek
MIS110581	Keebler Co	Plaster Creek
MIS110583	Consolidated Metal Prdts Inc	Silver Creek Drain
MIS110585	Consumers Concrete-15	Plaster Creek
MIS110586	CSX Transport-Wyoming Yard	Plaster Creek
MIS110591	Lacks Ent-Plastic Plate 2	Plaster Creek
MIS110592	Lacks Ent-52nd-Paint East	Plaster Creek
MIS110593	Lacks Ent-52nd-Paint West	Plaster Creek
MIS110594	Lacks Ent-Barden Assembly	Plaster Creek
MIS110595	Lacks Ent-52nd Mold	Plaster Creek
MIS110596	Lacks Ent-Airlane Plant	Plaster Creek
MIS110597	Lacks Ent-Distribution Center	Plaster Creek
MIS110599	Interface AR-32nd Street	Whiskey Creek
MIS110601	Meridian Auto-GR-Plt 1	Plaster Creek
MIS110602	Meridian Auto-GR-Plt 4 & 5	Plaster Creek
MIS110603	Meridian Auto-GR-Plt 7	Plaster Creek
MIS110607	Allied Finishing Inc	Plaster Creek
MIS110613	American Litho-Inc	Plaster Creek
MIS110616	Adac Plastics Inc-GR	Plaster Creek
MIS110618	Autocam Corporation	Plaster Creek
MIS110621	Advance Packaging Corp	Plaster Creek
MIS110626	Amerikam	Plaster Creek
MIS110630	A & K Finishing-Danvers	Plaster Creek
MIS110631	A & K Finishing-Donker	Plaster Creek
MIS110658	Electro Chem Finish Co-44th	Plaster Creek
MIS110660	Detroit Diesel Remanufacturing	Plaster Creek
MIS110673	Smith Industries Inc-Patterson	Plaster Creek
MIS110703	MC Van Kampen Trucking	Plaster Creek
MIS110707	Modular Transportation-Mart	Plaster Creek

Table 2 (continued).

PERMIT NUMBER	FACILITY NAME	RECEIVING WATERS
MIS110709	Lacks Ent-Airwest Mold	Plaster Creek
MIS110751	Venture Grand Rapids	Plaster Creek
MIS110778	Reliance Plastisol Coating Co	Plaster Creek
MIS110802	Diecraft-GR	Plaster Creek
MIS110818	Paladin Ind Inc	Plaster Creek
MIS110820	Parker Motor Freight Inc	Plaster Creek
MIS110823	Team Industries	Plaster Creek
MIS110825	Fki Indust-Keeler Die Cast	Silver Creek Drain
MIS110827	Plastic Mold Technology Inc	Plaster Creek
MIS110829	Yamaha Musical Products	Little Plaster Creek
MIS110840	M & E Manufacturing	Plaster Creek
MIS110848	Grand Rapids Plastics-4050 RBC	Plaster Creek
MIS110850	MacDonalds Ind-44th St	Plaster Creek
MIS110894	American Metal & Plastics	Plaster Creek
MIS110945	Master Finish Company	Plaster Creek
MIS111015	Development-GR	Plaster Creek
MIS111017	Dieline-GR	Plaster Creek
MIS111028	Magic Finishing Company	Plaster Creek
MIS111048	Bishop Distributing Co	Plaster Creek
MIS111058	Eerdmans Printing Co	Plaster Creek
MIS111078	Steeltech Ltd	Silver Creek Drain
MIS111080	Davidson Plyforms Inc	Plaster Creek
MIS111104	Towne Air Freight Inc	Plaster Creek
MIS111105	Beverlin Manufacturing Corp	Plaster Creek
MIS111106	Cascade Engineering 4950-37	Little Plaster Creek
MIS111110	Magna-Lakeland	Plaster Creek
MIS111111	CSX Transport-BIDS GR	Plaster Creek
MIS111119	Federal Express-GRRA	Plaster Creek
MIS111137	Michigan Wheel Corp	Plaster Creek
MIS111190	Lacks Airlane Campus	Plaster Creek
MIS111191	Lacks Brockton Campus	Plaster Creek
MIS111192	Lacks 52nd Campus	Plaster Creek
MIS111193	Lacks Barden Campus	Plaster Creek

Table 3. Individual and general NPDES permitted facilities in the Plaster Creek Watershed and estimated loadings of total suspended solids.

Permit No.	Facility Name	Design Flow (mgd)	Mean TSS* (mg/l)	Daily Load (Pounds)	Annual Load (Pounds)
MI0002861	R.K. Enterprises	0.025	30	6	2285
MI0043061	SteelCase Inc. – Kentwood	0.25*	30	63	22856
MI0043877	GM – NAO – Grand Rapids	0.836	30	209	76438
MI0026069	Grand Rapids WWTP (Emergency Outfall 002)	NA	NA	-	-
MI0001236	Delphi Automotive Systems LLC	3.5	30	877	320014
				Total:	421,593
MIG080036	THRIFTY PETROLEUM-WYOMING	0.14	30	36	13166
MIG080083	MEIJER #11-GRAND RAPIDS	0.03	30	7	2633
MIG080115	BULK PETROLEUM-WYOMING	0.01	30	2	658
MIG080172	J & H OIL CO-WYOMING	0.14	30	36	13166
MIG080422	BUDGET RENT-A-CAR SYSTEMS	0.01	30	2	658
MIG080985	BULK PETROLEUM-GRAND RAPIDS	0.01	30	4	1317
MIG081003	DALE BAKER-SERVICE BUILDING	0.01	30	2	731
MIG250151	KEEBLER CO	0.70	30	175	64003
MIG250152	BLACKMER-A DOVER RESOURCES CO	0.004	30	1	357
MIG250156	WAMAR PRODUCTS INC	0.002	30	1	219
MIG250271	YAMAHA MUSICAL PRODUCTS	0.11	30	28	10058
				Total:	106,967
				Grand Total:	528,560

* Assumed worst case discharge flow or TSS concentration, NA = not applicable.

Appendix 5

Watershed Survey Data Sheet

Plaster Creek Watershed

Site ID# (reach.twp.sct.site) _____

Picture # _____

Date _____

Investigator(s) _____

Waterbody Name _____

Waterbody Reach _____

County _____ **Township** _____ **Section #** _____ **Qtr** _____

GPS (in decimal degrees format) **Lat:** _____ **Long:** _____

Pollutant Source (choose only one, then complete that section)

1. Debris/Trash/Obstructions	**2. Stream Crossing**	**3. Gully Erosion**
4. Livestock Access	**5. Non-point Ag. Source**	**6. Tile Outlet**
7. Streambank Erosion	**8. Construction**	**9. Urban/Residential (includes Yard Waste)**
10. Rill Erosion	**11. Other:** _____	

Current precipitation	None	Light	Moderate	Heavy		
Days since last rain	1 or less	2	3 or more	**How much?**	_____	inches
Water Color	None	Clear	Green	Cloudy/Milky	Very Muddy	Black
Water Odor	None	Musty	Rotten Eggs	Chemical	Oil	Sewage
Aquatic Vegetation	None	slight	moderate	extensive		
Algae	None	microscopic	filamentous	mat forming		
Stream flow type	Dry	Stagnant	Slow Flow	Moderate	Rapid Flow	
Stream bottom substrate	Clay	Sand	Gravel	Cobble	Bedrock	Organic
Size:		Smaller than ladybug	Ladybug to tennis ball	Tennis ball to basketball		

Average Stream Wetted Width _____ **feet**

Average Stream Depth _____ **feet**

Streambank Height _____ **feet**

Highest Visible Water Mark _____ **feet**

Riparian Habitat (facing u/s)	**Left Bank**	Trees	Shrubs	Herbaceous	Grass	Bare
	Right Bank	Trees	Shrubs	Herbaceous	Grass	Bare
	Other (Left Bank)	_____				
	Other (Right Bank)	_____				
Buffer/Filter Strip Width	**Left Bank**	<25 feet	25-50 feet	**Right Bank**	<25 feet	25-50 feet
		50-100 feet	>100 feet		50-100 feet	>100 feet

Land Use (facing u/s)	**Left Bank**	Woodland	Wetland	Idle	Agricultural	Res/Comm	Roadway
	Right Bank	Woodland	Wetland	Idle	Agricultural	Res/Comm	Roadway

Watershed Survey Data Sheet

Plaster Creek Watershed

SITE ID# _____

SECTION 1. DEBRIS/TRASH/OBSTRUCTIONS

Describe debris/trash on page 4. Include major obstruction types/ numbers.

Volume of trash/debris in stream	____ft. L x ____ft. W x ____ft. H		**cubic ft**	
Amount of Trash/Debris	Slight	Moderate	Large	Extensive
Is the obstruction diverting flow into the streambank?			Y / N	
Could the obstruction cause an impairment to navigation?			Y / N	

SECTION 2. STREAM CROSSING

Type of Crossing	Bridge	Single Culvert	Double Culvert	Box	Other: _____
Construction material	Concrete	Galvanized	Plastic		Other: _____
Condition	Good	Fair	Poor		
If obstructed, how much?	partial	half	full		
Road Surface	Paved	Gravel	Unimproved		
Erosion Location	Streambank (L/R)	Embankment	Culvert outlet	Shoulder/Ditch	
Extent of Erosion	Minor	Moderate	Severe		
Average Erosion Width	_____	**feet**	(Top width + Bottom width)/2		
Erosion Depth	_____	**feet**			
Erosion Length	_____	**feet**			
Years present	_____	**years**			

SECTION 3. GULLY EROSION

Location	Left Bank	Right Bank	
Average Erosion Width	_____	**feet**	(Top width + Bottom width)/2
Erosion Depth	_____	**feet**	
Erosion Length	_____	**feet**	
Years present	_____	**years**	

SECTION 4. LIVESTOCK ACCESS

Location	Left Bank	Right Bank		
Is erosion active?	Y / N			
Vegetation cover	Bare		Sparse vegetation	Stable vegetation
Average Erosion Width	_____	**feet**	(Top width + Bottom width)/2	
Erosion Depth	_____	**feet**		
Erosion Length	_____	**feet**		
Length of Needed Fencing	_____	**feet**		
Years present	_____	**years**		

SECTION 5. NONPOINT AGRICULTURE SOURCES

Location	Left Bank	Right Bank			
Cropland Erosion/Runoff	Conventional Tillage		Manure Spreading		Plowing perpendicular to stream
Manure in Stream	None		Some Evident		Extensive Amount
Manure Storage Structure	Y / N	**How far is the feedlot from top of streambank?**			_____ **feet**
Animal Operation Type	Dairy	Hog	Beef	Other	None

Watershed Survey Data Sheet
Plaster Creek Watershed

SITE ID# _____

SECTION 6. TILE OUTLETS - EROSION AND DISCHARGE

Location of outlet	Left Bank	Right Bank				
Erosion type, if applicable	plunge pool	gully	outlet failure	other	_____	
Pipe diameter	_____	**inches**				
Pipe Material	Plastic	Clay	Metal	Concrete	Other	_____
Height above Stream Bottom	_____	**inches**				
Discharge Color	Clear	Green	Cloudy/Milky	Very Muddy	Black	
Discharge Odor	None	Musty	Ammonia/eggs	Chemical/oil	Sewage	
Erosion Length	_____	**feet**				
Erosion Height	_____	**feet**				
Erosion Depth	_____	**feet**				
Years Present	_____	**years**				

SECTION 7. STREAMBANK EROSION

Location	Left Bank	Right Bank		
Length of Erosion	_____	**feet**		
Height of Erosion	_____	**feet**		
Years Present	_____	**years**		
Severity of Erosion	Some Bare Bank	Mostly Bare Bank	Bare bank w/ Rills	Undercut/Washout
Location of Erosion	Toe	High Water Mark	Top of Bank	Entire Bank

SECTION 8. CONSTRUCTION

Location	Left Bank	Right Bank	_____	**acres**	
Erosion	Y / N				
Are Control Measures being used?	Y / N				
Type of Control Measures	silt fence	filter barrier	mulch	sediment basin	check dams
	other:	_____			
Site Slope	slight	moderate	steep		

SECTION 9. URBAN / RESIDENTIAL (Includes Yard Waste)

Location		Left Bank	Right Bank			
Source:		Septic seepage	Outlet	Mows to streambank	Yard waste dumping	
Yard Waste Pile	____ ft. L x ____ ft. W x ____ ft. H					
Buffer width	_____	**feet**				
Water odor		None	Musty	Ammonia/eggs	Chemical/oil	Sewage
Water color	None	Clear	Green	Cloudy/Milky	Very Muddy	Black
Discharge Water Quality	None	oil sheen	bacterial	foamy	sediment	other

SECTION 10. Rill Erosion

Is the field being tilled?	Y / N	**Erosion Severity?**	Minor	Moderate	Severe	
Crop type	Soy	Edible Beans	Corn			
Area	_____	acres				

SECTION 11: OTHER

Location	Left Bank	Right Bank
Site Description	_____	
	_____	

Use reverse side to write comments.

Watershed Survey Data Sheet
Plaster Creek Watershed

SITE ID# _____

Additional Comments

Sketch of site

Appendix 6

Determining Sources of *E. coli* in the Lower Grand River Watershed (LGRW)

The work plan for the LGRW Implementation project states that the existing sampling and analytical data be reviewed for variability at each sampling site using the Watershed Characterization System (WCS) tools, as well as additional modeling extensions made available through the toolbox.

First, historic data from previous studies was entered into the project database to compile recorded *E.coli* levels and provide a single source of water quality documentation for the entire watershed. Existing land cover maps, topography, and aerial photos were also used to evaluate potential *E.coli* contamination sources and provide a basis for selecting field monitoring locations.

The additional modeling extensions that were made available through the toolbox were not adapted for *E. coli* analysis (mainly Nitrogen, Phosphorus, and Mercury). Also, the sampling results revealed that *E. coli* levels were high throughout the watershed, thus making it useless to correlate the sampling data to the original regional land data that had been entered into the WCS. Thus, it was very difficult to determine the most likely source of *E. coli* based on the available data and data results. However, it is important to note that the wet weather flow samples yielded exceedingly high levels of *E.coli* as compared to dry weather flow samples. This indicates that the most severe sources of contamination are most likely introduced as a result of storm water runoff, rather than a persistent, continuous source.

During the course of the project, individual sites were documented as potential *E. coli* contributors. Some of these sites were the focus of Best Management Practice (BMP) efforts, and all of the landowners at the documented sites were contacted regarding possible BMP opportunities. The table below includes a list and locations of potential *E. coli* sources.

Site Location	Potential Cause of *E. coli*	Project Efforts	Results
Verduin Farms, Plaster Creek	Cattle in stream, manure runoff from barnyard/pasture	Contacted owner, indicated that grant funds are available through this project to install BMPs	No response
Post Farms, Plaster Creek	Cattle in stream, manure runoff from barnyard/pasture	Contacted owner, indicated that grant funds are available through this project to install BMPs	No response
Pet waste stations - City of Kentwood (East Paris Nature Park, Paris Park, Kenneth Stanaback Park)	Improper pet waste disposal	Contacted community about grant funds available to install pet waste stations	Installed 6 pet waste stations at parks

PLASTER CREEK INVENTORY DATA
1-Debris, Trash, Obstructions

SITE_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Picture #	COUNTY	TWP	SEC	STR	LAT	LONG	POLLUT	FIELD CP	MAIN (Days)	% of INCHES	W_COLOR	W_ODOR	AQ_VEG	AQUAE_1	AQUAE_2	FLOW	ST_BOT1	ST_BOT2	ST_BOT3	ST_WIDTH (ft)	ST_DEPTH (ft)	ST_HEIGHT (ft)	HIGH_WATER (ft)	HAB_LFT1	HAB_LFT2	HAB_LFT3	HAB_LFT4	HAB_RT1	HAB_RT2	HAB_RT3	HAB_RT4	OTHER_LT	OTHER_RT	BUF_LT (ft)	BUF_RT (ft)	Land Use_LT1	Land Use_LT2	L_U_RT1	L_U_RT2	LU_NOTES	S(DCU-1.0")	AMOUNT_1	OVER_W_1	Impair WAY_1	COMMENTS
PMBWC0100		07-Oct-2003	BR2, RH	PLASTER CREEK	1170	KENT	GRAND RAPIDS	12		42.921833	-85.691667		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	COBBLE	30	0.5		0	TREES	SHRUBS	SAME	NONE	SAME	STIP WAP	NONE	NONE	NONE	NONE	N	N	WOODLOT	NONE	ROAD	NONE		1164	EXTENSIVE	YES	YES	KIPS THE BEDOF 128.1ST BRIDGE
PMBWC0203		19-Jul-2007	BR2, LBN	PLASTER CREEK	351	KENT	KENTWOOD	35	SW	42.86725	-85.59242		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	COBBLE	NONE	10	0.5	6	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		615	MODERATE	YES	YES	WOODY DEBRIS CREATING LOG JAM
PMBWC0204		19-Jul-2007	BR2, LBN	PLASTER CREEK	350	KENT	KENTWOOD	35	SW	42.86700	-85.59078		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	16	1	10	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		120	MODERATE	YES	YES	BANKS TO OVERFLOW
PMBWC0205		19-Jul-2007	BR2, LBN	PLASTER CREEK	349	KENT	KENTWOOD	35	SW	42.86825	-85.59235		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	50	2	7	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		450	EXTENSIVE	YES	YES	ON BENDS IN STREAM - MANY LARGE LOGS
PMBWC0207		19-Jul-2007	BR2, LBN	PLASTER CREEK	495	KENT	KENTWOOD	35	SW	42.86765	-85.59278		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	20	2	6	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	ROAD	WOODLOT	NONE		320	EXTENSIVE	YES	YES	ENTERTING FLOW TO LEFT AND RIGHT BANK
PMBWC0208		19-Jul-2007	BR2, LBN	PLASTER CREEK	494	KENT	KENTWOOD	35	SW	42.86699	-85.59138		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	8	0.5	6	0	TREES	SHRUBS	HERBACEOUS	NONE	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	ROAD	WOODLOT	NONE		30	MODERATE	YES	YES	LOG JAM DIVERTS FLOW
PMBWC0209		19-Jul-2007	BR2, LBN	PLASTER CREEK	493	KENT	KENTWOOD	35	SW	42.86697	-85.59138		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	MODERATE FLOW	SAND	CLAY	GRAVEL		0.5	1.5	0	TREES	SHRUBS	HERBACEOUS	ROAD	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	ROAD	WOODLOT	NONE		80	LARGE	YES	YES	ROAD ON LEFT BANK
PMBWC0210		19-Jul-2007	BR2, LBN	PLASTER CREEK	492	KENT	KENTWOOD	35	SW	42.86692	-85.59128		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	10	0.5	3	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	ROAD	WOODLOT	NONE		160	EXTENSIVE	YES	YES	
PMBWC0212		19-Jul-2007	BR2, LBN	PLASTER CREEK	489	KENT	KENTWOOD	35	SW	42.86682	-85.59051		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	20	0.5	3	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE	Road to home	330	EXTENSIVE	YES	YES	8 DAMAGED CULVERTS IN STREAM. PIPE DIAMETER = 2' ORIGINALLY
PMBWC0213		19-Jul-2007	BR2, LBN	PLASTER CREEK	487	KENT	KENTWOOD	35	SW	42.86684	-85.59048		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	NONE	20	1	3	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		430	EXTENSIVE	YES	YES	LOG JAM
PMBWC0214		19-Jul-2007	BR2, LBN	PLASTER CREEK	482	KENT	KENTWOOD	35	SW	42.86690	-85.59048		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	10	0.5	3	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		250	EXTENSIVE	YES	YES	WOODY DEBRIS
PMBWC0217		19-Jul-2007	BR2, LBN	PLASTER CREEK	462	KENT	KENTWOOD	35	SW	42.86692	-85.59448		NONE	1 OR MORE		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	10	0.5	3	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		40	MODERATE	YES	YES	LOG JAM
PMBWY0205		25-Jul-2007	BR2, RH	PLASTER CREEK	1366	KENT	WYOMING	13		42.91985	-85.67436		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	COBBLE	30	0.5	15	0	TREES	SHRUBS	NONE	NONE	SHRUBS	WATR	NONE	NONE	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		1350	MODERATE	YES	NO	LOG JAM
PMBWY0206		25-Jul-2007	BR2, RH	PLASTER CREEK	1375	KENT	WYOMING	12	EE	42.91955	-85.68671		NONE	1		CLEAR	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	40	0.5	15	0	SHRUBS	HERBACEOUS	NONE	NONE	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	ROAD	NONE	ROAD	NONE		2000	EXTENSIVE	NO	YES	CONCRETE SLABS ON STREAMBANK
PMBWY0209		25-Jul-2007	BR2, RH	PLASTER CREEK	1369	KENT	GRAND RAPIDS	12		42.91971	-85.67936		NONE	1 OR MORE	0.25	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	CLAY	NONE	10	0.5	10	0	TREES	SAME	NONE	NONE	TREES	HERBACEOUS	SAME	NONE	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		445	SLIGHT	YES	NO	LOG JAM
PMBWY0208		25-Jul-2007	BR2, RH	PLASTER CREEK	1365	KENT	GRAND RAPIDS	12		42.91950	-85.67732		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	COBBLE	38	0.5	7	0	TREES	SAME	NONE	NONE	TREES	HERBACEOUS	SAME	NONE	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		1125	LARGE	YES	NO	LOG JAM
PTHNC0010		19-Jul-2007	BR2, LBN	PLASTER TRIB 1	476, 477, 478	KENT	KENTWOOD	35	SW	42.86165	-85.59339		NONE	1 OR MORE		NONE	NONE	NONE	NONE	DRY	SAND	GRAVEL	NONE	5	0.5	2	1	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	Y	N	RES/COMM	NONE	WOODLOT	NONE		COUNPTRUCKS	LARGE	NO	NO	Bike, Large garbage piles
PTGNT1402		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	753	KENT	GAINES TWP	14	SW	42.82486	-85.57582		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	6	0.25	6	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	Y	WOODLOT	NONE	VGR DUL TURAL	NONE		66	MODERATE	YES	YES	LOG JAM
PTGNT1403		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	754	KENT	GAINES TWP	14	SW	42.82372	-85.57285		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	-	-	-	6	0	6	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	AGRICULTURAL	NONE	FIWIRE	NONE		11 x 2.5 ft	EXTENSIVE	Y	Y	LOG JAM
PTGNT1404		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	755	KENT	GAINES TWP	14	SW	42.82368	-85.57284		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	5	0.5	5	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	NONE	FIWIRE	NONE		64	MODERATE	YES	YES	LOG JAM
PTGNT1405		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	756	KENT	GAINES TWP	14	SW	42.82287	-85.57245		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	5	0.5	15	0.5	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		70	MODERATE	YES	YES	LOG JAM
PTGNT1406		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	757	KENT	GAINES TWP	14	SW	42.82283	-85.57237		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	5	0.5	8	0.5	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		410	LARGE	YES	YES	LOG JAM
PTGNT1407		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	759	KENT	GAINES TWP	14	SW	42.81786	-85.57270		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	4	0.5	6	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		160	LARGE	YES	YES	LOG JAM
PTGNT1408		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	760	KENT	GAINES TWP	14	SW	42.81655	-85.57218		NONE	1 OR MORE		CLEAR	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	NONE	NONE	4	0.5	10	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	WOODLOT	RES/COMM	WOODLOT	NONE		130	LARGE	YES	YES	LOG JAM
PTGNT1409		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 2	1370	KENT	GAINES TWP	13		42.82140	-85.58337		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	NONE	DRY	ORGANIC	NONE	NONE	NONE	20	0.5	4	0	TREES	SHRUBS	NONE	NONE	TREES	GRASS	AGRICULTURAL	NONE	NONE	NONE	N	N	AGRICULTURAL	NONE	RES/COMM	NONE		100	EXTENSIVE	YES	YES	GARBAGE CREATING LOG JAM OBSTRUCTION
PTGNT1503		01-Nov-2007	BR, RH	PLASTER CREEK AD TRIB 3	1373	KENT	GAINES TWP	13		42.82140	-85.58337		NONE	1 OR MORE	0.5	NONE	NONE	NONE	NONE	DRY	ORGANIC	NONE	NONE	NONE	20	0.5	4	0	TREES	SHRUBS	NONE	NONE	TREES	GRASS	AGRICULTURAL	NONE	NONE	NONE	N	N	AGRICULTURAL	NONE	RES/COMM	NONE		100	EXTENSIVE	YES	YES	GARBAGE CREATING LOG JAM OBSTRUCTION
PTGNT1004		01-Nov-2007	BR2, RH	PLASTER CREEK AD TRIB 3	1372	KENT	GAINES TWP	13		42.82073	-85.58278		NONE	1 OR MORE	0.5	NONE	NONE	NONE	NONE	DRY	ORGANIC	NONE	NONE	20	0	3	0.5	TREES	HERBACEOUS	NONE	NONE	TREES	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	AGRICULTURAL	NONE	RES/COMM	NONE		1750	LARGE	YES	YES	WOODY DEBRIS UPSTREAM ABOUT 100 FEET THE OBSTRUCTION CONTINUES, BUT IS MUCH SMALLER
PTGNT1005		01-Nov-2007	BR2, RH	PLASTER CREEK AD TRIB 3	1371	KENT	GAINES TWP	13		42.82000	-85.58008		NONE	1 OR MORE	0.5	NONE	NONE	NONE	NONE	DRY	ORGANIC	NONE	NONE	12	0	3	0.5	TREES	SHRUBS	NONE	NONE	TREES	SHRUBS	NONE	NONE	NONE	NONE	N	N	WOODLOT	NONE	WOODLOT	NONE		440	EXTENSIVE	YES	YES	LOG JAM WITH AN OVERHANGING CANOPY, CREATING OBSTRUCTION
PTGNT1007		01-Nov-2007	BR2, RH	PLASTER CREEK AD TRIB 3	1368	KENT	GAINES TWP	13		42.81464	-85.58005		NONE	1 OR MORE		NONE	NONE	NONE	NONE	DRY	ORGANIC	NONE	NONE	16	0	5	0.5	TREES	SHRUBS	HERBACEOUS	NONE	TREES	SHRUBS	NONE	NONE	NONE	NONE	N	N	AGRICULTURAL	NONE	WOODLOT	NONE	ADR-150TRE,ANG	1 DUMPTRUCK	MODERATE	NO	YES	8 SEPARATE LOG JAMS
PTGNT1406		01-Nov-2007	BR2, LBN	PLASTER CREEK AD TRIB 3	1534	KENT	GAINES TWP	14	NE	42.82481	-85.57178		NONE	2	0.1	NONE	NONE	NONE	NONE	DRY	SAND	CLAY	NONE	10	0	5	0.5	GRASS	NONE	NONE	NONE	SHURUB	NONE	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	EDLE	NONE		120	LARGE	YES	YES	CONCRETE DRAINS AND LOGS INSTREAM
PTAWC1201		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1376	KENT	WYOMING	12		42.91972	-85.67432		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	10	0.5	TREES	SHRUBS	HERBACEOUS	SAME	SAME	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	RES/COMM	NONE	PARK	50	MODERATE	NO	YES	WOODY DEBRIS AND GARBAGE
PTAWC1202		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1377	KENT	WYOMING	12		42.91972	-85.67432		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	10	0.5	TREES	SHRUBS	HERBACEOUS	SAME	SAME	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	RES/COMM	NONE		50	MODERATE	NO	YES	WOODY DEBRIS AND GARBAGE
PTAWC1301		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1371	KENT	WYOMING	12		42.90885	-85.67538		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	12	0.5	SHRUBS	HERBACEOUS	NONE	NONE	TREES	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	ROAD	NONE		378	LARGE	YES	YES	8 PILES OF LOG JAM AND GARBAGE
PTAWC1302		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1369	KENT	WYOMING	12		42.90489	-85.67537		NONE	1 OR MORE	0.5	CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	15	0.5	TREES	SHRUBS	HERBACEOUS	NONE	NONE	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	ROAD	NONE		20	SLIGHT	NO	NO	GARBAGE AND WOODY DEBRIS
PTAWC1304		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1368	KENT	WYOMING	12		42.90350	-85.67550		NONE	1 OR MORE	0.5	CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	11	0	TREES	SHRUBS	HERBACEOUS	SAME	NONE	TREES	SHRUBS	HERBACEOUS	WATR	NONE	NONE	NONE	N	N	RES/COMM	NONE	ROAD	NONE	PARK	20	MODERATE	YES	YES	
PTAWC1306		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1362	KENT	WYOMING	13		42.90360	-85.67408		NONE	1 OR MORE		CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	10	0.5	15	0.5	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	N	N	RES/COMM	NONE	PARK	NONE	PARK 1 TOWING, RT (EN	120	LARGE	YES	YES	
PTAWC1307		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1361	KENT	WYOMING	13		42.90075	-85.67515		NONE	1 OR MORE		CLOUDY/MILKY	ROTTEN EGGS	NONE	NONE	NONE	STAGNANT	SAND	ORGANIC	NONE	12	0	13	0	TREES	GRASS	SAME	NONE	TREES	SHRUBS	GRASS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	ROAD	NONE	TRACKS	450	EXTENSIVE	YES	NO	8 SEPPO DOG
PTAWC1308		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1360	KENT	WYOMING	13		42.89950	-85.67515		NONE	1 OR MORE		CLEAR	NONE	NONE	PILAMB WTOUS	NONE	SLOW FLOW	SAND	GRAVEL	NONE	12	0.75	14	0	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	SHURUB	HERBACEOUS	GRASS	NONE	NONE	NONE	NONE	N	N	RES/COMM	NONE	PARK	NONE	PARK	40	MODERATE	YES	YES	10 PIPE SEPARATE PILES OF LARGE GARBAGE ABOUT 10 FEET APART
PTAWC1309		01-Nov-2007	BR2, BW	PLASTER CREEK TRIB WYO	1359	KENT	WYOMING	13		42.89865	-85.67515		NONE	1 OR MORE		BLACK	NONE	HUGE NATI	PILAMB WTOUS	MAT FORMING	STAGNANT	SAND	ORGANIC	NONE	12	0	8	0	SHRUBS	HERBACEOUS	GRASS	NONE	SHURUB	HERBACEOUS	GRASS	NONE	NONE	NONE	NONE	N	N	ROAD	NONE	ROAD	NONE	TRACKS	450	EXTENSIVE	NO	YES	WOODY DEBRIS/GARBAGE BLOCKING CULVERT

Note
1= <25 ft 3= 50-100 ft
2= 25-50 ft 4= >100 ft

PLASTER CREEK INVENTORY DATA
2-Roadstream Crossing

SITE_ID	PICK_LATEST_RECORD	DATE	INVEST	NAME	PRIMARY	COUNTY	TWP	RECD_BY	RCD_QLY	X_DEG	X_MIN	X_SEC	Y_DEG	Y_MIN	Y_SEC	DATUM	PROJECT	PROJECT_DESC	ID_COLOR	ID_SIZE	ID_SHAPE	ID_LOC	ID_DIST	ID_DIR	ID_DIST_1	ID_DIR_1	ID_DIST_2	ID_DIR_2	ID_DIST_3	ID_DIR_3	ID_DEPTH	ID_LEN	ID_HEIGHT	ID_DIAM	BANK_LFT	BANK_LFT_1	BANK_LFT_2	BANK_LFT_3	BANK_RT	BANK_RT_1	BANK_RT_2	BANK_RT_3	BANK_STAB	BANK_VEG	LB_TREE_PT	BKF_LT	BKF_RT	BKF_RT_BT	Land Use_LT	Land Use_LT_1	Land Use_LT_2	LU_RT	LU_RT1	LU_RT2	LU_RT3	TREE_2	BEARING_1	CONC_LEN	CONC_LEN_2	BF DESCRIBED TEXT	HORI BUCKT_2	HORI SUM_2	HORI LOC_2	VERT DROP	VERIS WIDTH_2	VERIS DEPTH_2	VERIS LENGTH_2	COMMENTS	COMMENTS
MBORC1 001		10/ 2001	AEI, HH	PL-ROTER CREEK	101	KENT	GRAND RAPIDS	10	1	-0.0	31	00.00		NONE	11	00.00	0.0	0.0	0.0	NONE	NONE	NONE	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	FREE	SHRUBS	HERBACEOUS	GRASS	FREE	SHRUBS	HERBACEOUS	GRASS	50-NO	NONE	NONE	0	0	0	NONE	0	NONE	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MBORC1 002		10/ 2001	AEI, HH	PL-ROTER CREEK	101	KENT	GRAND RAPIDS	10	1	-0.0	31	00.00		NONE	11	00.00	0.0	0.0	0.0	NONE	NONE	NONE	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	FREE	SHRUBS	HERBACEOUS	GRASS	FREE	HERBACEOUS	NONE	NONE	NONE	NONE	0	0	0	NONE	FIELD	NONE	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MBRAC2 001		09/ 2001	AEI, LBN	PL-ROTER CREEK	105, 304	KENT	KENTWOOD	30	300	-0.0	48	00.00		NONE	11	00.00	0.0	0.0	0.0	NONE	NONE	NONE	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	FREE	SHRUBS	HERBACEOUS	GRASS	FREE	SHRUBS	HERBACEOUS	GRASS	50-NO	NONE	NONE	0	0	0	NONE	0	NONE	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PLEAS1 001		10/ 2001	AEI, HH	PL-ROTER CREEK	101	KENT	GRAND RAPIDS	10	1	-0.0	31	00.00		NONE	11	00.00	0.0	0.0	0.0	NONE	NONE	NONE	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	FREE	SHRUBS	HERBACEOUS	GRASS	FREE	SHRUBS	HERBACEOUS	GRASS	50-NO	NONE	NONE	0	0	0	NONE	0	NONE	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PLEAS1 002		10/ 2001	AEI, HH	PL-ROTER CREEK AS TRB 1	101	KENT	GRAND RAPIDS	10	1	-0.0	31	00.00		NONE	11	00.00	0.0	0.0	0.0	NONE	NONE	NONE	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	FREE	SHRUBS	HERBACEOUS	GRASS	FREE	SHRUBS	HERBACEOUS	GRASS	50-NO	NONE	NONE	0	0	0	NONE	0	NONE	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PLEAN1 004		11/ 2001	AEI, ERO, BM	PL-ROTER CREEK AS TRB 1	107, 314	KENT	GRAND RAPIDS	10	2	-0.0	31	00.00		NONE	11	00.00	0.0	0.1	0.1	BROWN	MUDDY	SILT/ VF	FL-MENTADOS	NONE	STRAIGHT	CLAY	NONE	50-NO	NONE	50-NO	NONE	0	0	4	0.5	FREE	SHRUBS	NONE	NONE	FREE	SHRUBS	GRASS	50-NO	50-NO	NONE	0	0	0	NEW COMP	NONE	SILT	NONE	0	FIELD CLAY/SIFT	CONCRETE	GOOD	0	PARTIAL	PAVED	NA	GONE/LOST	0	0	0	0	0	0	0	0	0	0	0	0

Notes
1 = <2m 4 = 50-100 ft
2 = 2m-30 ft 5 = >100 ft

PLASTER CREEK INVENTORY DATA
3-Gully Erosion

SITE_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Picture #	COUNTY	TWP	SEC	QTR1	LAT	LONG	POLLUT	FREQUP	RAIN (Days)	# of INCHES	W_COLOR	W_ODOR	AQ_VEG	ALGAE_1	ALGAE_2	FLOW	ST_BOT1	ST_BOT2	ST_BOT3	ST_WIDTH (ft)	ST_DEPTH (ft)	ST_HEIGHT (ft)	HIGH_WATER (ft)	HAB_LFT1	HAB_LFT2	HAB_LFT3	HAB_LFT4	HAB_RT1	HAB_RT2	HAB_RT3	HAB_RT4	OTHER_LT	OTHER_RT	BUF_LT (ft)	BUF_RT (ft)	Land Use_LT1	Land Use_LT2	LU_RT1	LU_RT2	LU_NOTES	LOC_3	EROS WIDTH_3	EROS DEPTH_3	EROS LENGTH_3	TRS_3	EXT_3	COMMENTS
PTSQNT1400	3		7/12/2007	MAS, EWO, RH	PLASTER CREEK AG TRIB 3	030	KENT	GANBS	TWP	14	NE	42.92425	85.56994	3	NONE	2		3.1	NONE	NONE	NONE	NONE	NONE	DRY	BARE	CLAY	GRAVEL	3	0.5	4		1		TREES	GRASS	NONE	NONE	TREES	HERBACEOUS	GRASS	NONE	NONE	NONE	1		RES/COMM	NONE	AGRICULTURAL	NONE		RT BANK	2.5	4	30	10	MODERATE	CORN FIELD DRAIN DIRECTLY INTO STREAM

* Note
1 = <25 ft 3 = 50-100 ft
2= 25-50 ft 4 = >100 ft

PLASTER CREEK INVENTORY DATA
5-Non-point Ag. Sources

S_N_ID	POLLUTANT SOURCE	DATE	EVENT	NAME	Picture #	COUNTY	TWP	SEC	S/N	LAT	LONG	POLLUT	END OF	BANK	Width	ST HEIGHT	ST WIDTH	ST DEPTH	ST HEIGHT	ST WIDTH	ST DEPTH	BANK MATERIAL	BANK LFT	BANK LFT	BANK LFT	BANK RT	BANK RT	BANK RT	BANK RT	BANK RT	BANK LT	LT ACTIVE	RIP LT	LT ACT	RIP RT	RT ACT	Land Use LT	Land Use LT	LU RT	LU RT	LU NOTES	JOC #	ENDSURUNOFF #	MANURE STREAM #	MANURE STOR #	EST. FEEDLOT #	EROSION TYPE	COMMENTS
PTSGNT14005		7/12/2007	0400-EW-GL-RH	PLASTER CREEK-AG-TRIB 1	205	KENT	OAKLES TWP	14	06	42.8246	-85.6315	85	NONE	0	0.1	NONE	NONE	NONE	NONE	NONE	DRY	SAND	CLAY	NONE	0		2.5	3	0		GRASS	NONE	NONE	NONE	RUSS	SHRUBS	HERBACEOUS	NONE	NONE	NONE	1	1	AGRICULTURAL	NONE	IDLE	NONE		LFT BANK	PASTURE ACCESS TO DITCH	NONE	NO	NA	OTHER	OUTSIDE OF FENCE;SUP AGAINST STREAM; MODERATE
PTSGNT14006		7/12/2007	0400-EW-GL-RH	PLASTER CREEK-AG-TRIB 2	206	KENT	OAKLES TWP	14	06	42.8246	-85.6315	85	NONE	0	0.1	NONE	NONE	NONE	NONE	NONE	DRY	SAND	CLAY	NONE	0		2.5	3	0		GRASS	CORN	NONE	NONE	GRASS	CORN	NONE	NONE	NONE	NONE	1	1	AGRICULTURAL	NONE	AGRICULTURAL	NONE		LFT BANK	NO TO DITCH	NONE	NO	NO	NONE	THRESHOLD;BUFFER ALONG STREET;APPROX 30FTEET; MINIMAL FILTER STRIP; MODERATE

Note
1 = <25 ft 3 = 50-100 ft
2 = 25-50 ft 4 = >100 ft

PLASTER CREEK INVENTORY DATA
6-Tile Outlet

STE_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Picture #	COUNTY	TWP	SEC	QTR1	LAT	LONG	POLLUT	PRECIP	RAIN (Drop)	# of INCTIE	SW_COLOR	W_ODOR	AQ_VISI	ALGAE_1	ALGAE_S	FLOW	BT_BOT1	BT_BOT2	BT_BOT3	ST_WIDTH (E)	ST_DEPTH (E)	ST_HEIGHT (E)	RISH_WATER (E)	RIB_LPT1	RIB_LPT2	RIB_LPT3	RIB_LPT4	RIB_RT1	RIB_RT2	RIB_RT3	RIB_RT4	OTHER_L	OTHER_R	BUF_LT (E)	BUF_RT (E)	Land Use_LT1	Land Use_LT2	LU_RT1	LU_RT2	LU_BOTTB	LOC_E	EROSION TYPE_E	SEA_E (in)	MAT_E	HEIGHT_E (in)	SEDI COLOR_E	DIS ODOR_E	EROS LENGTH_E	EROS HEIGHT_E	EROS DEPTH_E	FIB_FREE BRT_E	COMMENTS
PTSGNT606	6	11/1/2007	AND, RW	PLASTER CREEK AG TRIB 3	1369	KENT	GAINES TWP	13		42.6163	-85.54083	6		NONE	1 OR LESS	0.5	NONE	NONE	NONE	NONE	NONE	DRY	SAND	NONE	NONE	16	1	3	5.5	TREES	SHRUBS	NONE	NONE	TREES	SHRUBS	NONE	NONE	NONE	NONE	5	4	AGRICULTURAL	NONE	WOODLOT	NONE		UPT BANK	GULLY	6	METAL	6	NONE	NONE	12	0.5	0.5	30	OUTLET IN POOR CONDITION. IS RUSTY ECT...
PTSGNT606	6	11/1/2007	AND, RW	PLASTER CREEK AG TRIB 3	1367	KENT	GAINES TWP	13		42.6138	-85.55043	6		NONE	1 OR LESS	0.5	NONE	NONE	NONE	NONE	NONE	DRY	CLAY	GROUND	NONE	16	2.5	4	1	TREES	SHRUBS	NONE	NONE	TREES	SHRUBS	NONE	NONE	NONE	NONE	5	4	AGRICULTURAL	NONE	WOODLOT	NONE		PT. BANK	GULLY	4	CLAY	6	OLIVE	NONE	12	0.5	0.5	30	

* Note:
1 = <25 ft 3 = 50-100 ft
2= 25-50 ft 4 = >100 ft

PLASTER CREEK INVENTORY DATA
7-Streambank Erosion

| S. R. ID | POLLUTANT SOURCE | DATE | PROJECT | NAME | Photo # | COUNTY | TWP | RNG | STRD | DATE | POLLUT | INTROP | DRAIN | Uses | WATRCH | RE COLOR | RE SOIL | NO. VEG | VOLUME 1 | ALGAE 2 | FLOW | BT EOT | BT EOB | BT BOTT | BT BOTS | BT MBW | BT MBW | BT DEPTH | BT HIGHT | BT HIGHT | HIGH WATER | EDGE LFT | EDGE RT | EDGE LFT | EDGE RT | EDGE LFT | EDGE RT | BANK RT | BANK RT | BANK

PLASTER CREEK INVENTORY DATA
8-Construction

SITE_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Picture #	COUNTY	TWP	SEC	QTR	LAT	LONG	POLLUT	PRECIP	RAIN (days)	# of INCHES	BV_COLOR	BV_ODOR	AQ_VIS	BUGME_1	BUGME_2	FLOW	ST_EOF	ST_BOTS	ST_BOT2	ST_WID	ST_DEPTH	ST_HEIGHT	HIGH_WATER	HAB_LFT1	HAB_LFT2	HAB_LFT3	HAB_LFT4	HAB_RT1	HAB_RT2	HAB_RT3	HAB_RT4	OTHER_LT	OTHER_RT	BUF_LT	BUF_RT	Land Use_LT1	Land Use_LT2	LU_RT1	LU_RT2	LU_NOTES	DOC_#	ACRES	SERVICE	CONTROL_MEASURES_1	TYPE_CONTROL_1	SITE SLOPE_1	COMMENTS
PMB GRC/001-S		7-25-2007	LBN, RH	PLASTER CREEK	1133, 1134	KENT	GRAND RAPIDS	17	NW	42.97877	85.68038	NONE	?	?		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	15	0.5	10	2	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	1	2	RESIDENTIAL	ROAD	RESIDENTIAL	ROAD		RT BANK	P	NO	NO	SILT FENCE	STEEP	ADJACENT OF THE BANK IS EROSION AND HAS A SILT FENCE
PMB GRC/002-S		7-25-2007	LBN, RH	PLASTER CREEK	1135	KENT	GRAND RAPIDS	17	NW	42.97872	85.68078	NONE	?	?		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	20	0.5	4	2	TREES	SHRUBS	HERBACEOUS	NONE	TREES	SHRUBS	HERBACEOUS	NONE	NONE	NONE	2	1	WOODLOT	NONE	RESIDENTIAL	ROAD		RT BANK	P	NO	YES	SILT FENCE	STEEP	SEDIMENT PUD FOR SURE PATH CONSTRUCTION IS SPILLING OVER THE SILT FENCE A
PMB GRC/003-S		7-25-2007	LBN, RH	PLASTER CREEK	1136	KENT	GRAND RAPIDS	17	NW	42.97704	85.68749	NONE	?	?		CLEAR	NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	45	0.5	10	2	TREES	SHRUBS	HERBACEOUS	NONE	TREES	HERBACEOUS	NONE	NONE	NONE	NONE	3	1	RESIDENTIAL	NONE	ROAD	NONE		RT BANK	P	NO	YES	SILT FENCE	STEEP	STREAM CROSSING
PMB GRC/004-S		7-25-2007	LBN, RH	PLASTER CREEK	1137	KENT	GRAND RAPIDS	17	NE	42.97875	85.68879	NONE	?	?		CLOUDY/MILKY	NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	NONE	15	2.5	6	2.5	TREES	SHRUBS	HERBACEOUS	GRASS	SHRUBS	HERBACEOUS	NONE	NONE	NONE	NONE	4	1	WOODLOT	NONE	ROAD	NONE		RT BANK	P	NO	YES	SILT FENCE	STEEP	STORE PLEA TIBE PATH CONSTRUCTION IS TE SPILLING OVER SILT FENCE
PMB GRC/005-S		7-25-2007	LBN, RH	PLASTER CREEK	1138	KENT	GRAND RAPIDS	17	NE	42.97902	85.68968	NONE	?	?		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	20	0.5	6	2	TREES	SHRUBS	HERBACEOUS	NONE	TREES	SHRUBS	HERBACEOUS	NONE	NONE	NONE	4	1	WOODLOT	NONE	RESIDENTIAL	ROAD		RT BANK	P	YES	YES	SILT FENCE	MODERATE	SILT FENCE NOT FUNCTIONING AT BIKE PATH CONSTRUCTION
PMB GRC/006-S		7-25-2007	LBN, RH	PLASTER CREEK	1139	KENT	GRAND RAPIDS	17	NE	42.97878	85.68874	NONE	?	?		CLOUDY/MILKY	NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	15	1.5	6	2	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	BARE	NONE	NONE	2	1	RESIDENTIAL	NONE	ROAD	NONE		RT BANK	P	YES	NO	SILT FENCE	STEEP	ADDITIONAL SILT FENCE NEEDED FOR 50 FT OF BANK

* Note
1 = <25 ft 3 = 50-100 ft
2= 25-50 ft 4 =>100 ft

PLASTER CREEK INVENTORY DATA
9-Urban_Residential

S_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Photo #	COUNTY	TWP	SEC	S/T	LAT	LONG	POLLUT	PRIORITY	DATA Using	PATHOGENS	BI_COLOR	BI_ODOR	BIO_VIS	ALGAE_1	ALGAE_2	FLOW	ST_BOT1	ST_BOT2	ST_BOT3	ST_BOT4	ST_BRTH	ST_DEPTH	ST_HEIGHT	FISH_WATER	HAB_LFT1	HAB_LFT2	HAB_LFT3	HAB_LFT4	HAB_RT1	HAB_RT2	HAB_RT3	HAB_RT4	STHER_LT	STHER_RT	BUF_LT	BUF_RT	Land Use_LT1	Land Use_LT2	LU_LT3	LU_LT4	LU_RT1	LU_RT2	LU_NOTES	LOC_S	SOURCE_S	EXTENT	SEDIG_SEV	BUFFER_S	BIOSOR_S	COLOR_S	ESQUAL_S	COMMENTS
PMBORE3-R3	0		08/08/01	8/8/01	PLASTER CREEK	CB4	KENT	GRAND RAPIDS	8	6E	42.91139	85.63846	0	NONE	1		0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	50		0.5		0	0.5	HERBA CEOUS	GRASS		NONE		TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	ROAD		LFT BANK	BOWS TO STREAM	EXTENSIVE	N/A	0		NONE	SLOUGHY BRLIKT	NONE	1 LANDOWNERS MOW TO THE STREAM BANK.
PMBORE3-R4	0		08/08/01	8/8/01	PLASTER CREEK	CB4	KENT	GRAND RAPIDS	8	6E	42.91139	85.63846	0	NONE	1		0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	50		0.5		0	0.5	HERBA CEOUS	GRASS		NONE		TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	ROAD		LFT BANK	BOWS TO STREAM	EXTENSIVE	N/A	0		NONE	SLOUGHY BRLIKT	NONE	-
PMBORE3-R5	0		08/08/01	8/8/01	PLASTER CREEK	CB4	KENT	GRAND RAPIDS	8	6E	42.91139	85.63846	0	NONE	1		0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	50		0.5		0	0	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	NONE		LFT BANK	BOWS TO STREAM	MODERATE	N/A	0		NONE	CLEAR	CLOUDY BRLIKT	NONE	-
PMBORE3-T10	0		08/08/01	8/8/01	PLASTER CREEK	CB4	KENT	GRAND RAPIDS	8	6E	42.91147	85.6411	0	NONE	1		0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	50		0.5		0	0	TREES	HERBACEOUS	NONE	NONE	NONE	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	NONE		LFT BANK	BOWS TO STREAM	MODERATE	N/A	0		NONE	CLEAR	NONE	3 LOWES MOW TO BANK
PMBRNC B1-B	0		09/28/01	9/28/01	LBW	PLASTER CREEK	KEE - BEV	KENT	42N TN OCO	03	8W	42.86409	85.5767	0	NONE	1 SOIL NEWE	0		CLOUDY BRLIKT		NONE	NONE	NONE	NONE	SLOW FLOW	SAND	CLAY	CLAY	70		1.0		0	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RES-COMM	NONE		RT BANK	YARD WASTE	LOW	N/A	0		NONE	CLOUDY BRLIKT	0	5 BANK WASHED OUT TO THE STREAM.
PMBRNC B2-B	0		09/28/01	9/28/01	LBW	PLASTER CREEK	KEE - BEV	KENT	42N TN OCO	03	8W	42.86409	85.5767	0	NONE	1 SOIL NEWE	0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	GRAVEL	COBBLE	50		0.5		0	0	TREES	SHRUBS	HERBACEOUS	GRASS	HERBACEOUS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	NONE		RT BANK	BOWS TO STREAM	EXTENSIVE	N/A	0		NONE	CLEAR	NONE	2 LOTS OF TRASH DUMPED TO THE STREAMBANK
PMBRNC B3-B	0		09/28/01	9/28/01	LBW	PLASTER CREEK	KEE	KENT	42N TN OCO	03	8W	42.86409	85.5767	0	NONE	1 SOIL NEWE	0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	CLAY	CLAY	70		0.5		0	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	NONE		RT BANK	BOWS TO STREAM	EXTENSIVE	N/A	0		NONE	CLEAR	NONE	3 LOTS OF TRASH DUMPED TO THE STREAMBANK
PMBRNC B4-B	0		09/28/01	9/28/01	LBW	PLASTER CREEK	KEE	KENT	42N TN OCO	03	8W	42.86409	85.5767	0	NONE	1 SOIL NEWE	0		CLEAR		NONE	NONE	NONE	NONE	MODERATE FLOW	SAND	CLAY	CLAY	70		0.5		0	0.5	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	0	0	RES-CONM	NONE	RECOLOT	NONE		RT BANK	BOWS TO STREAM	EXTENSIVE	N/A	0		NONE	CLEAR	NONE	4 LOTS OF TRASH DUMPED TO THE STREAMBANK
PMBWYC G3B	0		10/30/01	10/30/01	PLASTER CREEK	107 6	KENT	WYOMING	13	6E	42.91445	85.67041	0	NONE	1		1		NONE		NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	20		1.5		0.5	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	1	0	RES-CONM	NONE	RES-COMM	NONE		RT BANK	OUTLET	MODERATE	10	NONE	CLEAR	NONE	0 TRASH AND RESIDENTIAL EROSION ALSO PRESENT DUE TO OUTLET - RT. BANK, LENGTH 10FT, HEIGHT - 7FT. YEAR 0 PRESENT 7 APPROX 20 - EROSION COVERS ENTIRE BANK AREA.
PMBWYC G3C	0		10/30/01	10/30/01	PLASTER CREEK	107 6	KENT	WYOMING	13	6E	42.91445	85.67041	0	NONE	1		1		NONE		NONE	NONE	NONE	NONE	SLOW FLOW	SAND	GRAVEL	NONE	20		1.5		0.5	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	1	0	RES-CONM	NONE	RES-COMM	NONE		RT BANK	OUTLET	MODERATE	10	NONE	CLEAR	NONE	0 TRASH AND RESIDENTIAL EROSION ALSO PRESENT DUE TO OUTLET - RT. BANK, LENGTH 10FT, HEIGHT - 7FT. YEAR 0 PRESENT 7 APPROX 20 - EROSION COVERS ENTIRE BANK AREA.
PMBWYC-1	0		09/28/01	9/28/01	LBW	PLASTER TRIB 1	KEE	KENT	42N TN OCO	03	8W	42.86409	85.58195	0	NONE	1 OVER HEME	0		CLEAR		NONE	OVERGROW	NONE	NONE	DRY	SAND	GRAVEL	NONE	1		0.5		0	0	GRASS	NONE	NONE	NONE	HERBACEOUS	GRASS	NONE	NONE	1	0	RECOLOT	HEAVY USE	RECOLOT	NONE	0.1 Grass	LFT BANK	BOWS TO STREAM	LARGE	N/A	0		NONE	CLEAR	NONE	0	
PTVINC3-B3-D	0		09/28/01	9/28/01	LBW	PLASTER TRIB 1	KEE - KENT	KENT	42N TN OCO	03	8W	42.86139	85.58195	0	NONE	1 OVER HEME	0		NONE		NONE	NONE	NONE	NONE	DRY	SAND	GRAVEL	NONE	1		0.5		0	0	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	1	0	RES-CONM	NONE	RECOLOT	NONE		LFT BANK	YARD WASTE	EXTENSIVE	STABIPRUDIST	0		NONE	NONE	NONE	Farm water pipe over bank
PTVINT1-B1	0		11/16/01	11/16/01	LBW	PLASTER CREEK AG TRIB 3	7TH	KENT	JAMES TWP	14	8W	42.81139	85.64756	0	NONE	1 OR LESS	0		NONE		NONE	NONE	NONE	NONE	DRY	SAND	NONE	NONE	1		0		0	0	GRASS	NONE	NONE	NONE	GRASS	NONE	NONE	NONE	1	0	RES-CONM	NONE	PRAIRIE	NONE		LFT BANK	BOWS TO STREAM	LARGE	N/A	0		NONE	NONE	NONE	
PTVINT1-B1	0		11/30/01	11/30/01	BIG EWO, 7TH	PLASTER CREEK AG TRIB 3	8M	KENT	JAMES TWP	14	8E	42.81139	85.57523	0	NONE	1	0	1	CLEAR		NONE	NONE	NONE	NONE	STAGNANT	SAND	CLAY	NONE	1		0.2		0.3	0	TREES	GRASS	NONE	NONE	TREES	HERBA CEOUS	NONE	NONE	NONE	NONE	1	0	RES-CONM	NONE	RECOLOT	NONE	1 FT. FT BANK, INCHRED TO EDGE	LFT BANK	YARD WASTE	EXTENSIVE	N/A	0		NONE	CLEAR	NONE	AND OWNER MOWS TO STREAMBANK.

1= <50 ft 3= 200-500 ft
2= 50-200 ft 4= >100 ft

PLASTER CREEK INVENTORY DATA
11-Other

SITE_ID	POLLUTANT SOURCE	DATE	INVEST	NAME	Rcds no #	CO UNT	TWP	SEC	QTR1	LAT	LONG	POLLUT	PRECIP	RAIN (Days)	# of INCHES	W_COLOR	W_ODOR	AQ_VIS	ALGAE_1	ALGAE_2	FLOW
PMBKNC3914	11	7/9/2007	AN2, LBN	PLASTER CREEK	898	KENT	KENT WOOD	25	NW	42.99488	85.58992	11	NONE	3 OR MORE	7	CLOUDY/MLKY	NONE	NONE	NONE	NONE	SLOW FLOW
PMBKNC3815	11	7/9/2007	AN2, LBN	PLASTER CREEK	894	KENT	KENT WOOD	25	NW	42.99209	85.58907	11	NONE	3 OR MORE	7	CLEAR	NONE	NONE	NONE	NONE	MODERATE FLOW
PTIGNT1402	11	7/12/2007	AN2, BWO, RK	PLASTER CREEK AG TRIB 3	262	KENT	GANES TWP	14	NE	42.92599	85.57272	11	NONE	2	0.1	NONE	NONE	NONE	NONE	NONE	DRY
PTAWYC1202	11	7/19/2007	AN2, BW	PLASTER CREEK TRIB WYC	1375	KENT	WYOMING	12		42.91611	85.67496	11	NONE	1 OR LESS	1	CLEAR	NONE	NONE	MAT FORMING	NONE	SLOW FLOW

SITE_ID	ST_BOT1	ST_BOT2	ST_BOT3	ST_WIDTH (ft)	ST_DEPTH (ft)	ST_HEIGHT (ft)	HIGH_WATER (ft)	HAB_LPT1	HAB_LPT2	HAB_LPT3	HAB_LPT4	HAB_RT1	HAB_RT2	HAB_RT3	HAB_RT4	OTHER_LT	OTHER_RT	BUF_LT (ft)*	BUF_RT (ft)*	Land Use_LT1	Land Use_LT2	LU_RT1	LU_RT2	LU_NOT BS	LO C_11	SITE DESC_11	COMMENTS
PMBKNC3914	SAND	CLAY	NONE	25	2	3	7	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	4	4	WOODLOT	NONE	WOODLOT	NONE		LFT BANK	ORV TRAIL 8 FT FROM STREAM	Moderate
PMBKNC3815	SAND	NONE	NONE	5	0.5	8	7	TREES	SHRUBS	HERBACEOUS	GRASS	TREES	SHRUBS	HERBACEOUS	GRASS	NONE	NONE	4	4	WOODLOT	NONE	WOODLOT	NONE		LFT BANK	ORV TRAIL ON STREAM BANK RECREATION	Large
PTIGNT1402	SAND	GRAVEL	NONE	4	0	4.5	0.5	TREES	GRASS	NONE	NONE	TREES	HERBACEOUS	NONE	NONE	NONE	NONE	1	4	RES/COMM	NONE	WOODLOT	NONE		RT BANK	RECREATION TWO TRACK ON BANK ENTERING STREAM BROSION POTENTIAL WHEN IN USE	CHICKEN COOP LFT BANK RECRSATION 2-TRACK, NOT HEAVILY ERODED, Moderate
PTAWYC1202	SAND	GRAVEL	NONE	15	0.5	10	2.5	TREES	HERBACEOUS	BARE	NONE	TREES	HERBACEOUS	NONE	NONE	NONE	NONE	1	1	RES/COMM	NONE	RES/COMM	NONE	PARK	LFT BANK	STORMWATER OUTFLOW CREATING VERTICAL BANK BROSION	OLD CONCRETE STABILIZATION ON BANK. STORMWATER OUTFALL PT. 15 FT. UPSTREAM, Large

* No to
1= <25 ft 3 =50-100 ft
2= 25-50 ft 4 =>100 ft

Appendix 7

Sediment and Nutrient Loadings and 100% Reductions for Nonpoint Source Sites

	Road/Stream Crossing			Gully Erosion			Tile Outlet Erosion			Urban/Residential Erosion			Streambank Erosion			TOTAL		
Subwatershed No.	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)
0	0.17	0.15	0.29	1.10	0.93	1.87	0.15	0.12	0.25	0	0	0	2.31	1.96	3.93	3.73	3.17	6.33
3	0.63	0.53	1.07	0	0.00	0	0	0	0	0	0	0	0	0	0	0.63	0.53	1.07
11	15.00	12.75	25.50	0	0.00	0	0	0	0	1.16	0.98	1.96	11.20	9.52	19.04	27.35	23.25	46.50
TOTAL	**15.80**	**13.43**	**26.86**	**1.10**	**0.93**	**1.87**	**0.15**	**0.12**	**0.25**	**1.16**	**0.98**	**1.96**	**13.51**	**11.48**	**22.96**	**31.71**	**26.95**	**53.90**

Sediment and Nutrient Loadings and 100% Reductions Estimated for the Plaster Creek Watershed[1]

	Road/Stream Crossing			Gully Erosion			Tile Outlet Erosion			Urban/Residential Erosion			Streambank Erosion			TOTAL		
	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)	Sediment Load/Reduction (ton/year)	Phosphorus Load/Reduction (lb/year)	Nitrogen Load/Reduction (lb/year)
TOTAL	**89.83**	**76.35**	**152.71**	**6.25**	**5.31**	**10.62**	**0.83**	**0.70**	**1.41**	**6.57**	**5.58**	**11.16**	**76.80**	**65.28**	**130.57**	**180.28**	**153.23**	**306.47**

Number of Nonpoint Source Sites by Subwatersheds Inventoried

Subwatershed No.	Debris/Trash/Obstructions	Nonpoint Ag. Source	Construction	Urban/Residential	Other
0	14	2	0	2	1
3	12	0	0	6	2
11	15	0	6	6	1
TOTAL	41	2	6	14	4

Number of Nonpoint Source Sites Estimated for the Plaster Creek Watershed[1]

	Debris/Trash/Obstructions	Nonpoint Ag. Source	Construction	Urban/Residential	Other
TOTAL	233	11	34	80	23

[1]Calculations were determined by extrapolation: (Watershed Acreage/Inventoried Acreage) * (Sediment or Nutrient Loading) or (Number of NPS Sites)
Watershed Acreage = 36446 acres
Inventoried Acreage = 6410 acres

Plaster Creek Pollutant Loading and Reduction Calculations for Nonpoint Source Pollution Sites

Road/Stream Crossing*

Site ID	Subbasin	Erosion Dimensions (ft) Width	Depth	Length	Years of Erosion	Severity	LRR (ft/yr)	Soil	Soil Weight (T/ft^3)	Correction Factor	Sediment Loading and 100% Reduction	Phosphorus (P) Loading and 100% Reduction	Nitrogen (N) Loading and 100% Reduction
PMBGRC1201	11	12	4	20	20	SEVERE	0.5	loamy sand	0.055	0.85	1.76	1.49	2.99
PMBGRC1204	11	25	6	45	20	MODERATE	0.2	loamy sand	0.055	0.85	12.36	10.51	21.02
PMBKNC3501	3	2	1.5	40	7	MODERATE	0.2	loamy sand	0.055	0.85	0.63	0.53	1.07
PMBWYC1203	11	4	8	15	20	MODERATE	0.2	loamy sand	0.055	0.85	0.88	0.75	1.49
PT3GNT1301	0	2	1	7	3	MODERATE	0.2	loamy sand	0.055	0.85	0.17	0.15	0.29
PT3GNT1404	0	0	0	0	0	NONE/LOW	0	loamy sand	0.055	0.85	0.00	0.00	0.00
										Subtotal	**15.80**	**13.43**	**26.86**
											tons/year	**lbs/year**	**lbs/year**

Gully Erosion

Site ID	Subbasin	Erosion Dimensions (ft) Width	Depth	Length	Years of Erosion	Severity	LRR (ft/yr)	Soil	Soil Weight (T/ft^3)	Correction Factor	Sediment Loading and 100% Reduction	Phosphorus (P) Loading and 100% Reduction	Nitrogen (N) Loading and 100% Reduction
PT3GNT1408	0	2.5	4	30	10	MODERATE	0.5	loamy sand	0.055	0.85	1.10	0.93	1.87
										Subtotal	**1.10**	**0.93**	**1.87**
											tons/year	**lbs/year**	**lbs/year**

Tile Outlet Erosion*

Site ID	Subbasin	Erosion Dimensions (ft) Width	Depth	Length	Years of Erosion	Severity	LRR (ft/yr)	Soil	Soil Weight (T/ft^3)	Correction Factor	Sediment Loading and 100% Reduction	Phosphorus (P) Loading and 100% Reduction	Nitrogen (N) Loading and 100% Reduction
PT3GNT1306	0	2.5	2.5	12	20	-	-	loamy sand	0.055	0.85	0.14	0.12	0.23
PT3GNT1308	0	1.5	1.5	2	20	-	-	loamy sand	0.055	0.85	0.01	0.01	0.01
										Subtotal	**0.15**	**0.12**	**0.25**
											tons/year	**lbs/year**	**lbs/year**

Urban/Residential Issue**

Site ID	Subbasin	Erosion Dimensions (ft)	Height	Length	Years of Erosion	Severity	LRR (ft/yr)	Soil	Soil Weight (T/ft^3)	Correction Factor	Sediment Loading and 100% Reduction	Phosphorus (P) Loading and 100% Reduction	Nitrogen (N) Loading and 100% Reduction
PMBWYC1204	11		7	5	15	MODERATE	0.2	loamy sand	0.055	0.85	0.39	0.33	0.65
PMBWYC1205	11		7	10	20	MODERATE	0.2	loamy sand	0.055	0.85	0.77	0.65	1.31
										Subtotal	**1.16**	**0.98**	**1.96**
											tons/year	**lbs/year**	**lbs/year**

Streambank Erosion

Site ID	Subbasin	Erosion Dimensions (ft)	Height	Length	Years of Erosion	Severity	LRR (ft/yr)	Soil	Soil Weight (T/ft^3)	Correction Factor	Sediment Loading and 100% Reduction	Phosphorus (P) Loading and 100% Reduction	Nitrogen (N) Loading and 100% Reduction
PMBGRC1202	11		4	10	20	SEVERE	0.5	loamy sand	0.055	0.85	1.10	0.94	1.87
PMBWYC1202	11		8	15	20	SEVERE	0.5	loamy sand	0.055	0.85	3.30	2.81	5.61
PT2GNT1409	0		3	8	10	SEVERE	0.5	loamy sand	0.055	0.85	0.66	0.56	1.12
PT3GNT1403	0		5	30	5	MODERATE	0.2	loamy sand	0.055	0.85	1.65	1.40	2.81
PT4WYC1203	11		5	20	5	SEVERE	0.5	loamy sand	0.055	0.85	2.75	2.34	4.68
PT4WYC1204	11		6	8	1	SEVERE	0.5	loamy sand	0.055	0.85	1.32	1.12	2.24
PT4WYC1303	11		2	4	7	MODERATE	0.2	loamy sand	0.055	0.85	0.09	0.07	0.15
PT4WYC1305	11		8	30	15	MODERATE	0.2	loamy sand	0.055	0.85	2.64	2.24	4.49
										Subtotal	**13.51**	**11.48**	**22.96**
										TOTAL	**31.71**	**26.95**	**53.90**
											tons/year	**lbs/year**	**lbs/year**

Notes:
*Calculated as Gully Erosion because dimensions are similar to that of gully erosion.
**Issue at both sites is an outlet that has caused streambank erosion. Calculated as a streambank erosion site.
1. Because three dimensions were given in Road/Stream Crossing and Tile Outlet Erosion field measurements, the equation for Rill and Gully Erosion was used (GEE).
2. Bottom Width of Gullies were not recorded in the field - used Top Width x 66% for average width.
3. Lateral Recession Rate used in Streambank Erosion is 0.5 ft/yr for Severe Erosion and 0.2 ft/yr for Moderate Erosion based on Figure 1 in "MDEQ Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual."
4. Soil Type as found in Kent County Soil Survey can be classified as loamy sand in the stream itself.
5. Soil Weight is found in Exhibit 1 of the MDEQ Training Manual.
6. Correction Factor is found in Exhibit 2 of the MDEQ Training Manual.
7. LRR = lateral recession rate.

Plaster Creek Pollutant Loading Calculations for Nonpoint Source Pollution Sites

ubbasin Summary

Subbasin 0	Acreage 2825	Sediment Load/Red.	P Load/Red.	N Load/Red.
Road Stream Crossing		0.17	0.15	0.29
Gully Erosion		1.10	0.93	1.87
Tile Outlet Erosion		0.15	0.12	0.25
Urban/Residential		0	0	0
Streambank Erosion		2.31	1.96	3.93
Total		**3.73**	**3.17**	**6.33**
		tons/year	**lbs/year**	**lbs/year**

Subbasin 3	Acreage 783	Sediment Load/Red.	P Load/Red.	N Load/Red.
Road Stream Crossing		0.63	0.53	1.07
Gully Erosion		0	0	0
Tile Outlet Erosion		0	0	0
Urban/Residential		0	0	0
Streambank Erosion		0	0	0
Total		**0.63**	**0.53**	**1.07**
		tons/year	**lbs/year**	**lbs/year**

Subbasin 11	Acreage 2802	Sediment Load/Red.	P Load/Red.	N Load/Red.
Road Stream Crossing		15.00	12.75	25.50
Gully Erosion		0	0	0
Tile Outlet Erosion		0	0	0
Urban/Residential		1.16	0.98	1.96
Streambank Erosion		11.20	9.52	19.04
Total		**27.35**	**23.25**	**46.50**
		tons/year	**lbs/year**	**lbs/year**

Watershed Summary

Watershed Acreage	36446
Sampled Acreage	6410

Sampled Subbasin Totals

	Sediment Load/Red.	P Load/Red.	N Load/Red.
Road Stream Crossing	15.80	13.43	26.86
Gully Erosion	1.10	0.93	1.87
Tile Outlet Erosion	0.15	0.12	0.25
Urban/Residential	1.16	0.98	1.96
Streambank Erosion	13.51	11.48	22.96
Totals	**31.71**	**26.95**	**53.90**
	tons/year	**lbs/year**	**lbs/year**

Extrapolated to Watershed

	Sediment Load/Red.	P Load/Red.	N Load/Red.
Road Stream Crossing	89.83	76.35	152.71
Gully Erosion	6.25	5.31	10.62
Tile Outlet Erosion	0.83	0.70	1.41
Urban/Residential	6.57	5.58	11.16
Streambank Erosion	76.80	65.28	130.57
Totals	**180.28**	**153.23**	**306.47**
	tons/year	**lbs/year**	**lbs/year**

Appendix 8

Activity:_____

Purpose:

Target Audience:

Theme:

Learning Objectives:

Behavioral Objectives:

Emotional Objectives:

Distribution:

Date Completed:

Budget:

Project Evaluation

- **Quantitative:**
- **External Qualitative:**
- **Internal Qualitative:**
- **Level of Success:**