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Grand River Assessment

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EXECUTIVE SUMMARY

This is one of a series of river assessments prepared by the Michigan Department of Natural Resources (MDNR), Fisheries Division for Michigan rivers. This report describes the physical and biological characteristics of the Grand River, discusses how human activities have influenced the river, and serves as an information base for future management of the river.

River assessments are prepared to provide a comprehensive reference for citizens and agency personnel who desire information about a particular aquatic resource. These assessments provide an approach to identifying fishery management opportunities and solving fishery related problems. This report describes the characteristics of the Grand River watershed and its biological communities in order to increase public awareness of the Grand River and its challenges and to promote a sense of public stewardship and advocacy for the resources of this watershed. The ultimate goal is to provide information to enable increased public involvement in the decision making process to benefit the river and its resources.

This document consists of four parts: an introduction, a river assessment, management options, and public comments (with our responses). The river assessment is the nucleus of the report. Within it, the characteristics of the Grand River and its watershed are described in twelve sections: geography, history, geology and hydrology, soils and land use, channel morphology, dams and barriers, water quality, special jurisdictions, biological communities, fishery management, recreational use, and citizen involvement.

The **Management Options** section of the report identifies a variety of challenges and opportunities. These management options are categorized and presented following the outline of the river assessment. It must be stressed that MDNR, Fisheries Division does not necessarily recommend the options listed. Rather, they are intended to provide a foundation for public discussions and comment.

The Grand River watershed is located in Michigan's southwestern Lower Peninsula and is the second largest river basin in Michigan with the Saginaw River watershed being the largest. The basin encompasses approximately 5,575 square miles and drains all or parts of Hillsdale, Jackson, Washtenaw, Livingston, Calhoun, Eaton, Ingham, Shiawassee, Gratiot, Clinton, Ionia, Montcalm, Mecosta, Barry, Allegan, Kent, Newaygo, Muskegon, and Ottawa counties. The Grand River main stem is 248 miles long, the longest river in the state, and drains a catchment that is 135 miles long and 70 miles wide. Within the watershed there are 5,320 miles of tributaries, ranging in size from first to fifth order. Major tributaries include the Portage River, Red Cedar River, Looking Glass River, Maple River, Flat River, Thornapple River, Rogue River and Bass River. There are 581 lakes greater than 10 acres within the basin. Spring Lake is the largest lake with a surface area of 1,097 acres.

In order to characterize the biological and physical attributes of the catchment, the Grand River main stem is divided into five sections called main-stem valley segments. Main-stem valley segments represent portions of a river that share common channel and landscape features and were identified using major changes in hydrology, channel and valley shapes, land cover, and surficial geology. The headwater segment begins at the main stem origin and extends 54 miles to a point upstream of the confluence with Sandstone Creek in north-central Jackson County. The upper segment includes the Sandstone Creek confluence and flows through Eaton Rapids and Dimondale. The upper segment includes 42 main stem miles and ends upstream of the Red Cedar River confluence. The middle segment is 60 miles long and extends downstream to the confluence with the Maple River near the villages of Muir and Lyons. Two large tributaries, the Red Cedar and Looking Glass Rivers, join the main stem in this segment. The main stem here is characterized as a large, warm water river and is impounded by six dams. The lower segment begins with the confluence of the Maple River. The lower segment is confined in a glacial-fluvial valley formed approximately 14,000 years ago when the Maple-Grand River drained glacial Lake Saginaw into glacial Lake Chicago. The lower segment is the largest and includes drainage from the Maple, Flat, Thornapple, and Rogue rivers. The mouth segment begins near the Village of Lamont and continues across glacial lake plain the remaining 25 miles to the confluence with Lake Michigan.

The history of the watershed can be traced back as far as the Paleo-Indians 12,000 to 8000 years ago. Several Paleo-Indian archaeological sites are located throughout the basin. During the Late-Archaic (8,000–6,000 years ago), hunting and fishing for subsistence was the way of life, and Indian communities were drawn to the Grand River area for its natural resources. Hunting and fishing camps were common in the watershed. The first European settlers in the area arrived in 1650 and established trading posts near tribal villages. The first logging operations began in the mid-1800s. The abundant and diverse forests within the watershed provided lumber for homes and led to the development of the furniture industry in Grand Rapids. The river from Grand Haven to Lyons served as a main thoroughfare for commerce and communications. Barges and riverboats traveled the channel until the development of the railroad.

The hydrology of the Grand River watershed is influenced by climate, surficial geology, soil types and land use. Climate in the watershed is determined by latitude, differences in land-surface altitude, and moderating effects of the Great Lakes. Mean precipitation is about 31 inches, whereas annual snowfall is highly dependent on proximity to Lake Michigan and can range from as low as 30 inches to over 100 inches. Surficial geology is varied and ranges from coarse-textured end moraine and ice contact topography to glacial lake plains. In some portions of the watershed glacial tills and deposits are several hundred feet thick while other areas are characterized by exposed bedrock. Coarse-textured soils are more permeable and allow for higher rates of infiltration and groundwater recharge. Watersheds with these soil types, coupled with intact, well-vegetated landscapes, are typically characterized as having higher stream flow stability. Conversely, fine-textured soils are less well drained and promote surface runoff. Streams draining catchments dominated by clays and other fine textured soils have a higher overland flow component and tend exhibit less stable flow patterns. Stream channel alterations, filling and draining of wetlands, installation of drainage networks for agriculture and urban development also contribute to stream flow instability.

Soil and land-use are, in part, controlling factors in water movement through the river basin. Soils develop over thousands of year as a result of the weathering of glacial parent materials. In general, minimally disrupted watersheds with intact vegetative cover have higher infiltration rates and less soil loss due to erosion associated with surface runoff. Changes within the land use and land cover can have dramatic effects on the channel shape. Soil groups in the Grand River watershed are widely distributed and are largely characterized as having moderately low runoff potential. Soil types with low runoff potential comprise 18% of the watershed, whereas soils with high runoff potential comprise 14%. Presettlement land cover in the watershed was primarily beech-maple, mixed oak, and coniferous forests. Forested wetlands, shrub-swamp/emergent wetland, wet prairie and open water accounted for approximately 18% of the presettlement land cover. Contemporary land use is dominated by agriculture (57%); forested land cover has been reduced to 25% and wetlands reduced by over 50%. Urban land use accounts for 9% of the current landscape. Runoff from impervious surfaces associated with large urban areas (Jackson, Lansing, and Grand Rapids) represents a threat to the quality of surface water and groundwater resources. Continued increases in impervious surfaces dramatically decreases groundwater recharge and significantly alters the timing and volume of storm water delivered to stream channels. There are over 8,600 road stream crossings in the Grand River watershed. Improper design and construction of bridges and culverts at stream crossings can result in disruption of water and sediment transport, limit movements of fish and other aquatic life, and serve as a pathway for the discharge of nonpoint source pollutants.

Channel slope or gradient is an important factor in the development of channel form and habitat characteristics of a river. Areas of higher gradient typically support more diverse and abundant populations of aquatic organisms. The elevation of the Grand River main stem drops 551.9 feet from 1130.7 feet above sea level at the headwaters to 578.8 feet above sea level at the mouth. The average gradient of the Grand River main stem is 2.2 feet/mile with a maximum of 5.48 feet/mile near the former rapids in Grand Rapids. The higher quality habitats located in the middle segment have been eliminated by the construction of six dams. These dams and their impoundments have eliminated and/or fragmented some of the best pool and riffle habitat on the main stem.

In addition to channel gradient, channel cross section can be a useful measure of habitat quality. Natural channels typically provide better habitat than those that have been manipulated by channelization or degraded by altered hydrology. Expectations of habitat diversity can be made based on an analysis of channel cross section and stream discharge. Stream channels that deviate from the expected channel dimensions may have unstable flow patterns or otherwise altered channel morphology. Channel cross sections of the Grand River fall within the expected range at average flow. However, channel cross sections are too narrow at high flow and too wide at low flow. Several miles of tributaries in the Grand River watershed do not support minimally acceptable fish and aquatic macroinvertebrate communities as a result of channelization or altered hydrology due to expansion of drainage areas through field tiling and construction of storm sewers.

There are 228 dams in the Grand River watershed registered with Michigan Department of Environmental Quality. Dams alter sediment and nutrient transport, change concentrations of dissolved gases, alter flow patterns and flood frequencies, and cause warming of downstream river habitat. Dams fragment river systems and turn high gradient river habitat into slow flowing habitat more typical of a shallow lake. Dams are typically constructed in areas of highest stream gradient which are essential habitats for flow oriented (rheophilic) fish species. These high gradient areas also provide critical spawning and feeding habitats for several other species of fish. Although fish ladders provide passage for some potamodromous fish species such as salmon and steelhead, dams on the Grand River main stem block the movements of lake sturgeon and several other species of fish. Dams located in the lower portions of the Rogue, Flat, and Thornapple Rivers block spawning runs and isolate fish populations. Fish mortality or injury often results when fish pass through or over dams, especially those with hydroelectric turbines. Many dams in the watershed serve as water level control structures designed to keep inland lakes at static levels. These structures disrupt seasonal flow patterns and alter the integrity of the lake ecosystem.

Point source water pollution from industrial and municipal sources in the watershed has decreased significantly since the implementation of the Federal Water Pollution Control Act. Historically, the river received improperly treated wastewater from a variety of industrial and municipal sources. These discharges significantly reduced water quality and resulted in the loss of pollution-sensitive aquatic species. Prior to the enactment of stringent water quality standards, the Grand River fish community was dominated by pollution-tolerant fish species. Currently, most point sources have adequate pollution controls and are in compliance with Michigan water quality standards. Water quality impairments that remain are related to exceedences of dissolved oxygen and bacteria standards. Reconstruction of sanitary wastewater collection systems is necessary in the larger urban areas to eliminate the discharge of untreated wastewater through combined sewer and sanitary sewer overflows.

Nonpoint source pollution is the greatest factor that degrades water quality. This type of pollution enters the water from atmospheric deposition and surface runoff and generally consists of sediment, nutrients, bacteria, organic chemicals, and inorganic chemicals from agricultural fields, livestock feedlots, construction sites, parking lots, urban streets, septic seepage, and open dumps. Implementing best management practices with farmland, construction sites, and urban development designs can significantly reduce runoff, erosion, and influxes of sediment, nutrients, and other chemicals into lakes and streams.

The Grand River catchment contains several unique and rare plant communities ranging from dry mesic southern forest to southern floodplain forest to interdunal wetlands. These plant communities represent remnants of the presettlement landscape and are rich in biodiversity. These communities provide critical habitats for numerous vertebrate and invertebrate species of conservation interest including several that are identified as endangered, threatened, or of special concern.

The watershed currently supports 107 species of fish, 14 of which are present through direct or indirect introduction. The fish community includes several species of conservation interest including the lake sturgeon, river redhorse, and cisco, which are identified as threatened, and the pugnose shiner, which is endangered. One fish species has been extirpated. The weed shiner was known from few locations in the watershed and was last reported in 1941. American eel were stocked in several lakes and streams in the watershed during the late-1800s as a food fish; however, no records of survival exist. This species gains access to the upper Great Lakes via the Welland Canal and is found infrequently in the Grand River watershed. Introduced aquatic pest species reported in the watershed include: common carp, round goby, sea lamprey, zebra mussel, curly leaf pondweed and Eurasian water milfoil. These species have had negative effects on the ecology of the waters where they have become established. Floodplain forests and nearshore environments have been significantly altered as a result of the introduction of terrestrial exotics such as the emerald ash borer, Dutch elm disease, garlic mustard, phragmites and purple loosestrife. These changes are transferred to the aquatic ecosystem in the form of reduced productivity and altered habitat.

Fishery management of the Grand River watershed began in the 1800's when the waters were initially surveyed by the Michigan Fish Commission. Direct manipulation of fish populations through species introduction or augmentation were common management actions for several decades. These actions occurred regardless of the temperature and habitat needs of the individual species. Stocked fishes include trouts and salmon, panfish, walleye, and northern pike. As fisheries science progressed, changes in management philosophies led to a reduction in the numbers and species of fish being stocked. Contemporary fisheries management in the Grand River watershed is guided by knowledge of the attributes of the individual lake and stream, emphasizing habitat protection and restoration with a goal of self-sustaining populations. The watershed supports significant and economically valuable warmwater and coldwater fisheries that are protected by managing harvest through size and creel limits. Current stocking programs in the watershed provide recreational fishing opportunities on the main stem, tributaries, inland lakes, and Lake Michigan.

Recreational use of the river main stem is highest in the middle, lower, and mouth segments. These areas are open to the passage of Lake Michigan salmon and steelhead and receive more angling pressure. There are numerous coldwater tributaries in the lower segment that support popular fisheries for brown trout, brook trout, and steelhead. Diverse warm water fisheries for walleye, smallmouth and largemouth bass, northern pike, panfish, and channel and flathead catfish are found on the main stem, tributaries and inland lakes. Public access to these waters is assured through many boating and public water access sites, state game areas, and numerous publicly owned parks. Other recreational activities associated with state owned lands within the watershed include hunting, camping, boating and canoeing, swimming, hiking and biking, and nature observation. Future increases in public access will likely be necessary to meet the future demands of the population centers of Jackson, Lansing, Grand Rapids and Grand Haven.

Historical pollution as well as the current discharges from the remaining combined sewer overflows has left the Grand River with a reputation of being polluted. Although this was an accurate description of the past, the river has recovered and currently supports a diverse aquatic community. The natural resources in the Grand River catchment are substantial and provide millions of dollars of recreation-based revenue to the residents of the watershed. Several community action groups and organizations work throughout the watershed to improve habitat and provide educational outreach toward protection of aquatic resources. Citizen involvement through these local initiatives is critical in making necessary changes in planning and zoning and to ensure that habitat protection, improvement of water quality and enhancement of recreational opportunities continues.

Michigan Department of Natural Resources
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GRAND RIVER ASSESSMENT

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INTRODUCTION

This river assessment is one of a series of documents being prepared by the Michigan Department of Natural Resources (MDNR), Fisheries Division, for rivers in Michigan. We have approached this assessment from an ecosystem perspective, as we believe that fish communities and fisheries must be viewed as parts of a complex ecosystem. Our approach is consistent with the mission of MDNR, Fisheries Division, namely to "protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for benefit of the people of Michigan".

As stated in the Fisheries Division Strategic Plan, our aim is to develop a better understanding of the structure and functions of various aquatic ecosystems, to appreciate their history, and to understand changes to systems. Using this knowledge, we will identify opportunities that provide and protect sustainable aquatic benefits while maintaining, and at times rehabilitating, system structures or processes.

Healthy aquatic ecosystems have communities that are resilient to disturbance, are stable through time, and provide many important environmental functions. As system structures and processes are altered in watersheds, overall complexity decreases. This results in a simplified ecosystem that is less able to adapt to additional change. All of Michigan's rivers have lost some complexity due to human alterations in the channel and on surrounding land. Therefore, each assessment focuses on ecosystem maintenance and rehabilitation. Maintenance involves either slowing or preventing losses of ecosystem structures and processes. Rehabilitation is putting back some of the original structures or processes.

River assessments are based on ten guiding principles in the Fisheries Division Strategic Plan. These are: 1) recognize the limits on productivity in the ecosystem; 2) preserve and rehabilitate fish habitat; 3) preserve native species; 4) recognize naturalized species; 5) enhance natural reproduction of native and desirable naturalized fishes; 6) prevent the unintentional introduction of invasive species; 7) protect and enhance threatened and endangered species; 8) acknowledge the role of stocked fish; 9) adopt the genetic stock concept, that is protecting the genetic variation of fish stocks; and 10) recognize that fisheries are an important cultural heritage.

River assessments provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement in management decisions, allowing citizens to learn, participate, and help direct decisions. They also provide an organized reference for Fisheries Division personnel, other agencies, and citizens who need information about a particular aspect of the river system.

The nucleus of each assessment is a description of the river and its watershed, using a standard list of important ecosystem components. These include:

Geography–a brief description of the location of the river and its watershed; a general overview of the river from its headwaters to its mouth, including topography. This section sets the scene.

History–a description of the river as seen by early settlers and a history of human uses and modifications of the river and watershed.

Geology–a description of both the surficial and bedrock geology of the area.

Hydrology–patterns of water flow, over and through a landscape. This is the key to the character of a river. River flows reflect watershed conditions and influence temperature regimes and habitat characteristics.

Soils and Land Use Patterns–soils and land use in combination with climate determine much of the hydrology and thus the channel form of a river. Changes in land use often drive change in river habitats.

Channel Morphology–the shape of a river channel: width, depth, and sinuosity. River channels are often thought of as fixed, apart from changes made by people. However, river channels are dynamic, constantly changing as they are worked on by the unending, powerful flow of water. Diversity of channel form affects habitat available to fish and other aquatic life.

Dams and Barriers–affect almost all river ecosystem functions and processes, including flow patterns, water temperature, sediment transport, animal drift and migration, and recreational opportunities.

Water Quality–includes temperature, and dissolved or suspended materials. Temperature and a variety of chemical constituents can affect aquatic life and river uses. Degraded water quality may be reflected in simplified biological communities, restrictions on river use, and reduced fishery productivity. Water quality problems may be due to point-source discharges (permitted or illegal) or to nonpoint-source runoff.

Special Jurisdictions–stewardship and regulatory responsibilities under which a river is managed.

Biological Communities–species present historically and today, in and near the river; we focus on fishes, however associated mussels, mammals and birds, key invertebrate animals, special concern, threatened and endangered species, and pest species are described where possible. This component is the foundation for the rest of the assessment. Maintenance of biodiversity is an important goal of natural resource management. Species occurrence, extirpation, and distribution are important clues to the character and location of habitat problems.

Fishery Management–goals are to provide diverse and sustainable game fish populations. Methods include management of fish habitat and fish populations.

Recreational Use–types and patterns of use. A healthy river system provides abundant opportunities for diverse recreational activities along its main stem and tributaries.

Citizen Involvement–an important indication of public views of the river. Issues that citizens are involved in may indicate opportunities and problems that Fisheries Division or other agencies should address.

Throughout this assessment we use data and shape files downloaded from the Michigan Geographic Data Library, maintained by the Michigan Center for Geographic Information (MDNR 2004). These data provide measures of watershed surface area for numerous categories (e.g., soil types, land use, surficial geology), measures of distance (e.g., stream lengths), and creation of associated figures. We used Arc View GIS 3.2a or Arc GIS (Environmental Systems Research Institute, Inc.; Copyright) to display and analyze these data, and create the landscape figures presented in this report. Unless otherwise referenced, all such measures and associated figures reported within the sections of this report were derived from these data.

Management options follow the river assessment sections of this report, and list alternative actions that will protect, rehabilitate, and enhance the integrity of the river system. These options are intended to provide a foundation for discussion, setting priorities, and planning the future of the river system. Identified options are consistent with the mission statement of Fisheries Division.

Copies of the draft assessment were distributed for public review beginning November 23, 2011. Three public meetings were held: Windsor Township Emergency Services Building, Dimondale on December 15, 2011, 11 people attended; Jackson District Library-Carnegie Branch, Jackson on December 21, 2011, 3 people attended; and Plainfield Charter Township Hall, Grand Rapids on December 28, 2011, 27 people attended. Written comments were received through January 15, 2012. Comments were responded to in the **Public Comment and Response** section.

A fisheries management plan will now be written. This plan will identify options chosen by Fisheries Division, based on our analysis and comments received. In general, a Fisheries Division management plan will focus on a shorter time, include options within the authority of Fisheries Division, and be adaptive.

Individuals who review this assessment and wish to comment should do so in writing to:

Michigan Department of Natural Resources
Fisheries Division, Southern Lake Michigan Management Unit
Plainwell Operations Service Center
621 N. 10th St.
Plainwell, MI 49080

Comments received will be considered in preparing future updates of the Grand River Assessment.

RIVER ASSESSMENT

Geography

The Grand River watershed is located in the southwestern portion of Michigan's Lower Peninsula and is the state's second largest river basin. The basin encompasses approximately 5,575 square miles and drains all or portions of Hillsdale, Jackson, Washtenaw, Livingston, Calhoun, Eaton, Ingham, Shiawassee, Gratiot, Clinton, Ionia, Montcalm, Mecosta, Barry, Allegan, Kent, Newaygo, Muskegon, and Ottawa counties. This area comprises 13% of the entire Lake Michigan drainage basin. The Grand River main stem is approximately 248 miles long, the longest river in the state, and drains a catchment that is 135 miles long and up to 70 miles wide. The river origin is a series of lakes in northeastern Hillsdale and southern Jackson counties. Beginning at an elevation of 1,130.7 feet above sea level, the main stem flows in a generally northwesterly arc through the cities of Jackson, Eaton Rapids, Lansing, Ionia, Grand Rapids, and Grand Haven to its confluence with Lake Michigan where the elevation is approximately 578 feet above sea level. Tributaries to the main stem range from first to fifth order and add an additional 5,320 stream miles (Zorn et al. 2008). The watershed includes several significant tributaries including the Portage, Red Cedar, Looking Glass, Maple, Flat, Thornapple, and Rogue rivers (Figure 1).

There are 581 lakes greater than 10 acres within the basin (Table 1). Five hundred three have a surface area between 10 and 100 acres, 51 have a surface area between 100 and 250 acres, 23 have a surface area between 250 and 500 acres and 4 are greater than 500 acres in size. The largest inland lake in the watershed is Spring Lake, Ottawa County, with a surface area of 1,097 acres.

The physical and biological characteristics of the Grand River watershed vary considerably from its headwaters to mouth. Therefore, the main stem was divided into five sections, or main-stem valley segments, which are described below and delineated in Figure 2. These valley segments were determined using the ecological classification system described by Seelbach et al. 1997. Each valley segment represents sections of the Grand River main stem with similar characteristics such as land cover, hydrology, channel and valley shape, and surficial geology; and these provide a useful framework for discussing the attributes of the river system. However, these similar characteristics often do not apply to the tributaries within a valley segment. For example, there are numerous cases where small first order streams that support coldwater species enter the Grand River main stem at a location characterized as warm water. The five main-stem segments are:

Headwaters

The headwaters segment is 48 miles long and originates from a chain-of-lakes in northeastern Hillsdale and southern Jackson counties that include: Lake Le Ann, Perch Lake, Crystal Lake, Mirror Lake, and Grand Lake. Downstream of these headwater lakes the main stem is also impounded by the Liberty dam. The river flows north through Vandercook Lake and through the City of Jackson. The North Branch of the Grand River joins the main stem in the City of Jackson. The Portage River is the first major tributary and joins the main stem just north of Jackson, after which the main stem turns west just before the junction with Perry Creek. This section drains rolling glacial till topography with numerous lakes in the headwaters area and flows through an area of low topographic relief with numerous swamps in the vicinity of Jackson.

Upper River Segment

This segment begins at Perry Creek and contains 47 main-stem river miles. Main-stem tributaries in this segment include Sandstone Creek, Spring Brook, Columbia Creek, and Silver Creek. The main stem is impounded by the Smithville dam upstream of Eaton Rapids and the by State Street dam within the City of Eaton Rapids. This segment is also the location of the former Wilson Dam near the Village of Dimondale. The downstream portion is impounded again by the Moores Park dam before flowing into the City of Lansing and reaching the junction with the Red Cedar River.

Middle River Segment

This segment extends 60 miles from the confluence of the Red Cedar River to the Maple River confluence near the Village of Muir. The gradient in this portion of the river begins to increase as evidenced by the five main-stem dams (North Lansing, Grand Ledge, Portland, Webber, and Lyons) that are located in this segment. The Red Cedar and Looking Glass rivers join the main stem within this segment. Evidence of increased groundwater inputs occurs in this valley segment as Sebewa Creek, a designated trout stream, enters the main stem. The landscape draining to this segment is characterized as a gently rolling topography with low hills and shallow valleys. The river flows through and over prominent bedrock outcrops near the City of Grand Ledge.

Lower River Segment

The lower valley segment includes approximately 70 main-stem miles and is confined within the broad and flat valley of the glacial Maple-Grand channel. Significant large tributaries including the Maple, Flat, Thornapple, and Rogue rivers join the main stem in this segment. In addition, numerous smaller (first and second order), cold and cold-transitional tributaries join the main stem throughout this segment.

The Maple River drains a portion of the Saginaw Bay Lake Plain which has little relief and is characterized as sand-clay lacustrine plain. Much of this watershed has been modified through channelization to promote drainage of extensive agricultural lands.

The greatest relief in the Grand River catchment occurs in this valley segment. The Flat, Rogue, and Prairie Creek basins all join the main stem from the north. This area has some more rugged relief features with rolling hills and highlands standing above deep valleys. The southern part of the area has deeply entrenched valleys with steep, well drained slopes as each of the streams incise in order to reach the lower elevation of the Grand River main stem. Some hills in this segment reach as high as 275 feet above the Grand River. These characteristics result in relatively low gradient tributaries that drain flat headwater areas containing numerous lakes, swamps, and marshes; and then become relatively fast-flowing, steeper-gradient streams as they encounter the steep walls of the former glacial valleys.

The Thornapple River is the largest tributary to join the main stem from the south. The upper part of the Thornapple basin has less relief and more areas of flat to gently rolling land with only a few lakes. The soils and glacial sediments in this portion of the Thornapple basin contain more clay and silt than the lower section. The exception to this is the extreme eastern part which is well drained. The lower part of the Thornapple basin is characterized as having more relief and contains numerous lakes and wetlands.

The river main stem drops significantly in the vicinity of the City of Grand Rapids. This is the location of the former rapids where the river cascaded over limestone bedrock sills for a distance of over a mile.

Mouth

The mouth segment begins near the Village of Lamont and continues the remaining 23 miles to the confluence with Lake Michigan. In this segment the main stem flows through glacial lake plain. The channel widens and has numerous bayous, particularly downstream of the Bass River confluence. Downstream of Stearns Bayou, the main stem splits into multiple channels and becomes braided as it nears the Grand Haven-Spring Lake area. A navigational channel is maintained by the Corps of

Engineers from the Bass River downstream to the outlet at Grand Haven. The Bass River, Crockery Creek, Deer Creek and Spring Lake outlet are the largest tributaries in this section.

History

The glacial Grand River was formed towards the end of the Pleistocene era, 14,000 years ago. The late stages of Lake Maumee, an early form of lakes Huron and Erie, drained north through the Imlay City Outlet and then west through the Glacial Grand River into Lake Chicago (Farrand 1988). Subsequent glacial advances and retreats formed other lake basins which also flowed westward across the "Thumb" area and then through the Glacial Grand River (see **Geology**).

About 1,800 archaeological sites have been reported in the Grand River drainage (Table 2; B. Mead, Michigan State Housing Development Authority (MSHDA), Office of the State Archaeologist, personal communication). The earliest record of human habitation in the state of Michigan dates back to the Paleo-Indians of approximately 12,000 B.C. to 8,000 B.C. They are believed to have traveled north, following the recession of the glaciers (Clifton et al. 1986). Knowledge of these people is scant, but it is believed that they traveled in small groups and lived by hunting and gathering. Most Paleo-Indian archaeological sites are located on the beaches and knolls along glacial Lake Algonquin (Cleland 1992). The Paleo-Indian's distinctive fluted spear points have been found throughout the southern two-thirds of the Lower Peninsula (B. Mead, Department of State, Office of the State Archaeologist, personal communication).

> In the Grand River region, mastodon bones dating to 1,000 years ago have been found in Ingham and Montcalm counties. Some bones show evidence of human butchering. Fluted spear points have been found here and there; these were probably hunting losses. Excavations at the Leavitt site in Clinton County showed that people camped long enough there to make stone tools and work hides for tents and clothing. Forty-eight Paleo-Indian sites have been investigated in the Grand River drainage." (B. Mead, MSHDA, Office of the State Archaeologist, personal communication).

The Archaic period occurred from 8,000 to 1,000 B.C. During this period, climate in the Great Lakes region became warmer and drier. Thus it is divided into three subperiods: early, middle, and late. People of the Early Archaic period, from 8,000 B.C. to 6,000 B.C., hunted moose, caribou, deer and bear. In southern Michigan, hardwood trees began to replace conifers during the Middle Archaic period of 6,000 B.C. to 3,000 B.C., and nuts, berries, and fish became important parts of the diet. It was during this time that people started to form more permanent villages along the Lake Michigan shores (Clifton et al. 1986). These communities became larger and more stable during the Late Archaic period of 3,000 B.C. to 1,000 B.C. They also apparently began to trade with groups of people in other regions. Copper from Michigan appears at many Late Archaic period sites in the eastern United States and Canada, and items made from Gulf of Mexico shells have been found at sites in the Great Lakes area (Clifton et al. 1986; Cleland 1992). During the Late Archaic, hunting and fishing for subsistence continued to be a way of life in northern areas with short growing seasons. Spears were used to take sturgeon, pike, and suckers in the shallow waters of lakes and streams, while fishhooks and gorges made from copper or bone were probably used from boats or fishing through the ice (Cleland 1982). In addition to hunting and fishing, in what is now southern Michigan, local plants were harvested for additional sources of sustenance. This eventually led to the development of agriculture in the southern parts of the Great Lakes, including the Grand River basin (Clifton et al. 1986). The total number of Early and Middle Archaic sites in the Grand River drainage is 68 and the number of Late Archaic sites is 92 (B. Mead, MSHDA, Office of the State Archaeologist, personal communication).

The Woodland Period occurred from 1,000 B.C. until the first Europeans arrived in 1650 A.D. There are a total of 238 Woodland-era sites in the Grand River watershed (B. Mead, MSHDA, Office of the

State Archaeologist, personal communication). It was during this time period that crops like squash and sunflowers were first cultivated, and ceramic pots to store these new foods were developed. The Hopewell Indians, also known as the mound builders, began moving into the southern part of lower Michigan around 100 B.C. (Clifton et al. 1986). The burial mounds that they constructed are still present in many areas, including the lower Grand River watershed. Artifacts found in these burial mounds document the animal species that were present and utilized by the Hopewells. Items found in the Norton mounds near Grand Rapids include spoons made from mussel shells (e.g., pocketbook, fat mucket and spike), bowls made from turtle shells (usually Blanding's turtle) and pins made from the bones of animals such as elk and deer. The most common items not native to the area were dippers, or cups, made from conch shells imported from the Gulf Coast (Griffin et al. 1970; Kingsley 1999).

Residents of the Woodland Period moved seasonally as food was available. The river valley margins provided nuts and acorns from oak-hickory forests in the fall and deer during the fall and winter. Waterfowl were hunted during the peak migrations in the spring and fall. Floodplain lakes were a good source of fish when during spring spawning runs, they were trapped as spring floodwaters receded. High-yielding seed plants such as lambs-quarters, sumpweed, and knotweed were harvested and possibly planted as crops (Kingsley 1999). Eventually, more species of plants were domesticated and adapted to more northern climates. Corn, beans, and squashes became more common in areas that had at least 140 frost-free growing days (Tanner et al. 1987). The entire Grand River watershed is within that range; thus, due to suitable climate and soil types, the cultivation of crops has sustained human settlements since earliest times (see **Climate**).

By the time the first Europeans arrived in the Grand River watershed, there were numerous villages occupied by various tribes of the Anishnabeg people: Potawatami in the southern portion, Chippewa or Ojibwe in the east, and Ottawa in the west. There were more than 3,000 apple trees and almost 2,500 acres of corn and vegetable crops in the Grand River valley. The main villages on the lower Grand were Nowaquakezick's (Noon Day's) at the current location of downtown Grand Rapids, and Mukatasha's (Blackskin's) which was a few miles to the south at the foot of the former rapids. Present-day Lyons was the site of another important village, that of Coocoosh, a shortened version of Muckatycoocoosh (Black Hog). Muckatycoocoosh was a child captured during the War of 1812 who grew up to be a respected leader of the local Ojibwa and Ottawa (Tanner et al. 1987).

The river was originally named Owashtenong (far away water or long flowing river) by the Anishnabeg people (Chrysler 1975). The early French explorers mapped the area in 1688 and called the river "Grande Riu, Ou Riu De Sakinand", or the Grand River to the Saginaw River. Their maps show the "Portage de Sakinand", a route that connected the Saginaw River system to the Grand by way of a short portage from the South Branch Bad River to the Maple River. Another portage route was established between the Big and Little Portage Lake chain northeast of Jackson through the Portage Lake Swamp to the "R.aux Ours," the current-day Huron River (Woodruff 2006, USACE 1972). Early English maps referred to the Grand as "Great River", a translation of the French "grande" (Lillie 1931).

The first European settlers in the watershed established trading posts near tribal villages. These settlements relied on the river for the transport of goods from lakes Huron and Erie via the portages on the Shiawassee and Huron rivers. Trading posts were operating on the Grand River as early as 1742. They traded cooking pots, cloth, and beads for fish, game, and furs (Kent County Library Staff 1975). Missionaries followed the fur traders inland and established the first mission at the rapids in 1824. Settlement of the Grand River watershed did not begin in earnest until land surveys were completed by the General Land Office during the 1820s and early 1830s (Comer 1996). Growth was rapid in the 1830s with settlements along the river main stem being established at Jackson, Onondaga, Eaton Rapids, Lyons, Ionia, Saranac, Grand Rapids, Grandville, and Grand Haven. These settlements were established just prior to the logging era- the most dramatic transformation of the Michigan landscape since the last glaciation (Comer 1996).

Prior to the construction of the railroads, the Grand River from Jackson to Grand Haven was the main thoroughfare for transportation and communication between settlements. Pole boats and river steamers became important means of transporting finished lumber, supplies, and people. River landings varied from large urban centers of Grand Rapids or Grand Haven to small settlements built around sawmills or a group of farms. The steamers were generally side-wheelers with shallow drafts of around fourteen inches that allowed them to navigate over sandbars and other hidden obstructions.

To promote navigational use, alterations to the Grand River channel began as early as 1836 when the settlers began to clear the "floodwood" blockage downstream of Jackson (DeLand 1903). In 1837, representatives of the Grand River region succeeded in passing a bill authorizing the survey for a canal route to unite Saginaw Bay with the navigable waters of the Maple or Grand River.

> The report of the survey was regarded as exceedingly favorable, showing the existence of a remarkable valley or depression, extending westward from the waters of the Saginaw to those of the Maple; that these waters flowing in opposite directions, were only three miles distant from each other at one point, and that between them the highest elevation necessary to be crossed was only seventy two feet above Lake Michigan. It was along this valley and across this low summit that the engineer located the route of the canal, which with certain slack water improvements to be made to the east and west of it, on the Bad, the Maple, and the Grand Rivers, was to open a line of uninterrupted navigation between Lake Michigan and Saginaw Bay, and to bring prosperity to all the country contiguous to it (Ellis 1880).

Construction of the proposed canal began in 1838 and continued for nearly a year, when work was suspended due to the state's failure to pay the contractors. A decade after the construction had been abandoned, the canal project was revived when the legislature appointed the Saginaw and Grand River Canal Company to complete the project. However, no further work was ever completed, and the project was officially abandoned in 1849 (Ellis 1880).

During the legislative session of 1838, thirty thousand dollars was appropriated for the improvement of the Grand and Maple Rivers and was applied to "improving the harbor at Grand Rapids, clearing out the river channel at Monroe Street, and removing the sunken logs all the way up the river to Lyons" (Baxter 1891). In 1847, the state legislature "enacted that the supervisors of the County of Kent be authorized to construct a canal, with sufficient locks for the passage of boats and other watercraft, around the rapids of the Grand River at Grand Rapids" (Chrysler 1975). Although the locks were never completed, from this account and others (Baxter 1891; Grimsley 1904), it appears the river bed excavation associated with this project hastened the removal of the river rapids.

Periodic state and federal appropriations allowed for additional improvements of the Grand River channel from Grand Haven to Grand Rapids. Dredging of a four-foot deep channel downstream of Grand Rapids was authorized by the River and Harbor Act of 1881 to more readily accommodate the steamers. By 1886, a 60-foot wide and four and a half-foot deep channel had been dredged 11 and one-quarter miles below Grand Rapids. However, this channel was not considered permanent, and no further appropriations were made for maintenance. An 1887 report concluded that because of the extreme range between high and low water stages and the tendency of the river bottom materials to create shoals, a deep-water connection between Grand Haven and Grand Rapids was not possible within the banks of the river. A canal using river water was proposed but never undertaken. Siltation of the river continued to be a problem, so when steamboat traffic had ceased, Congress adopted the River and Harbor Act of 1930 and officially abandoned the Grand River above the Bass River mouth for any commercial navigation (USACE 1977). Below the Bass River mouth, a navigational channel is still maintained at an eight-foot depth.

In addition to transportation, the river and tributaries provided a source of power for sawmills and grist mills. Construction of dams and mills on the main stem and tributaries began shortly after the arrival of the first settlers, and by the mid-1830s there were several dams throughout the watershed. In this era before steam-powered machinery, water powered these mills, and dams and canals or mill races were built to harness this source of power. For example, the original Sixth Street Dam was constructed to divert the flow of water to several mills that were located on east and west side canals. Milling operations were regionally significant; in the 1860s and 1870s flour milled in Grand Rapids was shipped down river and on to Chicago and by rail to Detroit for distribution over the eastern half of the United States. Such dams and canals were built not only on the main stem but also on many of the tributaries and were often the sites of early pioneer settlements (see **Dams and Barriers**).

The first logging operations started in the mid-1830s, and after the Civil War, as much as 50 million board feet of logs were being floated down the Grand River each year. Tributaries such as the Rogue, Flat, and Maple rivers sustained local mills and also contributed timber to the sawmills in Grand Rapids and Grand Haven (Olson 1992). Originally, the first settlers used the standing timber as building material for their own homes or for firewood. As the population centers grew, the demand for lumber increased. New England furniture makers started moving to Michigan in greater numbers during the 1830s and ‘40s, drawn by what appeared to be an endless supply of lumber. By this time, much of the hardwood forests in New England had already been harvested, yet 95 percent of Michigan, or thirty-five million acres, was still covered by virgin forests. The Grand River basin was ideally located for furniture builders since the presettlement vegetation of the region was dominated by vast white pine forests in the north and hardwoods such as walnut, oak, maple, ash and cherry to the south. The white pine provided the material for building infrastructure such as houses, railroad ties and telegraph poles, while the hardwoods were sought after by the furniture makers (Carron 1998).

Logs were stamped with the brand of their owner and then set afloat to drift downstream to the various mills. During the peak decades of the 1870s and 1880s, more than two billion board feet of timber passed through Grand Rapids on its way to mills either in Grand Rapids or Grand Haven. Nearly 750 million board feet of lumber was cut by Grand Rapids sawmills and furniture companies during those two decades (Mapes and Travis 1976). By 1885, the lumber output from the mills began to decline, and by 1892, the pine forests of the Grand River had been essentially cleared (Moore 1915).

In addition to the timber industry, there were other industries that utilized the Grand River’s resources. A scythe stone factory was built on the banks of the river between Jackson and Lansing in 1843. It sharpened the haying scythes used by farmers. Sandstone for the factory was quarried from the natural ledges along the river and floated down to the factory on a flat-bottomed boat (Huggler 1990). In Grand Rapids, limestone was quarried from the river rapids for use in the construction of homes and for curbstones in the city’s streets. Following the flood of 1904, limestone was mined from the river to provide material for the concrete work and backfill used in the construction of the city’s flood walls.

Another industry that formed in the early 1900s was the pearl button industry. In Michigan, this industry was restricted to the larger southern, warmwater rivers which had abundant populations of thick-shelled mussels. Sources indicate that there were at least five button factories along the Grand River: one in Lamont, three in Grand Rapids, and one in Lowell (Lydens 1967; Lowell Area Historical Museum 2004). Mussels were raked from the river bottom using crow-foot dredges and baked in long pans on the shore. The buttons were then punched from the shells, polished, and sold to market. A combination of overharvesting, habitat degradation from dam construction and pollution, caused a major decline in mussel populations leading to the closure of commercial mussel harvesting by the Michigan Conservation Commission in 1944 (van der Schalie 1938, 1948; see **Biological Communities**).

By the early 1900s, most of the marketable timber had been removed from Michigan lands. Cleared lands were then marketed to farmers, and many thousands of acres were sold. However, much of the land turned out to be unsuitable for sustained agricultural use. When word spread amongst the settlers that the timbered land was worthless for farming, the demand for the land disappeared. Owners eventually stopped paying taxes on all but their best lands. By 1932, Michigan experienced a severe tax delinquency problem, with 17.2 million acres of land falling into delinquency. By 1941, 4.5 million acres had reverted to the state. Many of these large tax-reverted parcels were retained by the state and are now state game and recreation areas. Remaining agricultural lands were often heavily modified with ditches and tile drains to drain off flood waters and to dry out wetlands sufficiently to farm (see **Soils and Land Use**).

Throughout the twentieth century, the Grand River watershed experienced rapid population growth and widespread industrial expansion and urbanization. During this period of rapid growth, the river and most of its tributaries were used to convey municipal and industrial wastewater discharges. These discharges often exceeded the assimilative capacity of the receiving streams, resulting in fish kills. The remaining fish populations were dominated by pollution-tolerant species such as common carp. Efforts to abate water pollution began with the organization of the Stream Control Commission created by Public Act 245 of 1929. Although Act 245 did not make the discharge of pollutants or sewage illegal, any injury as a result of the discharge was illegal. Initially, the Stream Control Commission was not politically supported, and its existence was challenged in nearly every legislative session. As conditions worsened, public demand for tighter pollution controls lead to the establishment of the Water Resources Commission in 1949. The Water Resources Commission required end-of-pipe treatment for all wastewater discharges to the waters of the state. During the mid-1960s, Michigan developed water quality standards, and the legislature revised Act 245 and finally declared the discharge of raw sewage illegal. This led to the wastewater discharge permit program and requirements for best treatment control technology. The federal Clean Water Act of 1972 established the goal of making all waters “fishable and swimmable” and created national standards for water quality. Over the last three decades, implementation of the Clean Water Act has resulted in the recovery of the Grand River and its tributaries. Waters that were once heavily polluted now support abundant populations of fish and offer diverse recreational opportunities.

Geology

Michigan’s bedrock geology is dominated by two rock formations. The Lower Peninsula and eastern half of the Upper Peninsula is made of sedimentary rocks that form the Michigan Basin and the western Upper Peninsula is underlain with primarily crystalline, igneous shield (Sommers et al. 1984).

The Grand River basin’s bedrock formations were deposited in large seas which covered most of the Great Lakes states and adjacent parts of Canada during the Paleozoic Era. The formations are sedimentary rock layers composed primarily of sandstone, limestone, dolomite, and shale (Figure 3). They also include some beds of salt, gypsum, and anhydrite, as well as some thin beds of coal (USACE 1970). These layers are covered to various depths by unconsolidated materials deposited during and following the Ice Age.

The Pleistocene Epoch, or Ice Age, occurred about 2 million years ago. During this period of extreme cold and snowfall, over one-third of the earth’s surface was covered by glaciers up to 10,000 feet deep. It is generally accepted that the Great Lakes did not exist during this period of time, but were carved out as a result of several periods of glaciation. The last of these occurred from about 18,000 to 4,500 years ago.

As the glaciers made their final advances, they came into the future Great Lakes region as a series of ice lobes with each lobe moving into the lowest existing spots on the landscape. These glacial lobes eventually formed the Great Lakes and their bays and have thus been named in accordance with them. There is a Superior lobe, a Keweenaw lobe, a Michigan lobe, a Green Bay lobe, a Grand Traverse lobe, a Saginaw lobe, and so on. They welded together south of the Great Lakes Region into one solid sheet and did not separate again until they retreated back through Michigan. The Grand River basin was covered by the Michigan and Saginaw lobes.

As the glaciers advanced and retreated across the state, they deposited a variety of sediment types (Figure 4). Most of the Grand River basin is underlain by till, which is a mixture of clay, silt, sand, gravel, cobbles and boulders. Till is not transported by water, but is deposited directly from the melting glacier. During periods of time when the ice front remained static, ridges of glacial sediment, or moraines, would form. Channels formed along the front of these moraines to carry the water flowing away from the melting glacial lobes. The main stem and many tributaries flow within the channels of these ancient glacial meltwater streams, many of which follow the concentric rings formed by the retreating Saginaw lobe. Sand and gravel deposits are generally connected with the channels of glacial meltwater streams. Coarse materials were deposited in the fast-flowing waters and the finer particles were carried downstream to areas of quiet water before settling out. Glacial sand and gravel deposits are called “outwash” as the sand and gravel was washed out of the glacier by meltwater streams. Areas underlain by the outwash tend to be flat, narrow and long. Many of the outwash areas are now covered by swamps and marshes (USACE 1970). The percentage of outwash in the Grand River watershed is 20% (Gooding 1995). The numerous lakes of the headwaters region are located within glacial outwash plains of the Saginaw-Erie interlobate region. Similar lake districts occur in Barry and Kent counties in the Michigan-Saginaw interlobate region. Bedrock outcrops are present in only a few locations in the watershed: near Jackson, Grand Ledge, and Grand Rapids. These protrude through sandy glacial drift deposits that are generally less than 100 feet thick (USACE 1972). The rest of the watershed is covered with several hundred feet of glacial deposits. The texture and thickness of these glacial deposits are important hydrologic characteristics controlling the capacity of groundwater aquifers to transmit water (See **Hydrology).**

About 14,500 years ago, the glaciers began their final series of advances and retreats. As the Grand River flows northward from Jackson to Lyons, it cuts through the Kalamazoo, Charlotte, Lansing, Grand Ledge, Ionia, and Portland moraines, which were formed by the Saginaw lobe during these final movements.

By 14,000 years ago, the Saginaw lobe had retreated and formed enough meltwater that when it then re-advanced, it forced Lake Maumee (early Lake Erie) to drain not only through the Wabash River, but also north and west across the “Thumb” area and across lower Michigan to Lake Chicago (early Lake Michigan). This continued for about 1,000 years, and formed the large broad valley of the current day Maple River and lower Grand River. The lower main-stem segment, from the mouth of the Maple River to Lamont is located in the glacial-fluvial Maple River-Grand River valley (Figure 5). This portion of the catchment displays the highest local relief with some areas exceeding 200 feet above the broad and relatively flat valley floor (Figure 6). Tributaries to the main stem of the Grand River in this area are incised as they cut through the high terrace, explaining why many have higher gradient in their lower reaches than in their headwaters. These incised tributary valleys represent the potential for the highest groundwater yield in the watershed (Figure 7).

Both the Maple River and the mouth segment of the main stem were formed on the sediments of the ancient glacial lakes Saginaw and Chicago, respectively. This lacustrine geology (silt, clays and fine sands forming flat plains) comprises 7% of the Grand River basin (Gooding 1995).

Hydrology

Climate

Climate of the Grand River basin is primarily determined by latitude, moderating effects of Lake Michigan, regional air masses and atmospheric disturbances, and differences in land-surface elevation.

The Grand River basin is contained in the Southern Lower Michigan Region as described by Albert et al. (1986). Compared with the Northern Lower and Upper Michigan Regions, the climate in the Southern region is warmer with an average annual temperature of 48.1°F, and has a longer, less variable growing season (Albert et al. 1986; NOAA 2002a, 2002b). Precipitation is highest and snowfall lowest in this region. Potential evapotranspiration is also higher although the ratio of precipitation to potential evapotranspiration is lowest. Overall climatic differences are less pronounced here than in the northern regions (Albert et al. 1986). Due to the moderating effects of Lake Michigan, local climates differ from the headwaters to the mouth.

Headwaters

The headwaters main-stem segment is located in the Ann Arbor Moraines, Jackson Interlobate, and Lansing ecoregions of lower Michigan (Figure 8; Albert 1995). This area has a growing season of 163 days, the longest in the state (Albert et al. 1986). Summer temperatures average 69.8°F with an average daily maximum temperature of 80.9°F. Winters are mild with average temperatures of 27°F (USDA 1981). Total annual precipitation is approximately 33 inches and average snow depth is 40 inches (Figures 9 and 10). Fairly steep slopes in the headwater valley segment result in the formation of distinctive microclimates on northeast and southwest facing slopes. Frost pockets occur in kettles in these areas (Albert et al. 1986).

Upper River Segment

This segment is in the Jackson Interlobate and Lansing ecoregions (Albert 1995). Because the local climate is influenced more by the movement of large pressure systems than the moderating influence of the Great Lakes, the climate in this district is characterized as continental (USDA 1978). Daily, seasonal and annual temperature changes recorded at the Charlotte weather station in Eaton County are larger than those recorded for Great Lakes stations in the same latitude (USDA 1978). This area experiences fewer growing days than the headwaters segment and averages 146 days. Summer temperatures average 66°F and exceed 90°F or higher for 15 days per year. Winter temperatures average 26°F with extreme lows of -11°F (Albert et al. 1986). Total annual average precipitation is approximately 34 inches (Figure 9). Average snowfall is approximately 40 inches per year (Figure 10).

Middle River Segment

This main-stem segment is primarily located in the Lansing ecoregion (Albert 1995) and follows seasonal temperature and precipitation patterns as similar to the upper main-stem segment.

Lower River Segment

The lower main-stem segment encompasses several ecoregions (Figure 6) but is largely contained in the Lansing ecoregion. Therefore the climate in the east and central portions of this segment is similar to that described for the upper and middle segments.

The extreme western portion (western Kent, southern Muskegon, and Ottawa Counties) of the lower main-stem segment is in the Jamestown and Southern Lake Michigan Lake Plain ecoregions where the climate is influenced by Lake Michigan. The climate in this portion of the lower main-stem segment is characterized by a long growing season (157 days), slightly cooler summers and significant lake effect snows and precipitation (Albert et al. 1986). Average and daily maximum summer temperatures recorded at the Grand Rapids weather station are 69.1°F and 80.6°F. Winter temperatures at this location average 23.7°F. The lowest temperature on record at Grand Rapids is -24°F (USDA 1986). Total annual precipitation is 36.5 inches and average snowfall depth is approximately 70 inches (Figures 9 and 10).

Mouth

Due to the effects of Lake Michigan, the climate in this segment differs greatly from the main-stem segments to the east. The prevailing westerly winds over Lake Michigan moderate temperature so that extreme highs and lows are rare (USDA 1972). Although spring is delayed due to the chilling effects of the cold lake waters, the growing season is warm and long (157 days), creating a maritime climate that is ideal for flowering fruits. On average, summer temperatures exceeding 90°F are uncommon. Although winter temperatures tend to be mild, lake effect snows are frequent and average snowfalls are the heaviest in the watershed (Sommers 1977).

Climate Change

Climate change scenarios for the Laurentian Great Lakes conclude that aquatic ecosystems in the region are sensitive and will adjust to a warming climate (Meyer et al. 1999). Wetlands are particularly vulnerable and are subject to reduced areal extent as a result of small changes in water balance. Inland lakes will experience alterations in annual mixing regimes, losses of thermal refugia, changes in nutrient delivery and cycling, and changes in trophic structures. Changes in precipitation delivery are anticipated to result in more frequent stream channel forming events, reduced low flows, and enlarged channels. Channel responses to these altered flow regimes will result in changes in floodplain connectivity, hyporheic exchange, and nutrient spiraling. Thermal habitat area is predicted to increase for warm and coolwater species and decrease for coldwater species. These changes will result in northern range expansions of warmwater species and accelerated rates of extirpation of coldwater species. Uncertainties associated with climate change and the adaptive capabilities of aquatic species to withstand these changes are exacerbated by increased demands for finite surface and groundwater resources (Palmer et. al. 2009). As future water management plans are developed, it will be important to consider the socioeconomic benefits and ecosystem services provided by the diverse aquatic resources in the Grand River watershed. Future management of the Grand River watershed and other aquatic resources within the region will require adaptive strategies as these changes become more apparent over time.

Annual Stream Flows

Streamflow characteristics are dictated by the interaction of climate and precipitation and by physical catchment features including: topography, hydrologic soil type, aquifer transmissivity, catchment storage, local geology, vegetative cover and land use. Streamflow is composed of a surface runoff component and a groundwater component. Surface runoff results from precipitation that flows directly into the channel overland or is otherwise intercepted and enters the stream without percolating into the aquifer. The groundwater component results from precipitation that infiltrates the soil, percolates into the aquifer and flows into the channel. Streams gain water through upwelling of groundwater through the channel bed, lose water to the groundwater as water enters the streambed, or both. Losing reaches typically occur at abrupt changes in channel slope or pattern. The subsurface pathways where stream water flows though short lengths of the channel bed and banks are referred to as the hyporheic zone (Figure 11). Areas of hyporheic exchange involve both surface and groundwater components influencing water quality constituents such dissolved gases, nutrients, and sorption of dissolved solutes. These flow dynamics are dictated by relative altitudes of the groundwater table and stream surface, and often are very complex (Brunke and Gonser 1997; Stanford 1998; Winter et al. 1999). These groundwater pathways can be short, as precipitation infiltrates to the shallow water table and moves across the floodplain; or long, as precipitation percolates into deeper aquifers (Wiley and Seelbach 1997).

Rates of groundwater discharge to the stream are determined by the capacity of these aquifers to receive and transmit water, which is largely controlled by catchment geology. Catchments characterized as bedrock, lacustrine fine, and thin drift over bedrock are typically associated with above average surface runoff, low aquifer transmissivity and more variable or "flashy" streamflows, whereas catchments draining lacustrine coarse-textured tills or ice-contact outwash display above average rates of infiltration, high aquifer transmissivity and more stable streamflow patterns (Neff et al. 2005; Hamilton et al. 2008). Rivers and streams that receive higher inputs of groundwater respond less to precipitation events than systems receiving high amounts of runoff. In the Grand River watershed coarser geologic materials tend to be associated with glacial meltwater channels and outwash plains. These areas have the highest relief and display the highest potential for groundwater yield (Figure 7).

The capacity of a groundwater aquifer to transmit water is referred to as its transmissivity and is a function of hydraulic conductivity and aquifer thickness (Heath 1982). The Groundwater Mapping Project, a multiagency study in Michigan, utilized the Michigan Glacial Landsystems Coverage (MDIT 2005a) classification of the surface geologic deposits of Michigan and lithologic information contained in water well drilling logs to assign aquifer transmissivity classes of low, medium, or high to each glacial land system (MDIT 2005b; Hamilton et al. 2008). In general the aquifer transmissivity in the Grand River watershed is classified as medium to high (Figure 12).

As with most Michigan rivers, the Grand River shows the following predictable annual flow pattern:

- flood flows or high flows (variable among years) in early spring due to a combination of saturated soils, large snow melt, spring rains, and lack of evapotranspiration;
- late-summer low flows or base flows reflecting low amounts of summer precipitation, unsaturated soils increased capacity to capture smaller precipitation events, increased evaporation, and peak transpiration demands during the growing season;
- high flows in the fall as a result of seasonal rains and shutting down of vegetative transpiration; and
- winter low flows reflecting reduced precipitation and water being stored as ice and snow.

Annual flows in the Grand River watershed can be examined by analyzing the data from continuous stream flow gauges maintained by the United States Geological Survey (USGS) at 16 locations within the basin (Table 3, Figure 13). At some locations discharge data from these gauges have been collected for over 100 years. In the past, continuous gauges were also operated in the basin at eight additional locations, and many miscellaneous discharge measurements have been recorded (Holtschlag and Eagle 1985). Daily measurements of stream discharges (cubic feet per second or cfs) are summarized in annual water resource reports (Blumer et al. 2004).

The USGS gauging station located on the main stem in Grand Rapids has been maintained since 1901. For the years 1901–2005 the mean annual flow is 3,775 cfs from a catchment of approximately 4,900 mi^2. During 1994 – 1995 a gauging station located at Grand Haven recorded a mean annual flow of 5,221 cfs. Based on a drainage area 5,575 mi^2, the Michigan Department of Environmental Quality estimates the average annual discharge to Lake Michigan to be approximately 4,300 cfs (M. Lesmez, Michigan Department of Environmental Quality, Land and Water Management Division, personal communication). Seasonally high flows are typical in March and April with low (base) flows in August and September, as shown by the daily hydrograph at Grand Rapids (Figure 14).

Seasonal Water Flow

Streamflow is an important factor in defining the character of a stream because of its relationship to stream channel formation and stream organisms. Seasonal high flows are important for channel-forming processes and maintaining functioning floodplains. Streams with stable flows tend to have less variation in stream temperature and have more stable channels, resulting in more diverse and robust aquatic communities compared to streams with more variable flow patterns (Angermeier and Karr

1986; Karr et al. 1986; Poff and Ward 1989; Fausch et al. 1990; Gordon et al. 1992; Poff and Allen 1995). The importance of flow stability has been discussed by previous authors.

> The flow stability of a stream is the variability in its discharge over periods of years, months, days or hours. The frequency, timing and magnitude of high flows determine stream channel characteristics, and are related to a river's water quality, temperature, and aquatic community, (Poff and Ward 1989). In Michigan, streams with more variable flow regimes tend to have more actively changing stream channels, warmer summer temperatures, fewer coldwater fishes, and greater year-to-year variation in fish reproductive success. Fishes in Michigan streams are adapted to streamflow conditions that are relatively stable on a daily, seasonal, and annual basis. In general, streams that have stable flows tend to have more fishes with specialized feeding habits, such as feeding on benthic invertebrates, other fishes, or surface insects (Poff and Allen 1995). Fish acclimated to streams with stable flows are generally also less tolerant of silt and turbidity, and more commonly associated with coarser substrates than fish species more common in hydrologically variable streams. The stability, timing, and volume of streamflows have been shown to influence the reproductive success of warm-, cool-, and coldwater fishes (Starrett 1951; Coon 1987; Strange et al. 1992; Bovee et al. 1994; Nuhfer et al. 1994). Increased flow stability has been positively related to fish abundance, growth, survival, and reproduction (Coon 1987; Seelbach 1986). Habitat suitability studies have documented the importance of flow stability to many fishes, including pink salmon (Raleigh and Nelson 1985), largemouth bass (Stuber et al. 1982a), smallmouth bass (Edwards et al. 1983), walleye (McMahon and Nelson 1984), brook trout (Raleigh 1982), Chinook salmon (Raleigh et al. 1986a) and brown trout (Raleigh et al. 1986b). Incorporating the need to maintain stable flows in land use plans will help support the balanced and diverse fish communities in Michigan streams (Richards 1990). [Zorn and Sendek 2001].

Seasonal flow stability can be assessed using a variety of indices. Three methods were utilized to assess that of the Grand River main stem and several tributaries; standardized flow-exceedence curves, 10:90 exceedence flow ratios, and low-flow yield. Standardized flow-exceedence curves are plots constructed from flow duration data from USGS gauging stations and standardized by dividing the exceedence discharge by the median flows recorded at that specific location. An exceedence value is discharge that can be expected to be exceeded for a given percentage of the time. A 5% or less exceedence value represents relatively rare high flow events, for example, spring flows during snowmelt or extraordinary storm events. The 50% exceedence value represents median discharge, meaning half of the time the flow is higher and half of the time flow is lower than this value. The 95% exceedence value is referred to as base flow (or low flow) and typically indicates the groundwater component of streamflow. The 10:90% (10:90 ratio) exceedence flow ratio provides another index of stream stability that is useful for comparing streams. The 10% exceedence flow represents high flow events whereas the 90% represents low flow events. Seasonal flow stability decreases with increasing values of this ratio. The third measure of flow stability, low-flow yield (LFY; 90% exceedence flow/catchment area) provides an index of a groundwater inputs, seasonal flow stability, thermal characteristics, summer current velocity, and other physical conditions important to fish and other aquatic life (Zorn et al. 1998).

The standardized flow-exceedence curves for the Grand River main stem and its tributaries exhibit a broad range of seasonal flow patterns (Figures 15–26). The most stable flow on the main stem is at Jackson (USGS Station 041090000) in the headwater segment, which has a standardized high flow that is 3.3 times greater than median flow (Figure 15). The gauge station at Lansing (USGS Station 04113000) on the main stem had the highest standardized discharge at 5% exceedence of 4.8 (Figure 19). This indicates a fairly stable system. For comparison, the most stable streams in Michigan (e.g., the Au Sable, Manistee, and Jordan rivers) have standardized high flows that are slightly less than twice their median flows. The Kalamazoo River has a standardized high flow value of 2.8 and is considered stable (Wesley 2005), whereas the flashy (unstable) lower Rouge River in southeast Michigan has a standardized 5% exceedence of 13.7 (Beam and Braunscheidel 1998).

The 10:90 ratio calculated for the period of record at the Ionia USGS gauge is 9.68 (Table 4; Figure 27) This value would classify the Grand River main stem at this location as "fair", not as stable as agricultural rivers draining coarse geologic deposits such as the Kalamazoo River to the south, and not as unstable as rivers draining fine-textured glacial deposits to the east (e.g., Tittabawassee River) (Table 4; Figure 27).

Low-flow yield (LFY) provides an index of flow stability and is a good predictor of stream temperature regimes, seasonal velocity conditions, and the physical characteristics of the catchment. In general, the higher the base flow relative to overland flow, the more stable the stream. Streams with high groundwater inputs have higher summer drought flows and cooler summer temperatures relative to streams with low groundwater inputs. The LFY for the Grand River main stem near Ionia is 0.16 cfs/mi^2 and is equal to the LFY of the similar-sized Tittabawassee River near Midland. In contrast, the LFY for the more stable Kalamazoo River is 0.52 cfs/mi^2 and for the high quality groundwater–fed trout streams such as the Manistee River LFY is 0.95 cfs/mi^2 (Table 4, Figure 28).

As discussed above, seasonal streamflow characteristics are constrained by the interaction of climate and precipitation, and physical catchment features including: topography, local geology and soil type. Given the diversity of glacial deposits throughout the watershed, these features are variable throughout the catchment, resulting in differing flow patterns. Flow patterns are further influenced by human-built dams and reservoirs which capture and store flow peaks generated by surface runoff, and allow for increased evaporative losses. Alterations to the landscape such as removal of vegetative cover or channel modifications (i.e. ditching or sewering) profoundly change flow patterns, typically accelerating deliveries of surface runoff and increasing flow flashiness. The effects of catchment physiography and anthropogenic changes on flow patterns are discussed more thoroughly for the Grand River and tributaries by main-stem segment:

Headwaters and Upper River Segment

The Grand River main stem at Jackson exhibits a relatively stable flow pattern with standardized 5% and 95 % exceedence flows of 3.3 and 0.3 respectively (Figure 15). Flow patterns are moderated to a large extent by numerous headwater lakes and wetlands which provide a steady release of groundwater to the river. Low flow yield is 0.23 cfs/mi^2, a value equal to the relatively stable St. Joseph River at a similar location in its catchment.

The Portage River enters the main stem downstream of the City of Jackson. Flow patterns in this subwatershed have been extensively modified through channelization and other drain practices (e.g., extensions, field tiling, etc.), which result in increased flashiness (Figures 15 and 16). The 10:90 ratio calculated for the period of record is 22.5, a value indicative of very unstable seasonal flow patterns.

The main-stem catchment area at the Eaton Rapids gauging station is approximately 660 square miles and includes the discharges of several tributaries: Portage River, Perry Creek, Huntoon Creek, Sandstone Creek, and Spring Brook. The headwaters of these tributaries have been modified to promote drainage of the fine-textured soils for agricultural land use. Here the main stem is slightly more flashy with a 5% exceedence flow of 4.0, a 10:90 ratio of 8.4 and reduced LFY of 0.18 cfs/mi^2 (Figures 15 and 16).

Middle River Segment

The flow patterns monitored in this main-stem segment are the most unstable in the Grand River watershed. The terrain is relatively flat, with fine-textured soils and low groundwater influx (Figure 7). In addition, surface runoff rates have been increased through wetland loss and stream channelization.

The tributaries located in this main-stem segment respond to rain events rapidly generating high peak discharges and returning to low base flows.

The Red Cedar River subwatershed contains five USGS monitoring stations, one each on: Deer, Sloan, and Sycamore creeks, and two on the Red Cedar main stem. Flow instability is evident at all gauging stations. Standardized high flows range from 6.6 to 15 (Figure 17). Standardized 95% exceedence flows are also highly variable and range from 0.07 to 0.29 (Figure 18). The 10:90 flow ratios calculated for these sites range from 12.04 to 77.22, the highest in the Grand River watershed and are on par with some of the more flashy streams in the state (Figure 27). Groundwater loading to these streams is low ranging from 0.02 to 0.12 cfs/mi^2 (Figure 28).

Carrier Creek, an urban stream near the City of Lansing, displays similar unstable flow patterns. This stream is one of the flashiest gauged tributaries in the Grand River watershed and has a 5% standardized exceedence of 15 and a 95% standardized exceedence of 0.06 (Figures 19 and 20). Groundwater loading to Carrier Creek is the lowest in the Grand River watershed and is negligible at 0.01 cfs/mi^2. The extreme high and low flow result in a 10:90 ratio of 73.88 (Table 4; Figure 27).

Flow statistics for the Looking Glass River suggest a slightly more stable flow pattern than the Red Cedar River with a 10:90 ratio of 13.12 (Figures 19, 20, and 27). Groundwater loading is slightly higher with a LFY of 0.12 cfs/mi^2 (Figures 7 and 28).

Grand River streamflow is monitored at two locations in the middle segment: downstream of the Red Cedar River confluence in City of Lansing and upstream of the confluence with the Looking Glass River near the City of Portland. Standardized 5% exceedence values at these locations are less than 5.0, and baseflow at these locations is slightly less than measured in the headwater and upper segments (Figures 19 and 20). Using the flow stability statistics the main stem exhibits its least stable flow patterns (e.g. highest 10:90 ratio, lowest LFY) at the Lansing gauge location. As the river nears the Portland gauge the main stem begins to descend toward the elevation of the former glacial river valley. As gradient increases, groundwater loadings begin to increase as the geology becomes coarser (Figures 6 and 7).

Lower River Segment

Within the lower segment, long term USGS flow monitoring data is available for four major tributaries (Maple, Flat, Thornapple, and Rogue Rivers), two small tributaries (Fish Creek and Quaker Brook), and two main-stem locations.

The catchment of the Maple River at the Maple Rapids gauging station is approximately 434 square miles of predominantly agricultural lands. The Maple River headwaters are in lacustrine lake plain, and the drainage is very flat with fine-textured soils. Groundwater loading in the headwaters of the Maple River is limited (Figure 7). Much of the Maple River watershed has been extensively channelized to promote drainage for agricultural use. These catchment features and channel modifications result in unstable or flashy seasonal flow patterns with relatively high standardized 5% exceedence and low standardized 95% exceedence flows (Figures 21 and 22). Compared to the other large Grand River tributaries, the Maple River has the highest 10:90 ratio and the lowest LFY (Figures 27 and 28).

In contrast to the Maple River, the Flat River drains deposits of coarse-glacial till and outwash sands and gravels in a relatively steep watershed. These characteristics provide for higher rates of groundwater movement and inflow into the channel (Figure 7). Flow stability indices (e.g. standardized exceedence curves, LFY, and 10:90 ratio) calculated for the period of record at the Smyrna gauging station indicate stable flows (Figures 21, 22, 27 and 28) The LFY calculated at this location is 0.38 cfs/mi^2 (Table 4). This value is similar to that of other stable warmwater rivers like the Kalamazoo River.

The headwater regions of the Thornapple River drain relatively flat terrain composed of medium-textured till and end moraines. Initially, groundwater inputs to the Thornapple River are modest, and increase as the channel slope steepens and cuts through areas characterized by coarse-glacial till and end moraines (Figure 7). Several coldwater tributaries join the Thornapple River main stem in this portion of the watershed. Seasonal flow statistics characterize the Thornapple River as more stable than that of the Looking Glass and Red Cedar Rivers, but not as stable as the Flat River (Figures 21 and 22). Low flow yield is 0.24 cfs/mi^2, which is considerably higher than the 0.05 cfs/mi^2 recorded for the Maple River at a similar location in its catchment (Figures 7 and 28).

Standardized flow-exceedence curves for the Rogue River display relatively stable flow patterns similar to the Flat River (Figure 20 and 21). The LFY for the Rogue River at Rockford is 0.47 cfs/mi^2 and is the highest groundwater loading measured in the Grand River watershed. This value is relatively high compared to other Lower Peninsula streams with similar-sized catchments (Table 4). Steady groundwater inputs from the permeable catchment provide for good seasonal flow stability. The 10:90 flow ratio for the Rogue is 3.8, a value much lower than the Thornapple River at a similar location in its catchment (Figure 27).

The flow stability of Fish Creek is rated good (Table 4; Figures 21 and 22). This Maple River tributary drains coarse-textured glacial deposits characteristic of the northern portions of the Grand River watershed. Flow stability indices for the period of record indicate Fish Creek is the most stable gauge tributary in the Grand River watershed.

Based on catchment area, at 7.6 square miles, Quaker Brook is the smallest gauged tributary in the Grand River watershed. Although groundwater input is relatively high, the 5% standardized exceedence flow and 10:90 ratio reflect moderate flow instability (Table 4; Figures 21 and 27). This flow instability is a result of extensive channelization and wetland loss within this small subwatershed.

Standardized 5% exceedence values for the Grand River main stem at Ionia and Grand Rapids are 4.7 and 4.1, consistent with the moderately unstable flows described for the middle segment (Figure 23 and 24). The 10:90 ratios for the Ionia and Grand Rapids gauges are 9.68 and 6.38, respectively (Table 4; Figure 27). The apparent increase in stream stability at Grand Rapids is related to an increase in LFY as a result of the constant inputs from the Flat, Thornapple and Rogue rivers and inputs from regional groundwater aquifers (Mandle and Westjohn 1989).

Mouth

There are no long term monitoring data for the main stem or tributaries within the mouth segment. USGS stations were established on the main stem at Eastmanville from 1976 to 1977 and Grand Haven from 1994 to 1995. The short period of record for these stations limits the use of the data as both standardized high and low flow exceedence curves suggest atypical water years when compared to the Grand Rapids station in the lower segment (Figures 25 and 26). The Grand Rapids gauge is located at river mile 41. Between this location and Lake Michigan few significant tributaries enter the mouth segment, and therefore it is assumed the flow patterns in the mouth segment are similar to those for the lower segment.

Daily Water Flow

Daily flows tend to be more consistent in watersheds with a high percentage of coarse textured soils and intact land cover. Conversely, watersheds with thin, tight soils and high percentages of impervious surfaces (e.g., parking lots, roof tops, etc.), or significant surface-runoff components are likely to be event responsive and display substantial daily flow fluctuations. Aquatic production and structure and diversity of biological communities are profoundly reduced by such extreme daily fluctuations (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988; Poff and Ward 1989; Poff and Allan

1995). Unstable flow regimes can induce increased bank and streambed erosion resulting in a large moving sediment bedload, which may bury quality instream habitats. Flow modifications can block movements of aquatic organisms and interfere with recreational uses of the river. In extreme cases the destabilized channel will begin to react in order to regain a stable pattern, dimension and profile (Rosgen 1996).

Hydrographs (graphs of daily discharge over time) are used to analyze stream flow stability, characteristics of a river channel, and the source of flow. Flow peaks for the Grand River main stem tend to be asymmetrical during the growing season and indicate a rapid increase in discharge followed by a more gradual decline (Figure 29). The rapid rise occurs after a heavy rain event and indicates immediate runoff into the river system. The descending limb of the hydrograph can also be used to characterize the catchment (e.g. land use and soils) above the gauge station and describe much about the hydrology of a stream. The hydrograph curve declines more gradually in watersheds with coarse-textured soils, intact floodplains and well vegetated landscapes due to high infiltration rates and the slow release of water from the surrounding soils. Examples of this more natural flow regime are Fish Creek and the Rogue River (Figures 30 and 31). In contrast, watersheds dominated by fine-textured soils or impervious surfaces, or with highly modified drainage areas (field tiles, storm drains) exhibit event responsive hydrographs with a steep ascending and descending limbs. For example, Sloan Creek near Williamston in the middle segment was examined for the period April 1, 2003 to April 13, 2003. From April 1 to April 2 daily flow averaged 2.5 cfs with no recorded precipitation. Following a rainfall event of 2.0 inches on April 3 and April 4, flow in Sloan Creek increased to 72 cfs. Within 24 hours, flow decreased to 20 cfs and following two minor rain events, decreased to normal flow by April 13 (Figure 32).

Daily flow can also be influenced by hydroelectric dams that operate in peaking mode, causing severe habitat degradation (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988). These dams discharge high flows during peak electrical demand (generally 8 AM to 8 PM) and store flow during low demand periods (generally at night) creating drought flows. Historically, most hydroelectric projects on the Grand River main stem were peaking operations. Now all projects operate in run-of-river mode, meaning outflow of water roughly equals inflow of water, as required by licenses or other control documents issued by the Federal Energy Regulation Commission (FERC). However, some hydroelectric dams have not been licensed and continue to cause severe flow fluctuations. In extreme cases, such as the Hubbardston hydroelectric dam on Fish Creek, large portions of the streambed were dewatered as flash boards were added to increase the storage capacity of the impoundment (C. Freiburger, Michigan Department of Natural Resources (MDNR), Fisheries Division, personal communication). In instances such as this, fish and other aquatic organisms are stranded and die in shallow pools during extreme low flow conditions.

Instantaneous flow data for the main stem at Portland were examined for September 21, 2004 through September 24, 2004 (Figure 33). Although unseasonably high temperatures and no precipitation was recorded during this period, instantaneous flows indicated a 24 percent increase followed by a 22 percent decrease, suggesting potential peaking at upstream dams may be occurring.

Flooding and Floodplains

Flooding in Michigan is a seasonally predictable occurrence, typically occurring in late winter or early spring when rains combine with snowmelt (Blumer 1991). Frozen soils prohibit infiltration, causing large volumes of runoff. Floods are part of the natural hydrological cycle and are vital in maintaining the physical characteristics of the river (see **Channel Morphology**) and the structure of the riparian and aquatic communities (Ward 1978; Junk et al. 1989; Wohl 2000; Stanford and Ward 1993; Rosgen 1996; Baker and Wiley 2009). Riverbanks are transitional boundaries between aquatic and terrestrial ecosystems and frequently reshaped under naturally dynamic hydrologic conditions such as flooding

(Florsheim et al. 2008). Flood timing and duration, intensity, and overall inundation are important factors influencing riparian plant community development. Large flood events influence both the generation and movement of large woody material and the deposition of nutrients and sediments (Baker and Wiley 2009). Flood flows of varying magnitude are necessary to maintain the channel geometry and transport sand, gravel, cobble, boulders, and other items that make up the stream bedload. There is a direct relationship between the movement and distribution of this bedload and flood discharge. Once flows drop below a certain threshold, the stream lacks the power necessary to transport these materials, and the bedload stops moving until the next flood of equal or greater value (Ward 1978).

Floodplains are known to provide functions such as storage and release of waters, nutrients, and sediments during flood pulses (Junk et al 1989; Gregory et al. 1991; Stanford and Ward 1993; Baker and Wiley 2004; Wang et al. 2006). Both hydrology and hydraulics affect riparian ecosystems and shape biological and ecological diversity of riparian corridors (Sedell and Beschta 1991; Opperman et al. 2008). Waters flowing onto the floodplain provide critical spawning and nursery habitats for fish, amphibians, and other aquatic and semi-aquatic organisms. Periodic inundation of the floodplain is necessary to maintain floral diversity and a diversity of aquatic habitats (backwaters, meander scars, vernal pools, etc.) associated with floodplain forest communities (Wiens 2002; Baker and Wiley 2009). Riparian areas are important in maintaining biodiversity, wildlife habitat, and stream integrity. In southern Michigan, intact forested floodplain corridors represent the highest remaining levels of biodiversity in the region.

Large woody structure, an important component of river ecosystems, washes into and is moved within streams during high flow periods. Large woody material is colonized by a variety of aquatic invertebrates and, in some lake plain systems, represents the majority of the habitat utilized by fish. In this way, floods contribute to the diversity of insects and fish found in a stream. Large woody material is also important in channel hydraulics and movement of sediments. As these materials become embedded into the streambed, they act to stabilize moving bedloads. Removal of logs and large woody material to promote increased stream flow can result in channel aggradation as local sediment transport is disrupted (Smith et al. 1993).

In areas where the floodplain is intensively farmed, flooding may contribute to pollution problems in a basin. Erosion from cropland that has been heavily fertilized, or from areas where animal waste is disposed or stored, releases excess nutrients to water bodies, and increases sedimentation. In urban areas, there is also potential for the transport of contaminated sediments or hazardous material from polluted areas within the floodplain (refer to **Water Quality**).

One hundred and six communities within the Grand River basin participate in the National Flood Insurance Program (Table 5). Most of these communities have floodplain maps that delineate 100- and 500-year flood boundaries for the rivers within their municipal limits. A floodplain management study of the Thornapple River completed in 2004 provides communities in Eaton, Barry, and Ionia counties with delineations of 10-, 50-, 100-, and 500-year flood events (USDA 2004). These maps are used by state and local agencies, and individuals for planning purposes, general floodplain management, and to determine the need for flood insurance. It is important for potential floodplain users to understand the advantages and disadvantages of development in such locations. It is necessary that community planning agencies review these maps and prevent unmitigated development within the bounds of the 100-year floodplain. Floodplains are a part of an active river system and should be treated accordingly.

The severity of flooding is influenced by stream channel and land use processes. Channelization causes increased water velocity, which reduces the height of flooding in smaller stream reaches but increases the magnitude of downstream floods in larger rivers. Roads and construction in riparian corridors can act as levees and prevent high flows from expanding across floodplains. Filling and tiling of wetlands and floodplains decreases the water storage capacity of a watershed by decreasing infiltration rates and increasing runoff. Development also increases runoff by creating impervious surfaces such as roads, parking lots, and rooftops. Storm water collection systems route runoff to the stream channel more quickly and can contribute to severe flooding (Wohl 2000).

Significant flooding events in the Grand River basin are documented in the years 1904, 1947, 1948, and 1975. Flooding events have also been referenced in 1843, 1852, 1861, and 1875 (Blumer 1991). The most significant flood event on record occurred in March 1904. Maximum discharges of 54,000 cfs at Grand Rapids and 24,500 cfs at Lansing were recorded for this event (http://waterdata.usgs.gov/mi/nwis/sw). Typical flows at these locations during this time of the year are approximately 7,500 cfs in Grand Rapids and 1,900 cfs in Lansing. During the flood numerous dams were washed out or badly damaged. Highway and railroad traffic was disrupted as bridges and sections of track were washed out. In Grand Rapids, 14,000 people were temporarily homeless, 2,500 homes were surrounded by floodwaters, 30 factories shut down, and 10,000 people were unemployed. As a result of this flood event flood control walls were constructed through the City of Grand Rapids. Significant flooding events also occurred in 1986 and 2004. These events were the result of prolonged rains.

Floods create hazards for humans living along rivers. Local flood mitigation measures, in turn, may create hazards for persons living further downstream as well as nonhuman aquatic and riparian communities (Wohl 2000). Seawalls and levees are often used to protect against floods and eroding banks. Levees prevent floodwaters from entering a floodplain and constrict water flow, causing flood peaks in areas downstream. They do not allow sediments to be deposited in the floodplain and prevent fish access to seasonally flooded areas which are important for spawning and feeding. River systems require 100-year floods for valley maintenance, and levees prevent this natural maintenance, causing an imbalance to the river system. Seawalls eliminate shallow water areas and natural diverse edge habitat that can be important to macroinvertebrates. They also block animal access to and from a stream. Through permitting processes, zoning procedures, and education, riparian property owners should be encouraged or required to use less intrusive and more natural methods to stabilize banks. Rock vanes, natural riprap, log and whole tree revetments, and vegetative plantings are good alternatives to hard-engineered structures such as gabions or seawalls (Alexander et al. 1995; Rosgen 2006; Smith et al. 2008).

Water Use

The majority (61%) of water actively used in the Grand River basin is derived from the main stem and tributaries. Groundwater withdrawals account for 26% while the remaining 13% is drawn from Lake Michigan (Figure 34; MDEQ 2002).

Electric power generation is the largest use of water withdrawn and accounts for 59%. Municipal water sources for the basin are groundwater aquifers (17%) and Lake Michigan (12%). Irrigation of agricultural fields relies primarily on groundwater aquifers (8%) and to a lesser extent surface waters (2%). Private industrial wells account for the remaining 2% of the water withdrawals in the watershed (Figure 35; MDEQ 2002).

Water use for irrigation is especially significant considering the high consumptive losses. At least 90% of the water used for irrigation is lost through evapotranspiration (Bedell and Van Til 1979). Effects of irrigation withdrawals are especially critical during summer low flow periods, when aquatic organisms are more easily stressed. Direct withdrawals from streams have the most direct effect, reducing amount of habitat available and magnifying effects of sedimentation and pollution. Wells developed near the stream channel can intercept groundwater that would have discharged to the stream, and if withdrawal rates are high enough, the well can pull water from the stream (Winter et al. 1999).

Recently the issue of consumptive water withdrawals in the Great Lakes basin led to the adoption of an Annex to the Great Lakes Charter. In Annex 2001, the Great Lakes states and provinces committed to the development of a water management system that would allow for water use while also protecting and conserving the water resource-dependent natural resources of the Great Lakes basin (Grannemann et al. 2000, Groundwater Conservation Advisory Council 2007). In response to this agreement and Public Act 34 of 2006, Michigan has developed criteria and biological indicators and instituted a water withdrawal assessment process to assess the potential for negative environmental effects posed by large water withdrawals. The water withdrawal assessment process is used to regulate new or increased large quantity withdrawals (more than 100,000 gallons per day) from any source. The process identifies withdrawals likely to cause an adverse environmental impact on the waters of the state by assessing whether the withdrawal will diminish the ability of a river or stream to support characteristic fish populations expected to be at a site (Groundwater Conservation Advisory Council 2007; Reeves et al. 2009). Mandatory water reporting from a variety of sectors, including agriculture, was instituted in 2004. As new use data are compiled, estimates of consumptive water uses in the Grand River basin will be improved.

Soils and Land Use

Catchment physiography (texture and landform) is the controlling factor in the natural hydrology of the watershed. Soils, land cover, and land use can modify water movement through the river basin. Soils develop over thousands of years as a result of the weathering of glacial parent materials and organic deposits. In general, minimally disrupted watersheds with intact vegetative cover have higher infiltration rates and less soil loss from erosion associated with surface runoff. Well vegetated stream corridors provide buffers between uplands and surface waters and prevent nutrients from nonpoint sources from entering the watershed (Sweeney et al. 2004). Because river networks, lakes, wetlands, and their connecting groundwater, receive drainage from the surrounding landscape, they are greatly influenced by terrestrial processes including many human uses or modifications of land and water. Changes in land use and land cover characteristics affect hydrologic response by affecting the rate at which water either infiltrates into the soil and groundwater aquifers or is delivered to a stream as overland flow. Land use refers to “man’s activities on the land that are directly related to the land” (Clawson and Stewart, 1965) whereas land cover describes “the vegetative and artificial construction covering the land” (Burly, 1961) [Hamilton et al. 2008].

Changes in land use and land cover can have dramatic effects on channel shape. In portions of the watershed predominated by agriculture, stream channels have been artificially deepened or widened to enhance drainage. Similar channel alterations can be observed as a result of urbanization and the attendant increase in impervious land surfaces. These changes in land cover and channel form modify the delivery rates of water to streams whereby localized disturbances can result in systemic effects, such as changes in nutrient delivery, altered thermal regime (Wehrly et al. 2006), reduced fish biomass (Infante et al. 2006), and impaired fish and macroinvertebrate communities (Karr et al. 1986, Baron et al. 2002, Diana et al. 2006; Stanfield and Kilgour 2006; Wang et al. 2006)

Soils

The Grand River watershed is predominately fine-, medium-, and coarse-textured end and ground moraines; with areas of outwash and ice contact topography and lucustrine plains. Land is gently to moderately sloping with sandy loam to clay soils. Drainage conditions are variable and range from poorly to excessively well-drained (Albert et al. 1986). Detailed soil surveys including soil maps and descriptions can be obtained for a specific county of interest from the STATSGO database at http://www.mcgi.state.mi.us (MDNR SDL 1994). Due to the high diversity of the soils types and associations found within the Grand River watershed, a comprehensive review is beyond the scope of this report. For the purposes of the river assessment, soils have been mapped using the four hydrologic soil types defined by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (2007):

- Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures.
- Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures.
- Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures.
- Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures.

Using this broad classification, the Grand River watershed is composed of 18% (991 mi^2) Group A soils, 45% (2,530 mi^2) Group B soils, 19% (1,064 mi^2) Group C soils, and 14% (773 mi^2) Group D soils. Approximately 4% of the watershed is classified as water or as undefined (Figure 36). The higher clay and loam contents found in the soil classed as Groups B and C are fertile and tend to be actively farmed whereas soils in Group A are too droughty. Without artificial drainage the soils in Group D are too wet to sustain agriculture. Groups B, C, and D soils are widely distributed throughout the watershed, whereas the spatial distribution of Group A soils tends to be patchy and associated with areas of coarse-textured glacial till and outwash.

Land use and Land cover

Maps constructed from transcribed field notes of the initial 1816–1856 General Land Office surveys provide the best available information on Michigan's land cover prior to widespread settlement (Comer 1996; MDNR SDL 2000). These field notes describe vast beech-maple forest covering over 43% of the central and western portions of the Grand River watershed. Large tracts of mixed oak and oak-hickory forest covered approximately 29% of the central and southern areas of the catchment. Large coniferous forests composed primarily of white pine made up 10% of the land cover and were largely confined to the northern areas drained by the Flat and Rogue rivers. Forested wetlands, shrub-swamp/emergent wetland, wet prairie, and open water accounted for approximately 18% of the presettlement landscape (Figure 37).

The State of Michigan uses the spatial data coverages in the 1978 Michigan Resources Information System (MIRIS) as the standard for hydrologic studies in Michigan (Hamilton et al. 2008). The 1978 land use and land cover imagery describes settlement activities in the basin since the completion of the circa 1800 General Land Office surveys and documents the conversion of a predominantly forested watershed to one dominated (57%) by agricultural land uses (MDNR, SDL 1999). Forested and emergent wetlands have been reduced to approximately 4% of the surface acreage. Urban and built-up areas comprise nearly 9% of the total land use. Although forested areas remain, total forested land cover has been reduced from the large continuous forests covering approximately 4,450 square miles down to 1,100 square miles of primarily fragmented woodlots (Table 6; Figures 38–40).

Headwaters

The headwaters lie in an interlobate region of coarse-textured end-moraine and outwash deposits. The northeast portion consists of steep, sandy kettle-kame topography. To the west the topography becomes gentler and is characterized by coarse-textured end-moraine ridges. The majority of the soil in the headwaters is classified as Group B and is well drained (Figure 41). In the 1820s areas underlain with Group B soils were predominantly forested (69%) and supported a mosaic of oak savanna, mixed oak forests, oak-hickory forests. Lowland areas consisted of wet prairie (13%), tamarack swamp (8%), emergent wetland (5%), and open water (2%). These communities were underlain by Group D soils and were present on the poorly drained outwash and ice contact deposits in the eastern portion of this segment. Mixed hardwood swamp accounted for 3% of the presettlement landscape and was common in the active floodplain of the Grand River and tributaries (Figure 42).

The predominant land use in the modern landscape of the headwater segment is agriculture (49%). Forest lands are still common and comprise 23% of the current land use. Urban areas account for 15% and open waters approximately 2%. Wetland loss and conversion in the headwaters segment is significant. Much of the wet prairie, tamarack swamp, and emergent wetlands documented in the 1820 survey have been drained or converted to another wetland type (Comer 1996). Wetland communities in the current landscape account for 11% of the surface area, a substantial reduction from the presettlement era (Figure 43).

Upper River Segment

The upper segment topography is mostly gentle, rolling ground moraine with broad, coarse textured ridges surrounded by deposits of outwash sand. The soils in the northern portion of the upper segment are primarily a mix of soil Groups B and C (Figure 44). Presettlement vegetation in this area was largely beech-maple forest interspersed with areas of mixed conifer swamp. Soils in the southern portion of the upper segment are primarily Group B with areas underlain by Group D soils along riparian corridors. In the 1820s, the upland vegetation in this area was a mix of oak-hickory forests and oak savanna. Mixed hardwood swamps of American elm, black ash, red ash, silver maple and white oak were common in floodplains. Wet prairies, shrub swamp and emergent wetlands were also found on poorly drained ground moraines in the southern portion of this segment (Figure 45).

Agricultural land uses represent 63% of the present day land use in the upper segment. Forest cover has been reduced to 19% of the landscape. Wetland and aquatic communities (i.e., forested, wet prairie, shrub/emergent, and open water), which historically covered 18% of the landscape, have been reduced to approximately 7%. Urban and residential land cover accounts for approximately 11% of the modern landscape (Figure 46).

Middle River Segment

Similar to the upper segment, topography in the southern and eastern portions of the middle segment is characterized as gently rolling till plain traversed with east-west oriented ridges. To the northeast, the surface is gently rolling to flat ground moraine and lake plain. In the western portion the topography begins to steepen with end moraine ridges alternating with flat ground moraines. Clay-rich soils characterize the middle segment with Groups B and C being the predominant soil types (Figure 47). Presettlement vegetation in areas underlain with these soil types was largely mixed beech, sugar maple, and basswood forests. Mixed oak forest, oak-hickory forest, and oak savanna were common in the uplands area of the Red Cedar and Looking Glass river watersheds. Areas underlain with poorly drained Group D soils were characterized by wet prairie and emergent wetland. Mixed hardwood and coniferous swamps, along with emergent wetlands, and shrub swamps were common in active floodplain areas. Large swamps of mixed hardwoods, black ash and tamarack were found on poorly drained portions of ground moraine. Smaller swamps and emergent wetland were also common on outwash and ground moraines (Comer 1996; Figure 48).

Present day land use and land cover is characterized as 58% agricultural, 14% forested, 12% urban and built up, 10% rangeland, and 1% open water (Figure 49). A comparison of General Land Office survey notes with the 1978 MIRIS land coverage indicates significant declines in wetland coverage from approximately 19% down to 5%. Although most wetland types are found on the current landscape, nearly all of the 52,300 acres of lowland coniferous forest present prior to settlement have been drained or converted to other wetland types (Comer 1996).

Lower River Segment

The topography in the lower segment ranges from flat lake plains in the northeast to gently sloping ground moraines in central portions to moderately steep sloping ridges in the west. To the north, outwash channels are found at the bottom of steeply sloping valleys formed by adjacent moraines. Several main-stem tributaries including the Flat and Rogue rivers are confined in these valleys. Soils in the lower segment are primarily Groups B and C (Figure 50). Presettlement forest in areas underlain by these soil types was primarily beech-maple (45%) and oak-hickory (15%). Approximately 15% of the presettlement land cover was mixed white pine forests and occurred in the northern areas underlain by Group A soils (Figure 51). In the poorly drained portions of the glacial Maple-Grand River outwash channel, soil types are predominantly Group D. Presettlement vegetation in this broad valley was mixed hardwood swamp, tamarack swamp, and emergent wetland. Presettlement vegetation maps indicate open water and wetland communities comprised approximately 15% of the land cover in the lower segment. The 1978 MIRIS coverage indicates that wetlands account for slightly more than 3% of the current landscape, a reduction from presettlement of more than 230,000 acres (Table 6, Figures 39, 40).

Current land use in the lower segment is described as: 59% agriculture, 20% forest land, 10% rangeland, 7% urban and residential, and approximately 4% wetlands, lakes and streams (Figure 52).

Mouth

Sandy lake plains cover most of the mouth segment with some steep, coastal sand dunes and fine-textured end-moraines present. Most soils are Group A and Group C (Figure 53). Poorly drained sands associated with the lake plain typically overlay a shallow clay subsoil. Outwash deposits found between moraine ridges contain the stream bed and floodplain of the Grand River and its tributaries. Poorly drained Group D soils in the outwash deposits are primarily associated with streams draining into the Grand River. Moraine ridges with Group B and C soils are located in the eastern portion of this segment. In the 1820s, beech-sugar maple forests dominated the end moraine ridges in the eastern portion of the mouth segment. Hemlock and beech forests were dominant on the sand lake plain and dunes near Lake Michigan. Mixed oak-pine forests were common on sand lake plain and outwash deposits close to the Grand River main stem. Lowland hardwoods and black ash swamp were common in the active floodplains. Near the mouth of the river, extensive Great Lakes marsh and alder-willow swamps were common (Comer 1996). In the central portion of the mouth segment, large swamps of tamarack, white pine, hemlock, black ash, and mixed hardwoods were common in areas of poorly drained lake plain and ground moraine (Figure 54).

Much of the historical beech-maple forest cover found in the eastern portion of the mouth segment has been converted to agricultural uses which now accounts for 60% of the overall land use. Forested lands are found primarily in areas underlain by Group A soils in the west and cover approximately 28% of the current landscape. Urbanized lands account for approximately 8% of current land use. In the 1820s, wetland communities accounted for approximately 15% of the land cover in the mouth segment. Comparison of historical data with the land coverage contained in MIRIS indicates substantial losses of hardwood and coniferous swamps and emergent marshlands (Comer 1996). On the current landscape, wetlands account for less than 2% of the land cover. Rivers, streams, and lakes make up 2% of the current landscape (Figure 55).

Bridges, Culverts and Other Stream Crossings

Bridges and culverts are among the most ubiquitous manmade channel modifications in a river network (Burford et al. 2009). These structures have been historically designed to pass a given storm event while minimizing the costs of the construction. In instances where the stream channel dimensions were not considered in the crossing design, several problems can occur. Most commonly these designs do not consider bank-full channel dimensions (see **Channel Morphology**) and result in undersized structures. Such structures can cause a backwater effect upstream of the crossing, resulting in channel widening due to aggradation as sediment transport is interrupted. Downstream of such structures, increased outlet velocities can result in bank instability and channel widening due to scour. Bank instability can also be induced if the culvert is not properly aligned with the thalweg and flow is directed toward the stream bank.

From a biological perspective, culverts with high exit velocity, inadequate water depth, or excessive outlet drops can result in the blockage of fish movements. Fish and other aquatic organisms have generally adapted to live near the channel margins where water velocities are slowest. With the exception of some of the larger introduced potamodromous fishes (steelhead, salmon) most fish species found in Michigan do not have the swimming and leaping ability to negotiate channel velocities greater than 3 feet per second, (S. Verry, Ellen River Partners, personal communication). When bridges or culverts with less than bank-full width restrict streamflow at road crossings, exit velocities can exceed the 3 feet per second threshold and partially or completely impede fish movements (Peake 2004; Leavy and Bonner 2009). Restricted movements associated with road crossings are documented for several warmwater fishes, including cyprinids (minnows) and centrarchids (basses and sunfish). Many species of fish found in the Grand River watershed spawn in early spring, ascending tributaries during peak annual flows. Movement to spawning areas can be blocked or limited by excessive exit velocities of undersized culverts. Such restriction or blockage of fish passage results in a direct loss of upstream spawning and rearing habitats, thus reducing overall productivity of the fish community (Fausch et al 2002; Gibson et al. 2005).

Properly sized culverts can also disrupt sediment transport and represent a barrier to fish movement if these structures are not installed correctly. Culverts that are not properly recessed during placement can lack adequate water depth and represent a barrier during periods of low flow. Placement must be at the same slope as the stream channel. If the pitch is too steep then exit velocities can exceed the 3 fps threshold. If the culvert slope is too low, sediment deposits can form upstream and inside of the culvert. Improper placement of the culvert can also result in a jump barrier if the downstream end of the culvert is too high resulting in a "perched" culvert (Warren and Pardew 1998; Burford et al. 2009).

Many of the problems associated with road crossings can be mitigated with appropriate design and construction methods. The MESBOAC approach to culvert design was initially developed through a cooperative effort between the Forest Service and Minnesota Department of Natural Resources. The method employs a geomorphic approach to design a crossing that properly sizes, orients and installs culverts based primarily on the stream's physical characteristics. MESBOAC is an acronym composed of the first letter of each of the six steps in the method: Match culvert width to bank-full stream width; Extend culvert length through the side slope toe of the road; Set culvert slope the same as stream slope (failure to set culverts on the same slope as the stream is the primary reason that many culverts impede fish passage); Bury the culvert into the streambed to provide roughness along the channel margins; Offset multiple culverts; Align the culvert with the stream channel; and, Consider head-cuts and cut-offs (S. Verry, Ellen River Partners, personal communication).

Fisheries Division considers the MESBOAC method as the best approach to ensure unimpeded fish passage. This approach also minimizes the risk of a culvert being washed out during a significant storm event. Following construction, a regular schedule of crossing maintenance is necessary as culverts and bridge pillars tend to become blocked with debris. These conditions can lead to flooding or erosion problems by restricting natural stream flow. This is especially true at multiple culvert crossings.

Many road crossings are located in valleys, thus road runoff is commonly directed to the road shoulder and down slope toward the stream channel, creating "point source discharges" of sediment, nutrients, and other pollutants. Crossing designs should incorporate stormwater best management practices to minimize or eliminate this potential pollutant source.

According to intersect counts using the Michigan Geographic Framework county transportation database, there are 8,639 road stream crossings in the Grand River watershed (Table 7; MCGI, SDL 2004). Kent County has the most road crossings with 1,698 or nearly 20% of total crossings in the watershed. Clinton, Ionia, and Ingham counties also had high numbers of road crossings with 990, 871 and 752, respectively (Figure 56). This high density of road crossings increases the potential for restricted fish passage and the potential to reduce the overall productivity of the Grand River fish community. Through the environmental permit review process, negative geomorphic and biological effects associated with road crossings are being corrected when replacement of a structure becomes necessary. When clear span bridges cannot be included in the crossing design, bottomless culverts are the preferred design. Fisheries Division routinely requests restricted work dates to protect the movements of spawning fish. Designs requiring channel enclosure or relocations should be permitted in only limited situations and only if accompanied by appropriate mitigation.

Submerged crossings (pipelines) are usually less evident unless erosion of the stream bottom has exposed them. The number and location of submerged crossings in the Grand River watershed are unknown. Depending on diameter and amount of pipe exposed in a stream channel, some crossings can act as low head dams, catch debris, or impede navigation. Installation of submerged crossings can also be a major source of sedimentation to a stream. In the past, failure of old pipeline crossings in the Grand River watershed has resulted in the release of polluting substances such as sewage and petroleum products, leading to significant reductions in water quality. In instances where a pipeline failure occurs over a prolonged period, these continuous releases can go undetected for a long time. Through Part 301 of the Natural Resources and Environmental Protection Act (1994 PA 451), proposed crossings are reviewed to ensure that proper construction techniques and best management practices are used to minimize stream degradation.

Channel Morphology

A description of channel form includes the pattern (sinuosity), dimension (width to depth ratio), and profile (slope) of the stream channel. Stable river channels are in dynamic equilibrium with the amount of water and sediment that is transported from headwaters to mouth. Although channel morphology can be altered by large flood pulses (e.g., 50- or 100-year events), maintenance of channel form is associated with the bank-full event which has typical recurrence interval of 1.5 to 2 years. Bank-full is the discharge which governs both channel size and shape.

> The bank-full stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels (Dunne and Leopold 1978).

When the stable discharge-sediment balance is altered through removal of vegetative land cover or when streams are directly modified through deepening or widening (dredging), impounding, or hardening (i.e. riprap, levies), channel adjustment is expected and the response is predictable (Rosgen 1996). For example as a result of channelization, the stream becomes incised and is cut off from its adjacent floodplain. Therefore, the channel is forced to convey discharges that exceed original bank-full conditions. The kinetic energy that would normally be dissipated in the vegetated floodplain is directed to the stream bank, resulting in higher sheer stress and bank instability. As the banks begin to fail, sediment loads increase, resulting in increased bar deposition, further acceleration of bank erosion, increased sediment supply, channel widening and aggradation. The stream channel will continue to evolve toward a balance between the slope and valley and will ultimately form a new floodplain at a lower elevation. As these adjustments occur, subsequent responses to tributary morphology can be expected.

Presented within this section are three river measures that describe channel characteristics and stability of the Grand River main stem and its tributaries. These measures are gradient, specific power and channel cross section.

Gradient

Gradient is the change in river channel slope over channel length and is commonly reported in feet per river mile. Together with flow volume, gradient is one of the main controlling influences on river habitat. Typically, as land elevation increases, so does gradient. Steeper gradients accelerate water flows with accompanying changes in depth, width, channel meandering, and bedload transport and distribution (Knighton 1984). River gradient is strongly influenced by surficial materials in the catchment. In areas of erodible materials, such as sands, gradient may change as flow varies. In the glaciated Midwest, higher stream gradients typically occur where streams flow across less erodible materials, such as glacial end moraines. These glacial deposits typically contain more rock and therefore are resistant to erosive downcutting of the channel. When the deposits are coarse-textured (e.g. sands or gravels) and elevation changes are large, stream channels receive high inflows of groundwater (Wiley and Seelbach 1997; Baker et al. 2003). Thus stream gradient is related to other important variables such as stream temperature, current velocity, bottom substrate, and flow stability. For this reason gradient can be used to describe habitat requirements of many fish species including smallmouth bass (Trautman 1942; Edwards et al. 1983), largemouth bass (Stuber et al. 1982a), bluegill and green sunfish (Stuber et al. 1982b, 1982c), northern pike (Inskip 1982), flathead catfish (Lee and Terrell 1987), white sucker (Twomey et al. 1984), black crappie (Edwards et al. 1982), blacknose dace (Trial et al. 1983), and creek chub (McMahon 1982).

In addition to the influences of soil type and surficial and bedrock geology, local channel gradient is also influenced by modifications in land use and land cover. Unstable flow patterns as result of excessive storm water runoff can create flood channels that are too wide and aggrade during low flows. Bridges, culverts, bank erosion and other channel modifications can also alter channel formation and thus gradient. Dam construction inundates productive high gradient areas reducing overall habitat diversity and lowering aquatic species diversity (see **Dams and Barriers**).

The elevation of the Grand River main stem drops a total of 551.9 ft, from 1,130.7 ft above sea level at the headwaters to 578.8 ft above sea level at the mouth (Figure 57). The average gradient of the Grand River main stem is 2.2 ft/mi from the headwaters to the mouth. Grand River gradient is low relative to other southern Michigan rivers of similar size. For example gradient of the Kalamazoo River is 3.0 ft/mile (Wesley 2005), the Muskegon is 2.6/mile (O'Neal 1997) and the St. Joseph is 2.5 ft/mile (Wesley and Duffy 1999). Rivers typically have steep gradient in their headwaters with more moderate gradient further downstream. However, gradient in the main stem between Lansing and Lyons remains relatively steep as evidenced by the close proximity of the dams in this reach. Gradient varies in different sections of the river, with some sections falling very rapidly and others falling very little (Figure 58). These different gradient areas create different types of channel, resulting in different types of habitat for fish and other aquatic life. Broad predictions concerning fish community habitat, channel characteristics, and hydraulic diversity can be made from knowledge of gradient (Table 8).

Hydraulic diversity refers to the variety of water velocities and depths found at a particular site in the river. The most productive river habitat offers a good hydraulic diversity to support various species. Fish and other life are often more diverse in those parts of a river with gradient between 10 and 69.9 ft/mi. These are relatively rare in Michigan because of our low relief landscape and particularly so in the Grand River watershed (Figure 59). High-gradient stream reaches that did occur in the state were often sites for dams and most are now inundated beneath impoundments.

Specific Power

The specific power of a stream is dependent on the gradient (or slope), rate of discharge, and width. Specific stream power, reported as watts/m^2, provides a measure of the potential energy supplied to a stream channel and its banks. Power is the amount of work done per unit time, and specific power is an important measure in understanding the dynamics of sediment transport and the channel forming processes of a river system. Specific power is expressed as:

$$\omega = 1000(pgQ_f\ s/w)$$

where *Q* is the discharge at exceedence flow *f*, *s* is the channel slope in meters/meter, *w* is cross-sectional width in meters, *p* is water density and *g* is gravitational acceleration. A value of 10 is used to approximate *pg* (Wiley and Gough 1995).

As the slope increases or as the volume of water increases, stream power also increases, and, as width decreases, specific power increases. As specific power increases, more energy becomes available for moving channel materials and is cumulatively highest during bank-full events (Dunne and Leopold 1978; Rosgen 1996). Materials of varying sizes from clays to boulders make up the bedload that is transported by a river. Sand particles are approximately 0.1 to 1.0 mm in size and are more readily transported than larger particles such as gravel or cobble. Clay materials are more cohesive and are less readily eroded, but tend to remain in transport over longer distances. (Figure 60).

Rivers and streams, regardless of the bed materials they flow through, are dynamic in nature and move laterally within their valleys. As the stream channel migrates, diverse floodplain habitats (e.g., oxbow lakes, secondary channels, temporary pools) are created as cut and fill processes redistribute organic and inorganic materials previously transported downstream. When a river moves laterally, the outside bank erodes as materials are deposited on the inside bank. Easily eroded materials such as sand are transported downstream while coarser materials (gravels, cobbles) are deposited in the streambed.

Rivers flowing through sand begin to adjust when specific power exceeds a threshold of 15 watts/m^2. That is, they may begin to erode laterally to increase sinuosity, become incised, overtop their banks, or a combination of these. These adjustments result in a reduction of specific power. Rivers flowing through clay channels require greater specific power to induce similar erosive responses.

Channel Cross Section

Similar to gradient, channel cross section is another measure of channel complexity and quality of aquatic habitat. In unaltered sinuous channels, glide-riffle-run-pool complexes contain diverse microhabitats that support higher aquatic species diversity and abundance. River systems that have been altered (straightened, deepened) typically lack a diversity of habitats and consequently support less diverse biological communities.

Measured channel width compared to predicted width is an indicator of channel alterations and riparian land use practices. In unaltered river systems, mean channel width typically increases downstream. When actual channel width is less than the expected width at 95% exceedence flow, the channel is incised. Overly narrow channels could be a result of channelization, bank armoring, bulkheads, or similar artificial construction that restricts channel width (Madison and Lockwood 2004). Channelization and land use modifications in the upstream areas often result in unstable flow regimes and excess bedloads leading to channel aggradation. As a result, channels become excessively wide given their low flow discharge. These channels are characterized by shallow water depths and low habitat diversity.

Mean expected widths and their upper and lower 95% confidence bounds are calculated using the following formulas (G. Whelan, MDNR, Fisheries Division, unpublished data):

Mean expected width *W* is calculated as:

$$W_e = 10^{(0.741436 + (0.498473 \cdot \log Qe))},$$

where Q is the discharge at exceedence flow ***e***. Upper 95% confidence bound for expected width W_e is calculated as :

$$W_{upper} = 10^{(0.819976 + (0.525423 \cdot \log Qe))}$$

and lower 95% confidence bound for expected width W_e was calculated as:

$$W_{lower} = 10^{(0.662895 + (0.471522 \cdot \log Qe))}$$

Actual and expected widths at 5% exceedence, 95% exceedence, and average discharge were determined for each USGS gauge site in the Grand River watershed using available flow data. The expected widths at average discharge all fall into the normal range except at the Portland gauge site which was wider than expected (Table 9). Measured channel widths at most of the gauge stations exceeded expected channel widths at 95% exceedence (Table 10). At high flow rates, (5% exceedence), many of the sites were narrower than expected (Table 11). Since all but one of the USGS gauge stations are located near road crossings, the variances in expected widths may be artifacts of bridge construction.

Headwaters

The headwaters segment of the main stem has the highest average gradient of the main stem at 4.2 ft/mi from the headwaters to Perry Creek. It varies from 25.4 ft/mi upstream of Goose Lake to 0.75 ft/mi at the Portage River mouth (Figure 57). The high average is deceiving because only 7% of this segment is high gradient while 93% is low gradient. These areas of higher gradient are found where the river steps down across deposits of glacial moraine.

The only gauge station is located at Jackson in the downstream end of the segment in the low gradient portion. Gradient in this area is 2.17 ft/mi. Specific power at this location is 0.3 watts/m^2 at 95% exceedence flow and 16.5 watts/m^2 at 5% exceedence flow with an average of 1.0 watts/m^2. Measured channel width at the Jackson gauge is within the expected range at average and low flows, but too narrow at 5% exceedence (Tables 9–11). The river main stem at this location is incised as a result of channelization.

Upper River Segment

The upper segment has an average gradient of 1.67 ft/mi with a range of 1.47 to 2.44 ft/mi. The change in slope between the confluences of Spring Brook and Perry Creek is 1.60 ft/mi. Gradient increases to 3.5 ft/mi near Eaton Rapids; however, habitat diversity is lost by the impounding effects of the Smithville and State Street dams. The Moores Park Impoundment is in the lower end of the segment and has an overall slope of 1.68 ft/mi.

The only gauge station in this segment is located just north (downstream) of Eaton Rapids. Gradient in this area is 2.44 ft/mi. Specific power is 0.5 watts/m^2 at 95% exceedence flow, 29.7 watts/m^2 at 5% exceedence flow, and 1.8 watts/m^2 at average flow. Channel width at Eaton Rapids is within the expected range at average and 5% exceedence flow, but wider than expected at 95% exceedence flow (Tables 9–11).

Middle River Segment

The middle segment has an average gradient of 3.02 ft/mi with a range of 2.26 to 3.78 ft/mi. Although gradient is lower than that of the headwaters segment, a higher percentage (44%) is considered to be fair gradient (Table 8).

Due to the construction of several dams in this segment, some of the most hydraulically diverse habitats are inundated by impoundments. The North Lansing Dam is at the beginning of the middle segment. At this location the river channel has an average gradient of 3.0 ft/mi. Gradient increases toward Grand Ledge and reaches approximately 3.88 ft/mi at the Grand Ledge Dam. The gradient at Portland Dam is 3.0 ft/mi. The tailwater of the Portland impoundment is the upper end of the Webber impoundment which stretches just over 7 miles to the dam. At Webber Dam the river channel drops 30 feet from impoundment to tailwater, and this impoundment covers an area with a gradient of 4.24 ft/mi. The village of Lyons has the last intact dam in the valley segment. This impoundment extends upstream to about the 650 ft. contour line, three miles upstream. The gradient through this stretch is 4.0 ft/mi (Figure 58).

The two gauge stations on the main stem are in Lansing and Portland. The Lansing gauge station is located just downstream of the Lansing dam. Gradient in this area is 2.81 ft/mi. The specific stream power at 95% exceedence flow is 0.5 watts/m^2. At 5% exceedence flow it is 50.3 watts/m^2 with an average of 2.4 watts/m^2. The width of the main stem at Lansing is within the expected range at average and 5% exceedence discharge, but wider than expected at 95% exceedence flow (Tables 9–11).

The Portland gauge station is located near Kent Street in the city of Portland, upstream of both the Portland impoundment and the Looking Glass River. Gradient in this stretch is 3.22 ft/mi. The specific stream power at 95% exceedence flow is 0.5 watts/m^2. At 5% exceedence flow it is 56.7 watts/m^2 and at average flow it is 2.1 watts/m^2. Channel width at Portland is greater than expected at both the 95% exceedence and average flows, and within the expected range at the 5% exceedence discharge (Tables 9–11).

The main stem of the Red Cedar River has very low gradient, 1.9 ft/mi at Williamston and 2.0 at East Lansing. The specific stream power at the Williamston gauge station is 0.1 watts/m^2 at 95% exceedence, 8.1 watts/m^2 with an average of 0.6 watts/m^2. At East Lansing, specific stream power is 0.1 watts/m^2 at 95% exceedence flow, 22.1 watts/m^2 at 5% exceedence flow, and 0.9 watts/m^2 at average flow. Measured channel widths at both locations are wider than expected range at low flow (Tables 9–11).

There are active USGS gauges on two Red Cedar River tributaries, Sloan Creek and Deer Creek. Both streams have higher gradients than the Red Cedar River but do not have very high specific stream power. The gradient in Sloan Creek is 11 ft/mi. Specific stream power at 95% exceedence is 0.1 watts/m^2, 18.9 watts/m^2 at 5% exceedence, and 0.7 watts/m^2 at average flow. Deer Creek has a gradient of 4.9 ft/mi. Specific stream power ranges from 0.1 watts/m^2 at 95% exceedence flow to 13.5 watts/m^2at 5% exceedence flow. Measured channel widths for Sloan Creek and Deer Creek are wider than expected at 95% exceedence flow and narrower than expected at 5% exceedence flow (Tables 9–11).

The Looking Glass River has one stream gauge located near the town of Eagle. Gradient in this stretch of river is 3.8 ft/mi. Specific stream power is low except during high flow conditions. Specific stream power is 0.2 watts/m^2 at 95% exceedence, 34.0 watts/m^2 at 5% exceedence, and 1.5 watts/m^2 at average flow. Measured channel width is wider than expected at 95% exceedence flow and less than expected at 5% exceedence flow (Tables 9–11).

Lower

This is the river segment that flows in the former glacial Grand River channel. The lower segment is very flat, with an average gradient of 0.8 ft/mi and a range of 0 to 5.48 ft/mi. The largest change in channel slope occurs near the City of Grand Rapids. Gradient of the main stem near the confluence with the Rogue River approaches 0 ft/mi and increases to 5.48 ft/mi through the location of the former rapids.

Ionia and Grand Rapids are the two gauge stations in this segment. Mean gradient at the Ionia gauging station is 0.81 ft/mi. Specific stream power was 0.2 watts/m^2 at 95% exceedence flow, 21.7 watts/m^2 at 5% exceedence flow, and 1.2 watts/m^2 at average flow. Measured channel width at Ionia is within the expected range at average and 5% exceedence discharges. At 95% exceedence flow the measured channel width of 225.8 ft. is wider than expected. Minimum and maximum expected widths are 74.6 ft. and 147.4 ft, respectively (Tables 9–11).

The Grand Rapids gauge station was established in 1901, providing long term flow data for the area. Gradient in this stretch is 5.5 ft/mi. The specific stream power is 2.3 watts/m^2 at 95% exceedence flow, 169.7 watts/m^2 at 5% exceedence flow, and 8.2 watts/m^2 at average flow. Measured channel width at this location also exceeded the expected range at 95% exceedence flow (Tables 9–11).

Much of the Maple River drainage was once glacial lake bed and thus is comparable to the lower and mouth segments of the Grand River main stem in terms of channel slope. Gradient of the Maple River at the Maple Rapids USGS gauging station is approximately 0.8 ft/mi. Specific stream power is very low: 0.1 watts/m^2 at 95% exceedence flow, 6.4 watts/m^2 at 5% exceedence flow, and 0.4 watts/m^2 at average flow. Measured channel width is within expected range at average and 5% exceedence flows. During low flows the channel is wider than expected (Tables 9–11).

Fish Creek, tributary of the Maple River, has moderate gradient at 6.1 ft/mi. Specific stream power figures are 0.6 watts/m^2 at 95% exceedence flow, 15.4 watts/m^2 at 5% exceedence flow, and 0.6 watts/m^2 at average flow. Measured channel width is within the expected range for low, median, and high flows (Tables 9–11).

The Flat River near Smyrna has a gradient of 6.0 ft/mi. Specific stream power at this site is as follows: 2.6 watts/m^2 at 95% exceedence flow, 89.1 watts/m^2 at 5% exceedence flow, and 5.1 watts/m^2 at average flow. Measured channel width of 90.3 ft is within the expected range at low and average flows but narrower than expected at high flows (Tables 9–11).

The gradient of the Thornapple River near the City of Hastings is relatively low at 1.2 ft/mi. Specific stream power is also low at 0.2 watts/m^2 at 95% exceedence flow, 13.8 watts/m^2 at 5% exceedence flow, and 0.6 watts/m^2 at average flow. The width of the Thornapple River at the Hastings USGS gauge is within the expected range during average flows. The channel is wider than expected at 95% exceedence flow and less than expected width at the 5% exceedence flow.

The gradient of Quaker Brook near the Village of Nashville is 15.3 ft/mi. Specific stream power is 0.6 watts/m^2 at 95% exceedence flow, 27.3 watts/m^2 at 5% exceedence flow, and 0.6 watts/m^2 at average flow. Channel widths fall within the expected range at average and 95% exceedence flows. Measured channel width at the 5% exceedence is 12.9 ft and is less than the expected range of 17.9 to 30 ft (Tables 9–11).

The USGS stream gauge on the Rogue River is located downstream of Rockford. Gradient at this location is 12.4 ft/mi. Specific stream power is 2.8 watts/m^2 at 95% exceedence flow, 112.3 watts/m^2 at the 5% exceedence flow, and 6.4 watts/m^2 at average flow. Measured channel width is within the expected range during average flows. The channel is wider than expected at 95% exceedence flow and less than expected width at the 5% exceedence flow (Tables 9–11).

In September of 1986, record rainfall resulted in a large flood event that caused the failure of the Childsdale Dam and nearly breached the structure at Rockford. Flows during the event were recorded at nearly ten times the 5% exceedence flow. Based on those flow estimates, specific stream power at the time of the 1986 flood would have been approximately 139.2 watts/m^2.

Mouth

The mouth segment flows across a landscape that was formerly glacial lake plain (see **Geology**). Thus the river channel has an extremely flat slope of 0.27 ft/mi. Such extremely flat gradient results in very little specific stream power and no attraction for use as water power. Due to the low gradient, Robinson Township in Ottawa County is particularly vulnerable to the formation of ice dams at a large bend in the river in the northwest part of the township. This was also the site of a massive log jam that occurred during high water in June and July of 1883. The water rose so high during this event that the captain of the steamboat *W. H. Barrett* was said to have taken a shortcut around the log jam across cornfields, where he "found plenty of water" (Kuiper 1983). No long-term USGS gauge stations were located within this portion of the main stem; specific power and expected channel width were not calculated.

Dams and Barriers

There are 228 dams in the Grand River watershed that are regulated pursuant to the dam safety provisions of the NREPA 1991 PA 451. Less than 10 percent of these structures are located on the river main stem (Table 12, Figure 61). These dams have been classified according to their purpose: 17 for hydropower generation, five retired hydropower projects, 117 for recreation (including lake-level control structures), eight flood-control dams, seven for irrigation, and 80 for other reasons (private ponds, county park ponds, hatchery ponds etc.). It is not known how many small, unregistered dams exist in the basin.

Dams were an important component of early settlement in the Grand River watershed. The earliest main-stem dam on record was constructed in 1830 near Jacksonburg (Jackson) to power a small sawmill (DeLand 1903). As settlement increased, the need for additional milling capacity increased. During 1835, the first official approval was given for the construction of a dam on the main stem in Summit Township, Jackson County.

> At the session of the legislative council in the winter, they obtained "concession" to "build a dam across the Grand River on the southeast quarter of section 3, town 3 south, 1 west, not to exceed seven feet above the water surface, with a lock or sluice of sufficient width to allow the passage of logs, rafts, of flat boats to float upon and navigate said river (DeLand 1903).

Early dams were located at high gradient stream reaches to harness water power for lumber and grist mills at numerous locations throughout the watershed. These dams and milling operations became the focus of settlement, and many present day communities were established at these locations. Construction of these dams continued until approximately 1944. Several of the older dams (circa 1850) were originally constructed for mechanical purposes and were later converted to hydroelectric generating facilities. According to dam safety records, most of the active and retired hydroelectric dams in the watershed were constructed between 1850 and 1939. The majority of dams in the watershed have been constructed for recreational purposes and are largely lake-level control structures.

Dams are regulated under Michigan's Dam Safety Act, Part 315 of the Natural Resources and Environmental Protection Act (NREPA), 1994 P.A. 451 as amended; and the Federal Energy Regulatory Commission (FERC) Regulation 18 of Part 12 of the Code of Federal Regulations. Most of the existing hydroelectric dams on the Grand River are operating under license agreements issued by FERC. In certain cases, hydroelectric projects may qualify for an exemption from full licensing. These facilities are exempt from the requirements of Part I of the Federal Power Act and are issued an exempt license. However, the exempted project is subject to mandatory terms and conditions (e.g., run-of-river operations) set by federal and state fish and wildlife agencies and by FERC. Dams which are constructed for the purpose of maintaining static water levels on inland lakes are regulated under Part 307 of NREPA and are typically maintained and operated by the local County Drain Commissioner.

As dams age, failure risks increase, and economic and environmental costs associated with these failures can be substantial. Over 30 percent of the registered dams in the Grand River watershed were constructed prior to 1960 and have exceeded their design life. Many of these aging structures are in varying states of disrepair. All registered dams in the watershed have been evaluated and assigned a hazard level rating pursuant to the dam safety provisions of Part 315 of the NREPA 1991 PA 451. These hazard levels are based on the potential that a catastrophic loss of the structure would result in either the loss of human life or severe property damage. Of the 231 registered structures in the watershed, twenty seven dams have been classified as having a high hazard potential. Eight dams are of hazard type 1 (dam failure would cause the loss of life), 19 are of hazard type 2 (dam failure would cause severe property damage), and the remaining 207 dams are of hazard type 3 (have low heads in remote areas). Most high hazard dams have a head of over 12 feet and are hydroelectric or retired hydroelectric facilities.

Dams interrupt and alter the ecological processes of rivers by changing the hydrology, disrupting sediment and nutrient transport, and modifying habitats (Ligon et al. 1995; Bednarek 2001; The Heinz Center 2002; Graf 2003). Most dams are located in areas of highest channel gradient in order to create the largest hydraulic head possible for energy production. Some segments of the Grand River and tributaries contained rapids and fast riffle areas before being impounded. These habitats were important areas for fish spawning and typically supported the highest diversity of fish and other aquatic organisms. These habitat types are now scarce in the watershed due to dam construction.

Dams further degrade aquatic habitat through changes in thermal regimes and concentrations of dissolved gases. Impoundments act as thermal sinks, and spilling of heated surface waters often causes an increase in downstream temperature (Lessard 2001). Impounded waters also act as sinks for nutrients and sediment. As these artificial lakes age and become nutrient enriched, large diurnal fluctuations in dissolved oxygen concentrations upstream and downstream of the dam can occur. Dams disrupt the sediment-water transport equilibrium of streams. Waters entering an impounded reach are slowed, thereby reducing sediment transport capacity, and resulting in channel aggradation and burial of high quality habitats. Sediment-free water released below the dam has unusually high erosive power, causing increased scour and bank erosion (American Rivers 2003). Woody structure, which is important for fish habitat, is caught in impoundments and eventually sinks, depriving downstream segments. The ability of dams to control flows can disrupt the incidence and severity of flooding both up and downstream if the reservoir has storage capacity. Reduced inundation of floodplains can decrease available backwater habitat for fish spawning and juvenile rearing. The decrease in flooding may also reduce the diversity of aquatic habitats associated with floodplain resources (Sparks 1995).

Dams have significant detrimental effects on the biology of streams. They impede fish movements creating isolated fish populations (Schlosser 1991, Porto et al. 1999), affect species distributions and fish community structure (Poff et al. 1997; Pringle 1997; McLaughlin et al. 2006; Catalano et al. 2007), and can lead to localized extinctions (Matthews and Marsh-Mathews 2007). Dams fragment river systems, blocking the longitudinal movements of fish and other aquatic life. Many species of fish (e.g., northern pike, suckers, salmon and steelhead) move upstream significant distances to spawn, and their offspring disperse back downstream using available habitats. Dams block these upstream movements thereby decreasing the overall productivity of the fish community. Mortality or injury resulting from fish passage through hydraulic turbines or over spillways during their downstream migration can be significant (Larinier 2000). Entrainment often causes mortality or injury as a result of fish being struck by turbine blades, pressure changes, sheer forces in turbulent flows, and water velocity accelerations (Cadwallader 1986; Cada 1990). Except in cases were fishways have been constructed on the main stem, upstream movement for nearly all species is blocked (see **Biological Communities**, *Factors affecting fish communities*).

Dams also have detrimental effects on benthic invertebrates (Stanley et al. 2002; Doyle et al. 2005; Tuckerman and Zawiski 2007). Seasonal fish movements are critical to native freshwater mussels for both reproduction and dispersal as mussels use fish as hosts for parasitic larval glochidia. Some species of mussels have very specific host fish requirements, and blockage of these fish species could result in local extirpation of the mussel species (Watters 1995; Vaughn and Taylor 1999; Sethi et al. 2004; Strayer 2008). Henry van der Schalie (1948) noted the decline in freshwater mussel populations in the Grand River as a result of river flows being altered by peaking operations at hydropower facilities. Additionally, many species of aquatic insects move upstream to deposit their eggs. Downstream areas are then recolonized through downstream drift. This dispersal mechanism is disrupted by the presence of dams (see **Biological Communities)**.

Lake-level control structures are frequently operated in a manner that benefits lake riparians at the expense of both the lake and outlet stream. During periods of high water, it is common practice to lower the structure to quickly drain the lake to “normal” levels. This practice results in the loss of shallow water spawning, feeding, and nursery habitats (O’Neal and Soulliere 2006). For example, critical spring spawning areas for fish such as northern pike are eliminated on some lakes when water levels are kept artificially low to protect riparian property. If the drawdown rate is too rapid, fish can be trapped or exposed in shallows, often leading to death. Less mobile aquatic life such as mussels, snails, and aquatic insects are also lost as a result of rapid dewatering of shallows. Downstream channel erosion in the outlet stream may result as water is rapidly released. Conversely, during periods of drought, the lake-level control structures retain water to maintain an unnaturally high lake level. This action intensifies low flow conditions and can result in the drying of the outlet channel. Lake-level control structures also block the movement of fish and other aquatic life. Typically these structures represent a jump barrier preventing fish from ascending into the lake to spawn, feed, or escape harsh downstream conditions.

Other barriers to fish movement in the Grand River watershed include poorly constructed road crossings such as perched culverts and poorly designed bridges which result in physical or velocity barriers to fish movement (see **Soils and Land Use Patterns**, *Bridges and other stream crossings*). In some instances, dredged stream channels designed for the rapid routing of water are too wide during summer low flows. During drought flow periods, fish become stranded in isolated pools as the channels become too shallow and prevent their escape to locations with adequate depth.

Headwaters

Four of the five main-stem dams in the headwaters are lake-level control structures on Crystal Lake, North and South Lake Le Ann, and Mirror Lake. These structures were built in the early to mid-1960s and impound water over Lime Lake, Little Grand Lake, and an extensive wetland area (Lane 2007). The remaining main-stem dam at Liberty Mills was constructed in 1848. This dam was originally constructed to power a grain mill and was later converted to produce electricity. Currently the dam is used only to maintain the pond elevation. Removal of this structure would restore river connectivity and provide upstream fish passage. All main-stem dams in this valley segment represent barriers to the movement of fish and other aquatic life.

The main stem was formerly impounded by the Holton Dam in the City of Jackson. This municipally owned hydroelectric structure was constructed in 1936. At one time, this portion of the river was routed in a capped concrete channel. The Holton dam and cap were removed in 2001 (Lane 2007).

Other dams in the headwaters segment were created largely for recreational purposes and serve as lake control structures or create wildlife floodings in the Waterloo State Recreation Area. The hazard levels for the 26 dams in the headwaters range from low to significant (Table 12).

Upper River Segment

There are 13 dams within the upper main-stem segment with five on the Grand River main stem. The three largest, Smithville, State Street, and Moore's Park, are active hydroelectric dams operating under license agreements issued by FERC.

Smithville Dam was built in 1887. It is an earthen structure with a 13 ft head and 500 kW generating capacity. The dam is currently operating under a 2001 license agreement (No. 11150) which expires in 2041. The license requires the dam to be operated in run-of-the-river mode but does not include fish passage provisions. The structure is currently classified as a Type 1 hazard (i.e., dam failure would cause the loss of life).

The State Street dam is an earthen structure that was built in 1933. This dam is part of the Mix hydroelectric power project and serves to divert water from the Grand River main stem into the turbines. The Mix hydropower project also includes a dam on Spring Brook and is currently operating under a 2001 FERC license (No. 11150), which expires in 2041. The license agreement requires run-of-the-river operation and a minimum flow of ten cubic feet per second in the bypass channel. Fish passage is not provided at this project. The structure has nine feet of head and a generating capacity of 202 kW. This structure is considered to be a low hazard.

Moores Park was built in 1908 and with 15 feet of head is the largest in this valley segment. The 600 kW generating project is owned by the City of Lansing and is being operated under a 1994 license agreement (No. 10864) which expires in 2024. The license requires run-of-the-river operation but does not contain fish passage provisions. The Moores Park Dam has a Type 1 hazard rating.

The remaining main-stem dams in this valley segment are municipally owned and are not regulated by FERC. The City of Eaton Rapids owns two structures identified in the records as the Sanitation Dam. The structure has two feet of head and was constructed in 1918. These structures are identified as low hazard and likely represents a seasonal barrier to most species of fish.

The Wilson (Dimondale) Dam and bypass channel were originally built in 1850 and then reconstructed in 1852. Originally the dam was used to power mills located at the dam site. In later years it served to maintain a shallow impoundment. In 1996, the dam partially failed, leaving the structure with a large bow facing downstream and a 40 foot breach on the east side. Because the majority of the main-stem flow was shunted through this large breach, the structure was a velocity barrier to fish and was a safety hazard to boaters and anglers. The remaining structure maintained approximately five feet of head and due to the breach was considered a low hazard. In 2003, the Village of Dimondale was awarded an Inland Fisheries Grant by the MDNR to remove the structure and restore this portion of the Grand River. The project design was based on principals of natural channel design with the project goal of restoring the river to a functioning, self-sustaining channel (Rosgen 1996). The project was successfully completed in 2007.

Most of the remaining dams in this valley segment are located on tributaries at the sites of old mills or are lake-level control structures used for recreation. These dams have the potential to reduce summer flows in small creeks, increase water temperatures, and prevent fish access to important habitat. The MDEQ has classified these as low hazard structures.

Middle River Segment

This segment has 26 recorded dams with five existing structures and one remnant (former Wagar Dam) located on the main stem. Two of the structures, Portland Dam and Webber Dam, are the remaining operating hydroelectric dams in the middle main-stem segment.

The Portland hydroelectric project is municipally owned and is operating under FERC license (No. 11616) issued in 2001, with an expiration date in 2041. The dam was built in 1894 and has 11 feet of head, an approximately 100-acre pond, and a generating capacity of 375 kW. The facility's operation license requires run-of-the-river and maintenance of 25 cubic feet per second in the fish ladder during periods of open water. The fish ladder is a vertical slot design constructed at the site in 1981. Portland Dam is considered to be a low hazard structure.

Webber Dam is the largest dam in the middle segment. It is privately owned and operated by Consumers Energy Company. Construction of the structure began in 1906, and operations were initiated in 1907. The dam is earthen with a concrete core, has a head of 33 feet, and impounds approximately 660 acres. The dam is capable of generating 3,250 kW and is currently operating under a 2001 FERC license (No. 2566) that expires in 2041. License requirements include run-of-the-river operation and maintenance of minimum flow through the fish ladder during the spring and fall fish spawning migrations. The Webber Dam fishway was constructed in 1981–1982 and is a pool-weir design. The fishway design includes a viewing chamber equipped with a video monitor that is used to count and identify fish using the ladder (See **Fishery Management**). During the spring of 2001 the Webber ladder was monitored 24 hours a day from February through April. During that period 14 fish species were recorded either ascending and/or descending the ladder (Dexter 2002). Upstream migrating steelhead were the most common species to use the ladder during this period. Bluegill, channel catfish, largemouth bass, and walleye were also recorded using the ladder during this time frame. In fall, 2001 the ladder operated from late August through December. In this period, passage of over 3,500 coho salmon, 313 Chinook salmon, and 819 steelhead was recorded. Warmwater species recorded during this monitoring period included bluegill, channel catfish, smallmouth bass, walleye, and various sucker species. Monitoring conducted during fall 2008 fish passage period reported similar findings (Taylor and Wesley 2009).

The Webber Dam FERC license also requires a two week shutdown period to allow for the passage of coho salmon smolts that are stocked upstream in the City of Lansing. The exact shutdown period is not specified in the license; therefore, it is the responsibility of Fisheries Division to notify Consumers Energy as to the appropriate shutdown period each spring. In 2005, the coho smolts failed to move downstream during the anticipated period and began to show up at the Webber project after the designated two week period, resulting in the entrainment of many smolts. Following notification, Consumers Energy voluntarily extended the shut-down period and discontinued power production until the smolts moved past the dam. This commendable action saved many of the coho smolts that had been tagged and clipped as part of a Fisheries Division research project.

Other main-stem dams in the middle valley segment include the North Lansing Dam owned by the City of Lansing, the Mudge Dam owned by the City of Grand Ledge, and the Lyons Dam owned by the Village of Lyons:

- North Lansing Dam—The North Lansing Dam, constructed in 1936, is a retired hydroelectric project that is maintained at about an eight-foot head. The 92-acre pond is long and narrow and extends upstream to Moore's Park Dam and the confluence of the Red Cedar River. Although the dam has aesthetic and recreational value to the City of Lansing, it no longer serves the purpose for which it was constructed. Because maintenance costs are high, the City of Lansing began a study in 2005 to examine the possibility of a permanent drawdown or complete removal of the structure. The fishway at North Lansing Dam, the William A. Brenke Fish Ladder, is a pool and weir design constructed in 1981. This structure allows ascending salmon and steelhead access to the Red Cedar watershed.

- Grand Ledge Dam—The Grand Ledge Dam is an earthen structure constructed by J.S. Mudge in 1900 to provide adequate draft for recreational river traffic by numerous steamboats using the river during this era. In its current condition the dam is maintained at approximately five feet of head with a one- acre pond. Fish passage is provided by a vertical slot ladder constructed in 1981. This structure is classified as low hazard.
- Lyons Dam—The Lyons Dam was originally built in 1857 under the name of Hales Mill. The structure was acquired by Consumers Power (Energy) in 1915 and rebuilt in 1929 following a dam failure that occurred between 1913 and 1919. The dam was capable of producing 450 kW of hydroelectric power until 1956 when operations ceased. The existing structure is essentially a rock-filled log crib capped with concrete. The dam has eight feet of head and forms an approximately 120-acre impoundment. Fish passage at this location is provided by a vertical slot fishway that was constructed on the site in 1981.

  Due to the age and poor condition of the existing structure, the Village of Lyons has been actively seeking funds for dam removal. The structural integrity of the dam and ladder was further brought into question in 2001, when a large sinkhole formed adjacent to the fishway. To alleviate safety concerns, Fisheries Division acquired approximately $65,000 in emergency funds to repair the damage. These emergency repairs will not withstand, therefore, the removal of the Lyons Dam and fishway has been identified as a priority by Fisheries Division. In 2008, the village was awarded an Inland Fisheries Grant from Fisheries Division to facilitate the removal of the structure.

Between the Lyons Dam and the Webber Dam lie the remnants of the former Wagar Dam. The dam was constructed in the early 1900s and retired in 1956. The dam was demolished shortly after. In 1984, Fisheries Division allocated $17,000 to remove approximately 50 feet from the right bank of the remaining structure to allow fish passage. The remaining foundation spans nearly the entire channel and during low flow conditions is a barrier to fish movement and navigation; therefore, removal of the remaining structure should be considered.

The remaining dams in this segment were constructed on tributaries to produce mechanical power for lumber and grist mills, to create small impoundments, or are lake-level control structures used to maintain court-ordered lake elevations. The majority of these are classified as low hazard structures.

Lower River Segment

The only two registered mainstream dams in the lower valley segment are the Sixth Street Dam and the beautification dam, both located within the Grand Rapids city limits.

Originally built in 1849 of rocks, logs and brush, the Sixth Street Dam was constructed as part of a lock and canal project to allow boat passage around the mile-long rapids of the Grand River. By 1850 the dam and canals were constructed, but the lock work was never finished. The project was terminated in 1855, and the remaining funds were used to construct a new dam at its present location in 1866. The river water was diverted to the canals constructed east and west of the river channel and was used to power several milling operations. Currently, the Sixth Street Dam is classified as a retired hydroelectric dam and maintains approximately eight feet of head. Although the structure is classified as a low hazard to downstream properties, the dam tailwater produces a dangerous hydraulic undertow that represents a significant risk to anglers and boaters. During the spring and fall spawning runs, trout and salmon concentrate below the dam creating excellent fishing opportunities. Unfortunately this also creates crowded fishing conditions, and anyone that ventures too close to the dam can become trapped in the boil created by the hydraulic undertow. The Sixth Street Dam has been the site of many rescues. The fishway at the Sixth Street Dam was the first operational fish ladder on the Grand River. The ladder was constructed in 1975 and is a pool-weir design.

The other registered main-stem dam was built in 1931 and is one of four low-head structures that were constructed as part of a river beautification project. The structure has approximately two feet of head and provides only aesthetic functions. Although the structure does not block the movement of ascending potamodromous fish, it likely represents a barrier to native fish species (e.g., walleye, suckers) during low flow conditions.

The steep valleys of the lower main-stem segment created several high gradient locations on tributaries that were ideal for establishment of hydropower dams. Although many that were constructed for milling operations are no longer functioning, several tributary dams were retrofitted for hydroelectric generation.

The Hubbardston Dam is located on Fish Creek, a coldwater tributary of the Maple River. The dam was originally constructed circa 1850 to provide mechanical power and was converted to hydroelectric generation sometime before 1920. The dam is currently undergoing licensing with FERC. As with all FERC-licensed facilities, Fisheries Division, is recommending that FERC include the following provisions in the license agreement: 1) establishment of run-of-river flow; 2) a minimum flow study in the bypass channel; 3) entrainment and impingement studies to estimate fish mortality and to mitigate for losses; 4) upstream fish passage options; 5) woody structure passage; 6) a dam retirement funding proposal; and, 7) funding for installation and maintenance of a stream gauge below the project. Hubbardston Dam creates 15 feet of head, impounds approximately 35 acres, and has 240kW generating capacity. The dam is considered to be a low hazard structure.

Significant dams on the Flat River include: Greenville, Belding, Whites Bridge, Fallasburg, and King Mill:

- Greenville Dam—Greenville Dam is a municipally owned, retired hydroelectric structure constructed in 1914. Prior to the gate failure, the dam impounded approximately 149 acres and had 8 feet of head. The dam is considered to be a significant hazard by the MDEQ Dam Safety Section. There are no provisions for passage of aquatic species at this location. The Greenville City Council is currently considering a proposal to replace the dam and re-establish the pond when the Franklin Street Bridge is reconstructed.

- Belding Dam—Belding Dam was constructed in 1887. The dam has 15 feet of head, impounds approximately 110 acres, and has a generating capacity of 280 kW. In 1989 FERC issued an order granting the facility an exempted license. However, the terms and conditions of the agreement require the dam is operated in run-of-the-river mode and in a manner protective of fish and wildlife resources. MDEQ considers the structure to be a low hazard. The dam is a barrier to the movement of aquatic organisms.

- Whites Bridge Dam—Whites Bridge Dam is a privately owned hydropower constructed in 1929. The dam height is 16 feet creating a 91-acre pond. The dam has a generating capacity of 775 kW. This facility was also granted an exempt license from FERC. The terms of the exempt license require run-of-the-river operation. There are no provisions for fish passage at this location. The hazard rating is low.

- Fallasburg Dam—Fallasburg Dam is an earthen structure constructed in 1900. The dam has 35 feet of head creating an approximately 260-acre impoundment. Similar to the Belding and Whites Bridge dams, the Fallasburg hydroelectric project has an exempt license from FERC. Operations at the dam are required to operate at run-of-the-river and maintain a minimum of 110 cubic feet per second in the bypass channel. Provisions for fish passage were not included in the 1985 exemption agreement. Due to the dam’s height and location, it is considered to be a significant hazard.

- King Mill Dam—King Mill Dam is located near the confluence of the Flat River and the main stem and as such serves as the primary barrier to fish migration into the Flat River watershed. The earthen structure built in 1942 provides 14 feet of head and creates a 53-acre pond. Because the dam produces mechanical power instead of electricity, FERC has concluded the operations are exempt from license requirements. The structure is considered to be a type 2 hazard (i.e., dam failure would result in severe property damage).

The relatively steep gradient in portions of the Thornapple River also attracted energy development resulting in the construction of numerous hydroelectric dams. Five operations are currently active and include Irving, Middleville, LaBarge, Cascade, and Ada dams.

Irving Dam was constructed in 1939. The dam is operated under a 2002 FERC license (No.11516) which expires in 2042. The license requires the dam to be operated at run-of-the-river; however, provisions for fish passage were not included in the agreement. The dam has 16 feet of head and creates approximately 32 acres of shallow impoundment. The structure is considered a low risk.

Middleville Dam is a gravity-earthen structure completed in 1938. The dam is 12 feet in height, with a 35-acre impoundment, and is capable of generating 250 kW. Middleville Dam is licensed by FERC (No. 11120-002) and is required to operate at run-of-the-river. The dam is a barrier to the movement of fish and other aquatic life. MDEQ considers this structure to be a significant hazard.

The LaBarge Dam was constructed in 1901 and is a gravity-earthen design. The project received a 40-year operating license (License No. 11300) from FERC in 2002. The license requirements include run-of-the-river operations but failed to include requirements for fish passage. The generating capacity of the LaBarge turbines is 800 kW. The dam has 19 feet of head creating a 100-acre impoundment. The LaBarge Dam represents a high hazard risk to downstream inhabitants.

The hydroelectric dams at Cascade and Ada were completed in 1926 and currently generate 3,000 kW and 1,100 kW, respectively. The Cascade Dam is the taller with 28 feet of head and a 270- acre pond. Ada dam is 23 feet in height and creates a 318-acre impoundment. The structures were considered exempt from Part I of the Federal Power Act and were granted exempt licenses from FERC in the early 1980s. The exemption agreements require run-of-the-river operations and both impoundments have court-ordered drawdown requirements in April and October. Requirements for fish passage were not included in either document. Although the Cascade and Ada impoundments receive a large amount of recreational use, these waters have limited access and are largely private.

Another significant dam on the Thornapple River was located in the Village of Nashville. The structure was built in 1894 to provide power to local mills. At full pool the dam provided approximately 11 feet of head and created a 56-acre pond. Over the years, the dam had fallen into disrepair and maintenance of the structure became a significant financial liability to the village. In 2006, the Village of Nashville contacted Fisheries Division for information regarding options for the removal or repair of the structure. In 2007–2008, the Village of Nashville partnered with the MDNR, MDEQ, USFWS, NFWF, and Barry Conservation District to remove the dam and restore this portion of the Thornapple River. The structure was successfully removed in 2009.

The Rogue River in the City of Rockford has a retired hydropower facility with one existing main-stem dam. The dam was originally constructed in 1888 of wood and was used to power local mills. The structure was weakened by the 1904 flood and breached by a high water event in 1905. The existing structure and spillway were rebuilt by 1920 and later retrofitted to generate electricity. The dam provided hydroelectric power to the city until the 1960s. The dam has approximately 12 feet of head and maintains a 23-acre pond. The dam is considered to be a moderate hazard. The Rockford Dam is a barrier to the movement of fish.

Numerous other dams exist in the lower main-stem segment. Many are small structures constructed for the purpose of regulating lake water levels or are former mill sites that are now maintained for recreational purposes. One of the tallest dams in the basin is located in this valley segment. Rainbow Lake Dam has 42 feet of head and impounds 238 surface acres. The earthen structure was constructed in 1962 on Pine Creek in Gratiot County to create a manmade lake. In 1986, following several days of heavy rain the Rainbow Lake Dam failed resulting in extensive property damage. The dam has since been rebuilt and is considered a significant hazard by MDEQ.

Mouth

All eight registered dams in this segment are constructed on tributaries with none located on the main stem. With the exception of the Crockery Lake Dam, which is maintained by Ottawa County, all of the structures are privately owned and are largely maintained for recreational uses. All of the dams in this valley segment are small, with less than four feet of head, and are considered low risk.

Water Quality

Overview

Water quality in the Grand River basin is influenced by many human activities including agriculture, industry, and urban development. Surface water quality in Michigan is outlined in the Part 4 Water Quality Standards promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended. At a minimum, waters of the state are protected for the following designated uses: warmwater or coldwater fisheries; other aquatic life and wildlife; agriculture; industrial and municipal water supply; navigation; and recreation. Waters of the state that are designated as trout streams (Table 13) or are principal migratory routes for potamodromous salmonids have more stringent dissolved oxygen and temperature standards to protect coldwater fish (Tables 14a and 14b). The Grand River main stem from Lake Michigan to the Moores Park Dam is identified as a principal migratory route for salmon and steelhead and therefore receives this additional protection.

State and federal laws have been developed to protect water quality for a variety of given uses (e.g., NREPA 1994 PA 451; Wolf and Wuycheck 2004). Regulatory agencies monitor river and lake water quality and water uses in a basin to ensure minimum water quality standards are met, to determine compliance with the law, and to document water quality conditions in the basin. The MDEQ, Water Resources Division is the lead regulatory agency for water quality in Michigan. Through its various water quality monitoring programs the MDEQ, Water Resources Division has conducted biological and chemical surveys of a number of lakes and streams in the Grand River watershed. Aquatic habitat and water quality vary throughout the watershed, with some areas supporting designated uses, while other areas are seriously degraded and do not meet minimum water quality standards. Federal Water Pollution Control Act reporting requires MDEQ, Water Resources Division to provide a biennial report to the United States Environmental Protection Agency (USEPA) detailing the status of monitored water bodies. Water Resources Division utilizes a numeric rating system (1 to 5) to describe the status of a water body and the extent to which water quality standards are being supported (Wolf and Wuycheck 2004). Waters that are fully supporting all designated uses receive a score of 1; whereas degraded waters requiring the development of a restoration plan, or Total Maximum Daily Load (TMDL) threshold are rated category 5 (Table 15).

It should be noted that Michigan does not list water bodies in category 1 because comprehensive data are not available for most locations. Water bodies in category 2 are considered to be supporting designated uses. Category 3 includes waters that were not assessed or require further evaluation. Categories 4 and 5 are those waters that do not support designated uses. Waters listed under categories 4a and 4b have been studied, and restoration plans have been implemented. Category 4c includes river and stream miles that have been physically altered pursuant to the activities authorized by the Michigan Drain Code PA 40 of 1956. The systems have been so highly modified and degraded they can no longer support minimally acceptable biological communities. Category 5 is those waters that are impaired and require the development of a TMDL (Table 16). Rivers, lakes, and streams are assigned to the various attainment categories as new monitoring information becomes available or as listing criteria are developed. Because listing criteria and thresholds are regularly updated, it is recommended that the reader consult the most recent listing assessment methodology to determine the attainment status of a particular water body (S. LeSage, MDEQ, Water Resources Division, personal communication).

The following description of the Grand River watershed attainment status is based on a review of the 2004 biennial report (Wolf and Wuycheck 2004). The 2004 report to USEPA indicated that of the 2,218 perennial river and stream miles assessed during the reporting period, 960 (43%) miles were considered to be supporting designated uses. A total of 1,257 miles were considered to be in nonattainment and failed to support one or more designated uses. Over half of the nonattaining waters were classified as such due to channelization and other drainage practices authorized by the Drain Code of 1956 (Category 4c). This percentage would increase considerably if intermittent stream mileage was included in the total.

The water quality in the Grand River basin has historically suffered from poor water quality due to unregulated discharges from municipal and industrial point source discharges. Water quality in the basin has steadily improved, and virtually all point source discharges are now regulated through the National Pollutant Discharge Elimination System (NPDES) permitting program administered by the MDEQ, Water Resources Division. Contemporary causes for nonattainment of water quality standards include poorly designed sanitary sewer systems that allow for combined sewer overflows (CSO) and sanitary sewer overflows (SSO) near urban centers, discharges from Confined Animal Feeding Operations (CAFOs), nonpoint source pollution from the lack of best management practices in the uplands, deposition of airborne pollutants, and localized degradation from contaminated sediments and venting groundwater from adjacent sites of contamination.

The USEPA, MDEQ, and USGS conducted the Lake Michigan mass balance project in 1994 and 1995. The study documented elevated loadings of pollutants coming from the Grand River into Lake Michigan. The mass balance study included 12 major Lake Michigan tributaries and focused on PCBs and trans-nonachlor, atrazine, mercury, and nutrients. These substances, among others, were studied because they are representative of classes of pollutants (i.e., persistent chlorinated compounds, herbicides, metals, etc.) of environmental significance in Lake Michigan and throughout the Great Lakes. Based on the analysis of the 1994–1995 data, the Grand River was reported to be one of the most significant contributors of contaminant loads to Lake Michigan (USEPA 1999). The Grand River had the highest annual total nitrogen loading (1.4×10^7 kg/yr) and second highest loading of the herbicide atrazine (approximately 400 kg/yr), and the second largest source for mercury. The Grand River was rated sixth in total PCB loads to Lake Michigan and was significantly lower than the Kalamazoo and Fox rivers, both of which are listed on the USEPA National Priorities List (Superfund) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (USEPA 2003, 2004).

Point Source Pollution

There are 189 municipal and industrial discharges to surface waters in the Grand River basin (Table 17a). These discharges are commonly referred to as point source pollution because the source of the pollutants is distinct. Discharges are permitted by the State of Michigan through the National Pollution Discharge Elimination System (NPDES), which regulates discharges to surface waters.

Discharges to the Grand River include effluents from municipalities: wastewater treatment plants, water treatment facilities, and storm sewers; industrial discharges: contact and noncontact cooling waters, process wastewater, sanitary wastewater, groundwater remediation sites; and miscellaneous discharges from trailer parks, campgrounds, concentrated animal feeding operations, and highway rest areas. Permits issued to these dischargers contain limits for parameters of concern (i.e. organic and inorganic toxicants, oxygen demanding pollutants, solids, nutrients, oil and grease, temperature, and chlorine) and are specific to each discharge. Water quality-based effluent limitations are developed based on the assimilative capacity of the receiving waters and incorporate a mixing zone, which is determined by the applicable volume, or design flow of the receiving waters. Permits are issued for five years and are reviewed by Water Resources Division staff before being reissued. Permit review and re-issuance is based on the location of the discharge, and the 8-digit USGS Hydrologic Unit Code for the receiving waters: Upper Grand River, Looking Glass/Maple rivers, Flat/Rogue/Thornapple rivers, and the lower Grand (Lesage and Wuycheck 2004). In general, permitted discharges are in compliance with specified limits and conditions contained in the NPDES permits.

Nonpoint Source Pollution

Nonpoint source pollution originates from diffuse sources and is delivered to surface waters through atmospheric deposition or through water transport. It can be generated locally (e.g., surface runoff from an agricultural field) or regionally (e.g., stacks for power plants). Pollutants associated with nonpoint sources include: nutrients, sediment, bacteria, bioaccumulative organic compounds, and other chemicals including metals, salts, etc. Sources of these pollutants include: agricultural fields, livestock feedlots, surface runoff from construction sites, parking lots, urban streets, uncontrolled septic seepage, groundwater contamination, open dumps, industrial sites, and inadvertent chemical spills.

Pollutants from diffuse nonpoint sources can exert an increased oxygen demand on the stream potentially lowering local concentrations of dissolved oxygen. Discharges of plant nutrients can lead to nuisance conditions and high diurnal fluctuations in dissolved oxygen concentrations. Introduction of increased sediment loadings can alter sediment transport mechanisms and destroy habitat due to bed aggradation. Additionally, metals, herbicides and pesticides, and other toxicants readily bond to fine sediments and can concentrate in depositional areas, potentially harming benthic organisms. Atmospheric deposition of mercury and PCBs is responsible for the general fish consumption advisory on inland lakes issued by the Michigan Department of Community Health.

Unlike the pollutant loadings from point source discharges, nonpoint source pollutant loadings in surface runoff from urban and agricultural lands are largely uncontrolled and contribute to water quality impairments throughout the Grand River watershed. Nonpoint source pollution may be best addressed through the implementation of best management practices (BMPs). BMPs are structural, vegetative, or managerial practices used to prevent, treat or reduce negative effects of pollutants on water or habitat quality (Peterson et al. 1993). Section 319 of the federal Clean Water Act provides funding for addressing nonpoint source problems. The MDEQ, Water Resources Division is responsible for providing grants to local agencies or organizations to develop watershed management plans with the goal of reducing nonpoint source pollutant loadings. Section 319 watershed management plans have been approved for: the Upper Grand River, Lower Grand River, Upper Looking Glass River, Upper

Maple River, Buck Creek, Coldwater River, Plaster Creek, and the Rogue River. Watershed plans are being drafted for other portions of the watershed (e.g., Thornapple River).

Storm Water Control

Storm water sewers can convey both point and nonpoint sources of pollution to the river. These discharges typically have elevated concentrations of dissolved solids and metals, and high nutrient and sediment loads. Because storm water collection systems typically drain large impervious areas, they can deliver flood pulses from relatively small rain events. Storm water discharges are regulated by the MDEQ, Water Resources Division or local unit of government. There are 714 permitted storm water discharges within the watershed (Table 17b).

Sites of Environmental Contamination (Part 201 Sites)

The Remediation Division of the MDEQ has identified 307 sites of environmental contamination within the Grand River watershed as of 2004 (Table 18). These sites are regulated under Part 201 of NREPA, 1994 PA 451 or the Comprehensive Environmental Response Compensation and Liability Act of 1980 as amended (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986. Part 201 provides laws and administrative rules for the identification and remediation of sites of environmental contamination, determines liable party responsibilities, and provides the regulatory framework for the remediation of these sites. Most of the listed sites have identified pollutants of concern in surface soils or groundwater and therefore are potential sources of contaminants to the Grand River main stem and tributaries. Corrective actions to control the further release of pollutants have been taken at most of the identified sites.

Dissolved Oxygen, Temperature, Nutrients, and Bacteria

Chemical and physical characteristics of water, such as temperature and dissolved gases, are important components of fish habitat and largely dictate the composition of the resident fish community. Summer temperature is one of the major factors in controlling growth, survival, abundance, and distribution of fish (Wehrly et al. 2003; Zorn et al. 2002; Zorn et al. 2004; Zorn et al. 2008). Fish species can be categorized based on their optimal thermal preferences, upper thermal tolerance limits, and temperatures at which they spawn. These categories are broadly classed as cold, cold-transitional, warm-transitional and warm (Lyons et al. 2009). Further, most fish require moderate levels of dissolved oxygen (above 3 mg/l) in order to survive. Standards for temperature, dissolved oxygen, and other parameters have been established to protect fish and other aquatic organisms. These standards are included in Part 4 Water Quality Standards (Part 31 of NREPA, 1994 PA 451) and are used when modeling water quality-based effluent limitations for NPDES permitted discharges (Table 13b).

MDNR Fisheries Division has collected stream temperature data at several locations on the main stem and numerous tributaries throughout the watershed. These data show that several tributaries are cold or cold-transitional streams with little variation in summer temperature (Table 19). This is consistent with the considerable groundwater flows to these streams. Although coldwater habitats are common in some of Michigan's northern watersheds, they are a relatively rare resource in the Grand River basin and should be protected through careful land use management.

Ambient chemistry monitoring has been conducted throughout the basin by the various federal, state, and county agencies prior to the signing of the Federal Water Pollution Control Act. Monitoring analyses included: temperature, dissolved oxygen, total and dissolved solids, chlorides, ions, nutrients, and toxicants. Many of these data have been archived in the US Environmental Protection Agency's Storage and Retrieval (STORET) database. The database can be accessed at http://www.epa.gov/storet. The more dated information, circa 1960 to 1999, is housed in the STORET Legacy database, while newer data are contained in the modernized format. Water quality data collected by the United States

Geological Survey is available at http://water.usgs.gov.nwis. Recent water chemistry analyses have been compiled for the main stem (Table 20) and select tributaries (Table 21). The following discussion provides a summary of water quality issues by main-stem segment.

Certain types of bacteria pose a health concern to humans and animals because they cause disease. *Escherichia coli* is the bacterium usually associated with human and animal waste. The total body contact standard (head immersion) is exceeded when there are over 300 *E. coli* colonies per 100 ml of water and the partial body contact (fishing, bathing) is exceeded with counts of 1,000 colonies per 100 ml of water. Regulatory compliance is based on geometric means of three or more samples within a defined sampling area. Bacteria sampling is conducted by the various County Health Departments and reported to MDEQ Water Resources Division. In some instances bacterial counts exceed standards, requiring swimming beach closures and potentially requiring the development of corrective measure (e.g., TMDL). Data regarding the results of monitoring activities can be accessed at http://www.mcgi.state.mi.us/miswims.

Headwaters

The water quality of the Grand River in the headwaters upstream from the City of Jackson is generally good. Water bodies identified as supporting designated uses include 42 miles of the main stem, 16 miles of assessed tributaries, and five inland lakes (Table 116). Areas of nonattainment include 25 miles on the main stem and Portage River due to untreated sewage discharges, violations of dissolved oxygen standards, and degraded biological communities. MDEQ has prepared TMDLs for biota (Wuycheck 2003), and dissolved oxygen (Sunday 2002) to restore designated use attainment in these areas. Other areas of nonattainment are related to fish consumption advisories due to elevated mercury concentrations in fish tissue.

There are 17 individual NPDES permits and 93 storm water permits issued for discharges to surface waters in the this valley segment (Tables 17a and 17b). The MDEQ has identified 36 sites of environmental contamination in the headwaters. Pollutants of concern include heavy metals, volatile organic compounds, waste oils, and polychlorinated biphenyls (Table 18).

Historical discharges, direct and indirect, from several area plating companies have resulted in elevated concentrations of heavy metals in main-stem sediments downstream of the City of Jackson (Rockafellow 2003a). Several of these contaminants exceed threshold and probable effects concentrations suggesting the potential for these sediments to be toxic to aquatic life (MacDonald et al. 2000).

Upper River Segment

Water quality is also good in the upper segment with portions of the main stem and 86 miles of tributaries identified as supporting designated uses. Nonattaining waters include seven miles of Columbia Creek, due to degraded biota as a result drain maintenance, and the Moores Park Impoundment for exceedances of fish consumption trigger levels for mercury in fish tissue.

The MDEQ has issued 10 individual discharge NPDES permits and 30 storm water related permits in this valley segment. Fifteen sites of environmental contamination have been listed by the MDEQ Remediation and Redevelopment Division.

Biological surveys conducted in this valley segment reported generally acceptable macro-invertebrate communities (Goodwin 2000; Rockafellow 2003b).

Middle River Segment

The middle segment and tributaries flow through the major urban areas of Lansing and East Lansing. Within this segment, there are 35 individual NPDES permits, 138 permitted storm water discharges, 72 sites of environmental contamination, five solid waste landfills, 11 hazardous waste management operations, and 50 permitted oil and gas development sites.

Exceedances of water quality standards in this valley segment include 12 miles of the main stem and Red Cedar River due to combined sewer overflows from the Cities of Lansing and East Lansing. During the warmer seasons, violations of the 5.0 mg/l dissolved oxygen standard have also been reported on the main stem and Red Cedar River (Sunday 2003). The main stem has a low current velocity through the City of Lansing resulting in reduced reaeration rates. During extended periods of high temperatures, fish kills as a result of low dissolved oxygen concentrations have been documented (Brunsen 1999). Biological surveys conducted at several locations on the main stem reported good to excellent macroinvertebrate communities upstream and downstream of the City of Lansing (Rockafellow 2003a).

One hundred and seventeen miles of tributaries were considered to be supporting designated uses in this reach (Wolf and Wuycheck 2004). Biological communities sampled in the Red Cedar River subwatershed were considered to be generally acceptable but some areas were limited by degraded habitat. Water and sediment chemistries were found to be within acceptable ranges for the measured parameters (Rockafellow 2003c). Water and sediment monitoring results in the Looking Glass River watershed were also reported to be within expected ranges, and no exceedances of water quality standards were identified. Fish and macroinvertebrate communities sampled during the survey indicated designated uses were supported (Roush 2003a).

Violations of the dissolved oxygen standard were also noted as the cause of nonattainment on 79 miles of tributaries. Other impairments include biological degradation and fish consumption advisories. Biological degradation due to drainage maintenance activities was reported on 188 tributary miles in this segment.

Lower River Segment

The lower main-stem segment includes drainage from the most significant tributaries in the watershed including the Maple, Flat, Thornapple, and Rogue rivers. Stream types in this segment range from high quality first order trout streams to the warm water reaches of the main stem. There are 107 individual NPDES permits (Table 17a) and 408 storm water permits (Table 17b) that authorize the discharge to the surface waters. Potential sources of contamination in the lower segment include 152 sites of environmental contamination, four solid waste landfills, 30 hazardous waste management operations, and 123 oil and gas operations.

Water quality sampling was conducted on the main stem of Grand River at several locations in 2003. No exceedances of Michigan's Water Quality Standards for measured parameters were documented, suggesting designated uses are largely being supported (Rockafellow 2005). The water quality standard for mercury was exceeded on the main stem in Ionia County (Wolf and Wuycheck 2004). Exceedances of the pathogen standard were also reported due to wet weather discharges from combined sewers in Kent County.

Biological and chemical monitoring surveys on the major subwatersheds in this valley segment document attainment of standards on approximately 630 perennial stream miles (Wolf and Wuycheck 2004). Attainment of designated uses as evidenced by the presence of good to excellent biological communities was reported at all sample locations in the Flat River subwatershed (Hanshue 2002a). The Rogue River subwatershed is also considered high quality and supporting designated uses. Water chemistry data for tributaries in this subwatershed tended to have low concentrations of nutrients and total solids, which is typical of groundwater dominated systems (Rockafellow 2003d). The lower portion of Prairie Creek in Montcalm and Ionia counties was also identified as a high quality tributary meeting coldwater designated uses despite extensive modification of the headwaters (Cooper and Rockafellow 2005). Water quality impairments due to agricultural runoff, nutrient enrichment, and habitat degradation associated with channelization were reported in the Maple River watershed (Hanshue 2002b; Roush 2003b; Rockafellow 2003e). Nutrient enrichment and habitat degradation were also identified as impairments in the Thornapple River (Hanshue 2002c; Rockafellow 2004). Degradation associated with hydrologic overloading from excessive storm water discharges has been reported in Plaster Creek and York Creek (Wuycheck 2002).

The MDEQ Water Resources Division classified 561 miles of perennial stream channel in the lower valley segment as nonattaining waters. A TMDL to restore 12 miles of Plaster Creek has been developed and TMDLs are scheduled to restore designated uses on approximately 115 miles of category 5 streams. Failure to support acceptable biological communities as a result of channel modifications and other activities undertaken pursuant to the Drain Code was documented on 434 miles of perennial water courses in this segment.

Mouth

There are 20 individual NPDES permits issued for this segment, and most of them are for sanitary wastewater treatment plants, noncontact cooling water, or the discharge of treated groundwater (Table 17a). The majority of the 45 storm water permits are for sites in Spring Lake and Grand Haven (Table 17b). There are 32 sites of environmental contamination, two hazardous waste management sites, one solid waste landfill, and eight oil and gas wells in this valley segment.

The main stem within this section is considered nonwadeable and limited biological sampling has occurred. Violations of pathogen and mercury standards on the main stem have been reported. Elevated concentrations of heavy metals, PCBs, DDE, and polycyclic aromatic hydrocarbons (PAHs) have been documented in Grand Haven, Harbor Island, and Middle Bayou (USEPA Great Lakes National Program Office 1999). Although many of these values exceed threshold and/or probable effects concentrations (MacDonald et al. 2000), additional study is necessary to determine the areal extent and magnitude of the contamination.

Tributaries meeting designated uses in this valley segment include Norris Creek, North Branch Crockery Creek and the main stem of Crockery Creek (Wolf 2000). Nonattaining waters include the entire Bass River subwatershed (66 miles) and the entire Deer Creek subwatershed (47 miles). These waters fail to support designated uses due to exceedances of standards for pathogens, dissolved oxygen, elevated nutrients, and degraded fauna (Wolf and Wuycheck 2004).

Fish Contaminants

As part of water quality surveillance activities, the MDEQ, Water Resources Division coordinates the Fish Contaminant Monitoring Program (FCMP) between several state and federal agencies and tribal organizations. The goals of FCMP are to: 1) evaluate whether fish contamination problems exist in specific surface waters; 2) identify spatial differences and temporal trends in the quality of Michigan's surface waters with respect to persistent, bioaccumulative chemicals; 3) evaluate whether existing pollution prevention, regulatory, and remedial programs are effectively eliminating or reducing chemical contamination in the aquatic environment; and 4) support the establishment or removal of public health sport fish consumption advisories by the Michigan Department of Community Health (MDCH). The Michigan fish contaminant monitoring program consists of both fish collections from streams and caged fish studies. MDCH is responsible for establishing, modifying, and removing sport fish consumption advisories for Michigan's surface waters. Fish samples are analyzed for contaminants and compared to the fish consumption advisory trigger levels (Table 22). If a concentration of contaminants exceeds a trigger level, a consumption advisory is issued for that species and water body.

Most fish consumption advisories in the Grand River watershed have been issued due to elevated tissue concentrations of PCBs. The advisories include the main stem from Grand Haven upstream to Webber Dam. Within this reach, women of child bearing age and children are advised to limit their consumption of common carp, channel catfish, northern pike, redhorse suckers, and walleye. The same advisory has been issued for Webber Dam upstream to the headwaters but also restricts consumption of white sucker. No consumption advisory exists for the general population for these species.

Restricted consumption of common carp and rock bass from the Flat River and common carp from Morrison Lake (Ionia County) is also advised to women of child bearing age and children.

In addition, there is an advisory on mercury for all inland lakes and reservoirs in Michigan. No one should eat more than one meal per week of rock bass, yellow perch, or crappie over nine inches or bass, walleye, northern pike, or muskellunge of any size. Mercury is an airborne pollutant that can contaminate lakes and reservoirs regardless of the environmental health of a watershed.

Anglers should consult the latest Michigan Fish Advisory published by the Michigan Department of Community Health, Environmental Epidemiology Division. Fish Consumption Advisories are published on the web at: http://www.michigan.gov/mdch.

Stream Classification

In response to concerns over increased consumptive water use and potential diversion of water resources, the Michigan legislature enacted Public Act 34 of 2006. The act required the development of an integrated assessment tool to determine the potential for water withdrawals to diminish or otherwise adversely impact water or water-dependent natural resources. To assess adverse resource impacts, a model was developed to determine how fish communities would respond to reductions in stream base flows. Model inputs included stream catchment size, base flow yield, and July mean temperature to predict fish community structure and characteristic fish assemblages in different river segments under a range of base flows. This model builds on the valley segments classification describe by Seelbach et al. (1997) and provides a landscape-based ecological classification system of streams in Michigan (Zorn et al. 2008; Lyons et al. 2009). Each stream reach is classified by size, (stream, small river, large river), thermal regime (cold, cold-transitional, warm-transitional, warm) and characteristic fish community (Figure 62). This classification system provides the ecological foundation for water withdrawal assessment process outlined by the Groundwater Conservation Advisory Council (GWCAC 2007) (see **Hydrology**, *Water Use*).

Special Jurisdictions

There are several federal, state, and local jurisdictions regarding rivers, riparian zones, and floodplains. The various MDEQ divisions administer some federal laws and several state statutes protective of the aquatic resources in the Grand River watershed (Table 23a and 23b).

Navigability

Issues associated with public rights on Michigan waters, including navigability, are discussed in detail by the MDNR Law Enforcement Division (MDNR 1993). Water laws are complex and are established through both legislative and judicial action. A navigable inland lake is any lake accessible to the public via publicly-owned lands, contiguous waters or highways, or via the bed of a navigable stream. It also must be reasonably capable of supporting a beneficial public interest, such as navigation, fishing, hunting, swimming or other lawful purposes inherently belonging to the people. A navigable inland stream is defined as: 1) any stream declared navigable by the Michigan Supreme Court; 2) any stream included within the navigable waters of the United States by the U.S. Army Corps of Engineers for the administration of the laws enacted by Congress for the protection and preservation of the navigable waters of the United States; 3) any stream which floated logs during the lumbering days or has sufficient capacity for the floating of logs in the condition which it generally appears by nature, notwithstanding there may be times when it becomes too dry or shallow for that purpose; 4) any stream having an average flow of approximately 41 cubic feet per second, an average width of some 30 feet, an average depth of about one foot, capacity of floatage during spring seasonal periods of high water limited to loose logs, ties and similar products, used for fishing by the public for an extended period of time, and stocked with fish by the state; 5) any stream which has been or is susceptible to navigation by boats for purposes of commerce or travel; 6) all streams that have been meandered by the General Land Office Survey in the mid-1800s (MDNR 1993).

The origin of utilizing the floating log test for navigability stems from a dispute during the logging era in which riparian landowners claimed water rights and tried to make a profit from them during log drives. A lawsuit over the issue on the Pine River in St. Clair County in 1853 clarified that a stream with capacity for floatage was navigable, and therefore all persons using it had equal rights. This set a legal precedent that not only allowed lumbermen to float logs downstream without interference from property owners, but has also been utilized for many other cases regarding navigability to the present time (Allen 1941).

Fisheries Division is interested in the definition of a navigable stream because anglers have the common interest of fishing in a navigable stream, subject to the restraints and regulations of state laws. For the water ways to best serve the public, recreational uses should be considered in the determination of navigability. There should be a means of determining the public accessibility of a stream without the need for judicial determination. “A statutory determination of a navigable stream is urgently needed to clarify the fishing, boating, and recreational rights of the public, as well as provide criteria of navigability, and direction to state agencies in the implementation of existing laws and regulations (MDNR 1993).”

The United States Army Corps of Engineers (USACE) exercises jurisdiction over several waterways in Michigan for the protection and preservation of the navigable waters of the United States. The areas of jurisdiction extend from their mouths to the heads of navigation as listed. For the Grand River, the USACE has jurisdiction from the mouth of the Grand River up to Fulton Street in Grand Rapids, 40 miles from the mouth.

The Michigan Supreme Court has adjudicated the navigability of several lakes and streams in the state. In the Grand River watershed, the Supreme Court has adjudicated the following waters as navigable (MDNR 1993):

- Grand River, Kent County, downstream from Grand Rapids
- Long Lake, Barry County
- Thornapple Lake, Barry County

The Michigan Supreme Court also, either by judicial notice or direct reference in opinions rendered during the period 1843–1930, indicated that some streams and lakes floated logs on a commercial basis during the early Michigan lumbering era. The streams in the Grand River watershed that were so noted are (MDNR 1993):

- Black Creek, Kent County, upstream to Flat Creek
- Flat River, Montcalm County, seasonably navigable
- Grand River, Kent County
- Looking Glass River, Shiawassee County, meandered

During the period 1837–1907, the Michigan Legislature by local act or general statute authorized construction on certain navigable streams in order to provide for the passage of boats, canoes, rafts or other watercraft and logs. These streams should, therefore, be deemed navigable by law downstream to their mouths from the indicated Legislature-authorized dam locations. In the Grand River watershed the affected streams are (MDNR 1993):

- Flat River, Section 30, T10N R8W, Montcalm County, Laws 1845
- Grand River, Section 28, T1N R2W, Ingham County, Laws 1843
- Looking Glass River, Section 8, T5N R3W, Clinton County, Laws 1837-38
- Red Cedar River, Section 25, T4N R1W, Ingham County, Laws 1842
- Thornapple River, Section 15, T4N R10W, Barry County, Laws 1837

Designated County Drains

There are over 4,400 designated county drains that make up over 5,100 miles of stream channel within the Grand River watershed. These values are estimates as a complete inventory of all designated drains is not available (Table 24). Additionally, the number and makeup of drains maintained by cities and villages throughout the watershed is unknown. Streams that are designated drains are under the authority of the Michigan Drain Code, Act 40 of the Public Acts of 1956, as amended, which is administered by an elected Drain Commissioner in each county. Among other authorities, the Drain Code grants the commissioner the authority to designate and maintain county drains. Maintenance activities include cleaning, dredging, straightening, widening, and enclosing. Many of these activities destroy instream habitats and result in impaired biological communities. Drains which were established before 1972 are largely exempt from the provisions of Part 303, Inland Lakes and Streams and Part 303, Wetland Protection, of the Michigan Natural Resources and Environmental Protection Act 451 PA 1994.

Michigan drain commissioners are also responsible for maintenance and operation of many lake-level control structures, particularly those established by the Inland Lake Level Act (PA 146 of 1961). Methods of operation are at the discretion of each Drain Commissioner. This can be a problem when riparian owners petition the Drain Commissioner to maintain unnatural lake levels. For example, it is common for riparian owners to want high water levels maintained during summer months for recreational boating and to maintain low water levels during winter and spring to prevent ice damage and flooding. Maintaining high water levels in summer can reduce or eliminate flow to an outlet, and low water levels in spring may prevent fish access to wetlands for spawning (see **Dams and Barriers**).

Parks and Natural Areas

There are numerous public conservation and recreational lands in the Grand River watershed. The MDNR is responsible for the maintenance of 28 state game areas, five state parks, four state recreation areas and one wildlife research area within the watershed (see **Recreational Uses**) (Table 25, Figure 63). Federal land holdings include the Schlee Waterfowl Production Area (WPA) near Jackson, the Edger WPA near Hastings, and approximately 1,700 acres of the Manistee National Forest in Muskegon and Newaygo Counties. There are also over 700 county and local parks, many of which provide public access to lakes or streams that would not otherwise have any access.

In addition to these public lands, several conservation groups (e.g., the Nature Conservancy, Audubon Society, Southwest Michigan Land Conservancy, etc.) have established natural areas or protected sensitive land though conservation easements. Some of these lands are quite large and are devoted to environmental education, while other, smaller tracts have been enrolled in conservation programs to restrict future development. Several of these properties are located on lakes and streams providing buffer zones between the water and adjacent developed areas. From a land and water management perspective, it should be a high priority to maintain and promote more natural riparian areas in the Grand River system.

Natural Rivers

Michigan's Natural Rivers Program was initiated in December, 1970 following passage of the Natural River Act, Part 305 of P.A. 451 of 1994 by the Michigan Legislature. This act authorizes the Department of Natural Resources, Fisheries Division, to develop a system of Natural Rivers in the interest of the people of the state and future generations. The purpose of such designation is to preserve and enhance a river's values for a variety of reasons, including; aesthetics, free-flowing condition, recreation, boating, history, water conservation, floodplain, and fisheries and wildlife habitat.

In the Grand River watershed, the Rogue and Flat rivers are designated Natural Rivers. Both are classified as country-scenic, denoting a river in an agricultural setting with narrow bands of woods or pastoral borders (MDNR 1973, 1979).

The Rogue River Natural River District is composed of the following areas (Figure 64):

a) main stem of the Rogue River from 20 Mile Road, section 14, T10N, R12W, in Kent County downstream to the confluence with the Grand River;
b) Barkley Creek from its headwaters downstream to the Rogue River;
c) Cedar Creek from its headwaters downstream to the Rogue River;
d) Duke Creek from its headwaters downstream to the Rogue River;
e) Rum Creek from its headwaters downstream to the Rogue River;
f) Shaw Creek from its headwaters downstream to the Rogue River;
g) Spring Creek from its headwaters downstream to the Rogue River;
h) Stegman Creek from its headwaters downstream to the Rogue River; and
i) the lands lying within 300 feet of the edge of the waters listed in subdivisions a–h.

Zoning and development restrictions in the Rogue River Natural River District require that new single family homes and associated buildings must be built on lots not less than 200 front-feet wide. On the Rogue River main stem, the setback from the river is 150 feet from the river's edge, and on the tributaries the setback is 100 feet. New structures also must be set back 50 feet or more from the top of a bluff on both the main stem and tributaries and no new structures can be located on land that is subject to flooding.

The boundaries of the Flat River Natural River District contain the following areas (Figure 65):

a) main stem of the Flat River from the Montcalm/Ionia County line to the northern limits of the city of Lowell, excluding those portions which flow through the incorporated city limits of Belding;
b) Dickerson Creek from the Montcalm/Ionia County line to its confluence with the Flat River;
c) Wabasis Creek from Mills Avenue, Oakfield Township, to the Kent/Montcalm County line;
d) Coopers Creek from Lincoln Lake Avenue, Spencer Township, to the Kent/Montcalm County line;
e) Clear Creek from Lincoln Lake Avenue, Spencer Township, to the Kent/Montcalm County line; and
f) the lands lying within 300 feet of the river's edge which are listed in subdivisions a–e.

Zoning rules in the Flat River Natural River District require new construction to be set back a minimum of 100 feet from the ordinary high-water mark or 25 feet from the 100-year floodplain, whichever is greater. In addition, new structures shall not be set back less than 50 feet from the top of a bluff, not less than 15 feet from side lot lines and not less than 25 feet from the right-of-way of a public road. New structures cannot be located on land that is subject to flooding.

Clean Water Act

The Clean Water Act is a 1977 amendment to the Federal Water Pollution Control Act of 1972. It sets the basic structure for regulating discharges of pollutants to waters of the United States. Section 404(b)(1) of this act gives the federal government authority to regulate discharges of dredged or fill materials. The State of Michigan administers Section 404 regulations for the federal government in Michigan using the Michigan Natural Resources and Environmental Code, Public Act 451, Parts 31, 301, and 303, 1994. Any dredging or filling of material within a floodplain or associated wetland within the Grand River watershed requires a permit from the Department of Environmental Quality.

In addition, the federal government retains authority to regulate dredge and fill activities under Section 10 of the Federal Rivers and Harbors Law and is administered by the U.S. Army Corps of Engineers. Section 10 regulation in the Grand River watershed includes the following areas:

- Grand River to Fulton Street bridge in Grand Rapids and all bayous in Ottawa County contiguous to the Grand River
- Crockery Creek up to I-96; T8N, R15W, Sec 23 (Ottawa Co.)
- Spring Lake to Airline Rd; T9N, R16W, Sec 36 and all contiguous bayous
- Norris Creek to upstream of Fruitport Road/Bridge Street; T9N, R16W, Sec 36

Coastal Zone Management

The Coastal Zone Management Program is administered by the Department of Environmental Quality. The Coastal Zone Management Act (CZMA), originally passed in 1972, enables coastal states, including Great Lakes states, to develop a coastal management program to improve protection of sensitive shoreline resources, to identify coastal areas appropriate for development, to designate areas hazardous to development and to improve public access to the coastline. The Coastal Zone Management Program provides grants to local units of government and administers coastal related sections of the Natural Resource and Environmental Protection Act, 1994 PA 451 (MDEQ 2005a).

The coastal zone designation for the Grand River watershed includes the Grand River, Spring Lake, and Grand River bayous upstream to Robinson Township, a distance of approximately nine miles.

Critical Dunes

Critical Dune areas represent the tallest and most spectacular dunes extending along Lake Michigan's and Lake Superior's shoreline and comprise approximately 70,000 acres. These dunes are considered to be a unique, irreplaceable, and fragile resource that provides significant recreational, economic, scientific, geological, scenic, botanical, educational, agricultural, and ecological benefits to the people of Michigan. They are protected under Part 353 of NREPA PA 451 of 1994 as administered by the MDEQ. Any earthmoving, vegetation removal or construction activities with a critical dune area are regulated through a permit program (MDEQ 2005b).

Within the Grand River watershed, the critical dunes are located in Grand Haven and Spring Lake townships to the north and south of the river mouth.

Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is authorized under the Federal Power Act of 1920, as amended, to license and regulate hydroelectric facilities that meet one or more of the following criteria pursuant to Section 23 (b) (1) of the Act: 1) the project is located on a navigable water of the United States; 2) the project occupies lands of the United States; 3) the project utilizes surplus water or water power from a government dam; or 4) the project is located on a body of water over which Congress has Commerce Clause jurisdiction, project construction occurred on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce. Presently when a project is being licensed or relicensed, power and nonpower aspects of a project are balanced by FERC, and the resulting license issued for the project contains specific articles to protect natural resources in the project area. Licenses are administered and enforced by FERC with MDNR Fisheries Division having a consultation role in both the licensing and enforcement proceedings (O'Neal 1997).

Tribal

There are portions of the Grand River located within the 1836 Treaty-ceded territory described by the 1836 Treaty of Washington (Figure 66). In 2007 the State of Michigan, United States government and five Michigan Indian tribes reached joint agreement which outlines and describes the extent of hunting, fishing, and gathering rights in this Treaty area. Harvest of natural resources within these boundaries is subject to the provisions and agreements contained in the 2007 Inland Consent Decree (United States *v* State of Michigan 2007).

Biological Communities

Original Fish Communities

There is a lack of information on the fish communities in the Grand River watershed prior to European settlement. Based on evidence collected from archaeological sites and historical accounts from early settlers, it is evident that lake sturgeon was an important resource to residents from the Woodland period until the 1850s.

Lake sturgeon remains are common artifacts at many archaeological sites in the valleys of the Grand, Kalamazoo, and St. Joseph rivers where they migrated upstream to riffles for spawning. Such large congregations of fish in relatively shallow water allowed them to easily be speared from shore or canoe (Martin and Brashler 2002). Harvesting of lake sturgeon has been attributed as the main reason for choosing a habitation site during the Middle Woodland period (Martin and Brashler 2002). Historical accounts suggest lake sturgeon were harvested from the main stem of the Grand River as far upstream as Eaton Rapids (Darling 1950). The main food of early pioneers in the Grandville area was sturgeon, then plentiful in the river (Kent County Library Staff 1975).

Mrs. Henry Leonard, an early settler in Lyons, described how the Native Americans would form a line with their canoes across the river and advance, shouting and splashing water, to drive lake sturgeon into shallow water before spearing them. The fish were salted and smoked and then stored for winter food (Leonard 1965).

Early settlers in Ionia during a long winter lived on "corn cake and maple sugar, with a piece of smoked sturgeon, or a venison steak occasionally" (Everett 1878). Lake sturgeon were so plentiful in Stony Creek that an early settler was overheard having an imaginary conversation with his family back home remarking, "Oh, if you old folks could only know how we're living out here in Michigan" (Schenck 1881).

"…the dam across the river was an obstacle to the upward passage of fish, which they had never before met. Consequently there was in this spring an unprecedented catch upon the rapids, of sturgeon, pickerel, bass, suckers, and other members of the finny tribe, to the great sport and profit of fishermen, with spears and nets" (Baxter 1891). This early documentation of a barrier to the spawning run, combined with the extensive harvest of spawning adults points to the probable causes of the decline in lake sturgeon populations in the Grand River basin.

Historical accounts also mention early settlers gathered fish from the river as a popular food source, but these references are usually limited to a few species:

"The river was fairly alive with fish, and the men caught large numbers of them. It was nothing unusual for a man to take his spear, step to the river bank, and spear a good sized bass or pickerel for his meal" (DeLand 1903).

". . .every fall father made an outing with others to Battle Point down the river and put up barrels of black bass in salt…"(Belknap 1922). Battle Point is located approximately eight miles upstream of the Lake Michigan confluence.

"While the big lakes furnished whitefish, trout, muskellunge, and even sturgeon, the settler depended most on what was near at hand. That meant black bass, sucker, and pike from the small lakes with sunfish and other small fry from the rivers and streams" (Davenport 1950).

Factors Affecting Fish Communities

The landscape of Grand River watershed changed dramatically during European settlement. These changes resulted in alterations to the physical character of the river and its tributaries and affected the composition and productivity of the fish community. Effects of point and nonpoint source pollutants, dams, agriculture and urban development, and nonnative species introductions are discussed in greater depth in **Geology**, **Hydrology**, **Channel Morphology**, **Dams and Barriers, Soils and Land Use**, and **Water Quality.** The cumulative effects of these human activities have produced present day fish communities and fish distributions.

Stream fish often require different habitats for spawning, feeding, and refuge and must be able to migrate between these habitats to complete their lifecycles (Schlosser 1991). Human activities that alter spawning, feeding, or refuge habitat or that limit access to these critical habitats can negatively affect fish communities by disrupting a portion or all of a species lifecycle. In some instances these actions can result in the isolation or extirpation of a species (see **Biological Communities**, *Present Fish Communities*).

The original fish habitat was greatly altered by European settlers and their activities. Presettlement vegetation along the banks originally provided shading and bank stabilization. This vegetation consisted largely of stands of beech, sugar maple, mixed oak, and coniferous swamp forests (Comer 1996). Downed trees and logs in the presettlement era provided an abundance of fish habitat both directly and by creating undercut banks. In some portions of the main stem, large wood accounted for much of the historical instream fish habitat, with as many as 20 large logjams per river mile (Sedell and Beschta 1991). Some of the earliest alterations to the river included the removal of large amounts of "floodwood" to open the river to unimpeded navigation. These logjam removals resulted in the loss of instream habitat both directly and through channel destabilization and sedimentation.

The logging era denuded much of the landscape, and most of the major tributaries and the main stem Grand River were used to transport logs which had major negative effects for the fish community. With the logging came removal of bank vegetation and habitat, destabilization of stream channels and banks, channel scouring from log drives, and the construction of dams and mills. These landscape scale changes resulted in mass soil erosion, increased sedimentation, and changes in stream temperatures. Due to lack of vegetative cover, flashiness of flow became more common. Negative effects on fish communities resulted from loss of critical habitat and reduced water quality.

Following the logging era, further changes to the landscape included clearing of land for agricultural development. Significant losses of functional wetlands through draining and filling reduced the storage capacity of the watershed resulting in altered stream flow patterns and increased flashiness in the river system. Altered flow regimes resulted in warmer and more variable water temperatures favoring more tolerant species. Channelization (dredging) reduced habitat diversity by removing instream cover and eliminating natural glide-riffle-run-pool sequencing and meanders of streams. The erosion that resulted from poor conservation practices and altered flows also buried gravel, cobble, and rock substrates, further reducing the biological productivity of the river.

Development of large population centers in the watershed has also negatively affected fish communities. Roads, impermeable surfaces, and storm sewer systems speed delivery of water to stream channels resulting in higher peak flows, warmer temperatures, and increased pollutant loads. Prior to the passage of the Clean Water Act, the Grand River was viewed as a convenient conveyance for municipal and industrial wastewater discharges. In 1970, a comprehensive study of the Grand River documented degraded fish and aquatic macroinvertebrate communities as a result of poor water quality (MDNR 1970). Species abundance and diversity were severely limited, and aquatic species known to be intolerant to pollution were eliminated from portions of the river. Prior to the upgrading of municipal wastewater treatment plants, fish kills resulting from low dissolved oxygen concentrations were common in areas downstream of the large urban areas. By 1978, water quality began to improve but was still lower downstream of the main metropolitan areas of Jackson, Lansing, and Grand Rapids. In 1978, it was noted that common carp were present throughout the river but were present in higher numbers below the major metropolitan areas (Nelson and Smith 1981). Discharges of untreated or partially treated sewage, toxicants, and bioaccumulative compounds have been largely controlled but continue to reduce the productivity of the biological community. Degraded habitat conditions in the large urban areas tend to favor more tolerant, less desirable fish and macroinvertebrate communities.

Dam construction has long term effects on the distribution and composition of the fish community. Unlike pollutant loadings that can be controlled through end-of-pipe treatment or implementation of BMPs, the negative effects of dams on fish communities are typically not addressed until the structure reaches the end of its design life. These structures alter the natural flow of water and sediment, fragment the continuity of a river, isolate fish populations, block fish movements, inundate higher gradient habitats, alter thermal regimes, and degrade water quality (see **Dams and Barriers)**. These changes are responsible for reduced fish biodiversity. As a result of dam construction, fish movement from the main stem into the Rogue, Thornapple, and Flat rivers has been largely eliminated (Figure 67). Similar to dams, improperly designed road crossings can act as barriers to the movement of fish. These crossings can eliminate access to critical habitats necessary for spawning, feeding, or refuge from harsh conditions (see **Soils and Land Use**, *Bridges, Culvert, and Stream Crossings*).

Long term hydrologic alterations affect fish and fish habitats. Intra-annual variation in hydrologic conditions is essential to the successful life-cycle completion for many aquatic and riparian species (Poff and Ward 1989; Richter et al. 1996, 1997). Seasonal high flows serve as an environmental cue to many species of fish, triggering movements to upstream spawning areas. During periods of high flow, riparian wetlands become flooded and provide nursery habitats for fish and other aquatic organisms. Changes in the timing or magnitude of these flows can reduce or eliminate access to these important habitats. Dams, channelization, levy construction, and water withdrawals can alter natural flow regimes and modify the distribution and availability of riverine habitat conditions, with adverse consequences for fish and other aquatic biota (Poff et al. 1997; Poff and Zimmerman 2010).

Several nonindigenous species have been intentionally or accidently introduced into the Grand River watershed and have also greatly affected fish communities. Introduced species influence the native fish community directly through competition or predation, or indirectly through habitat alterations (e.g., common carp). Inadvertent introductions result from discharge of ballast water, shipping canals, bait bucket releases, and unauthorized stockings. Many times introduced or colonized species tend to outcompete and displace native fish species (see also Aquatic Nuisance Species).

Present Fish Communities

Fish diversity and distributions are largely dictated by catchment size, thermal regime, hydrologic stability, and current velocity (Zorn et al. 2008; Zorn et al. 2009). Knowledge of species attributes and local fish communities is necessary for proper management of the resource. This information can guide managers in assessing the quality of the resource and making informed decisions regarding stocking or recommendations for rules governing harvest. Knowledge of species distribution is also necessary for the development of statewide and regional planning documents such as the Wildlife Action Plan.

One hundred eight fish species representing twenty three families are currently known in the Grand River watershed (Table 26). The list includes 13 taxa that were introduced by direct and indirect human activities. Maps of current fish distributions (Appendix A) were prepared based on previous collections by the MDNR Fisheries Division, the MDEQ Water Resources Division, historical collections cataloged at the University of Michigan Museum of Zoology, and literature (Bailey et al 2004; Hubbs, Lagler, and Smith 2004; Latta 2005). Supplemental information was collected by MDNR Fisheries Division during several main-stem fish surveys from 2004–2006. Several species inhabiting Lake Michigan utilize the Grand River main stem or its tributaries on a seasonal basis; these species were included to document this portion of their range. Many species can be found throughout the entire watershed, while others have patchy distributions. The pugnose shiner is an endangered species in Michigan, and the lake sturgeon, cisco, and river redhorse are currently listed as threatened (MDNR 2009). Several other species have been identified in the Michigan Wildlife Action Plan as Species of Greatest Conservation Need (SGCN) suggesting the need for more comprehensive monitoring of native fish populations (Eagle et al. 2005; Table 26). Fish communities are characterized more extensively within the following main-stem segments.

Headwaters

Fish community samples were collected on the main stem and Portage River by the MDEQ Water Resources Division in 1996 (Goodwin 2000). The main stem was sampled at two locations upstream of Jackson. The stream channel was characterized as low gradient with moderate sedimentation. The survey reported the collection of 25 fish species. The collection included several centrarchid species including smallmouth bass and largemouth bass. Several intolerant species including redhorse and darters were noted in the collection. The collection also included greenside darter, a species not previously reported at this location.

The Portage River is the largest tributary in this segment. The river has been historically channelized through wetland areas and is overly wide resulting in pool type habitat with deep accumulations of organic sediments. Violations of water quality standards in the Portage River required the development of a TMDL for dissolved oxygen (Sunday 2002). During the 1996 surveys 18 species were collected, with bluegill and pumpkinseed sunfish being the most abundant. Intolerant species were absent from the sample (Kosek 1997).

Upper River Segment

Through much of this segment, the river is low gradient with a wide, forested floodplain. Large woody material, overhanging vegetation, and deep runs are common, with submerged vegetation and pools being less common. Thirty seven fish species were reported from boomshocking surveys conducted near Eaton Rapids, Dimondale, and the Moores Impoundment during 2004 (MDNR, FD, unpublished data). The fish community is predominately warmwater although some species classified as warm-transitional are present (Lyons et al. 2009). Centrachid, cyprinid, and castostomid species are well represented in this segment of the river. Northern pike, walleye, and channel catfish were the game fishes present at most of the seven survey locations. These surveys documented the presence of greenside darter, the first report of this species in this segment. Species of Greatest Conservation Need (SGCN) collected included golden redhorse and striped shiner. Redear sunfish were collected at two locations near Eaton Rapids. This species is introduced and likely colonized this portion of the main stem after being stocked in upstream lakes. The weed shiner is an extirpated minnow species that once occurred in the upper main-stem segment. The last report for this species in this area was 1941.

Sandstone Creek and Spring Brook are the largest tributaries in the upper segment. Sandstone Creek was surveyed at three locations by the MDEQ Water Resources Division in 1996 (Rockafellow 2003f). These fish collections recorded 24 species with cyprinids composing most of the catch. The lower reach of Sandstone Creek is impounded at Minard Mill. The influence of the impoundment was indicated by the increase diversity of sunfishes immediately below the dam. Fantail darter (SGCN) was also reported in the collections.

Spring Brook was surveyed in 1984 and in one location in 2001 (MDNR unpublished data). The headwater portions of Spring Brook are in a flat wetland plateau and have been historically dredged resulting in limited habitat. Species composition in this reach is limited to brook stickleback, central mudminnow, and johnny darters. In the downstream reaches, gradient increases and substrates become coarser. The fish community in these reaches is more diverse and contains smallmouth bass, rock bass, northern pike, and several darter and minnow species.

Middle River Segment

The middle main-stem segment gains in size with the addition of two large tributaries, the Red Cedar and Looking Glass rivers. Habitat in this segment alternates between free flowing and impounded reaches as the river is blocked by six main-stem dams. The streambed substrates in this segment range from coarse sands and gravel to localized bedrock near the City of Grand Ledge. Beds of aquatic vegetation are more prominent in this reach as the channel widens and becomes less shaded. The thermal classification of the main stem and tributaries in this segment is warm (Zorn et al. 2008). Thirty-nine fish species were collected with a boomshocker from six main stem locations during 2005. Cyprinids, catostomids, and centrarchids accounted for the highest species diversity and abundance. Several species associated with larger water were collected at the lower reaches of the segment including silver redhorse, quillback, and flathead catfish. These species have not been reported from the main stem at locations above the Webber Dam. Species diversity and abundance were lowest in the Lansing area. The fish community was sampled between the North Lansing and Moores Impoundment Dams, a stream reach with known water quality impairments (Table 15). Diversity and abundance were highest in the free-flowing portions of the river downstream of the Portland and former Wagar dams. The middle segment represents the upper bounds for migration of Chinook salmon, coho salmon, and steelhead. Based on fall monitoring of salmon passage, averages of 2,500–3,500 coho salmon ascend the main stem past Webber dam (Dexter 2002; Taylor and Wesley 2009). Many of these fish continue their migrations up Carrier Creek and the Red Cedar and Looking Glass rivers.

The fish community in the Red Cedar River is relatively diverse and contains a mix of warm and warm-transitional species (MDNR 1992; Zorn et al. 2008; Lyons et al. 2009). Common centrarchids include rock bass, green sunfish, bluegill, largemouth bass and smallmouth bass. Collections reported for the lower reaches include five sucker species, eight species of cyprinids, and four species of darters. Coho salmon and steelhead are present on a seasonal basis.

Twenty six species of fish were reported during recent surveys of the Looking Glass River (MDNR-FD unpublished data). The collection was dominated by rock bass, green sunfish, common shiner, and bluntnose minnow. The remaining nine minnow species accounted for approximately thirty percent of the catch. Five Species of Greatest Conservation Need, black redhorse, grass pickerel, river chub, pirate perch, and stonecat, were reported from this location. The survey also reported an isolated population of flathead catfish.

Lower River Segment

The lower main-stem segment is a large warm river and includes drainage from the Maple River, Prairie Creek, Flat River, Thornapple River, and Rogue River. In addition to these larger tributaries, several smaller cold, cold-transitional, and warm-transitional tributaries discharge to the main stem providing a variety of thermal microhabitats. Channel form is diverse, ranging from relatively shallow riffles and runs to deep pools. In some portions, the channel is constrained in a valley and in other locations the channel meanders through a wide floodplain. The river in this segment supports a diverse fish community (MDNR-FD unpublished data). Catostomid diversity is very high with 11 of the 15 Michigan species present. Surveys conducted during 2005–2007 documented the presence of the state-threatened river redhorse throughout the entire segment. Sunfish and minnow assemblages are also diverse with nine and 16 species, respectively. This portion of the river supports good populations of channel catfish, flathead catfish, largemouth bass, smallmouth bass, and walleye. Other species of interest found in this segment include: black buffalo, black redhorse, golden redhorse, spotted sucker, river chub, striped shiner, and grass pickerel, all of which are identified as SGCN (Eagle et al. 2005). The influence of Lake Michigan on the composition of the fish community is seasonally apparent as potamodromous species including lake whitefish, round whitefish, lake trout, longnose sucker, lake sturgeon, brown trout, steelhead, Chinook salmon, coho salmon, and sea lamprey ascend the river. With the exception of the salmon and steelhead, upstream movement of these species is blocked by the Sixth Street dam. In the days of early settlement, the lake sturgeon was common in the lower and mouth segments. Due to over fishing and habitat fragmentation the species is now on the list of threatened species in Michigan. Recent surveys targeting this species reported a remnant but stable population in the river below the Sixth Street Dam.

The Maple River was part of a large glacial river that drained Lake Saginaw to Lake Chicago (see **Geology**). The river is low gradient and has an especially low base flow yield. The Maple River is known for its unique fish population that includes flathead catfish, channel catfish, white crappie, black crappie, northern pike, largemouth bass, smallmouth bass, rock bass, and walleye. The river is open to migratory fish species capable of navigating the fishway at the Sixth Street dam. Quillback, Chinook salmon, coho salmon, and steelhead have been reported in the watershed. Species with limited distribution in the Grand River watershed are recorded from this drainage including redfin shiner, brassy minnow (SGCN), river redhorse (threatened), stonecat (SGCN), tadpole madtom (SGCN), pirate perch (SGCN), and least darter (SGCN).

Major tributaries to the Maple River are Stony Creek and Fish Creek. Stony Creek was most recently surveyed in 2003. Although habitat is limited as a result extensive channelization, it does have a fairly diverse fish population with smallmouth bass being the primary game fish. Fish Creek is a cold stream in its headwaters and supports self-sustaining populations of brook trout and brown trout. Further downstream, it becomes a warm-transitional stream as it receives inputs from several small, warm tributaries. The fishery in this portion of the stream is maintained with annual stockings of brown trout (see **Fisheries Management**).

The headwaters of Prairie Creek are located in Montcalm and Ionia counties. The creek begins as a cold-transitional small stream and becomes a warm-transitional small river as it gains inputs from several warm tributaries. The fish community is relatively diverse with 25 species collected during a recent survey. Prairie Creek also supports a significant coldwater fishery for brown trout and steelhead.

Although both trout species are stocked on an annual basis, natural production of steelhead is significant (P. Seelbach, MDNR Fisheries Division, Personal communication).

The Flat River originates in southern Mecosta and northern Montcalm Counties. It gained its name from the Native American word Kau-bau-gwas-shee, flat like a belt of wampum (Augustine 1971). The Flat River supports a diverse warmwater fish community with several species of cyprinids, centrarchids, and percids (Hanshue 2002a). Sucker diversity in the Flat River is reduced, likely a result of the dam at the mouth which blocks migrations. It is best known for its smallmouth bass fishery. Some of its tributaries also support naturalized trout populations.

Spring Brook is a coldwater tributary that flows into the main stem near the City of Lowell. This stream was historically managed for trout and was stocked with brook trout from 1938 through 1951. Recent fisheries surveys report Spring Brook contains a naturalized population of brook trout and is utilized to some extent by spawning steelhead. Other species present in this tributary include mottled sculpin and creek chub.

Similar to the Flat River, the Thornapple River contains a diversity of warmwater fish species (MDNR-FD unpublished data; Hanshue 2002c). The headwaters of the Thornapple River drain primarily agricultural lands in Eaton County. The channel in this location is characterized as low gradient and quality riffle/run habitats are limited. As the river begins to cut through glacial moraines, gradient increases and coarser substrates (gravel, cobble) become more prevalent. The river supports good populations of smallmouth bass, northern pike, walleye, and various panfish species. Habitats in the lower segment are highly fragmented by five dams. An isolated population of the threatened river redhorse was recently reported in the river reach near the Cascade and Ada dams (MDNR-FD, unpublished data). Several tributaries to the Thornapple River are classified as cold- or cold-transitional streams and are managed for brown trout fisheries.

The Rogue River is a medium-sized system that changes from a warm-transitional to cold-transitional as localized groundwater inputs increase. The Rogue River supports a popular stocked brown trout and rainbow trout fishery above the dam at Rockford. Downstream of the dam the river is known as a good steelhead fishery. Several of its tributaries, including Duke, Cedar, Stegman, Shaw, and Rum creeks have self-sustaining brook trout and brown trout populations.

Several tributaries join the main stem in the vicinity of Grand Rapids. Honey, Egypt, Bear, Scott, Sunny, Mill, and Strawberry creeks are relatively small cold- and cold-transitional streams that were historically stocked. These streams currently support small self-sustaining populations of brown trout. York Creek was stocked with brook trout during 1933–1941 and once supported a popular fishery. In the past 20 years the stream has changed dramatically. In the mid-1980s land use was a mix of agricultural and low density residential. A large golf course was located in the central portion of the watershed. Since that time, the golf course was sold and developed into retail stores and housing complexes. The conversion of permeable soils to imperious surfaces, and rapid routing of storm water to the creek resulted in unstable hydrology and channel morphology. As the habitat quality lessened, the brook trout population declined. Brook trout were last reported in York Creek in 1991.

Limited historical information is available for Plaster Creek. It has long been an urbanized watershed with severe flooding and storm water control problems. The available information indicates the creek contains a warmwater fish community (e.g., bluegill, green sunfish, rock bass, black bullhead, and various minnow species).

Buck Creek begins as a cold-transitional stream and changes to a warm-transitional stream in the lower half of the watershed. The stream flows through an urban environment and is the receiving water for relatively large amounts of storm water runoff. Water temperature data for this stream is limited and indicates that mean temperatures are at the upper thermal limits for supporting trout populations. The stream is stocked annually with brown trout. Other fish species reported in the watershed include black crappie, bluegill, green sunfish, largemouth bass, and yellow perch.

Sand Creek has a predominately agricultural watershed with some residential land use in the lower section. A few brown trout were stocked in the early 1970s, but it does not have an extensive management history.

Mouth

The fish community composition of the mouth segment reflects the large channel size and open connection to Lake Michigan. Largemouth bass, bluegill, freshwater drum, gizzard shad, and several species of redhorse suckers and minnows are common. Several Lake Michigan species enter the lower river on a seasonal basis. Recent observations indicate that lake sturgeon are successfully spawning in the mouth segment. The shallow habitats in the braided section of the channel provide nursery habitat for juvenile lake sturgeon and other fish species.

Crockery Creek originates in Newaygo County and flows in a southerly direction to join the Grand River main stem west of the Bass River. Crockery Creek and some of its tributaries are cold-transitional streams and are stocked with brown trout and steelhead (see **Fishery Management**).

Aquatic Invertebrates

Invertebrates are an important and diverse component of lakes and streams. Organisms in this grouping include sponges, moss animals, worms, arthropods (scuds, sowbugs, spiders, and crayfish), insects (mayflies, stoneflies, caddisflies, dragonflies, beetles, etc.) and mollusks (snails. clams, and mussels). They are an important food source for fish and other animals including birds, mammals, reptiles, and amphibians. Although invertebrates play a significant role in the ecology of river systems, as a group their value is largely overlooked by the public. The general public tends to view most invertebrates with aversion and avoidance (Kellert 1993). Recent national assessments on the conservation status of invertebrates have revealed some alarming trends (Master et al. 2000). These assessments noted a disproportionate number of aquatic organisms in need of conservation attention when compared to those of the terrestrial environment. This is especially true of freshwater mussels (Williams et al. 1993; Strayer 2008) and crayfishes (Taylor et al. 1996, 2007). These assessments have increased awareness regarding the plight of these imperiled groups. More ambitious educational programs are needed to enhance public recognition of the positive values of these organisms.

Invertebrates are less mobile than fish and are often used to assess water and habitat quality (Statzner and Higler 1986; Loeb and Spacie 1994; Hauer and Lamberti 1996; Rosenburg and Resh 1996). For example, most mayfly, caddisfly, and stonefly species are sensitive to degraded water quality and therefore are excellent indicator organisms. Several surveys of aquatic invertebrates have been conducted on major tributaries within the Grand River basin. Aquatic biologists with the MDEQ, Water Resources Division inventory invertebrates as part of the State of Michigan water quality surveillance program. Beginning in 1991, the Water Resources Division implemented qualitative multimetric bioassessment protocols (Procedure No. 51 MDEQ 1990) to evaluate the relative biological integrity of wadeable streams throughout the State of Michigan (see **Water Quality)**. The underlying premise is that better stream quality is normally indicated by greater macroinvertebrate diversity and a greater abundance of pollution-sensitive organisms (e.g., mayfly, stonefly, caddisfly). Conversely, streams with degraded water quality or limited habitat would support overall lower diversity and an abundance of pollution-tolerant organisms (isopods, leeches, surface dependent taxa) would indicate persistent, degraded stream quality (Lenat and Barbour 1994; Davies and Jackson 2006). These data were compiled for the main stem and select tributaries by valley segment (Tables 27–31). Because these bioassessment protocols were developed for wadeable streams, information regarding the distribution of aquatic insects is limited for the Grand River main stem in the lower and mouth valley segments.

Freshwater Mussels

Freshwater mussels are an important component of the biodiversity of Michigan's aquatic ecosystems. They have a unique ecological role in both rivers and lakes and are valuable indicators of ecosystem integrity. The diversity and distribution of freshwater mussels in Michigan were greatly influenced by the connection of southern Michigan waters to the headwaters of the Mississippi River during glacial recession. As a result of this connection, the majority of the species present in the state are found in the southern half of the Lower Peninsula or below the Saginaw-Grand Valley region (van der Schalie 1941). A total of 45 species have been reported in Michigan lakes and rivers, with 32 of them present in the Grand River watershed (van der Schalie 1941 and 1948; Goforth et al. 2000; Badra and Goforth 2002).

Mussels are of significant value to the health of aquatic ecosystems. They are a food source for some fish (e.g., river redhorse) and terrestrial predators (e.g., muskrat, raccoon, river otter) and often comprise a significant amount of the total biomass of all benthic invertebrates (Strayer et al. 1994, Strayer 2008). The spent shells also serve as physical habitat and are often colonized by a variety of aquatic insects and other macroinvertebrates. Since they are important filter feeders, they may play an important role in nutrient uptake and increasing water clarity. Freshwater mussels are comparatively sensitive to declines in habitat and water quality. Because mussels are generally long-lived, are relatively immobile, and are reliant on fish host for both reproduction and dispersal, their community status can provide an integrative view of physical, chemical, and biological changes in the watershed (Grabarkiewicz and Davis 2008).

In North America, freshwater mussels have been identified as the most imperiled of any major group of animals (Williams et al. 1993; Master et al. 2000; Strayer 2008). Of the 45 mussel species found in Michigan, 19 (42%) are listed as either endangered or threatened pursuant to Part 365, Endangered and Threatened Species, of NREPA (1994 PA 451) (MDNR 2009). An additional eight species are in decline and are identified as Species of Special Concern (http://web4.msue.msu.edu/Mnfi/). The primary reasons for decline of unionid mussels include habitat loss as a result of dam and road construction, stream channelization, water quality degradation, siltation, alterations to natural streamflow, over harvest, and the introduction of nonindigenous species such as zebra mussels (Williams et al. 1993; Watters 2000; Strayer 2008). In some instances these human actions can result in immediate population reductions (e.g., poaching, discharge of a toxicant), whereas other anthropogenic impacts may take decades to be fully expressed. For example, dam construction and operation may limit mussel reproduction by blocking necessary host-fish species or may suppress reproduction as a consequence of discharging cold-hypolimnetic waters. Because mussels are long-lived, the loss of recruitment as a result of the dam may not be manifested as a localized extirpation for decades.

Humans have long utilized the vast mussel beds in the Grand River valley. Native Americans utilized the meat of mussels for food and the shells as spoons, hoes, and scraping tools (Griffin et al. 1970; Martin 1993). In the early part of the 20^{th} century, mussels were harvested from the Grand River for the production of buttons (see **History)**.

In 1922, a report by the U.S. Bureau of Fisheries listed 4,825,170 pounds of shell were taken from Michigan streams with a value of $196,026, but by 1935, the then Conservation Department reported that 479,952 pounds of shell were taken with an estimated value of $8,942 (van der Schalie 1938). Grand River mussel populations had declined so dramatically by the late 1930s that the Michigan Conservation Commission declared a closed period of five years beginning January 1, 1944 with the hope that mussel populations would rebound (van der Schalie 1948). In 1945, a survey of the Grand River was conducted to determine if mussel populations had recovered from over-harvest. A total of 17 species were found, seven fewer than had been reported by earlier surveys (Coker et al. 1921).

Although fewer species were collected, it was apparent that some of the mussel populations had seen some significant recovery (van der Schalie 1948). Near the end of the 1940s the demand for mussel shells declined due to the increased use of plastics to manufacture buttons. The river was never re-opened for commercial harvest.

Interest in freshwater mussel shells remained virtually nonexistent for the next few decades until the rise of the cultured pearl industry. Cultured pearls begin as beads or seed pearls made from thick-shelled mussel species such as the three-ridge and mapleleaf which are inserted into oysters. The oysters then form additional layers of shell material called nacre over the beads, resulting in cultured pearls. Commercial mussel harvest is legal in some parts of the country, and in some areas populations of commercial species have been so depleted that new harvest areas are being investigated. Michigan law prohibits the take of freshwater mussels or parts of any freshwater mussels whether living or dead (Fisheries Order 228.03; Part 487 of 1994 PA 451). In 1995, as the result of an extensive investigation, two people were arrested for poaching mussels from the Grand River for the cultured pearl industry (Badra and Goforth 2003).

Comparison of current surveys to observations made by early researchers in the late 19th and early 20th centuries shows some interesting and rather disturbing changes to mussel populations in the Grand River (Table 32). For example, the mucket is a large, thick-shelled species that was extensively harvested for pearl buttons. Coker et al. (1921) state that at Lyons, muckets comprised 80% of the collection of mussels, although the three-ridge, pocketbook, spike, and black sandshell were also quite common and could be readily collected by hand from shallow water. In 1945, the number of muckets in the Lyons area was down to less than 1% of the total catch (van der Schalie 1948). The decline in the mucket population may have been the result of unstable flows associated with dam operations (peaking) at the time of the survey (van der Schalie 1948). Unfortunately, no current surveys have been conducted in this area, but the catch of muckets in recent surveys throughout the lower segment of the Grand River was less in 1999 than in 1945 (Goforth et al. 2000). The spike is another mussel species that has had a precipitous decline. Coker et al. (1921) and van der Schalie (1948) both listed this noncommercial species as common, yet only one live specimen was found in surveys from 1999 through 2002 (Goforth et al. 2000; Badra and Goforth 2002; Badra and Goforth 2003).

Although the relative abundance of several other species was unchanged, the decline of what were formerly abundant species raises concerns about the overall health of mussel fauna in the Grand River watershed. The spike and mucket use a variety of host fish (e.g., bluegill, black crappie, central stoneroller, flathead catfish, and smallmouth bass) that are relatively common in the watershed (Fuller and Brynildson 1985; Cummings and Watters 2004). Thus, their decline may be indicative of a decline in habitat and/or water quality. Temperature stress, particularly during the summer reproductive season when river levels are low, has been implicated in both mortality and failed reproduction of mussels (Watters and O'Dee 2000). The mucket has a lower thermal threshold than other species and has been recommended as an indicator species to monitor the health of mussel beds in the Kiamichi River in Oklahoma (Spooner et al. 2005). Temperature stress coupled with fluctuating river levels may be partially responsible for the inability of the mucket population to recover below the Lyons Dam.

Given the conservation status of several species of freshwater mussels in the Grand River watershed, additional surveys to determine their distribution and abundance are needed. Further information regarding physical habitat preferences, streamflow needs, host fish relationships, and sensitivities to environmental contaminants is needed to develop a comprehensive recovery plan for these species.

Snails

Freshwater snails (gastropods) in the Great Lakes region have been studied since early in the 19th century. However, many early studies emphasized species composition and taxonomy rather than research on ecology. Freshwater snails have an important ecological role in the aquatic food web and contribute greatly in nutrient exchange processes. Primarily by controlling algae growth, they also maintain water quality and clean substrates utilized by other bottom-dwelling organisms such as aquatic insects. Freshwater snails are also an important food source for fish, turtles, and other species of wildlife. Finally, because many species are pollution-intolerant, they are excellent indicators of water quality.

Freshwater snails, like many other river species across North America, are in decline. The abundance and diversity has dramatically decreased over the past 80 years (Johnson 2009). This rapid decline is attributed to habitat degradation associated with dams and impoundments, channelization and dredging, sedimentation and channel instability, and water quality degradation. Vegetation control and dumping of wastes was cited as probable causes for a decline in snail populations as early as 1936 (Goodrich and van der Schalie 1939).

Targeted surveys for freshwater snails have not been conducted in the Grand River watershed; therefore, knowledge of diversity and distribution is limited. Species potentially present in the Grand River watershed are listed in Table 33. Freshwater snails of conservation interest that are present in the watershed include spindle lymnaea, and watercress snail (Eagle et al. 2005).

Crayfish

Crayfish represent one of the most diverse faunal groups in North America with 363 known species (Taylor 2007). The status of crayfish in North America is declining with nearly 48% of the known species listed as endangered, threatened, or vulnerable (Taylor 2007). Crayfish habitats are diverse and include rivers and streams, lakes, ponds, and wetlands. Crayfish are ecologically important omnivores consuming benthic invertebrates, algae, macrophytes, detritus, and decaying organisms. They are important food sources for a variety of fish and other aquatic and terrestrial predators. Several species of crayfish in the family Cambaridae have unique life history characteristics including the ability to burrow. Burrows are typically created in riparian wetlands and extend below the groundwater table. Crayfish burrows allow numerous species to colonize seasonally wet habitats (Welsh and Eversole 2006). Crayfish burrows serve as hibernacula for eastern massasauga rattlesnakes and are a critical habitat component in their conservation (USFWS 2009).

Crayfish are susceptible to habitat damage caused by impoundments, stream channelization, pollution, and sedimentation. Probably the biggest threat is nonnative crayfish introduced as fishing bait. Introduced crayfish may compete with natives for shelter, hybridize with them, and destroy vegetation beds used by native crayfish and other organisms for foraging, nesting, and shelter. One introduced species in particular, the rusty crayfish, has displaced native species in many areas.

The crayfish fauna of Michigan includes eight native species and the exotic rusty crayfish (Table 34). Although native species populations are considered stable, the devil crayfish and the digger crayfish, are identified as Species of Greatest Conservation Need in the Michigan Wildlife Action Plan. These species are considered to be at elevated risk due to a lack of knowledge of their distribution and abundance. Experts suggest these species are in decline as a result of urbanization and the associated loss of wooded areas with ephemeral wetlands (Eagle et al. 2005).

Amphibians and Reptiles

Amphibians and reptiles are integral components of the watershed and inhabit a variety of aquatic habitats. They are valued consumers of a variety of plant and animal materials and are an important food source for other species including fish, mammals, and birds. Unfortunately negative attitudes toward amphibians and reptiles persist and as a group they are often feared and persecuted (Czech et al. 1998; Eagle et al. 2005).

The degradation, fragmentation, and destruction of natural habitats due to watershed development are undoubtedly the greatest threats to amphibian and reptile populations (Harding 1997). Populations have become restricted to smaller habitats making them more vulnerable to disease, mortality, and exploitation. Effects of watershed development have favored adaptable species with broad habitat tolerance.

Forty-three species of amphibians and reptiles have been found in the Grand River watershed (Table 35). Information on the distribution and abundance of amphibians and reptiles in the basin is limited (Holman 1989; Harding and Holman 1990; Harding and Holman 1992). Several species are of conservation interest.

The Grand River watershed is home to nine species of turtles. Three of these species, Blanding's turtle, wood turtle, and eastern box turtle, are species of special concern. The spotted turtle is listed as threatened. These populations are threatened by habitat fragmentation, conversion of forest and wetland habitats to agriculture and urban land uses, and collection as pets.

Two species of frogs, Blanchard's cricket frog and northern leopard frog, are listed as threatened and special concern, respectively. These species were once common but have declined in number over most of their range in the state. In addition, eight species of amphibians are identified as species of greatest conservation need (Table 35). These species are considered to be in decline as a result of habitat fragmentation, land use changes, altered hydrologic regime, and toxic chemicals (Eagle et al. 2005).

Sixteen species of snakes are found in the Grand River watershed, nine of which are of conservation interest (Table 35). The most imperiled is the copperbelly water snake which is state listed as endangered and federally listed as threatened. Kirkland's snake is listed state endangered. Eastern massasauga and queen snake are identified as special concern. Eastern massasauga has also been identified as a candidate species for listing on the Federal Endangered Species List. (USFWS 2009). An additional five species are identified as species of greatest conservation need (Eagle et al. 2005; Tables 38a and 38b).

Birds

Many birds use rivers and river corridors in the Grand River basin as nesting, feeding, and resting areas. Some species are year-long residents, and many others are migratory or occasional visitors. Birds are an integral component of the watershed's biodiversity. Many recreational birders appreciate the aesthetics of their sight and sound. Other bird species also provide hunting opportunities and table fare for humans. MDNR, Wildlife Division has successfully reintroduced wild turkeys into several areas of the basin.

As part of the Mississippi Flyway, Canada geese, many species of dabbling and diving ducks, and trumpeter and mute swans use the Grand River watershed. This area encompasses both the northern and southern ranges of Michigan warblers. Riparian floodplain forests offer critical habitat to many of these species. There are over 218 breeding and regular migrant bird species found in the watershed (Table 36). Historically, northern goshawk, short-eared owl, barn owl, common raven, black-throated blue warbler, and pine warbler also bred in the watershed but were not reported during the Michigan breeding bird survey conducted from 1983 to 1988 (Brewer et al. 1991). Endangered species found in the watershed include the king rail, prairie warbler, short-eared owl, and migratory loggerhead shrike. Threatened species include the common loon, osprey, least bittern, trumpeter swan, red-shouldered hawk, Caspian tern, common tern, long-eared owl, cerulean warbler, and Henslow's sparrow. The bald eagle and osprey are identified as species of Special Concern.

Mammals

The Grand River basin is home to a diverse assemblage of mammals. The riparian corridors of the main stem and tributaries provide food, water, cover and travel routes for many mammalian species. Watershed development has reduced, fragmented, and degraded natural habitat, requiring mammals to adapt in order to coexistence with humans (see **Soils and Land Use).** As populations increase, management of game species (e.g., white-tail deer) is necessary to avoid conflicts with humans and maintain balanced assemblages in limited habitat.

There have been no comprehensive inventories of mammals in Grand River watershed. There are at least 50 species known to use the area and evidence of several others that have been locally extirpated (Baker 1983; Table 37). Several fur-bearing species, such as American beaver, river otter, muskrat, mink, coyote, red fox, grey fox, and raccoon are present. Popular game species include white-tailed deer, eastern cottontail, gray squirrel, and fox squirrel. Black bear are rare but have been reported with increasing frequency within the various state game areas throughout the watershed. The woodland vole is listed as special concern; the least shrew is threatened; and the Indiana bat is listed as endangered (Table 38b).

Other Natural Features of Concern

The Michigan Natural Features Inventory maintains a list of endangered, threatened, or otherwise significant plant and animal species, plant communities, and other natural features (Tables 38a and 38b). Vascular plants are the most commonly listed group of threatened and endangered species in the basin. Many are wetland plants or are found in floodplains and river corridors. Significant plant communities include southern swamps, prairie fens, coastal plain marshes, tall grass prairies, bogs, Great Lakes marshes, interdunal wetlands, open dunes, submergent and emergent marshes, wet and mesic prairies, hardwood conifer swamps, intermittent wetlands and Southern floodplain forests.

Aquatic Nuisance Species

Aquatic nuisance species are waterborne nonnative organisms that have been intentionally or accidentally introduced and pose a significant threat to native species or their habitat. Many species identified as threatened or endangered are considered to be at elevated risk because of competition with nonindigenous species. Negative ecological consequences on aquatic ecosystems include dramatic modifications to food webs, alterations of biogeochemical cycles, and declines in native biodiversity. In aquatic ecosystems, nonindigenous species are transported through vectors such as shipping, intentional release, migration through manmade canals, escape from aquaculture, and baitfish release (Holeck et al. 2004). More than 184 nonindigenous species have become established in the Great Lakes though these vectors (Ricciardi 2001). During the past four decades, shipping has been the primary mechanism responsible for these introductions.

Pest fish species in the Grand River basin include: sea lamprey, goldfish, round goby, and common carp. The recent range expansion of the exotic round goby into tributaries in the mouth segment from Lake Michigan is of concern. It is likely that round goby are direct competitors with native benthic fishes such as darters and sculpins. (Jude and Smith 1992). Common carp are found in high densities within impoundments and bayous and in some of the inland lakes. Carp are noted for increasing turbidity as they forage, stirring up the bottom and causing reduced water clarity.

The sea lamprey became established in the upper Great Lakes between 1936 and 1946, and in a very short period developed a large population (Scott and Crossman 1973). The parasitic adults quickly decimated, or contributed significantly to the decline of several commercially important fishes such as lake trout and lake whitefish. It is estimated that adult sea lampreys can kill up to 40 pounds of fish per year (Coscarelli and Bankard 1999). Sea lampreys are potamodromous and migrate upstream to spawn.

Lampreys spawn on gravel riffles in the lower Grand River and tributaries. Juvenile lampreys, called ammocoetes, create burrows in sand and silt areas and feed on detritus and small organisms. The ammocoetes remain in the burrows for a period of three to eight years, at which time they transform into the parasitic adult phase and migrate downstream to Lake Michigan.

Efforts to control lamprey parasitism of Great Lakes fish populations have been ongoing since the late-1940s. The U.S. Fish and Wildlife Service routinely surveys tributaries accessible to sea lampreys. Streams with high densities of sea lamprey ammocoetes are treated with the lampricide TFM (3-trifluoromethyl-4-nitrophenol) to eliminate or reduce lamprey populations. Treatments are scheduled every three to four years, or as often as necessary to ensure no lampreys older than age three will be in a stream. Historically, sea lamprey distribution was limited to the streams below the Sixth Street Dam. However, recent surveys located a population upstream of the dam in the Rogue River. Because this population was large enough to warrant management, the Rogue River was treated with lampricide for the first time in 2009.

The lampricide TFM can negatively affect local aquatic communities. Studies have found temporary reductions of burrowing mayfly populations after treatments. Tadpoles and salamanders are susceptible, but most amphibians have left the water for terrestrial habitats during treatment time. Mudpuppies, a permanently aquatic salamander, are sensitive to TFM (Harding and Holman 1992). Limited fish kills as a result of lampricide treatments do happen on occasion. TFM may affect fish that are already stressed from pollutants, low dissolved oxygen levels, increased water temperatures, or spawning. Although most fish are not affected by lampricides, native lamprey species, channel catfish, logperch, stonecat, mudpuppy, rainbow trout, and juvenile lake sturgeon are known to be sensitive to TFM (GLFC 1985; Hay-Chmielewski and Whelan 1997).

The zebra mussel is native to the Baltic Sea and was introduced to the Great Lakes through the discharge of ballast water from oceangoing cargo ships. The zebra mussel has rapidly colonized the Great Lakes, inland lakes and rivers and has caused significant ecological and economic harm to the region (Pimentel et al. 2000). The zebra mussel is established in Lake Michigan and found in the lower Grand River near the mouth and in the bayous. The Flat River, lower Thornapple River, and many inland lakes within the basin have also been invaded. Larval zebra mussels, or veligers, suspend in the water column and have the potential to colonize other waters through downstream drift. Dispersal through human activities, such as the discharge of bilge or live-well waters containing veligers, has likely hastened the spread of mussels throughout the basin. Zebra mussels are notorious for their biofouling capabilities by colonizing water intake pipes of power plants, public water supply plants, and industrial facilities. They colonize pipes constricting flow, therefore reducing water intake in heat exchangers and cooling systems. Zebra mussels attach to any hard surface and can become a nuisance on docks, piers, navigational buoys, and boats.

Zebra mussels can have profound effects on the ecosystems they invade. They are filter feeders and primarily consume phytoplankton, but other suspended material is filtered from the water column including bacteria, protozoans, and other zooplankton. Large populations of zebra mussels in the Great Lakes reduced the biomass of phytoplankton significantly following invasion (Benson and Raikow 2010). Survival rates of native unionid mussels have been shown to decline significantly with the increase in zebra mussel colonization (Hart et al. 2001a, 2001b). Through epizootic colonization and competition, extirpation of native unionid clams has occurred in Lake St. Clair and western Lake Erie (Nelepa 1994; Schloesser et al. 1996; Baker and Hornbach 1997). Zebra mussel colonization of larval dragonflies resulted in decreased mobility, increased mortality through predation, and reduced rates of emergence (McCauley and Wehrly 2007; Fincke et al. 2009).

The rusty crayfish is a nonindigenous species that has colonized the harbors along the eastern Lake Michigan shore, including the mouth of the Grand River (Lodge and Feder 2001). This species is endemic to the Ohio River basin, and its establishment in Michigan is likely the result of a bait bucket introduction. Rusty crayfish inhabit inland lakes, ponds, and streams. They prefer areas that offer rocks, logs, or other structure as cover. Bottom substrates may be clay, silt, sand, gravel, or rock. Rusty crayfish can be found in riffle and pool habitats. Unlike native crayfish, they are generally not a burrowing species. Rusty crayfish are opportunistic feeders and consume a variety of aquatic plants, benthic invertebrates, detritus, fish eggs, and small fish.

Rusty crayfish may cause a variety of negative environmental and economic impacts when introduced to new waters. This aggressive species often displaces native or existing crayfish species (Lodge et al. 2000; Klocker and Strayer 2004). Rusty crayfish have been shown to reduce aquatic plant abundance and species diversity by overgrazing. As rusty crayfish populations increase, declines in macroinvertebrate populations were noted (McCarthy et al. 2006). Rusty crayfish can harm fish populations by eating fish eggs and fry, through direct competition for food resources, and habitat loss through the destruction of submersed aquatic plants (Gunderson 2008). They are known nest predators and will attack the nests of bluegill, pumpkinseed, and largemouth bass.

Rusty crayfish are not readily controlled, although evidence suggests restrictive fishing regulations protective of crayfish predators (e.g., smallmouth bass) may be an effective management strategy. Preventing future introductions by educating anglers and bait dealers is likely the best method of control.

Purple loosestrife is a serious plant pest in the watershed. It can be found in most wetlands and in some areas, it dominates wetland vegetation. Purple loosestrife spreads quickly. Due to its attractive purple flower, humans have spread it through transplantation to gardens and lakeshores. Wind, flowing water, and animals disperse seeds. Purple loosestrife will out-compete more beneficial native plants for space. It provides little cover for wildlife, and is not used as a food source (Eggers and Reed 1987). Because of its ability to form monotypic stands, it has the potential to destroy the wildlife value of wetlands. Purple loosestrife thrives on moist soils, often invading after some type of disturbance. Eradicating an established stand is difficult because mature plants produce large quantities of seeds, and plants can reestablish from root fragments and broken stems. Biological control of purple loosestrife has been accomplished through the introduction of a root-boring weevil and two leaf eating beetles. The plant can also be controlled through the application of selective herbicides (MSUE 1997).

Common reed is a perennial, wetland grass that can grow to 15 feet in height. Although phragmites is native to Michigan, an invasive, nonnative form is becoming widespread and is threatening the ecological health of wetlands and the Great Lakes coastal shoreline. Invasive phragmites creates tall, dense stands which degrade wetlands and coastal areas by crowding out native plants and animals. Phragmites can be controlled using an integrated pest management approach which includes herbicide treatments followed by either mechanical removal (e.g., cutting, mowing) or prescribed burning

Eurasian water milfoil and curly leaf pondweed are two widespread nuisance plants found in lakes and impoundments throughout the watershed. These nuisance plants can out-compete native plants and form dense monotypic stands. These dense beds cause a loss of plant diversity, degrade water quality, and can reduce habitat for fish, invertebrates, and wildlife. In shallow areas, these plants can interfere with water recreation such as boating, fishing, and swimming. These plants are readily moved between waterways on recreational equipment. Plant fragments should be removed from boats, trailers, and other equipment prior to transport. Control of these invasive aquatic species is best accomplished through early detection. New colonies can be removed through hand pulling and raking. Larger stands may be controlled through the MDEQ-permitted use of selective herbicides. Biological control methods, such as the release of weevils, provide an alternative to chemical herbicides. Because most lake-dwelling fish and invertebrate species are dependent on submersed aquatic vegetation for habitat, whole-lake chemical treatments should be avoided. Significant biological risks associated with large-scale aquatic plant treatments include a loss of sensitive plants, declines in fish populations, and declines in water quality (Valley et al. 2004).

Nuisance aquatic organisms also include fish pathogens and parasites. Outbreaks of fish diseases such as largemouth bass virus and viral hemorrhagic septicemia have resulted in large-scale fish die-offs in affected waters. Infected waters cannot be treated; therefore, prevention through the implementation of best management practices is the only means of control. To prevent or slow the spread of VHS and other diseases, MDNR Fish Disease Control Order (FO-245) was issued to restrict movement of live and frozen baitfish and fish eggs (roe), movement of live game fish, and movement of water in any container (e.g., bait buckets, live wells and bilges) from water body to water body.

Fishery Management

Fisheries management in the Grand River watershed began in the late 1800s when the Michigan Fish Commission began to inventory fish populations in inland waters. Management to improve the recreational fishery has generally concentrated on specific tributaries and lakes. Fisheries management includes the manipulation of fish populations through the introduction of desired species (e.g., walleye, brown trout) or control of undesirable species (e.g., common carp, sea lamprey). Fisheries management also involves aquatic habitat protection through environmental regulations, and habitat improvement and restoration (e.g., installation of instream fish cover, dam removals). The entire watershed is subject to fishing regulations (e.g., size, possession limits, and gear restrictions), as prescribed by law. Laws and regulations are forms of fisheries management aimed at protecting, preserving, and enhancing a fishery resource. The following is a description of fisheries management of the Grand River watershed. Emphasis is placed on historical and current fisheries management, fisheries management limitations, and potential fisheries enhancement.

Headwaters

Main stem.–Fisheries management in the headwaters dates back to the 1870s when American eel, Chinook salmon, Atlantic salmon, and channel catfish were stocked (Table 39). Following these early introductions, management efforts included supplemental stocking of smallmouth bass in 1944. Fish communities in this segment were limited by degraded water quality caused by several inadequately treated industrial and municipal discharges in and near the City of Jackson. Since the enactment of the Clean Water Act, these discharges have either been terminated or currently receive proper treatment resulting in much-improved water quality. Portions of the main-stem channel in the headwaters segment have been highly modified by channelization, relocation, and in some locations-enclosure. Currently, the main stem receives annual stocking of spring fingerling walleye as a result of a walleye culture program on the grounds of the Jackson State Prison. Channel catfish, walleye, and panfish provide angling opportunities.

Tributaries.–Past fisheries management in the headwater tributaries involved stocking brook trout and brown trout in Willow and Portage creeks. These were primarily put-and-take fisheries as both water quality and temperature are marginal for sustained trout management. These streams are no longer stocked and are now managed for native species. All other tributaries are managed for self-sustaining native fishes.

Lakes.–Most lakes were stocked by Fisheries Division during the 1930s through the 1950s. Species stocked during this period included bluegill, largemouth bass, smallmouth bass, yellow perch, and in some instances, tiger muskellunge and walleye. These management actions ceased when Fisheries Division determined that stocking of fish species in waters where they are already present does not enhance the populations or fishery (Cooper 1948).

Recent management has included the introduction of redear sunfish to Gilletts Lake, Pleasant Lake, and Grass Lake. Channel catfish are stocked in Gilletts Lake on an annual basis. Future management of lakes in this segment will concentrate on habitat protection to maintain self-sustaining populations of native game fish.

Upper Segment

Main stem.–Past fisheries management in this main-stem segment included stocking American eel, walleye, and smallmouth bass (Table 39). Recent surveys of the Grand River have documented good populations of walleye, smallmouth bass, northern pike, and channel catfish. Several good access points provide diverse angling opportunities. Due to spawning habitat limitations, natural recruitment of walleye is not anticipated. Future fisheries management will focus on maintaining the walleye fishery through supplemental stocking, and maintaining self-sustaining populations of native species through habitat protection. Additional dam removals and other habitat improvement opportunities should be considered in the Eaton Rapids vicinity. Where dam removal is not an option, installation of fish passage structures should be considered where feasible.

Tributaries.–Mackey Brook and Sandstone Creek are coldwater resources that have been managed for trout since the 1930s. However, because public access could no longer be secured, these stockings were discontinued in 2007.

Spring Brook and Columbia Creek are high-quality, warm-transitional streams that historically were managed for trout. After several failed attempts to establish trout fisheries, these management strategies were discontinued. Currently these waters are managed for native species.

Lakes.–The three managed lakes in the upper valley segment are manmade and include Lake Delta, Lake Interstate, and Moores Park Impoundment. Lake Delta is a cooling-water reservoir for the Lansing Board of Water and Light, Erickson generating station. The lake has been stocked with bluegill, black crappie, largemouth bass, channel catfish, and walleye. Lake Interstate was created from sand and gravel mining operations during the construction of Interstate Highway 69. Ownership of the lake and adjacent lands was transferred to the Department of Natural Resources as partial mitigation for the loss of aquatic and wetland habitats during highway construction. Initially, the lake was stocked with rainbow trout, largemouth bass, and redear sunfish and provided a popular fishery. Due to poor survival, rainbow trout management has been discontinued. Lake Interstate is now managed for warmwater fish including sunfishes, largemouth bass, and stocked channel catfish. The Grand River impoundment formed by the Moores Park Dam contains a variety of game fish species including northern pike, smallmouth and largemouth bass, channel catfish, walleye, and panfish species. The current management strategy includes alternate year stocking of spring fingerling walleye.

Middle Segment

Main stem.–Following the successful introduction of Chinook and coho salmon to the Great Lakes in the mid-1960s, fish ladders (or fishways) were built on the Grand River main stem to allow these fish to migrate upstream from Lake Michigan to the City of Lansing (See **Dams and Barriers)**. The first ladder was constructed in 1975 at the Sixth Street Dam in the lower main-stem segment. Five other fishways, located at the middle segment dams (Lyons, Webber, Portland, Grand Ledge, and North Lansing), were completed in 1981 (Ryckman 1986). The objective of these projects was to allow salmon and steelhead to ascend the river and to diversify inland angling opportunities.

To maintain the Lake Michigan and Grand River fisheries, coho salmon and steelhead have been stocked in the City of Lansing since the early 1980s. These fish are released at this location to imprint and improve upstream returns during the spawning migrations. An average of 300,000 coho salmon yearlings and 25,000 steelhead yearlings are released upstream of the North Lansing Dam on an annual basis. After the coho salmon and steelhead are stocked, they must migrate downstream approximately

185 river miles and negotiate the six main-stem dams to reach Lake Michigan. The costs associated with these high stocking densities make Lansing one of the most expensive stocking sites in the state, therefore; estimates of the number of returning fish and angler harvest are necessary to evaluate the effectiveness of this management.

Currently, accurate estimates of total salmon and steelhead returns to the Grand River cannot be made. This is due to the lack of counting facilities at the Sixth Street Dam and the many coldwater tributaries that provide some natural reproduction of these species. Partial estimates have been developed for the upper segment using data collected at the Webber Dam fish ladder. The fishway at the Webber Dam is the only facility constructed with an underground viewing chamber. The chamber contains a window and video monitoring equipment that allow for the identification and counting of fish ascending the ladder during the spring and fall migration periods. Counts of coho salmon passage at the Webber ladder for 2001, 2002, and 2008 were 3,573, 2,173, and 1,575, respectively. Based on mean stocking numbers, the counts translate into return estimates of 0.9%, 0.6%, and 0.7%, respectively (Taylor and Wesley 2009). Total counts (spring and fall) of steelhead passage were also modest at 1,695, and 163; for 2001 and 2002, respectively. Extremely low spring flows during 2002 resulted in reduced spring migrations. Steelhead passage in fall 2008 was estimated to be 164 fish, which is low compared to other Michigan rivers and previous fall numbers recorded at the Webber ladder (Dexter 2002; Taylor and Wesley 2009).

Estimates of angling effort and harvest were developed for the upper segment through creel surveys in 2003 and 2004. The surveyed portions of the river included the greater Lansing area (Moores Park to Grand Ledge) and from the City of Portland to the Village of Lyons. Angling effort was estimated at 6,717 angler trips (17,996 angler hours) in 2003 and 21,635 trips (64,143 angler hours) in 2004. Warmwater fish species (e.g., smallmouth bass, bluegill, and channel catfish) comprised the majority of the catch. The estimated steelhead catch during the 2003–2004 creel period (harvest and released) was 860, the majority of which were returned to the river. The estimated coho salmon catch (harvest and released) between Lansing and Lyons totaled 432 for 2003 and 318 for 2004. Based on the 2002–2004 coho stocking rates, the return to creel was estimated to be 0.1% (Taylor and Wesley 2009). The creel estimates and low numbers of coho salmon observed in the Webber ladder suggest the high stocking rates in Lansing are not producing significant returns; therefore, further evaluation of the coho salmon stocking strategy is warranted (see **Management Options**).

Combined angling effort from the 2003 and 2004 creel surveys, estimated at 28,352 trips, reveals the recreational value the Grand River fishery provides the greater Lansing area. From an economic perspective, data generated from the 2000 U.S. Census estimates the average daily trip expenditure per angler in Michigan is $24 (U.S. Department of Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006). Based on this estimate, the combined value of the 2003 and 2004 angling trips in this portion of the Grand River was approximately $680,450.

Other fisheries management actions in the middle main-stem segment include alternate year walleye stocking and periodic fisheries surveys to monitor fish populations. Future management should be focused on maintaining diverse angling opportunities through the continued stocking of salmonids and walleye. Efforts that improve habitat (e.g., dam removal) and improve water quality in the main stem, including eliminating combined sewer overflows in the greater Lansing area, should be promoted.

Tributaries.–Fish communities in the Red Cedar and Looking Glass rivers are not actively managed through supplemental stocking. Both rivers have diverse resident warmwater fish communities and offer angling opportunities for northern pike, largemouth bass, and smallmouth bass and are popular during the spring sucker runs. The rivers also provide modest fisheries for salmon and steelhead. In addition to periodic fisheries surveys, one location on the Looking Glass River is identified as a long-term fixed monitoring location and is sampled at regular intervals as part of Fisheries Division's Status and Trends Program. Future management of these rivers should focus on self-sustaining populations of native fish species. Habitat improvement should target wetland restoration and rehabilitation of channelized tributaries with the goal of restoring subwatershed hydrology.

Sebewa Creek is the only designated trout stream in the middle valley segment. The creek was managed for brown trout and stocked on an annual basis from 1969 to 1990 when public access became an issue. Although the stream has been highly modified by dredging, it has good stream temperatures and water quality. Due to public interest and the willingness of riparian land owners to grant public access, the brown trout stocking program was reinitiated in 2010. Future management should focus on maintaining the fishery through stocking and restoring instream habitat.

Lakes.–There are relatively few public access lakes in the middle valley segment. Those with active fishery management include Lake Lansing (Ingham County) and Park Lake (Clinton County). Past management of Lake Lansing included stocking of channel catfish and tiger muskellunge. The lake in now managed for native fish species. Park Lake is being stocked with channel catfish as a means to control bluegills. Redear sunfish were also introduced to provide a faster growing panfish that utilizes a different niche and food resources.

Lower Segment

Main stem.–Fisheries management in the lower main-stem segment began in the 1880s with stocking American eel, salmon, and channel catfish. Walleye population management has continued since the supplemental stocking program began in the 1930s. Although historical management efforts included salmon stocking, the present day coho and Chinook salmon fisheries did not become established until the late 1960s. For decades, the fish community in the lower river was limited as a result of uncontrolled municipal and industrial wastewater discharges. In the 1970s standing stocks of game fish species were greatly diminished, and the fish population was dominated by common carp and white suckers (MDNR 1970; Nelson and Smith 1981). Fish population recovery began with the passage and implementation of the Clean Water Act of 1973 (see **Water quality).** The lower segment now supports diverse populations of fishes and a significant recreational fishery. In addition to the popular spring and fall runs of potamodromous fishes, river fisheries include channel catfish, flathead catfish, smallmouth bass, largemouth bass, walleye, northern pike, and sunfishes.

Angler surveys in the Grand Rapids metropolitan area were conducted in the spring and fall of 2003 and 2004. Survey statistics estimated a combined total 46,164 angler trips to the river with a catch of 1,228 coho salmon, 5,948 Chinook salmon, 15,852 rainbow trout (steelhead), 791 brown trout, 80 lake trout, 2,473 walleye, and 2,880 smallmouth bass (MDNR Fisheries Division, unpublished data). At a value of $24 per angler trip (U.S. Department of Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006) the combined economic value of angler trips was slightly less than 1.11 million dollars. This value would be significantly higher if the angler survey would have included other popular main-stem fishing sites such as the area from Ionia to Saranac, and the confluences of the Flat and Thornapple rivers.

Future river management decisions in the Grand Rapids area will need to consider the fate of the Sixth Street Dam. According to MDEQ records, the current structure has been in place since 1917, long past the anticipated 50-year design lifespan of most dams (Lane 2008). The dam is not currently used for power generation and offers limited potential for hydroelectric power development (Black and Veatch 1988). Given the age of the dam, significant capital expenditures can be expected to maintain structural integrity. Many Michigan communities are facing similar liability and financial decisions associated with aging and deteriorating dam structures (Michigan River Partnership 2007). Costs of dam removal are often less expensive than the costs of repair and long-term maintenance, and removal can provide significant local economic benefits (Graber 2003). Funding is also available for selective dam removal but not for dam repair, replacement, or maintenance. When faced with similar decisions, the Villages of Dimondale and Nashville opted for dam removal.

The Sixth Street Dam has a significant influence on fish populations in the Grand River and in Lake Michigan. The structure is a barrier to the movement of several Lake Michigan fish species that ascend the river to spawn. Although the ladder provides upstream passage for coho salmon, Chinook salmon, and steelhead, other migratory species (e.g., lake sturgeon, walleye, longnose sucker, and redhorses) do not successfully pass upstream through the ladder. Failure to reach upstream spawning areas limits the productivity of these populations. Natural salmon and steelhead recruitment is also negatively affected, as not all adults successfully pass. A major obstacle to lake sturgeon rehabilitation is its inability to ascend to upstream spawning habitats (Hay-Chmielewski and Whelan 1997). Conversely, the dam also has a positive influence on the Lake Michigan fishery in its control of sea lamprey populations. The tailwater hydraulic created at the face of the dam prevents most adult sea lamprey from reaching upstream spawning areas. When the Sixth Street fish ladder was constructed in 1975, the pool-weir configuration was selected because a sea lamprey barrier could be readily incorporated into the design. Future management of the dam and fishway will need to consider management of this and other pest species.

Ultimately, the decision to maintain or remove the Sixth Street Dam must be made by the owner, the City of Grand Rapids. The decision-making process should consider the social, economic, and environmental costs and benefits associated with dam retention or removal. This decision will have significant implications regarding future management of the Grand River and Lake Michigan fishery resources. Removal of the Sixth Street Dam would be supported as consistent with Fisheries Division policies. However, due to the potential for adverse effects to the Lake Michigan fisheries, this support would be contingent on the identification and implementation of alternative sea lamprey control strategies (e.g., integrated pest management, adjustable-crest barrier, etc.). If the City chooses to maintain the dam, design modifications to the existing ladder including construction of a viewing room equipped with fish counting equipment should be included in any renovation or major modification of the structure. Alternatively, construction of rock arch rapids (Aadland 2010) immediately in front of dam would allow for the passage of nearly all fish species, would eliminate the dangerous hydraulic undertow, and would restore habitat similar to the natural rapids that were once found at this location.

At the time of European settlement, the most significant physical and ecologically important feature of the Grand River was the former rapids. " The rapids are not the nature of an abrupt leap or cataract, but have nearly uniform descent for the distance of a little more than a mile, through the central part of the city, amounting to a fall of about eighteen feet, over a limestone bed, the western outcrop of the limestone rock in this part of Michigan" (Baxter 1891). Prior to their destruction, the rapids provided substantial rocky spawning habitat for several Lake Michigan species, including cisco, lake whitefish, lake trout, and lake sturgeon. Although lake-run populations of cisco, lake whitefish and lake trout are no longer extant, restoring the rapids in Grand Rapids would greatly benefit lake sturgeon recovery efforts (Hay-Chmielewski and Whelan 1997, Aadland 2010). In addition to improving fish habitat, restoration of the rapids downstream of Sixth Street Dam would improve river aesthetics and would be an attraction to paddling enthusiasts.

Future fisheries management of the lower main-stem segment should continue to focus on maintaining the potamodromous fishery. The diverse warmwater fishery that includes northern pike, walleye, smallmouth bass, largemouth bass, channel catfish, and flathead catfish should be promoted. Future river management should recognize the diverse mussel populations distributed throughout the lower segment and insure that actions are protective of critical habitats and host fish populations.

Tributaries.–Fisheries inventories of the Maple River were completed in 1974 (Lincoln 1974) and 1989 (MDNR unpublished data). The Maple River is a unique northern river in that it has many characteristics (flow pattern, terrain, and fish community) that are more typical of rivers located in the southern United States (P. Seelbach, Fisheries Division, personal communication). With the exception of the fisheries surveys, active fisheries management of the Maple River has been limited to stocking channel catfish and walleye during the 1980s. The river also receives a modest run of steelhead as a result of the stocking site located on Fish Creek. Returning steelhead stray upstream to the Elsie Dam, which is a barrier to further upstream movement. Despite the lack of fisheries management, the river supports as significant fishery for channel catfish, flathead catfish, black crappie, and white crappie. A 1973 angler survey estimated 18,990 angler days were spent on the river. On a per acre basis, this estimate of angler effort was higher than any other warmwater river in the state (Lincoln 1974). Future fisheries management of this unique warmwater fishery should focus on habitat protection and maintaining self-sustaining populations of native fish species. The removal of the Elsie Dam has been advocated by Fisheries Division since 1974. Removal of this structure would result in expanded fishing opportunities and restore fish migration in the upper watershed.

The Maple River has two main tributaries with fisheries potential: Stony Creek and Fish Creek. Stony Creek is a warmwater tributary that supports a seasonal population of smallmouth bass. Extensive channelization in the Stony Creek watershed has altered the hydrology and channel morphology and significantly reduced fisheries management options. Future management in this watershed should focus on restoration of the stream channels and riparian corridors. In many locations, a two-staged channel design could be utilized to restore connectivity with the floodplain. Restoration of headwater wetlands should be promoted to benefit watershed hydrology and provide wildlife habitat.

Fish Creek begins as a small coldwater stream that receives ample groundwater inputs and supports a brook trout and brown trout fishery. Further downstream the thermal classification becomes warm-transitional as several warmwater tributaries join the main stem. At this point the stream is too warm for brook trout but still cool enough to support a stocked brown trout fishery. The damming of the creek at Hubbardston further increases stream temperature, creating conditions unsuitable for brown trout management. In addition to annual stocking of brown trout, fisheries management has included habitat improvement projects which were completed by the Lansing Chapter of Trout Unlimited in the late 1990s. Approximately five thousand steelhead yearlings are stocked in Fish Creek near Matherton on an annual basis. This stocking creates a fairly popular steelhead fishery below the Hubbardston Dam and in the Maple River. Future management of Fish Creek should focus on maintaining the trout fisheries through stocking and protection of the coldwater habitats. Operations at the Hubbardston Dam should be monitored to assess compliance with FERC license provisions.

Prairie Creek originates in Montcalm County and flows south through Ionia County, joining the Grand River at the city of Ionia. Although Prairie Creek is classified as warm-transitional (Zorn et al. 2008), groundwater yield increases as the stream descends into the Grand River valley and is sufficient to support managed coldwater fisheries in the lower portion of the watershed. Prairie Creek has been actively managed through annual stocking of brown trout since 1966. Annual stocking of steelhead in the lower portion of creek began shortly after the construction of the Sixth Street ladder in 1975. Although access is limited, Prairie Creek is a popular fishing destination because of its proximity to Lansing and Grand Rapids. Fisheries surveys have documented natural recruitment of steelhead from Prairie Creek. However, further studies are needed to determine the extent of the natural production and whether this is supported by wild or hatchery-produced fish. Currently upstream migration of steelhead is hampered by an unnamed lowhead dam in the lower watershed. Although a steep-pass fishway was installed, the structure is easily blocked, preventing upstream passage to suitable spawning habitat. Improved passage, either through dam removal or installation of rock arch rapids, would likely increase natural recruitment of steelhead and would allow for a reduction in stocking rates. Future management will focus on maintaining the trout fisheries through stocking and protection of the coldwater habitats.

Bellamy Creek also begins as a warm stream, changing to a cold-transitional stream as it drops into the Grand River valley. Although only one historical stocking of brown trout in 1953 is recorded, the population appears to be self-sustaining. Adult steelhead stray into Bellamy Creek, and limited natural recruitment has been documented.

Lake Creek is also a self-sustaining brown trout stream. It originates from Morrison Lake but gains sufficient gradient and groundwater to support trout. It was stocked with brown trout periodically from the 1940s through the 1970s and currently supports itself through natural reproduction.

Other small streams in Ionia County that were once stocked with brook and/or brown trout include: Cannon, Hawns, Tibbets, and Timberline creeks. Current models suggest these streams are warm-transitional (Zorn et al. 2008) and should be managed for self-sustaining native fish species. Most of these are in need of surveys to determine the composition of the current fish populations.

The Flat River is a large, warmwater river that joins the Grand River south of the City of Lowell. Although the river was once polluted, it now has excellent water quality and is known for its quality smallmouth bass fishery. The river also supports a diverse fish community and a rich assemblage of freshwater mussels, including several species of conservation interest. Past fisheries management has included limited stockings of largemouth bass and smallmouth bass, but this practice was discontinued as these species are typically self-sustaining. Current fisheries management includes the annual stocking of approximately 5,000 steelhead yearlings downstream of the King Mill Dam in Lowell. Returns of these fish provide a popular fishery during the spring and fall runs.

Management of the aquatic resources of the Flat River is complicated by the presence of several main-stem dams. These dams block the fish movements, resulting in several populations that are isolated between dams. In addition to reducing the overall productivity of the fish community, these dams have a negative effect on the dispersal and distribution of several species of fish and freshwater mussels. In fact, the upstream distributions of several Flat River mussel species are bound by the presence of a dam. Additionally, several species of fish that migrate from the Grand River are prevented from reaching upstream habitats by the King Mill Dam in Lowell. During migrations these fish congregate below the dam and become more susceptible to predation and harvest. The river redhorse, a state-threatened fish species, typically returns to the Flat River to spawn during May and June. This large sucker species is particularly vulnerable to bow and spearfishing as it congregates below the dam. Special regulations, such as gear restrictions, or spawning closures may be required for conservation of this species.

Several tributaries of the Flat River were historically managed for trout. Curtis, West Branch, and Dickerson creeks were once stocked with trout on a regular basis. These creeks now support naturalized trout populations and are no longer stocked. Current inventories of the fish populations in Flat River tributaries are needed to better evaluate management goals and potential.

Future management of the Flat River will concentrate on maintaining self-sustaining populations of native fish species through habitat protection and the implementation of the Flat River Natural River Plan. The potamodromous fishery in the lower river should be maintained through continued stocking. Opportunities to improve river connectivity, such as dam removal or construction of natural fishways, should be promoted. The river downstream of the Fallasburg Dam will be monitored at regular intervals as part of the Fisheries Division Status and Trends Program. Recovery plans for the several threatened and endangered aquatic species that remain in the river should be developed and implemented.

Between the confluences of the Flat and Thornapple rivers, there are several small cold- and cold-transitional streams that enter the Grand River in the vicinity of Lowell and Ada. Many of these tributaries were stocked with trout in the 1930s and 1940s. Fisheries surveys conducted in the 1990s documented that naturalized trout populations are supported in several of these tributaries. Active fisheries management in most of these streams is limited to periodic surveys. Spring Brook is a long-term fixed monitoring location that is sampled at regular intervals as part of Fisheries Division's Status and Trends Program (Wills et al. 2005).

The Thornapple River enters the Grand at the Village of Ada. The Thornapple River watershed contains a diversity of warmwater and coldwater habitats and is the focus of several fishery management actions. The fish community in the headwaters consists of largely nongame species but does provide some fishing opportunities for northern pike. The Thornapple River near Nashville is generally more navigable and provides angling for northern pike, largemouth bass, smallmouth bass, and walleye. The Village of Nashville Dam was a barrier to upstream fish movement for several species of game and nongame fish species (MDNR Fisheries Division, unpublished data). The structure was removed and replaced with a series of arch rock rapids in 2009. The project resulted in restored fish passage to approximately 60 main-stem river miles, 105 tributary miles, and five inland lakes in the headwater reaches of the Thornapple River. Future fisheries management in this portion of watershed will include stocking walleye and maintaining self-sustaining populations of warmwater fish species.

Thornapple Lake is a natural water body, 409 acres in size and up to 30 feet deep. The lake has a long management history and has been stocked since the late 1800's. Current fisheries management includes stocking walleye, and northern muskellunge. Thornapple Lake also offers angling opportunities for other sport fish including northern pike, smallmouth bass, channel catfish, and panfish (Wesley 2000). The lake is managed for trophy northern muskellunge and serves as a broodstock lake to support the state's northern muskellunge rearing program. Special harvest regulations apply to the lake to protect the muskellunge fishery. These regulations include gear restrictions and limited harvest through a 50-inch minimum size limit and a reduced season. Thornapple Lake will continue to be managed as a top-quality warmwater fishery. Stocking of northern muskellunge and walleye will be continued to ensure the fishery will be maintained.

There are several coldwater and cold-transitional tributaries to the Thornapple River many of which are designated trout streams (Zorn et al. 2008; Table 13). Active trout management in some of these tributaries has been discontinued due to channelization (e.g., Quaker Brook) or because trout populations have become self-sustaining (e.g., Hill Creek). The trout fisheries in Highbanks, Cedar, Glass, Duck, and Tyler creeks are currently managed through stocking. Although natural recruitment has been documented in some of these tributaries, it is not sufficient to maintain the fisheries.

The Coldwater River is the largest tributary to the Thornapple River and is classified as a cold-transitional small river (Zorn et al. 2008; Lyons et al. 2009). Trout management in the Coldwater River dates back to the initial stocking of brook trout in 1884. Since the mid-1970s the river has been stocked with various strains of rainbow trout and brown trout. Management has also included chemical reclamation and several successful habitat improvement projects. Because the river is in a rural setting near high population centers, it is a relatively popular brown trout fishery. An angler survey conducted during the 2002 trout season estimated 2,144 angler trips were made on the river with a catch of 9,025 brown trout.

Future management of the coldwater streams in the Thornapple River watershed will focus on maintaining the existing fisheries through annual stockings of yearling trout. The trout fisheries in Quaker Brook, Duck Creek, Tyler Creek, and the Coldwater River would benefit from additional stream corridor and channel rehabilitation projects. Removal of the Coldwater Dam near the Village of Freeport would restore the channel to free-flowing conditions and eliminate an unnecessary barrier to fish movement.

The Thornapple River downstream of the City of Hastings is fragmented by five main-stem hydroelectric dams, and the lack of fish passage at these structures limits fisheries management options.

The fish populations between the dams are isolated and are either self-sustaining or reliant on recruitment from upstream locations. Although a fish ladder was constructed at the Ada Dam, it is not functional. As a result, several native fish species (e.g., smallmouth bass, northern pike, walleye, and redhorse) that would historically have utilized the Thornapple River on a seasonal basis are blocked from these habitats. The lack of fish passage also prevents the further development of the Grand River steelhead and salmon fisheries. Because public access to the lower impoundments is limited, no active management of these fisheries is planned. Future management of the lower portion of the Thornapple River should include the development of a comprehensive fish passage program.

Several small cold- and cold-transitional tributaries join Grand River main stem between the confluences of the Thornapple and Rogue Rivers. Honey, Egypt, Sunny, and Bear creeks were historically managed trout streams and now support naturalized populations of brook trout and brown trout. Urban development in these small subwatersheds has the potential to negatively affect trout populations through increased delivery of storm water runoff and increased sediment loadings. Habitat protection through the implementation of storm water best management practices and protection of the riparian corridors is critical to the continued existence of these urban trout populations.

The Rogue River is a large, cold-transitional tributary that has a long history of trout management. Initial management actions included the stocking of brook trout in 1884. The river has been managed through annual stockings of both brown trout and rainbow trout since 1933. Although limited natural recruitment of brown trout occurs, the trout fishery is maintained through annual stockings of approximately 16,500 yearling rainbow trout and 16,500 yearling brown trout. The main stem also supports a significant steelhead fishery from the confluence with the Grand River upstream to the Rockford Dam. This fishery is maintained by stocking 30,000 steelhead yearlings on an annual basis. Due to its close proximity to the City of Grand Rapids, the Rogue River receives a high amount of angling pressure. Spring and fall angler surveys were conducted above and below the Rockford Dam during 2002-2004. Total catch estimates (harvest and released) for the three year survey period were 13,683 brown trout and 28,672 rainbow trout (including steelhead). The survey estimated a total combined effort of 60,559 trips during the 2002-2004 trout seasons (MDNR Fisheries Division, unpublished data). At a value of $24 per angler trip per day, the combined value of spring and fall angling trips to the Rogue River was 1.45 million dollars or approximately $485,000 per year (U.S. Department of Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006).

The Rogue River has several cold, cold-transitional, and warm-transitional tributaries which were actively managed in the past. Many of the tributaries (i.e., Spring, Duke, Cedar, Stegman, Becker, Shaw, and Rum Creeks) were stocked with brook trout and brown trout from 1933 until the mid-1960s (Table 39). These tributaries now support self-sustaining trout populations and are no longer stocked. Groundwater yield to these tributaries is significant, providing stable coldwater rearing habitat for juvenile trout and summer thermal refuge for adult trout inhabiting the warmer main stem. Implementation of the Rogue River Natural River Plan to protect riparian corridors and coldwater habitats associated with these tributaries is critical to maintaining the coldwater fishery in the Rogue River main stem. Future fisheries management of the Rogue River and tributaries will continue stocking brown trout, rainbow trout, and steelhead, to maintain the current recreational fisheries. The potential removal of the Rockford Dam should be explored. If dam removal is not a feasible option, then fish passage in the form of a constructed rock arch rapids or other natural fishway should be considered. The thermal effects of the dam should also be evaluated and mitigated for as necessary. Additional habitat protection measures, such as the development of comprehensive storm water management plan to protect the hydrology and thermal quality of the watershed, should be a priority.

Buck Creek is currently managed for brown trout and is stocked on an annual basis. Although the lower portion of the watershed is a warm-transitional stream (Lyons et al. 2009), temperature data indicate that the stream is on the upper thermal limits for supporting trout. An angler survey was conducted on Buck Creek during the 2002 trout season. The survey estimated 46 angler trips and reported no trout in the catch. Land use in the Buck Creek watershed is predominantly urban, and the stream receives significant storm water inputs. It is possible the stream quality has declined and can no longer sustain a brown trout fishery; further evaluation of this management strategy should be conducted.

Lakes.–There are 254 lakes greater than 20 acres in the lower segment of the Grand River watershed. Although the majority of these lakes contain warmwater fish communities (e.g., largemouth bass, bluegill), some are coldwater and support populations of cisco and rainbow trout. Inland lakes are popular angling destinations and receive a considerable amount of fishing pressure. Creel census statistics (i.e. angler hours per acre) vary widely between lakes, region, and years. A 1985 statewide summary of on-site creel surveys reported that larger lakes tend to have lower average catches and catch rates (Ryckman and Lockwood 1985). Angler surveys conducted on nine southern Michigan inland lakes from 125 to 2050 acres in size, estimated summer angling effort at 9.5 to 68.3 angler hours/acre (Waybrant and Thomas 1988; MDNR Fisheries Division, unpublished data). Using a mean value of 31.9 angler hours per acre, total summer angling effort on 49 inland lakes within this size range in the lower segment is estimated at approximately 403,000 angler hours. At an estimated 3,352 angler trips/lake and $24 expenditure /trip, the economic benefit derived from angling on these lakes is estimated at 3.9 million dollars.

Many of these lakes were once stocked by Fisheries Division but are no longer managed due to a lack of public access. Historically, fish stocking was the primary means of lake management in the lower segment (Table 39). Inland lake management methods also included the use of rotenone and other chemicals to control fish populations, population reductions through netting, and harvest restrictions through special fishing regulations. Currently, fish populations in the majority of the inland lakes located in the lower segment are protected by general fishing regulations, and fisheries management on these waters is directed toward habitat protection to promote self-sustaining populations of native fish. Some publicly-accessible inland lakes are still stocked by Fisheries Division to create unique fishing opportunities.

There are four lakes in the lower segment that are currently managed for muskellunge fisheries: Lake Ovid (Clinton County), Thornapple Lake (Barry County), and Murray and Campau lakes (Kent County). These lakes are currently stocked with fall fingerling northern muskellunge at a density of 2–3 fish per surface acre. Although harvest is limited to one fish per day, angler surveys conducted on Murray and Campau lakes during the 2005 season indicate these fisheries are primarily catch and release fishing. The surveys estimated that during 9,284 trips (31,651 angler hours) 621 northern muskellunge were caught and released, and none were harvested.

Walleye are inexpensive and relatively easy to grow in rearing ponds. In southern Michigan, fisheries biologists have attempted to plant walleye in various locations that were thought to be suitable in order to provide a diverse fishery. Lakes are initially stocked for three years annually and then on alternate years. Population evaluations are conducted with a combination of trap netting for adults and electrofishing in the fall to evaluate fall fingerlings stocked the previous spring. Not all lakes stocked with walleye have established a fishery. Wabasis, Bass, and Reeds lakes, all in Kent County, are examples of lakes that had been stocked and did not establish a viable fishery. Lakes in the lower segment that are currently stocked with walleye include: Sessions (Ionia), Crystal and Clifford (Montcalm County), Thornapple Lake (Barry), and Lincoln (Kent County). Additionally, several lake associations have received approval from Fisheries Division to purchase and stock fall fingerling walleye in their lakes. Walleye have also been stocked by fisheries managers as additional predators to restore population levels of prey fish. Woodard Lake (Ionia County) and Long Lake (Kent County) have both been stocked with walleye in an effort to control stunted bluegill populations.

In southern Michigan, there are a few lakes that are deep, well oxygenated, and cold enough to support a trout fishery. These lakes are often referred to as “two-story lakes”, having a good bluegill and largemouth bass fishery in the shallower waters and a trout fishery in deeper waters. These lakes require annual trout stocking in order to maintain the fishery since most of the trout stocked are harvested in their first year in the lake. Unfortunately, when northern pike become established in these lakes, the trout stocking program often has to be discontinued since pike are notorious predators of trout. This, combined with the relative scarcity of lakes with management potential for a two story fishery means there are very few of these lakes. In the lower segment, Nevins Lake (Montcalm County) and Lime Lake (Kent County) are currently stocked with rainbow trout. Deep Lake in Barry County and Derby and Half Moon lakes in Montcalm County are no longer stocked with trout due to poor survival or overabundant northern pike populations.

Rainbow Lake in Montcalm County was stocked with redear sunfish from 1991 through 1993. This was an experiment to determine if redear sunfish would survive and establish a breeding population so far north of their natural range and to provide an alternative species that could potentially grow larger than the native bluegills. In addition, the lake association has purchased and stocked channel catfish under permit. The catfish are growing well and providing a fishery. The redear sunfish have established a self-sustaining population based on a 1999 survey that caught fish from 4 to 11 inches in size.

Mouth Segment

Main stem.–The Grand River main stem in Ottawa County has a very diverse fishery for walleye, flathead catfish, channel catfish, largemouth bass, northern pike, and several species of suckers. It also has seasonal fisheries for coho and Chinook salmon, steelhead, brown trout and lake trout during spawning runs.

Although this portion of the river is not stocked, walleye fry stocked in upstream areas drift downstream into the mouth segment. Recent electrofishing surveys of the spring walleye run up to the Sixth Street Dam have shown an alternate year pattern in ages of walleye present that corresponds to the years that fry are stocked upstream in Ionia and Kent counties.

Approximately 170,000 Chinook salmon and 16,000 brown trout are planted annually at the river mouth in Grand Haven. Chinook salmon are stocked in net pens in Grand Haven to improve acclimation and imprinting to the Grand River. Brown trout are stocked at the mouth to provide a nearshore Lake Michigan fishery (Table 39).

Early records show that the Great Lakes form of muskellunge was known from the coastal and inland waters of southern Michigan, including the Grand River and some of its larger tributaries such as the Thornapple River. Presently, none of the original southern inland populations remain, presumably as a result of habitat fragmentation and poor water quality (Seelbach 1988). Present day conditions (i.e. habitat, water quality, forage base) in the mouth segment are suitable for muskellunge and provide an opportunity to reintroduce a large predator to the river. Although Fisheries Division currently stocks the northern strain of muskellunge in select inland waters, Seelbach (1988) recommended that Great Lakes muskellunge should receive primary consideration for stocking in southern Michigan rivers. The Great Lakes form is native to these waters and represents the lowest risk of genetic contamination to existing Great Lakes populations. A rehabilitation plan for Great Lakes muskellunge, including the establishment of a broodstock population, is being developed by Fisheries Division. Future fisheries management should include stocking of the Great Lakes strain of muskellunge when the rehabilitation plan is implemented.

A small remnant population of lake sturgeon is still present in the Grand River downstream of the Sixth Street Dam. Biologists report several adult and juvenile individuals have been captured, tagged, and released. Incidental catches of lake sturgeon occur below the Sixth Street Dam, downstream near

Walker, and at the river mouth in Grand Haven. Evidence suggests high annual variation in the numbers of adults returning to the river to spawn (Kregg Smith, MDNR Fisheries Division, personal communication). Open-population capture–recapture models have been used to evaluate population status and estimate survival and the relative importance of survival and recruitment in influencing population trends. The rate of population change (λ) indicates that the population is barely maintaining itself (average λ across years = 0.67; 95% confidence interval [CI] = 0.86–0.54). Annual population estimates have ranged from about 66 fish to almost 130 fish but had wide confidence intervals. Estimates of new lake sturgeon entering the population each year are low, with the current population age structure composed of fish older than 36 years. Growth is similar to other populations along the eastern Lake Michigan shoreline. Ongoing studies suggest that the population is essentially maintaining itself through a combination of episodic recruitment and relatively constant survival of adults. The likely impact of recent illegal harvest on survival of adults underscores the importance of compliance with the closed fishery.

Physical habitat characteristics were measured at juvenile lake sturgeon capture locations and areas where tagged individuals were tracked through radio telemetry. These data indicate that shallow areas of the river with sand substrates and moderate flows are critical nursery habitat for juvenile lake sturgeon. These areas are typically found along braided-channel margins or along shorelines that are away from the high-velocity areas associated with the main channel. Habitat areas with finer substrates are of secondary importance and may be critical during active movement periods (September to December) when juvenile lake sturgeon forage for small benthic prey. Evidence of recruitment during recent fall gill net surveys may be due to improvements in water quality.

Management of the Grand River lake sturgeon population is limited by the lack of historic information on the population to compare to the assessed current status. In order to protect and rehabilitate this population, additional study is needed. Maintaining closure of the recreational fishery still appears necessary. Bolstering of recruitment through streamside rearing may be needed to increase the population. Full recovery will require persistence and long-term commitment to restoration for this long-lived, late-maturing, infrequently reproducing species.

Tributaries.–Crockery Creek was first stocked with brook trout in the 1930s and has been managed for brown trout and steelhead since 1971. Although the stream has limited habitat, stream temperatures are acceptable, and it does provide a modest trout fishery. A 2003 creel survey from May through August estimated 711 angler trips and a catch of 109 steelhead and 38 brown trout. Future management will focus on habitat protection and maintaining the brown trout population through stocking. To maintain the potamodromous fishery, approximately 5,000 steelhead yearlings will be stocked on an annual basis.

Deer Creek and the Bass River are warmwater tributaries that currently receive no active fisheries management. These catchments are predominantly agricultural lands and have been channelized to promote drainage. Biological assessment indicates degraded macroinvertebrate communities and moderately impaired habitat (Rockafellow 2005). Future management of these streams should include further inventories of the fish communities and assessment of management potential. Habitat projects, such as restoration of headwater wetlands, in these watersheds should be promoted.

Norris Creek, a tributary of Spring Lake, was stocked with brown trout plants from 1993 through 1998. However, trout management was discontinued due to poor survival. Water temperatures are suitable for trout survival, but habitat tends to be very poor. Future management should focus on habitat protection and rehabilitation. If these efforts are successful, low-level stocking of brown trout could be reinitiated.

Lakes.–Publically accessible lakes in the mouth segment are limited. The bayous along the Grand River, including Spring Lake, provide the most opportunity for fishing lakes in this segment. The bayous are well known for their good bluegill, largemouth bass and northern pike fishing. In recent years, bow fishing for common carp and black buffalo has also become popular along the lower Grand River and its bayous.

Half Moon Lake in Muskegon County is managed as a two-story fishery and is stocked with approximately 7,500 rainbow trout on an annual basis. A 2003 creel survey conducted from June through August estimated nearly 2,400 angler trips (6,100 angler hours) were made to the lake with a catch of 101 rainbow trout and 9,200 bluegills. Assuming rainbow trout survival remains high, the stocking program in Half Moon Lake will continue

Recreational Uses

The Grand River watershed offers a variety of water-based recreational uses. Opportunities for hunting, fishing, swimming, camping, picnicking, boating, and wildlife viewing exist at numerous locations throughout the watershed (Table 25; Figure 63). Public access is provided by lands administered by federal, state, county, township, city, and village governments. Privately held marinas and boat launches are also numerous in the watershed.

Historical estimates of fishing pressure and harvest are available from angler surveys conducted by Conservation Officers from 1928 to 1964 (Appendices B and C). These records indicate preferred fish species, most heavily fished waters, and species abundance. More recent (2002–2005) angler surveys have been conducted on the main stem, inland lakes, and streams throughout the watershed. These surveys typically follow traditional roving-count and access interview protocols of both boat and shore anglers to develop estimates of angling effort and harvest (see **Fisheries Management**).

There are 140 boating access sites and boat launches (Figure 68) advertised within the watershed, as well as, several unmarked sites on lakes and streams, such as road crossings and road endings, that are commonly used for public access. There are 29 access sites on the Grand River main stem, many of which are limited to shallow draft boats, kayaks or canoes. The Grand River is navigable from the headwaters to the mouth; however, several dams and road crossings would require portage (see **Dams and Barriers**). Additional public boating access sites are needed on the main stem and larger tributaries such as the Maple, Looking Glass and Red Cedar rivers. Specific information regarding boating access designs and amenities can be found at http://www.mcgi.state.mi.us/MRBIS/. Fisheries Division continues to work toward acquiring additional access on rivers, streams, and inland lakes throughout the watershed.

The numerous state game areas in the watershed contain a large variety of upland, wetland, lake, floodplain, and stream habitats. These areas were purchased to provide hunting opportunities for small game, waterfowl and upland birds, and whitetail deer but are also open to fishing, hiking and wildlife viewing. There are significant amounts of public lands in the headwaters, middle, lower, and mouth segments (Figure 63). Future land acquisitions should target floodplains and adjacent uplands to establish greenways and restore connectivity along riverine corridors.

Headwaters

Canoeing and kayaking are popular in the headwaters. Due to shallow waters and numerous log jams, boating is limited. Public access to the main stem is provided at Maple Grove Road and Center Lake outlet. Additional canoe/kayak access sites are needed upstream of the City of Jackson. Although there are only eleven boating access sites on inland lakes within this valley segment, many are located on lake chains and provide access to multiple waters. Carefully planned log jam removal would improve river access and promote recreational use.

Upper

The Grand River in this valley segment is large enough to provide recreational opportunities throughout the year and can be navigated with canoes and small boats. There are eight main-stem boating access sites providing access to both free flowing portions of the river and the impounded reaches near Eaton Rapids and Lansing. Public lands are limited to county, city, and township parks.

Middle

The middle segment offers a variety of recreational opportunities, due largely, to the park systems of Eaton and Ingham counties. Although canoe/kayak access is somewhat limited on the tributaries (e.g., Red Cedar and Looking Glass rivers), good access is provided to the main stem. The local units of government are working to develop extensive river walks connecting various neighborhoods along the Grand River main stem, Red Cedar River and Sycamore Creek. Major state-owned recreational lands in the middle segment include the Portland State Game Area and Rose Lake Wildlife Research Area.

Lower

Due to its large size and diverse geology, the lower segment offers more variety in recreational opportunities than the other segments. Camping, hiking, mountain biking, skiing, wildlife viewing, hunting, and fishing are available on public lands at a variety of state game areas, state parks and recreation areas, and numerous county, township, and city parks. Information detailing the recreation opportunities on state-owned lands can be found at http://www.michigan.gov/dnr. Significant state-owned lands protecting river corridors and providing public access include the Maple River, Stanton, Langston, Flat River, Barry, and Rogue River state game areas, and the Yankee Springs and Ionia state recreation areas. Additionally, significant park lands are administered by the Kent County Parks and Recreation Department. Ten boating access sites are found on the main stem and an additional eighty sites are located on tributaries and inland lakes

Mouth

This main-stem segment is also heavily used for recreation. Fishing, hunting, and other recreational opportunities are provided at the Grand Haven State Game Area, Bass River State Recreation Area, and Grand Haven State Park. The Ottawa County Parks and Recreation Commission is developing the Grand River Greenway and has acquired over nine miles of frontage on the main stem and bayous. The Port of Grand Haven is the home to a large fleet of charter boats offering trips for Lake Michigan salmon, steelhead, brown trout and lake trout. Numerous marinas catering to pleasure boaters operate in the Grand Haven-Spring Lake area.

Citizen Involvement

Citizen involvement is a critical component in the management of the natural resources of the Grand River watershed. The overall mission of Fisheries Division is “to protect and enhance fish stocks and other forms of aquatic life and aquatic habitat, and to promote optimum use of these resources for the benefit of the people of Michigan”. To achieve this mission, and the goal of sustainable fisheries resources, Fisheries Division supports collaborative efforts and open dialog with the public and many stakeholder groups representing a variety of watershed interests. As current trends point toward smaller government, these collaborative and cooperative partnerships are of increasing importance and will be invaluable in the future management of the Grand River watershed.

Citizen involvement occurs in many forms, from letter writing and meeting attendance to membership in watershed councils or angling groups. Many diverse groups are involved in efforts to protect and restore the quality of natural resources in the Grand River watershed (Table 40).

Several of these citizen groups were established as a community response to local watershed issues or to promote recreational uses within the watershed. Many are the recipients of funding grants from federal Clean Water Act funds or other funding initiatives (e.g., Inland Fisheries Grants, Clean Michigan Initiative). These grants have enabled them to develop land use planning tools, foster education and outreach activities, improve habitat, and implement best management practices in their adopted watersheds. Their involvement in management of the Grand River watershed is not limited to interactions with various government agencies charged with the administration of environmental laws and policies. Many of these groups sponsor or participate in annual river clean-ups, and volunteer water quality monitoring networks such as the Michigan Clean Water Corps (MiCorps).

- Grand River Environmental Action Team (G.R.E.A.T.)—The mission of the Grand River Environmental Action Team is "to promote, through activities and educational programs, public awareness for the need to protect and preserve the Grand River, including its watershed and surrounding wetlands in Jackson County, Michigan". GREAT was founded in 1989 and is a local nonprofit organization. Activities include: river cleanups to pull trash from the river, labeling of storm drains to remind citizens that the drains lead directly to the Grand River, maintenance of an inventory of the rare plants and animals that line the Grand River, and recreational canoe trips along the river to promote an understanding and appreciation of Grand River natural resources.
- Upper Grand River Watershed Alliance (UGRWA)—The Upper Grand River Watershed Alliance is a coalition of municipalities, agencies, businesses, and individuals in the headwaters and portions of the upper segment of the Grand River basin, working together to protect and restore the river, its lakes, streams, and wetlands.
- Michigan State University Watershed Action Through Education and Research (MSU-WATER)—Initiated in 2000, this project is led by faculty, staff and students from various colleges, departments and support units at MSU. This project integrates research, teaching, and outreach activities within the Red Cedar River watershed. Their goals are: to determine the University's ecological footprint on the Red Cedar River; enhance MSU's reputation in water resources research, teaching and outreach; develop a comprehensive watershed plan that includes practical management alternatives; and meet storm water management objectives as required by Phase II of the Clean Water Act.
- Friends of the Looking Glass River—The mission of Friends of the Looking Glass is "to promote the enjoyment of and responsibility for the river and to maintain and improve the watershed". Their goals and objectives are to: promote responsible land use and environmental practice within the watershed; communicate watershed information to managers, decision makers and the general public; develop networks with stakeholders in the Looking Glass Watershed, and; promote responsible recreational use of the Looking Glass River.
- Middle Grand River Organization of Watersheds (MGROW)—its mission is "To protect and preserve the history and natural resources of the Middle Grand River watershed by promoting education, conservation, restoration, and wise use of watershed resources." The group is an outgrowth of Grand River Expedition 2010, and works to bring together local communities, subwatershed groups and other stakeholders in the Middle Grand River to promote a greater understanding and stewardship of the river.
- Greater Lansing Regional Committee—This committee is composed of the communities participating within Phase II of the Clean Water Act. Their goal is to guide the

implementation of the Phase II program for communities within the Lansing area watersheds of the Grand River, Red Cedar River and Looking Glass River.

- Lansing "Perrin" Chapter of Trout Unlimited—This chapter embraces the national Trout Unlimited mission "to conserve, protect, and restore North America's Trout and Salmon fisheries and their watersheds". They work to accomplish this through: education of our members and the public on important mission issues; conservation/improvement of specific cold water habitat watershed projects; participation in Trout Unlimited meetings and initiatives to legislative reform; cooperative fund raising activities to allow financial grants to be selectively awarded for activities in agreement with the chapter's mission: "to preserve, protect and restore Michigan's watersheds which support wild trout and salmon".

- Friends of the Maple River—The mission of Friends of the Maple River is to preserve, improve and promote through education, the wise use of the Maple River and the Maple River Watershed. They are working toward the following goals: develop an inventory and monitoring program for the water resources, flora and fauna within the Maple River and the Maple River watershed; develop a watershed restoration and management plan; develop educational materials and presentations to educate the public on issues related to the Maple River and the Maple River watershed.

- Lower Grand River Organization of Watersheds (LGROW)—A multidisciplinary watershed organization to oversee restoration, protection and enhancement activities in the lower Grand River drainage basin that encompasses more than 3,000 square miles starting at the confluence of the Grand and Looking Glass Rivers in downtown Portland in Ionia County through Metro Grand Rapids to Lake Michigan. The watershed covers ten counties and includes the Thornapple River, Flat River, and Rogue River Watersheds.

- Coldwater River Watershed Council—The mission of the Coldwater River Watershed Council is: "Working together to protect, rehabilitate and sustain the ecological and cultural communities that make up the Coldwater River Watershed." They have developed both a management plan and an atlas available at their website to identify nonpoint source pollutants and to find ways to prevent those pollutants from entering the waterways.

- Thornapple River Watershed Council—The goal of the Thornapple River Watershed Council is for the Thornapple River to regain its reputation as some of the best fishing in the Midwest. Their goals and objectives are as follows: to provide a regional vision for the Thornapple River watershed; to promote responsible land use and environmental practices within the watershed and coordinate multiple interests within the watershed; communicate watershed information to managers, decision-makers and the general public; speak with a collective voice and secure state and federal resources for the watershed; develop networks among stakeholders within the Thornapple River watershed.

- Kalamazoo Valley Chapter of Trout Unlimited—This chapter of Trout Unlimited has over 500 members. Chapter members have participated in various projects on trout streams throughout southwestern Michigan. In the Grand River watershed, they have been involved in projects on the Coldwater River and Tyler Creek.

- Rogue River Watershed Council—The Rogue River Watershed Council is dedicated to the long-term protection and enhancement of the Rogue River and its tributaries. Functions of the Watershed Council include assessment and characterization of the natural resources and water quality conditions of the Rogue River and its tributaries and identification of critical areas and environmental threats.

- Bear Creek Watershed Council—The goal of the Bear Creek Watershed Council is to protect our natural resources and educate the citizens of Cannon Township on the importance of watershed health.

- West Michigan "Schrems" Chapter of Trout Unlimited—The mission of the West Michigan Chapter of Trout Unlimited is "to conserve, protect and restore west Michigan's coldwater fisheries and their watersheds and to provide a forum for the exchange of information concerning coldwater fisheries and the techniques and the sport of trout fishing". They have been involved in many activities including river clean-ups, stream monitoring, bank erosion control, and fly fishing clinics. In the Grand River watershed, most of their work has been associated with the Rogue and the Coldwater rivers.
- Trout Unlimited National—Trout Unlimited is the nation's largest grassroots coldwater conservation organization with a mission to conserve, protect, and restore North America's trout and salmon fisheries and their watersheds. Trout Unlimited works to achieve this mission on a local, state, and national level through an extensive volunteer network and dedicated staff. A simple yet effective framework guides our work: where rivers are intact, we protect them. Where they are fragmented by dams, we reconnect them. Where they are degraded, we restore them. And to sustain these efforts into the future, we invest in youth education and outreach, creating a new generation of stream champions to continue our work.
- West Michigan Walleye Club—The mission of the West Michigan Walleye Club is "to promote the sport of walleye fishing through the education of its members, involvement of youth, and conservation, in a fun and friendly environment". This club assists Fisheries Division with walleye rearing pond management. Spring fingerlings from this partnership are stocked throughout the watershed.

It is evident that there are many concerned and motivated citizens supporting the goals of water quality improvement and the protection of aquatic resources in the Grand River watershed. Citizen involvement is critical for the long-term protection and enhancement of the Grand River watershed.

MANAGEMENT OPTIONS

The Grand River watershed is a fairly healthy system, with habitats that range from cold to cool to warm water in tributaries to predominately warm water in the main stem. However, fish populations and habitat are degraded in many areas and in need of attention. The management options presented in this assessment are meant to address the most important problems that are now understood and to establish priorities for further investigation. Some management options will be pursued by MDNR Fisheries Division. However, many of the identified options are beyond the scope of MDNR authority and will require the cooperation of private entities and collaboration with many partners.

The options follow recommendations of Dewberry (1992), who outlined measures necessary to protect the health of river ecosystems. Dewberry stressed protection and rehabilitation of headwater streams, riparian areas, and floodplains. Streams and floodplains need to be reconnected where possible. A river system must be viewed as a whole, for many important elements of fish habitat are driven by whole system processes.

The identified options are consistent with the mission statement of Fisheries Division "to protect and enhance fish stocks and other forms of aquatic life and aquatic habitat, and to promote optimum use of these resources for the benefit of the people of Michigan". In particular, the division seeks to: protect and maintain healthy aquatic environments and fish communities and rehabilitate those that are degraded; provide diverse public fishing opportunities to maximize the value of recreational fishing to anglers; and foster and contribute to public stewardship of natural resources through a scientific understanding of fish, fishing, and fisheries management.

Four types of options for correcting problems in the watershed are presented: 1) options to protect and preserve existing resources; 2) options requiring additional surveys; 3) opportunities for rehabilitation of degraded resources; and lastly, 4) opportunities to improve an area or resources, above and beyond the original condition, are listed last.

History

Archaeologists are interested in the recent past as well as more ancient times. Pioneer homesteads, mills, logging camps, trading posts, and Native American villages can teach us much that was not recorded in written records.

Archaeological and other historic sites can be damaged or destroyed by any activity that disturbs the soil. Most artifacts lie in the upper foot of soil; a few are more deeply buried. The Office of the State Archaeologist and the State Historic Preservation Office maintain records on archaeological sites and other historic sites and can advise on management. Archaeological artifacts cannot be removed without the permission of the land owner. Permits are required for investigation of sites on federal or state lands. There are guidelines to follow while working near archaeological sites (Mead 1985), but the overriding principle is to avoid disturbing soil.

Option: Protect existing and future archaeological and historical sites by contacting the Office of the State Archaeologist and the State Historic Preservation Office before any major earth moving or river restoration projects.

Option: Survey for and identify animal artifacts at archaeological sites to further our understanding of the historical presence of animals within the watershed.

Geology and Hydrology

The main stem of the Grand River exhibits relatively stable annual flow patterns. However, some reaches and many tributaries have flows that are less stable than expected based on their surrounding geology. Poor land use, channelization and extensive drainage, irrigation practices, and dams cause most of these flow problems.

Option: Protect all existing cold water and cold-transitional, stable streams from effects of land use changes (e.g., increases in impervious surfaces from development practices), channelization, surface and groundwater withdrawals, and construction of dams and other activities that may disrupt the hydrologic cycle by educating and working with planners, zoning boards, developers, drain commissioners, and land owners.

Option: Protect critical groundwater recharge areas by identifying these and developing state and local strategies to protect them. Identify existing large quantity removals of groundwater (e.g., irrigation, industrial, and municipal withdrawals). Promote development and implementation of ecologically-based water withdrawal standards protective of river and stream, inland lakes, and wetlands.

Option: Protect and rehabilitate the function of wetlands, riparian buffers, and floodplains as water retention structures for high flow conditions. Develop an inventory of existing and potential areas for creation or protection of wetlands, with emphasis on riparian areas.

Option: Protect remaining natural lake outlets by opposing the establishment of new legal-lake levels and the associated construction of lake-level control structures. This would allow for natural variation of water levels in lakes and associated riparian wetlands, and maintain flow in outlet streams.

Option: Protect and rehabilitate flow stability by developing a hydrologic routing model for the entire river system that describes both ground and surface water routes in response to changes on the landscape. Such a model would allow various alternatives to be examined and drive future planning processes by providing fundamental information critical for proactive landscape and storm water management planning. It could also be used to identify critical tributary watersheds.

Option: Protect nearshore habitats and floodplain connectivity of both lakes and streams by encouraging and requiring natural methods of bank and shoreline stabilization (e.g. rock riprap, log or whole tree revetments, and vegetative plantings) rather than seawalls through permitting processes, zoning procedures, and education.

Option: Inventory surface and groundwater withdrawals and establish minimum flow regime standards for the main stem and all tributaries. Support implementation of the Michigan Water Withdrawal Assessment Tool and other programs that promote water conservation and regulate surface and groundwater withdrawals.

Option: Survey flows and water quality below main-stem and tributary dams and lake-level control structures to determine if minimum flow or run-of-river flow requirements are necessary.

Option: Partner with state and federal hydrologist to identify needs for additional streamflow gauges or miscellaneous flow measurements. Identify funding resources needed to maintain current gauging stations and seek opportunities to improve collections of streamflow data.

Option: Rehabilitate main-stem and tributary run-of-river flows by operating dams and lake-level control structures as fixed-crest structures rather than by opening and closing gates.

Option: Rehabilitate main-stem and tributary run-of-river flows by removing dams and lake-level control structures where possible.

Option: Rehabilitate summer base flows on main stem and tributaries by establishing natural flow regime standards downstream of all dams and lake-level control structures. These could be established through administrative or legal processes. This could also be accomplished through maintenance of run-of-river conditions.

Option: Rehabilitate main-stem and tributary flow stability by working with county drain commissioners to incorporate annual and seasonal flow patterns into criteria for drain design and storm water management.

Option: Rehabilitate flow stability and storage capacity through wetland restoration by removing or plugging agricultural drain tiles that are no longer critical for land drainage.

Option: Rehabilitate flow stability by reducing runoff in agricultural catchments through implementation of conservation programs (e.g., Conservation Reserve Program (CRP), Wetland Reserve Program (WRP)). Partner with state and federal Departments of Agriculture and county conservation districts to identify priority areas for restoration.

Option: Rehabilitate developed floodplains by supporting policies that regulate land use activities and reconstruction of roads, homes, and other structures in floodplains after large floods.

Option: Rehabilitate developed floodplains by supporting mitigation that targets removal of flood walls and other structures.

Soils and Land Use

Agricultural and urban land uses have altered large portions of the Grand River system. The basin has gone from a predominately forested landscape to a predominately agricultural and urban landscape. Undeveloped land within the watershed has buffered some changes. However, projected urban sprawl and intensive, high acreage farming threaten the integrity of the buffer and will alter the water budget, routing more water along a surface path. There are 8,639 known road crossings in the watershed; adverse effects attributable to these sources are significant. In addition, pipelines and other submerged crossings affect streams during placement and can cause erosion and barrier problems when exposed in the streambed.

Option: Protect undeveloped landscapes through property tax incentives, transportation policies, integrated land use planning, conservation easements, and policies to encourage redevelopment of urban areas.

Option: Protect water quality and stream hydrology in agricultural catchments through the enrollment of marginal lands into Farm Bill conservation programs (e.g., CRP, WRP). Identify the Grand River as a priority watershed for inclusion in the Conservation Reserve Enhancement Program (CREP) to assist agricultural producers to protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard groundwater and surface water.

Option: Protect pervious open spaces by preserving agricultural landscapes through best management practices and agricultural zoning plans.

Option: Protect developed and undeveloped lands through land use planning and zoning guidelines that emphasize protecting critical areas, minimizing impervious surfaces, and improving storm water management for quality and quantity, and maximizing use of groundwater infiltration systems.

Option: Protect remaining wetlands, especially small, “unregulated” wetlands, by working with local governments and planners, zoning boards, agricultural agencies, and conservation groups to preserve them.

Option: Protect riparian wetlands near the river mouth from additional marina development. Encourage new marinas to utilize off-river basins, with single outlets to the river.

Option: Protect and rehabilitate forested corridors along the river and its tributaries. Encourage additional tree planting and reforestation throughout the watershed.

Option: Protect and rehabilitate critical areas through maintenance of current storm water management systems and retrofitting areas that are in need of storm water management systems.

Option: Protect existing streams from sedimentation and flow constrictions by routing new roads to avoid streams rather than crossing, where feasible. Use MESBOAC design guidelines to review crossing construction and reconstruction proposals to ensure adequate stream protection.

Option: Protect streams from degradation by promoting bore and jack or flume methods of pipeline stream crossings as an alternative to open trench construction.

Option: Protect the functionality of the watershed through legislation that preserves rural lands by controlling urban sprawl and industrial development.

Option: Protect natural river functionality through the purchase of flooding rights within the floodplain (i.e., similar to conservation easements by public and private organizations).

Option: Survey watershed to locate crossings that are degrading streams through sedimentation, disruption of stream flow, or creation of barriers to fish passage.

Option: Survey watershed and create map of all known submerged pipelines. Identify pipelines that are exposed and causing bank erosion or barriers to fish movement and notify the appropriate company for repairs.

Option: Rehabilitate any crossings identified above through erosion control measures, reconstruction of poorly placed crossings, replacing perched culverts, and replacing undersized culverts and bridges.

Option: Survey watershed to identify sources of sediment in runoff from gravel and other secondary roads and rehabilitate through implementation of best management practices.

Channel Morphology

The Grand River channel ranges from normal to degraded for habitat diversity and natural form. Most high-gradient areas have been impounded, covering sections that formerly provided good hydraulic diversity. Dredging, straightening, and high sediment loads have created channels that are homogenous, over wide, shallow, lacking diversity, and lacking woody structure, which has adversely affected both the main stem and tributaries.

Option: Protect tributaries from further channelization by developing and promoting alternatives to current dredging practices for drainage improvements.

Option: Protect riparian greenbelts through adoption and enforcement of zoning standards. Encourage development of linear parks as a means to protect riparian corridors.

Option: Survey to identify and map all floodplains. Protect existing floodplains and restore historical floodplains to control storm water runoff, stabilize flows, increase infiltration, reduce erosion, preserve natural areas, and prevent flood damage.

Option: Survey channel cross-sections throughout the watershed and further investigate streams that deviate from an expected channel form.

Option: Rehabilitate rare, high-gradient habitats by removing dams no longer used for their original purpose (e.g., Liberty Mill, Putnam Mill, Leoni Mill, Minard Mill, Sixth Street, Lyons, Grand Ledge, Carson City, Rockford, Greenville, North Lansing, Coldwater, and others). Failed dams should be thoroughly evaluated on the basis of environmental and social factors to determine whether reconstruction is appropriate (e.g., Greenville dam). Existing hydroelectric dams should evaluate options for removal or modification at the close of their license term (e.g. Smithville, Mix, Moores Park, Portland, Webber, Hubbardston, Belding, Whites Bridge, Fallasburg, King Mill, Irving, Middleville, Labarge, Cascade, Ada, and several others).

Option: Rehabilitate recruitment of woody structure by developing and managing wooded greenbelts on riparian lands and managing amounts of wood in a channel (e.g., river clean-ups should be carefully planned and carried out to ensure that most structure remains).

Option: Rehabilitate natural channel morphology in the Grand River main stem and tributaries (e.g., Maple, Flat, Thornapple, Rogue rivers; Prairie and Fish creeks; Quaker Brook; and others) to enhance existing habitat diversity

Option: Rehabilitate stream banks by replacing artificial flood wall structures with more natural banks made of vegetation or field stone (e.g., cities of Jackson, Lansing, and Grand Rapids).

Option: Rehabilitate stream banks by providing a minimum width for vegetated buffer strips and eliminating livestock access.

Dams and Barriers

There are 228 registered dams in the Grand River watershed, and many have significant negative effects on aquatic resources. Dams fragment habitat for resident fish, impede fish movements, impound high gradient areas, trap sediments and woody structure, cause flow fluctuations, cause fish mortalities (entrainment with hydroelectric dams), and block navigation. Lake-level control structures alter natural water regimes and can severely impair downstream aquatic habitat. Some dams, however, provide impoundments with existing and future potential for fisheries and other recreational uses not provided by flowing water.

Option: Protect and improve biological communities by providing upstream and downstream fish and large woody structure passage at dams to mitigate for habitat fragmentation (e.g., Smithville, Mix, Moores Park Hubbardston, Prairie Creek, Greenville, Belding, Whites Bridge, Fallasburg, King Mill, Irving, Middleville, Labarge, Cascade, Ada, Rockford and several others).

Option: Protect fishery resources by recommending screened turbine intakes at operating hydroelectric dams (e.g., Moores Park).

Option: Protect remaining connectivity of the river system by opposing construction of dams and within-stream-channel storm water detention basins.

Option: Protect fishery habitat and river functionality through active opposition to hydroelectric facilities development within the Grand River basin. Encourage the use of turbine technology that does not require damming of the river. If hydroelectric development cannot be avoided, the Department of Natural Resources should forcefully pursue mitigation of all project effects on the resource. Such mitigation would include, but not be limited to, passage of all fish species.

Option: Survey and develop an inventory of barriers to fish passage, such as perched or misaligned culverts, and explore options to correct any problems.

Options: Survey and develop a list of the most environmentally damaging dams and barriers to fish passage in the river, with recommendations to mitigate damage.

Option: Survey to determine the number of small unregistered dams in the basin.

Option: Rehabilitate free-flowing river conditions by encouraging dam owners to make appropriate financial provisions for future dam removal, and seek legislation to require dam owners to establish such funds.

Option: Rehabilitate free-flowing river conditions by removing dams, requiring dam owners to operate at run-of-river, and modifying all possible dams to fixed-crest structures (e.g., Smithville, Mix, Moores Park, Hubbardston, Greenville, Belding, Whites Bridge, Fallasburg, King Mill, Irving, Middleville, Labarge, Cascade, Ada, Rockford and several others).

Option: Rehabilitate river navigability by constructing canoe portages and upstream and downstream access sites at dam locations on the main stem and major tributaries (e.g., Ada, Cascade).

Option: Rehabilitate natural water levels by requiring all lake-level control structures to be operated to maintain existing seasonal water level fluctuations. Lake-level control structures could be removed or converted to fixed-crest structures to accomplish this.

Option: Rehabilitate river functionality through foundation support and appropriations to create a dam removal fund that local communities (e.g., Eaton Rapids, Lyons, Grand Ledge, Grand Rapids, Greenville, Rockford, and others) can use to help remove their unwanted dams.

Options: Promote benefits of river restoration through alternative proposals that provide an attractive waterfront in communities where dam removal may be an option (e.g., Eaton Rapids, Lyons, Grand Ledge, Grand Rapids, Greenville, Rockford, and others).

Special Jurisdictions

Natural resources and environmental quality are managed directly by the State of Michigan through the Department of Natural Resources and Department of Environmental Quality. The Federal Energy Regulatory Commission licenses active hydropower facilities within this watershed. County drain commissioners have authority over designated drains and many lake-level control structures. Township and city officials control zoning and ordinances that can affect the quality of the river system.

Option: Protect recreational access to streams by continuing to advocate and work toward legislative adoption of the recreational definition of navigability (e.g., a stream is legally navigable if it can be navigated by a canoe or small boat).

Option: Protect and rehabilitate the river system by supporting cooperative planning and decision-making. Develop a Geographic Information System that could be used in these processes (e.g., the Watershed Interactive Mapping initiative that was developed as part of the 319 project for the lower Grand River watershed, could be expanded both in content and geographic extent to the entire watershed).

Option: Protect cold water tributaries by designating appropriate reaches as trout streams to ensure proper management and environmental protection.

Option: Protect the quality of wetlands, streams, and lakes through rigorous enforcement of Parts 31, 91, 301, and 303 of the Natural Resources and Environmental Protection Act, PA 451 of 1994.

Option: Survey and identify river reaches for Country-Scenic designation pursuant to the Natural Rivers Act, Part 305 of the Natural Resources and Environmental Protection Act, PA 451 of 1994 (e.g., Grand, Maple, and Thornapple rivers).

Option: Rehabilitate designated drains by encouraging drain commissioners to use stream management approaches that protect and rehabilitate natural processes rather than traditional deepening, straightening, and widening practices that emphasize moving water away quickly with little consideration for the effect on the stream or biota.

Option: Rehabilitate designated drains to natural stream status where drain designation is no longer appropriate or where past drainage modifications have been excessive and permanently altered stream channels (e.g., Grand River, Portage River, Coldwater River, Stony Creek, Maple River, and Thornapple River).

Option: Rehabilitate designated drains by supporting efforts to amend the Drain, Code, PA 40 of 1956, to include provisions for the protection and enhancement of fish and wildlife resources.

Option: Rehabilitate lake outlet streams by encouraging run-of-river management at lake-level control structures. Support establishment of natural flow regime standards through amendments to Part 307, Inland Lake Levels, of the Natural Resources and Environmental Protection Act, PA 451 of 1994.

Option: Protect surface water and groundwater resources from over-exploitation through the support of the Michigan Water Withdrawal Assessment Program. Support future refinements including the development of index of flow alterations for Michigan streams.

Water Quality

The Grand River basin has historically suffered from poor water quality due to unregulated discharges from municipal and industrial point source discharges. Water quality in the basin has steadily improved, and virtually all point source discharges are now regulated through the National Pollutant Discharge Elimination System (NPDES) permitting program administered by the MDEQ Water Resources Division. Contemporary causes for nonattainment of water quality standards include poorly-designed sanitary sewer systems that allow for combined sewer overflows (CSO) and sanitary sewer overflows (SSO), nonpoint source pollution from the lack of best management practices in the uplands, deposition of airborne pollutants, and localized degradation from contaminated sediments and venting contaminated groundwater. The Grand River watershed is a significant source of nitrogen, mercury, and atrazine loadings to Lake Michigan. It is sixth overall in total PCB loads to Lake Michigan.

Option: Partner with federal, state, and local agencies to identify high quality river and stream segments and ensure protection of these areas through full implementation of Parts 31, 301, 303, of the Natural Resources and Environmental Protection Act, PA 451 0f 1994.

Option: Partner with federal, state, and local agencies to establish a network of fixed monitoring stations to develop long-term trends of water and sediment quality, biological diversity, and attainment of designated uses.

Option: Protect and rehabilitate water quality through infrastructure redevelopment projects to identify and eliminate discharges from combined sewer overflows and sanitary sewer overflows.

Option: Protect and rehabilitate water quality by implementing improved storm water and nonpoint source best management practices. These projects are needed in urban and agricultural areas throughout the entire watershed.

Option: Protect and rehabilitate water quality by supporting the development and implementation of total maximum daily load (TMDL) limits for pollutants in the watershed (e.g., mercury, PCBs, pathogens, etc.).

Option: Protect water quality and fish habitat by ensuring enforcement and compliance of erosion control permits under Part 91 of the Michigan Natural Resources and Environmental Quality Protection Act (1994 PA 451).

Option: Protect water quality by conserving existing wetlands and riparian corridors, rehabilitating former wetlands, and maximizing use of constructed wetlands as natural filters. Promote use of low impact development technologies.

Option: Protect river quality by supporting educational and other pollution prevention programs targeting the agricultural industry, land developers, and other resource users who teach land and water management practices that prevent further degradation of aquatic resources.

Option: Protect groundwater and stream flows through implementation of the water withdrawal assessment process pursuant to PA 34 of 2006.

Option: Protect major aquifers in the watershed by promoting hydrogeologic studies to characterize groundwater and programs to protect groundwater from contamination.

Option: Measure of nutrient and sediment loading to the river and develop strategies to reduce nonpoint source pollution problems by working with federal, state and local partners.

Option: Survey groundwater use to determine resource availability and potential for overuse.

Option: Survey water quality to determine the effects of water withdrawal.

Option: Survey thermal effects of dams to determine where effects are greatest.

Option: Rehabilitate and protect water quality by supporting remediation of environmental contamination sites.

Option: Rehabilitate water quality (reduce nonpoint source pollution) by encouraging communities to implement best management practices that reduce contributions of refuse, sediment, and pollutants to the river.

Biological Communities

The biological communities of the Grand River have improved significantly since the 1970s due to water quality improvements. However, certain problems still require consideration. There has been a decline in species that require clean gravel substrates. This habitat has been lost to sediment deposition, impoundments of high gradient areas from dams, and channelization. There has also been a loss of potamodromous species that historically used the river for spawning (e.g., lake sturgeon). These species have been cut off from spawning habitats by dams on the main stem and tributaries. Channelization and stream clearing have degraded channel morphology and removed woody structure used for habitat and raised stream temperature. Mussel and aquatic invertebrate species have declined from poor water quality, sedimentation, and loss of free-flowing river and gravel habitats due to impoundments. Amphibians and reptiles have been on the decline presumably from wetland loss. Introduction of exotic species has harmed native biodiversity through direct competition or indirectly through habitat impairment.

Option: Protect remaining stream margin habitats, including floodplains and wetlands, by encouraging setbacks and vegetated buffer strips in zoning regulations, controlling development in the stream corridor, and acquiring additional greenbelts through agricultural conservation programs, conservation easements, or direct purchases by conservation organizations or government agencies.

Option: Protect remaining high gradient and naturally-graveled habitats, especially the area downstream of the City of Grand Rapids, which contains lake sturgeon spawning habitat potential. Other natural stretches on the main stem and tributaries should also be protected (e.g., main stem in the Portland State Game Area).

Option: Protect native biological communities from the spread of nonindigenous species through education and public awareness. Encourage rigorous enforcement of laws prohibiting possession and/or release of banned species.

Option: Protect native mussels through channel restoration (e.g., dam removal) and through survey and translocation requirements for all instream construction projects (e.g., bridge, pipelines, and other crossings).

Option: Protect and rehabilitate cold, cold-transitional, and warm-transitional thermal habitat areas and their unique biological communities. Examples include: Rogue River and tributaries, Flat River and tributaries, Thornapple River and tributaries and most of the small tributaries of the main stem in Ionia and Kent Counties.

Option: Protect and rehabilitate upland habitats for native plant and wildlife diversity.

Option: Survey and map biological community distributions in the watershed using advanced technology including global positioning and geographic information systems. Identify measures to protect areas with unique biological communities and locations supporting significant aquatic biodiversity.

Option: Survey distribution and status of aquatic invertebrates (crayfish, mussels, snails, and insects) and fish fauna.

Option: Survey distribution and status of amphibians and reptiles within the watershed and protect critical habitats.

Option: Survey distribution and status of other species of conservation interest (e.g., endangered, threatened, special concern, and species of greatest conservation need), develop protection and recovery strategies for those species, and explore options to protect critical habitat and maintain biodiversity (e.g., Michigan Wildlife Action Plan, southern Michigan ecoregional planning process).

Option: Develop a lake sturgeon management plan for the Grand River. Continue survey efforts to strengthen population estimates and determine distribution and status in the mouth and lower main-stem segments. Identify and map critical spawning and juvenile rearing habitats and develop protection plans for these areas.

Option: Survey distribution and status of river redhorse and other redhorse species identified as species with the greatest conservation need throughout the watershed but primarily in the lower main-stem segment and lower segment tributaries such as the Flat, Thornapple and Rogue Rivers. Develop and implement a redhorse management plan.

Option: Survey distribution and status of cisco throughout the watershed. Complete and implement a cisco management plan.

Option: Rehabilitate rare, high-gradient areas and fragmented habitats by removal of dams where feasible, as described above.

Option: Rehabilitate and improve populations of fish and native mussel species by installing upstream and downstream passage at dams and barriers where removal is not feasible (e.g., rock arch rapids, rock ramps). Structures should restore fish passage for all species during all seasons and flows. Since fish serve as hosts and vectors of distribution for mussels, passage for all fish species benefits mussels as well. Existing passage facilities that currently pass only salmonids need to be redesigned and constructed to accommodate all species (e.g., Sixth Street, Lyons, Webber, Portland, Grand Ledge, and North Lansing).

Option: Rehabilitate fish diversity by re-establishing the extirpated weed shiner to the watershed.

Option: Increase public awareness regarding the detrimental ecological effects of spreading aquatic pest species. Promote education through signage at all water access sites, bait shops, boat dealers. Promote education and outreach programs through local outlets (e.g., MSU Extension, Sea Grant, and Conservation Districts). Encourage Department of Agriculture to notify aquarium and pet trade of restricted and banned species lists.

Fishery Management

The Grand River watershed has the potential to support substantial populations of cold, cool and warmwater fish along much of its length. Angling is good, particularly in the lower and mouth segments. Yet, angling pressure is generally low, except during the spawning runs of potamodromous species and the trout fishery in some of the tributaries. Angling opportunities could be expanded through more concerted management and careful review of existing management practices.

Option: Protect aquatic habitats through technical review of environmental permit applications. Make recommendations to mitigate unavoidable habitat impacts.

Option: Survey fish populations and inventory habitat in waters where data is limited or lacking (e.g., Maple and Flat rivers).

Option: Conduct inland creel surveys to assess fishing pressure, and understand angler behaviors, interests, values, attitudes, and knowledge.

Option: Evaluate alternative sea lamprey barrier technologies in the mouth segment to allow for removal or modification of the Sixth Street Dam and fish ladder and restore fish passage for all species.

Option: Survey water temperatures and trout survival in managed waters (e.g., Buck Creek, Sand Creek, etc.) to determine if trout stocking is prudent (e.g., summer temperatures too marginal, natural reproduction can sustain fishery, adjust strains, or continue stocking).

Option: Survey and evaluate fish and invertebrate species of conservation interest (e.g., lake sturgeon, cisco, redhorse suckers, freshwater unionid mussels, and crayfish).

Option: Survey and evaluate existing walleye, channel catfish, and flathead catfish populations in the lower and mouth segments.

Option: Rehabilitate habitat continuity by removing unnecessary dams. Require upstream and downstream fish passage of all fish species on those dams that remain.

Option: Rehabilitate lake sturgeon spawning activity in the lower main-stem segment by removing or providing adequate fish passage at Sixth Street, Lyons, Webber, and Portland dams.

Option: Rehabilitate historical populations of Great Lakes muskellunge in the mouth and lower main-stem segments by initiating stocking programs and providing fish passage or removing dams.

Option: Improve angling opportunities by continued improvement and acquisition of public access property (e.g., Bear Creek, Prairie Creek, and others).

Option: Maintain fishing opportunities through existing stocking programs (e.g., walleye, brown trout, coho salmon, Chinook salmon, and steelhead). Stocked waters should continue to be surveyed to evaluate fish populations and angler use to justify future stocking.

Option: Survey and evaluate need for special regulations to protect species (e.g., river redhorse), to provide unique fishing opportunities (e.g., muskellunge management), or provide trophy fisheries through catch and release angling.

Recreational Use

The watershed provides great recreational opportunities in public-owned areas. The river and tributaries are used frequently for fishing, hunting, canoeing, and nature watching, especially through state recreation and game areas. These recreational opportunities would be enhanced by increased public access (e.g., more boat and canoe launches) to the river and its tributaries. Navigation is impeded by poorly designed and maintained portages around some main-stem and tributary dams. Recreational use would also significantly increase once the stigma of combined sewer overflows is removed.

Option: Protect, encourage, and support existing parks and promote responsible management for riparian areas in public ownership.

Option: Protect recreational (fishing, canoeing, hunting, wildlife viewing etc.) use of small tributaries by supporting establishment of a “recreational” definition of legal navigability as opposed to the “commercial” definition.

Option: Protect angler access by considering development of a stream public right-of-way by purchasing easements for angler access from private land owners.

Option: Survey and quantify recreational user groups within the river system, and identify programs to enhance compatible use of resources (e.g., educate liveries of the importance of woody structure in streams; educate pleasure boaters and personal watercraft users of proper operational etiquette near shorelines, wildlife, swimmers, and anglers).

Option: Survey recreational users to assess access needs (e.g., locations, facilities). Use this information to identify priority areas to expand or enhance public access.

Option: Survey and promote recreational areas through more efficient use of media outlets and publications.

Option: Rehabilitate canoe portages and boat launches at all dams along the main stem and on the Flat, Thornapple and Rogue rivers. These sites can be maintained by hydropower facilities under FERC relicensing agreements where applicable.

Option: Rehabilitate small-scale public access where lacking through MDNR, county, township, and other municipal recreation departments, as well as private organizations.

Option: Rehabilitate access through funding support for fishing piers, river walkways, and other facilities to provide recreational use of the river. Allow these grant monies to be used for maintenance needs.

Citizen Involvement

Citizen involvement in the watershed is increasing. Several groups have developed with specific goals for the watershed. It is important that all interest groups communicate with each other as well as with other groups around the state to develop educated and effective management strategies toward watershed improvements.

Option: Protect the natural landscape by supporting local land conservancies, and conservation districts in identifying lands for acquisition and conservation easements.

Option: Improve communication between interest groups in the Grand River watershed.

Option: Maintain and expand Fisheries Division's partnerships with continued involvement with citizen groups by attending meetings, reviewing project proposals, and providing information about the watershed.

Option: Maintain and improve strategies to educate the community to the benefits of river ecosystems, wetlands, and floodplains by supporting local conservation organizations.

Option: Rehabilitate and improve river habitat by encouraging and supporting habitat improvement projects conducted by sport and/or watershed groups.

Option: Improve citizen use of the river by supporting programs that encourage use and contact with the river and its tributaries.

PUBLIC COMMENT AND RESPONSE

The draft of the Grand River Assessment was distributed for public review November 23, 2011. Although the primary means of distribution was the MDNR Fisheries Division web site, links to the document were posted on various internet sites and forums. Statewide MDNR Press Releases were issued in conjunction with release of this draft. Printed copies and compact discs were also available from the MDNR Plainwell Operation Service Center.

Three public meetings were held to receive comments concerning the river assessment draft. Windsor Township Emergency Services Building, December 15, 2011 (11 people attended); Jackson District Library-Carnegie Branch, December 21, 2011 (3 people attended); and Plainfield Charter Township Hall, December 28, 2011 (27 people attended).

The public comment period for the river assessment draft ended January 15, 2012. However, comments received after this period were accepted and included. Comments of similar subject were combined to avoid unnecessary duplication. All comments received were considered. Where Fisheries Division agreed with comments, changes were made. Where Fisheries Division disagreed with comments, reasons why are stated in our response.

Introduction

Comment: Various comments were made supporting the watershed assessment process and complimenting the Division on the effort.

> Response: These comments are acknowledged and appreciated.

Comment: The image of the Grand River needs to be changed and addressed. The local population has a very negative viewpoint of the river. More good news needs to be spread about the improvement of the river.

> Response: We agree. The image of the Grand River suffers from past decades of uncontrolled discharges from industrial and municipal sources. Through the implementation of the Federal Water Pollution Control Act, these point source discharges have been regulated resulting in cleaner water, improved habitats, and healthy biological communities. Today the river main stem and its tributaries support significant recreational opportunities including angling and other water-based activities. It is our goal through the river assessment and future management actions to educate the public to the tremendous resources the Grand River offers.

Comment: How often will the river assessment be updated and reviewed?

> Response: The Grand River Assessment was prepared to provide a comprehensive reference describing past and current resource conditions and direct future management of the aquatic resources within the watershed. The river assessment has a long-term focus (40 to 50 years) and is intended to provide a foundation to guide specific long- and short-term planning throughout the watershed. Following the publication of the river assessment a Grand River Management Plan will be developed to direct Fisheries Division's short-term management priorities. This management plan will be reviewed and updated on an annual basis.

Comment: I was just reading through the Grand River report this morning. Nice, thorough job. I particularly like the historical approach, which includes reference to the ice age and even deeper history. It encourages the proper evolutionary view, the long view, which so many people fail to grasp. I also like the use of the term "humans," instead of people, as it encourages readers to see our species as part of the biological mix, rather than something superior to it.

Response: Thank you for your comment.

Comment: Thank you for the invitation to review the draft Grand River Assessment and the opportunity to comment. I commend you on a thorough assessment of the Grand River and its watershed. This document, once finalized, will hopefully be used in future planning activities to protect and manage the freshwater and aquatic resources of the Grand River Watershed. I am coordinating the nonpoint source planning activities for a portion of the Grand River Watershed and will certainly incorporate information from this assessment into the watershed management plan that I develop. I will likely be asking if you are able to share any data or GIS files that I can use in my planning project.

Response: All materials used to develop the river assessment can be made available for use in planning projects or to pursue grant opportunities.

Geography

Comment: Lake Le Ann and Mirror Lake are artificial impoundments behind earthen dams. Lake Le Ann drowns Lime Lake and Mirror Lake drowns one of the Grand Lakes.

Response: This is correct, as discussed in the section on Dams and Barriers.

Comment: The North Branch or East Branch (Grand River) in Section 7 of Leoni Township should be mentioned in the description.

Response: The description of the headwaters segment was modified to include the North Branch Grand River.

History

Comment: Page 7. Paragraph 4. "Another portage route was established between Big and Little Portage Lake chain northeast of Jackson to the "R.aux Ours," the current-day Huron River (USACE 1972).

This is incorrect; the portage is southeast of Stockbridge leading to the Portage Lake Swamp. The route taken was from the Huron River to Portage Creek through the Portage Lake Swamp to the Portage River to the Grand River.

Response We believe this is the same route, albeit less detailed, than that described in the referenced document. The text was modified to include more detail.

Comment: The portage connecting the Grand River to Saginaw Bay was through the Maple River-South Branch Bad River route not the Maple River-Shiawassee River route.

Response: There were multiple portages connecting the Grand River and Lake Michigan to Saginaw Bay. Further research indicates this comment is correct and the text has been changed.

Dams and Barriers

Comment: In the Executive Summary, on page 16 it reads: "Dams located in the lower portions of the Rogue, Flat, and Thornapple Rivers block spawning runs and isolate fish populations."

This is a rather one-sided statement as it omits mentioning that these dams also block most of the sea lamprey from infesting the upper river and tributaries. Removing the dams would open these areas to them.

Response: The sixth street dam and fish ladder in Grand Rapids are the primary barriers to the upstream movement of sea lamprey in the Grand River watershed. The dams located on the Rogue, Flat, and Thornapple rivers are upstream of the sixth street dam and are not considered primary barriers to sea lamprey movement. We agree that in the event the sixth street dam was compromised, these dams would be important in limiting the spread of sea lamprey to other waters in the watershed.

Comment: How is the state planning on funding future dam removals?

Response: Securing funds for the removal of dams is often difficult due to the complex nature of the projects. The total costs associated with most projects often exceed available funding sources, requiring dam owners to seek funds from several granting agencies. Fisheries Division has advocated for the establishment of a statewide dam removal fund and recommends that all FERC-regulated dam owners establish a decommission fund as part of the relicensing of these projects.

Comment: Is there a way to educate public decision makers about the fish passage?

Response: Fisheries Division, along with several of our resource partners (e.g., USFWS, Conservation Districts, Trout-Unlimited, Michigan Steelheaders), works with local decision makers to promote the removal or modification of existing barriers to fish movement. Many times these are project specific efforts. Several projects are currently underway to inventory barriers in several tributaries within the Grand River watershed. These inventories will be provided to local decision makers to assist in establishing priority areas for rehabilitation.

Comment: The Grand River in the summer/fall currently is very shallow for training our rowers on the water. Our shells have run aground or hit submerged objects and our coach launch hit a lot also causing prop damage.

Any recommendation that reduces the water level above Sixth Street Dam would be devastating to the five high school crews and Grand River boathouse crews.

Response: Fisheries Division recognizes there are multiple recreational uses of the Grand River main stem. Rowing on the impoundment created by the Sixth Street Dam has been identified as an issue if the dam were to be removed. Any future project that proposes the removal or modification of the Sixth Street Dam will need to evaluate potential changes in existing recreational uses.

Comment: How can the public become more involved with the process to remove dams?

Response: Dam removals are often very controversial. Community acceptance is often difficult to gain because of historic attachment to existing structures. Our approach has been to assist community leaders through public forums to educate residents as to the ecological and economic benefits of dam removals. Many times this has been accomplished by inviting speakers from nearby communities that have successfully completed a dam removal project.

Comment: Are there any plans to publish a single source database or document to identify dams which have potential to be removed, pose danger, or significantly diminish fish passage?

Response: The inventory of the dams contained in Table 12 of the Grand River Assessment was created utilizing the Michigan Department of Environmental Quality, Water Resources Division's dam safety database, which contains information on over 2500 dams statewide. Currently, the information is not contained in a published document but is available upon request.

Comment: There seems to be so much uncertainty or unknown factors regarding dam removal. I would like to have better visibility to what is on the horizon and what could be done.

Response: Fisheries Division advocates for dam removal when the structure no longer serves a purpose, and there is a reasonable expectation that dam removal will benefit the environment and aquatic resources. If the dam is likely to cause significant damage to public safety, welfare, property, natural resources, or the public trust in those natural resources, Fisheries Division will recommend that MDEQ order its removal. Ultimately, it is the individual dam owners' (both public and private) responsibility to properly maintain and operate these facilities. Uncertainty arises when funds are not budgeted for general maintenance and repair, and over time the structures become too great of a financial burden and are eventually abandoned. Further information regarding dams and dam removals can be found at http://www.michigan.gov/dnr/0,4570,7-153-30301_31431_31529---,00.html

Comment: P. 39 The description of the Hubbardston Dam may need to be revised. Currently the power dam is closed and shuttered, with meters removed. This is a critical dam relative to fish passage (natural reproduction of steelhead and salmon and the threatened river red horse *Moxostoma carinatum*) and perhaps a recommendation for improved fish passage via dam removal or a ladder should be included in the assessment.

Response: As of this writing, the Hubbardston Dam on Fish Creek in Ionia County is not producing hydroelectric power. The turbines have been removed and are being refurbished. The future of the facility remains uncertain. If the owner intends to complete the repairs and return to power production, then Fisheries Division will continue to recommend that the FERC license agreement contain the provisions outlined on page 39 of the text. If the owner chooses to decommission the structure, then Fisheries Division will commit to working with the owner to return Fish Creek to a free-flowing system.

Comment: How can the public get involved to streamline the dam removal process?

Response: Over the past decade, Fisheries Division and the MDEQ have worked through several complex issues related to the dam removal process. Recent changes in the MDEQ

Inland Lakes and Streams permitting process have streamlined the removal of small low-head dams. However, larger dam removal projects are often very complex and typically require several years of planning and thoughtful design. The public can be involved throughout the entire process to provide support and feedback to the agencies and local officials. However, because each project is unique, future dam removals will continue to be a relatively lengthy process.

Comment: Lansing fishermen will volunteer to check smolt traps if they are put in (at Webber dam).

Response: Fisheries Division is exploring alternative coho salmon stocking locations to reduce mortality of stocked yearlings. One alternative that is being explored is relocating the stocking location to a site downstream of Webber Dam. These proposed changes would eliminate the need for a smolt trap.

Comment: In looking through this, I don't see any discussion of the dams in Eaton Rapids except the Smithville dam. I am interested in the State street dam and the two smaller downstream dams. Any thoughts on those?

Response: The State Street Dam on the Grand River main stem is a diversion structure associated with the Mix hydroelectric project. This structure and the two low head downstream dams are barriers to fish movement. Fisheries Division would support the removal or modifications to these dams to allow for fish movement.

Comment: P. 5 – 1st paragraph – the Maple River confluence is near Muir, not Lyons.

Response: The change was made.

Comment: P. 14 second bullet – late summer low flows are due mostly to high transpiration and high evaporation rates as August and September are fairly wet months – greater that 3" of rain. Fourth bullet winter low flows due to both storage in ice and snow plus low precipitation – less that 2" per month.

Response: The suggested wording change has been made.

Comment: In the lower section (pages 39–41) the Rockford Dam is not mentioned here. It might be good to get some background information on this dam since you mention it throughout the report.

Response: The text was modified to include some background information on the Rockford Dam.

Recreational Uses

Comment: Is recreation use on the Grand River increasing or declining?

Response: Recreational use of the river is increasing. This can be largely attributed to the implementation of the Clean Water Act and control of point source discharges. This has led to the recovery of the sport fishery and public acceptance that the river is a significant resource offering a variety of recreational opportunities.

Comment: How is the state supporting "heritage trail" efforts and are different rivers consistent?

Response: The Michigan Heritage Water Trails program was authorized by Public Act 454 of 2002. The program is an initiative to connect communities using navigable waterways and provide historical education to trail users. The program is a collaborative effort between the Great Lakes Center for Maritime Studies at Western Michigan University, and local partners. The Grand River Heritage Water Trail in Ottawa County was developed by the Ottawa County Parks and Recreation Commission to highlight current recreational opportunities and educate visitors about historical significance the Grand River played in the settlement of Ottawa County.

Comment: One area that needs improvement is river access and camping opportunities. To my knowledge there are no overnight campsites on the Grand. We camped with permission at public and private land that would normally be off limits for camping. Launch sites with restrooms is another problem. People need restrooms. If you are going to promote recreation on the river, that needs to be addressed.

Response: One of the management goals is to increase public access within the watershed. We will continue to seek opportunities to acquire additional access sites where appropriate. Overnight camping is allowed, by permit, on state game areas during September 11 through May 14. Most improved boating access sites have restroom facilities. Unimproved access sites tend to be remote and restroom facilities placed at these locations are easily vandalized. The costs associated with maintenance and repeated repairs often exceed current budget limitations.

Comment: Appropriate signage is needed at dams for public safety; development and distribution of appropriate maps and guides on recreational facilities, including user responsibilities.

Response: We agree that signage directing canoeist to portages is an important safety issue and is typically a requirement of FERC regulated dams. Maps and other information regarding state-owned recreational facilities are available at MDNR Operation Service Centers and Unit field offices. Smart phone apps are also being considered to assist recreation users regarding know access sites throughout the state.

Water Quality

Comment: It was a good presentation. I would like the DNR to do a side-by-side test with fish from the Grand River and fish purchased from the local grocery store. I think it would show how clean our river really is.

Response: The Michigan Department of Environmental Quality and Department of Community Health (MDCH) are the lead agencies responsible for monitoring contaminant levels in wild fish in Michigan. The U.S. Food and Drug Administration (FDA) is responsible for monitoring contaminant levels in fish available for sale. Based on FDA test results for mercury, the MDCH advises either no or limited consumption of several species of store-bought fish.

Comment: P. 59 2nd paragraph – Is the proper classification for upper Fish Creek, cold-transitional? Above Colby Road its peak temperature stays in the 60's and wild brook and brown trout are present. Since trout survive year around for multiple years as evidenced by the presence of many browns greater than 20 inches, it would seem like the creek downstream from the confluence of the West Branch to Carson City should be cold transitional and then warm-transitional below Carson City.

> Response: This is correct, upper Fish Creek downstream to the confluence with Duck Lake outlet is classified as a cold stream. Below this confluence Fish Creek is considered a warm-transitional small river.

Comment: P. 60 3rd paragraph – Based on my trout fishing results and water temperature readings, I believe Buck Creek should still be classified as cold-transitional in its lower reaches (e.g., Ivanrest Avenue/Road).

> Response: Although Buck Creek supports brown trout, the fish community is predominantly warmwater species indicative of a warm-transitional stream.

Comment: P. 74 3rd paragraph – Is Prairie Creek correctly classified as warm-transitional? Is it possible to have very good steelhead natural reproduction, fair to good brown trout natural reproduction, and brown trout that live to be six years old and 20 plus inches in length in a warm transitional stream? What does recent temperature data say relative to the Rogue and Prairie? My sense (and temperature readings) is that Prairie is colder than the lower Rogue yet the Rogue is classified as cold transitional.

> Response: Warm-transitional streams are characterized by a July mean water temperature range of 67°F to 70°F and a fish community that is composed of predominantly warmwater fish species. These systems can support brown trout, rainbow trout, and Chinook salmon. Mean July water temperatures recorded in Prairie Creek range from 66.8°F to 70.4 °F and recent fish surveys reported a diverse fish community which is consistent with a warm-transitional classification.

Comment: Portions of the headwaters and upper segments of the Grand and Portage Rivers fail to meet state water quality standards for dissolved oxygen (DO), pathogens (E. coli bacteria), and the support of aquatic biota. Total Maximum Daily Load (TMDL) allocations are in place for all of these. Development of additional E. coli TMDLS in these segments are scheduled for 2012. Portions of the river and tributaries also fail to meet water quality standards for PCBs and mercury, for which TMDLS have yet to be developed. We do not have specific improvements to Water Quality Management Recommendations to recommend, but thank you for including recommendations to both protect remaining high quality waters and to rehabilitate degraded waters, and for stressing the need for storm water and nonpoint source runoff management in both urban and rural areas. We also applaud the recommendation for a network of fixed monitoring stations within the watershed.

> Response: Thank you for the comment.

Comment: Please revise the paragraph on page 44 to reflect the MDEQ approval of the Lower Grand River Watershed Management Plan on September 13, 2011, indicating that it met all of the EPA required elements.

> Response: The recommend change has been made.

Citizen Involvement

Comment: There are many other areas that need improvement, and with everyone working together the Grand will continue to improve over time. Please check out our website for more information on what we are and what we represent at http://mgrow.org.

Response: We agree that improvements to the watershed will require the cooperation of community action groups, local units of government, and state and federal agency support.

Comment: Other groups that you might want to mention (page 82) is the Rogue River Watershed Council, Bear Creek Watershed Council, and Trout Unlimited.

Response: The document was modified to include these groups.

Comment: We ask that you include MGROW in Table 40 as well as the following description on Page 83 of the Assessment:

"Middle Grand River Organization of Watersheds (MGROW) – its mission is "To protect and preserve the history and natural resources of the Middle Grand River watershed by promoting education, conservation, restoration, and wise use of watershed resources." The group is an outgrowth of Grand River Expedition 2010, and will strive to bring together local communities, subwatershed groups and other stakeholders in the Middle Grand River towards a greater understanding of and stewardship for the river. One objective is to serve as a data bank and an information clearinghouse for the entire watershed. It will organize and conduct educational and scientific expeditions on the entire mainstream every ten years, and encourage and support periodic similar educational activities on the tributaries of the entire Grand River."

We note also the absence in Table 40 of a few Lansing area organizations that are addressing the Grand River either through conservation measures, public education or both. These include: Quiet Water Society; Woldumar Nature Center; Impression 5 Science Center; and the Verlen Kruger Memorial.

Response: The suggested changes were made.

Comment: Page 83 references the Upper Grand River Watershed Council. Formerly a watershed council, this organization has changed its organizational structure and is now the Upper Grand River Watershed Alliance (UGRWA). An updated/improved description for the Alliance would be: "The Upper Grand River Watershed Alliance is a coalition of municipalities, agencies, businesses, and individuals in the headwaters and portions of the upper segment of the Grand River basin, working together to protect and restore the river, its lakes, streams, and wetlands."

Response: The suggested changes were included in the text.

Fishery Management

Comment: Have there been any assessments done to measure how Fish Creek could contribute wild steelhead and salmon to the Grand River watershed?

Response: Although there is likely some successful reproduction of steelhead in Fish Creek no assessments or population estimates have been completed.

Comment: It seems like natural reproduction of salmon and steelhead in the Grand River watershed could be greatly improved with greater access to suitable spawning and rearing habitat. In order for these waterways to be better accessible, impenetrable barriers need to be removed. Increased natural reproduction decreases stocking costs and has posed better opportunity for self-sustaining populations. As a sportsman, I have a vested interest in preserving our natural resources, and I appreciate all of the work put into the assessment. If I can be of any help please contact me.

> Response: We agree the removal of barriers provides benefits to all species of fish and other aquatic life and restores natural stream functions. Fisheries Division continues to seek opportunities to restore dammed rivers to free-flowing conditions.

Comment: I believe the state record or second largest American eel in Michigan came from the Grand in Grand Rapids. And, I believe there are other records of them being caught in the Grand over the years.

> Response: American eel have access to the upper Great Lakes via the Welland Canal and are occasionally reported by anglers. A state-record American eel was caught on the Grand River in 1989. The fish was 38 inches in length and weighed 4.44 pounds. This record was surpassed later that year and again in 1990. The current state-record came from Lake St. Clair is 43 inches and 7.44 pounds.

Comment: If you have lampreys above the ladder it is because the lamprey barrier in the ladder has not been maintained, folks are taking lampreys from the ladder and passing them upstream, or some physical characteristic of the flow over the dam has changed to allow their passage. None were found above there for 25+ years under a variety of spring flow conditions including some floods.

> Response: According to the United States Fish and Wildlife Service the Sixth Street Dam and sea lamprey barrier are not 100% effective in blocking the upstream movement of spawning adult sea lampreys. The Sixth Street fish ladder was recently modified to enhance its effectiveness in deterring the upstream movements of adult sea lamprey.

Comment: There should be some records of estimates of natural reproduction of steelhead in Prairie Creek by Paul Seelbach in the 1990's? I believe the number was somewhere between 5-10,000.

> Response: This was a rough estimate of natural reproduction developed from samples collected during the 1991 Prairie Creek rotenone treatment. Although the estimate is somewhat imprecise, it verifies the significance of Prairie Creek to the Lake Michigan and Grand River steelhead fisheries.

Comment: How about chemical treatment of Rogue and others on periodic basis? This was very successful and provided very popular fishery with good returns.

> Response: Piscicides (rotenone and other toxicants) have been an important tool in Michigan's fisheries management for several decades. These chemical treatments were performed to survey existing fish communities, or remove unwanted fish species prior to the stocking of sport fish such as brown trout. Although this management technique provided some short-term successes, these piscicides are not selective and remove all fish species. Several fish species found in the Grand River watershed have been identified as Species of Greatest Conservation

Need and the use of toxicants in waters where these species occur is no longer an acceptable management option.

Comment: The northern pike are easily removed with large mesh gill nets. That was done on Nevins, Derby, Half Moon and others. I don't think they were spawning there – someone wanted them there and stocked them from adjacent waters.

Response: Although the physical removal of northern pike is a potential management option, these efforts are labor intensive and are rarely completely successful. Given limited staff resources, the management direction in these lakes was shifted to habitat protection and management of native fish species.

Comment: I don't recall ever stocking it (Norris Creek) with brown trout. You might check accuracy of those records. There was a northern pike rearing marsh on it maintained by a sportsman club in the late 1960's through early 1970's.

Response: Norris Creek was stocked with brown trout and supported a moderate fishery during the 1960s through mid-1970. The fishery was not self-sustaining and when stocking was discontinued in 1977, the brown trout population quickly diminished. Efforts to rebuild the fishery occurred during 1993–1998 with annual stocking of brown trout. Due to limited habitat, these later efforts were not successful.

Comment: P 69 last paragraph – Sandstone Creek is probably best classified as warm-transitional and has not been stocked with trout for more than 20 years. Snyder Brook, a "segment" of its headwaters, still supports trout and is still stocked. MacKay Brook continues to support a wild brown trout population.

Response: We agree, Sandstone Creek is currently classified as a warm-transitional stream from the confluence with the main stem Grand River to the headwaters. Mackey Brook is a tributary to Sandstone Creek and is classified as cold-transitional.

Comment: P 70 1st paragraph – "Diversifying inland angling opportunities" is an important objective. I like to think of it as "bringing the fish to the people". Before you reduce/eliminate the stocking of coho salmon and steelhead in Lansing, I think you should consider management options that improve survival and fish returns. Some possibilities: Stock fish in the Red Cedar instead of the Grand to avoid the adverse impact of the cooling water warming the Grand to the 70's before the smolts leave in early May. Stocking the smolts closer to their actual smolting time – they often mill around Moore's Park for a month or more where many are "harvested" by the locals even though they are not of legal size. Monitoring smolt migration so that the spilling of water (and shutting down of turbines) at Webber Dam is better timed (perhaps anglers can help there). Relative to poor returns to Lansing, it is also important to note that many of the Lansing bound fish are caught on their way to Lansing, especially below 6th Street, Lyons, and Webber dams.

Response: Fisheries Division is committed to maintaining diverse recreational fishing opportunities throughout the watershed. Proposed plans to change the current stocking locations of coho salmon are intended to increase survival and return of stocked yearling coho salmon. Any changes to the current stocking strategies will be evaluated by monitoring coho salmon returns at the Webber Dam fish ladder.

Comment: If the Sixth Street Dam were to be removed: sea lamprey would have free access to the upper reaches of the Grand River to seek cooler water to spawn. In the last few years only the Rogue River was treated for Lamprey. A survey of Crockery Creek, located below the Sixth Street Dam revealed the presence of sea lamprey as far up the stream as Ferris Street in Newaygo, according to the USFWS.

The Grand River Assessment, on page 73 points out that it would be possible to use an adjustable crest barrier as a Lamprey Barrier. According to Greg Klinger of the USFWS Marquette Office, an adjustable crest barrier will not work at the mouth of the Grand River.

> Response: We agree. Any projects proposing to remove or modify the Sixth Street Dam would need to identify alternative measures to prevent the upstream passage of adult sea lamprey.

Comment: As known today, fishing would be adversely affected. The (Sixth Street) Dam holds migrating game fish such as salmon and steelhead for a short period of time. This allows people excellent opportunities to fish from shore and from boats. Most of the people fishing on the banks or East Wall do not have boats and would not be able to cast out to the main flowing stream of a wide river. Without the dam, migrating game fish will swim right though Grand Rapids.

> Response: Currently the dam is a barrier to fish movement. Steelhead and salmon hold below the dam until they locate the entrance to the fish ladder. Many returning adults do not successfully pass upstream through the ladder. We believe a successful project would remove the barrier and enhance fishing opportunities by providing more diverse habitat types. To many other species of fish, the dam represents a migration barrier and removal or modification of the dam would reconnect these species to upstream spawning areas.

Comment: Business would be adversely affected. The two bait shops located on the West Side of Grand Rapids depend on fall through spring river product sales to keep them in business for the year. The popcorn vendor depends on sales in the fall on Saturdays and Sundays on the West side of the fish ladder.

> Response: Conversely, modifications to the existing dams would improve fish habitats and local businesses could potentially derive benefit from a more diverse year-round fishery. Modification to the structures would also improve safety through the removal of the deadly hydraulic currents, likely resulting in increased recreational use. Studies have documented economic benefit and community revitalization as a result of well-planned dam removals.

Comment: Environmental education opportunities will be diminished. The thousands of people and school groups who come to the fish ladder to watch fish climb the ladder and learn about the migration and spawning habits of some of our best natural resources will not see any fish.

> Response: We disagree. The removals of the Sixth Street and downstream coffer dams offer tremendous opportunities to educate the public about the ecological values of free-flowing, functional river ecosystems.

Comment: There is a probability of loss of property values due to lower water conditions for home owners living on the Grand River upstream from the (Sixth Street) Dam if removed. .

Response: An economic analysis of dam removal effects on local property values concluded that shoreline frontage along small impoundments confers no increase in property value compared to frontage along free-flowing streams. Additionally, nonfrontage residential property located in the vicinity of a free-flowing stream is more valuable than nonfrontage properties located near a small impoundment.

History

Comment: Buttons were being made out of another material by then which also killed the clamming industry. There is a whole report on the industry by van der Schalie.

Response: Agreed, see page 62. In the 1940's the demand for mussel shells declined as plastics were used to manufacture buttons.

Floodplains

Comment: Protecting the floodplains is a significant habitat protection need for the future of the river. Present regulations are inadequate or poorly enforced.

Response: We agree. Several of the management options identify floodplains as priority areas for protection and rehabilitation.

Water Use

Comment: I question if agriculture (water) use isn't much larger. I know the potato and bean farmers in Montcalm irrigate from surface waters as well as groundwater intensely. Not sure on the remainder

Response: These estimates were based on data collected prior to the implementation of Public Act 34 of 2006 and the mandatory water use requirements contained in that legislation. As new data are compiled, estimates of water uses within the Grand River watershed will be improved.

Bridges, Culverts, and Stream Crossings

Comment: Correcting improperly constructed bridges and culverts would seem to be an improvement that could be one of the most easily addressed sources of sediment and contaminants including salt.

Response: We agree. All new stream crossings are receiving increased environmental review to assure new structures are appropriately sized and constructed and appropriate stormwater best management practices are in place.

Special Jurisdictions

Comment: The Drain Code needs to be revised if we are interested in improving the quality of the Grand River watershed. It might be in Fisheries Division's best interest to place a priority on this for the long term.

Response: We agree and identify several management options directed toward amending the Drain Code.

Comment: Significant portions of the Grand River mainstream in the headwaters segment and the Portage River are designated intercounty drains and historic channelization has greatly impacted the hydrology, woody debris recruitment, erosion potential, and substrate and water quality within these segments. Natural river designation may be more appropriate to all or portions of these river sections, particularly as restoration initiatives proceed. Special Jurisdictions Management Recommendation #7 should be amended to include the Grand and Portage Rivers as well as those listed.

Response: The recommended changes were made.

Parks and Natural Areas

Comment: All of the Grand River floodplain should be purchased and maintained as a natural area, game area, park, etc. It can address the future need for recreational facilities in the watershed as well as providing much needed protection.

Response: Purchase of recreational lands is identified as a management option. We will continue to seek opportunities with our partners to acquire and protect sensitive lands, including floodplains.

Original Fish Communities

Comment: There is a reference to sturgeon being harvested at Eaton Rapids where they were funneled into shallow water.

Response: A historical account of early settlement near the City of Lansing includes a description of lake sturgeon being harvested with spears near Eaton Rapids. This was noted in the text and the citation was added to the reference section.

Present Fish Communities

Comment: All of the small tributaries to the Grand River in Kent and Ionia counties also have/had brook trout.

Response: This is largely true; many of the small cold and cold-transitional tributaries to the Grand River main stem in Kent and Ionia counties were stocked with brook trout and continue to support naturalized populations.

Biological Communities

Comment: Are present bait dealer regulations on harvesting any crayfish adequate?

Response: Harvest or collection of crayfish for commercial purposes is regulated under the authority Part 487 of PA 451, Sport Fishing, and Fisheries Order 227.12. Water Open and Regulations Governing the taking of Wigglers and Crayfish for Commercial Purposes. These regulations prohibit the collection, possession, or sale of rusty crayfish. To date, bait dealers have been compliant with the provisions and reporting requirements and these regulations have been adequate to protect the aquatic resources.

Comment: Please provide an index to the fish species maps, with page references, or present the maps alphabetically for ease of use. Are the individual fish maps available as GIS data layers?

> Response: The published Grand River Assessment will include page references to the fish species distribution maps. The shape files depicting the individual species distributions can be made available upon request.

Comment: We encourage MDNR to develop, and would seek to participate in implementing, a cisco management plan for Brown and Vandercook Lakes.

> Response: A multi-year assessment of the status of cisco in southwest Michigan inland lakes is currently in progress. A final technical report of the findings and suggested future management options will be drafted following completion of the assessment.

Management Options, Geology and Hydrology

Comment: Many of the options you list deal with Drain Commissioners and are contrary to their present mode of operation. They need to go or at least be brought in line with good watershed management. That needs to be a Department goal.

> Response: In the past several years, Fisheries Division and the MDEQ Water Resources Division have partnered with several county Drain Commissioners on pilot projects, which incorporate the principles of natural channel design to improve stream function and aquatic habitats while providing necessary drainage and minimizing maintenance. These projects have included stream crossings, channel maintenance, and enhanced fish passage. It is our goal to broaden these partnerships so these methods become identified as standard best management practices for future work in designated county drains.

Comment: We would like to see DNR state clearly that they will assume a leadership role in bringing stakeholders together to prioritize and implement management strategies.

> Response: As indicated in the preface to this section, the MDNR Fisheries Division will assume a leadership role in the development and implantation of specific management options where appropriate. Several of the identified management options are beyond the scope of the mission and mandates of Fisheries Division and would be best administered by local partners.

Comment: We recommend a separate item entitled “Public Education”. We feel strongly that public education is perhaps the greatest key to proper management and rehabilitation of natural resources.

> Response: We agree that knowledge and understanding are key components to proper management. We believe there is an underlying educational component implied with each of the identified management options.

Comment: The Watershed Assessment makes clear the importance of stream flow data. In 2011, MDOT announced that they would no longer fund operation of the USGS gage at Jackson. As the Assessment notes, this is the only gage in the headwaters segment of the Grand. The Watershed Alliance and the USGS have developed a 50:50 funding arrangement so that the gage may remain in operation. We suggest revising Geology & Hydrology Management Option #9 to include identifying funding resources to maintain current stream flow data collection as well as improve the data collected.

Response: The recommended change has been made.

Comment: Management recommendations #14 and #15 advocate that county drain commissioners develop design standards that accommodate/emulate annual and seasonal flow patterns and abandon use of noncritical drainage tiles/ditches. The UGRWA has been working with the Ingham and Jackson County Drain Commissioners, and the Grand River Inter-County Drainage Board in an ongoing dispute over how best to manage agricultural drainage and management of the Portage River Inter-County Drain. Your analysis of hydrologic data for the Portage River should prove useful in that debate.

We suggest that this recommendation be expanded to include protection of riparian buffers and recognition of annual and seasonal flow patterns in establishing goals and objectives and management prescriptions for agricultural drainage and temporary on-field storage. You have included this focus in Soil and Land Use, Channel Morphology, and Special Jurisdictions recommendations, but the connections to hydrology could also be made in this section.

Response: Protection of riparian buffers has been added to the Geology and Hydrology Management Options.

Comment: My main comment about the plan is that the management options in the assessment follow the recommendations of Dewberry (1992) to protect the health of river ecosystems (p. 85). Although I have not read Dewberry, my concern is that the management options are based upon criteria that are twenty years old, and may not take into consideration projected impacts from climate change. Ideally, when changing baseline conditions are considered, management options can best be proposed and evaluated toward achieving desired management goals for some future condition. For example, a proposed management option under the geology and hydrology section states "rehabilitate mainstream and tributary flow stability by working with county drain commissioners to incorporate annual and seasonal flow patterns into criteria for drain design and stormwater management." However, climate predictions for the Great Lakes Region suggest that increased precipitation between 8.4% - 16%, with an average of approximately 12% resulting in river discharge increases between 2% - 55%, with an average of 22.3% (DeMarchi et al., 2011 and DeMarchi et al., 2009, as cited in DeMarchi and Dai, available at http://www.miseagrant.umich.edu/greatlakes/climate/images/Climate-Change-Impact-on-Great Lakes-Navigability-CWRU-SARP.pdf). If management options are based on annual and season flow patterns, then the selected management strategies may be flawed because baseline environmental conditions have changed. Increased precipitation and river discharge predictions can be a problem or an opportunity. If framed as an opportunity, then creating groundwater recharge zones can help address the increase in river discharge and help recharge aquifers and stabilize the streams through groundwater reaching the streams.

Response: We follow the watershed management framework outlined by Dewberry (1992) to establish priorities. The highest priority management actions should be devoted toward the protection of high quality resources, followed by efforts to restore or rehabilitate degraded systems. In most cases efforts to protect aquatic resources is far less costly than the rehabilitation efforts needed to restore impaired ecosystem functions.

Comment: I realize that climate and hydrology modeling is extremely complex given the number of variables and estimates of uncertainty, however, if MDNR incorporates the idea of the future conditions will be different from historic patterns, then management approaches can be more proactive and anticipate the management options needed to achieve goals when the hydrology is different.

> Response: We agree. Climate change scenarios for the Laurentian Great Lakes indicate aquatic ecosystems in the region will be sensitive to a climate predicted to become warmer and wetter. Preparing for changing aquatic habitats (wetlands, inland lakes and streams, Great Lakes) will require Fisheries Division to utilize predictive and adaptive management strategies to fulfill its mission and attain goals and objectives. Future management plans developed for the Grand River watershed will need to recognize these changes as thermal habitat area increases for warm and coolwater species and decreases for obligate coldwater species.

Soils and Land Use

Comment: We need to protect all the floodplains habitats from any further development.

> Response: We agree. Several of the management options refer to protection of floodplain and riparian habitats throughout the watershed.

Comment: Fisheries Division needs to work to amend wetland laws to allow permits down to minimum of ½ acre, preferably all wetlands. Some townships, etc. have already done that.

> Response: Agreed. Fisheries Division continues to work collaboratively with the Michigan Department of Environmental Quality and other stakeholders to improve the effectiveness of the various state statutes protective of aquatic habitats. Our most effective habitat protection measures are achieved through review and comment of environmental permits.

GLOSSARY

aggradation – the accumulation of bed materials

ammocetes – juvenile lampreys that burrow in the substrate of streams for 3 to 6 years before transforming and migrating downstream to Lake Michigan

base flow – groundwater discharge to a stream system

basin – a complete drainage including both land and water from which water flows to a central collector such as a stream or lake at a lower level elevation, synonymous with watershed

bedrock outcrop – emergence of early geologic rock at the soils surface

benthic – plants and animals living on, or associated with, the bottom of a water body

biological integrity – the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region

biological oxygen demand – the measure of the consumption of oxygen in an ecosystem within a fixed period of time

biota – animal and plant life

BP – before present

cfs – cubic feet per second

channelize – to straighten and clean a streambed or waterway to enhance land drainage

channelization – a process of altering natural stream channels by straightening, widening, and deepening to improve water movement

channel morphology – the study of the structure and form of stream and river channels including pattern (sinuosity), dimension (width, depth), profile (slope) and bed materials

cobble – naturally rounded stones larger than pebbles and smaller than boulders arbitrarily limited to a size of two to ten inches in diameter

confluence – the joining or convergence of two streams

CSOs – Combined Sewer Overflows

draft – the depth of water that a ship requires, particularly when loaded with cargo

drawdown – removal of stop logs, or similar retaining structure, resulting in the lowering of water levels in an impoundment

drought flow – water flow during a prolonged period of dry weather

ecological – the relations between living organisms and their environment

ecosystem – a biological community considered together with the nonliving factors of its environment as a unit

effluent – the outflow of a sewer, septic tank, municipality, industry etc.

electrofishing – the process of putting an electric current, either AC or DC, through water for the purpose of stunning and capturing fish

end moraine – an arch-shaped ridge of moraine found near the end of a glacier

entrainment – to trap an object during a given mechanical process (e.g. fish in hydropower turbine)

erosion – the process of moving soil particles by wind or rain

evapotranspiration – the loss of water from plant material to the atmosphere

exceedence flow – the probability of a discharge exceeding a given value

exotic species – successfully reproducing organisms introduced by human action into regions where they did not previously exist

extirpate – to make extinct by removing

fauna – the animals of a specific region or time

FCMP – Fish Contaminant Monitoring Program

FD – Fisheries Division

FERC – Federal Energy Regulatory Commission

flashy – streams and rivers characterized by rapid and substantial fluctuations in stream flow

floodplain – a relatively flat valley floor formed by floods which extends to the valley walls

forage – a group of fish that provide food for piscivorous fish

game fish – fish species that are commonly sought by anglers; also called sport fish

glacial outwash – gravel and sand carried by running water from the melting ice of a glacier and deposited in stratified layers

GLFC – Great Lakes Fishery Commission

gorge – a primitive fishing device made of a sliver of copper or bone that is pointed at both ends with a line attached at mid-shank and then baited. When a fish swallowed it, it was pulled so that it became lodged in the mouth of the fish

gradient – rate of decent of a stream usually expressed in feet per mile

gradient class – an index of hydraulic diversity in streams

ground moraine – continuous layer of till near the edge or underneath a steadily retreating glacier

groundwater – water that contained in subsurface aquifers

heterogeneity – having composition of dissimilar parts: diversity or variety

hydraulic diversity – the variability of water depths and velocities in a stream or river channel

hydrograph – a graph of the water level or rate of flow of a stream as a function of time, showing seasonal change

hydrology – the science of water

hyporheic zone – Subsurface zone in streams where surface water and groundwater exchanges occur (*hypo* = under; *rheo* = flow)

ice contact – pervious glacial material (gravel) found in moraines that is associated with groundwater recharge

impermeable – will not permit fluids to pass through

impervious – not permitting penetration or passage

impingement – a process of physically capturing juvenile and adult fishes on screens designed to prevent debris from entering a power plant along with process cooling water

impoundment – water of a river system that has been held up by a dam, creating an artificial lake

indigenous – a species that is native to particular area

infiltration – a process of water moving through soil particles

interlobate – between lobes of a glacial moraine formation

invertebrate – an animal having no backbone or internal skeleton

lacustrine – pertaining to lakes

lake plain – land once covered by a lake that is now elevated above the water table

lake-level control structure – a low head dam placed at the outlet of a lake to control the lake level

land cover – primary character or use of an area of land (e.g. forest, wetland, agriculture, urban, barrens, water, etc.)

large woody structure – trees, logs, and logjams that are in a stream or lake

lentic – pertaining to or living in still water

loam – a soil consisting of an easily crumbled mixture containing from 7 to 27% clay, 28 to 50 % silt, and less than 52% sand

macroinvertebrates – animals without a backbone that are visible to the naked eye

main stem – the primary branch of a river or stream, sometimes referred to as mainstream

main-stem segment – reach of a river with similar ecological characteristics

MESBOAC – Acronym describing process for proper culvert replacement. Match-Extend-Set-Bury-Offset-Align-Consider head cuts

MDCH – Michigan Department of Community Health

MDEQ – Michigan Department of Environmental Quality

MDNR – Michigan Department of Natural Resources

meander – a winding, curving stream segment

mitigation – action required to be taken to compensate for adverse effects of an activity

moraine – a mass of rocks, gravel, sand, clay, etc. carried and deposited directly by a glacier

morphology – pertaining to form or structure of a river or organism

moss animals – taxa belonging to the Bryozoa phylum

niche – the position or function of an organism in a community of plants and animals

NOAA – National Oceanic and Atmospheric Administration

NPDES – National Pollution Discharge Elimination System

nonpoint source pollution – pollution to a water course that is not attributable to a single, well-defined source, e.g., sediment resulting from poor agricultural practices

outwash – sand and gravel washed from a glacier by the action of meltwater

P.A. – Public Act

panfish – fish in the centrarchid family commonly harvested by anglers to eat. Species include bluegill, black crappie, pumpkinseed sunfish, and rock bass

PCB – polychlorinated biphenyl

peaking mode – operational mode for a hydroelectric project that maximizes economic return by operating at maximum possible capacity during peak demand periods (generally 8 am to 8 pm) and reducing operations and discharge during nonpeak periods

perched culvert – an improperly placed culvert that fragments habitat by creating a significant drop between the culvert outlet and stream surface

permeable – soils with coarse particles that allow passage of water

pestilent – noxious species that out compete native or more socially valuable species

phytoplankton – minute, free-floating aquatic plants

piscivorous – fish eating

plankton – floating or drifting organisms in a body of water

Pleistocene Epoch – also known as the Ice Age; period from 1,600,000–10,000 BP

point source pollution – pollution to a water course that is attributable to a single, well-defined source, e.g., outfall of a wastewater treatment plant

potamodromous – fish that migrate from fresh water lakes up fresh water rivers to spawn; in the context of this report it refers to fish that migrate into the Grand River from Lake Michigan

reach – a section of river

retention time – the amount of time it takes for the total volume of water in an impoundment to be replaced by incoming stream flow; also referred to as the reservoir's flushing rate

riffle – a shallow area extending across the bed of a stream where water flows swiftly so that the surface is broken in waves

riparian – adjacent to or living on the bank of a river; also refers to the owner of stream or lakefront property

riverine – of or pertaining to a river

rotenone – a natural substance found in roots of plants in the pea family; it is used as a toxicant to gill breathing animals and often as a home garden insecticide

run habitat – fast nonturbulent water

run-of-river – instantaneous inflow of water equals instantaneous outflow of water; this flow regime mimics the natural flow of a river on impounded systems

salmonids – collective group of all trout and salmon in the family Salmonidae

savanna – a treeless plain or grassland with scattered trees

sedimentation – a process of depositing silt, sand, and gravel on a stream or river bed

side-wheeler – a ship that has a paddle wheel on each side for propulsion

sinuosity – the degree of bending, winding, and curving of a river system

specific stream power – rate at which potential energy is supplied to a stream channel bed and banks; primarily a function of discharge and slope

sport fish – fish valued by anglers

surficial – referring to something on or at the surface

TFM – 3-trifluoromethyl-4-nitrophenol, A chemical toxicant used in the control of sea lamprey populations

thalweg – the line of the lowest points in valley defining a river or streams deepest channel

tile – an underground enclosed drainage system generally installed for draining farmland

till – a mix of glacial clay, sand, boulders, and gravel

TMDL – total maximum daily loading

topography – the configuration of the earth's surface including its relief and the position of its natural features

tributary – a smaller stream feeding into a larger stream, river, or lake

turbidity – the measure of suspended sediments in the water column

USDA – United States Department of Agriculture

USGS – United States Geological Survey

valley segment – reaches of a river with similar ecological characteristics

veliger – the free-swimming larval stage of zebra mussels

watershed – the drainage area of basin, both land and water, from where water flows toward a central collector such as a stream, river, or lake at a lower elevation; synonymous with basin

wastewater treatment – the treatment of sewage

WD – Water Division of the Department of Environmental Quality

wetland – those areas inundated or saturated by surface or groundwater at a frequency and duration enough to support types of vegetation typically adapted to life in saturated soil; includes swamps, marshes, fens, and bogs

zooplankton – small, usually microscopic animals suspended in water

FIGURES

Figure 1 Legend

1. Michigan Center Lake outlet
2. Portage River
3. Perry Creek
4. Sandstone Creek
5. Spring Brook
6. Middle Branch Red Cedar River
7. West Branch Red Cedar River
8. Sycamore Creek
9. Red Cedar River
10. Carrier Creek
11. Sebewa Creek
12. Looking Glass River
13. Stony Creek
14. Pine Creek
15. Fish Creek
16. Maple River
17. Prairie Creek
18. Bellamy Creek
19. Dickerson Creek
20. Flat River
21. Tyler Creek
22. Coldwater River
23. Quaker Brook
24. Highbanks Creek
25. Cedar Creek
26. Glass Creek
27. Thornapple River
28. Bear Creek
29. Cedar Creek
30. Rogue River
31. York Creek
32. Plaster Creek
33. Buck Creek
34. Rush Creek
35. Sand Creek
36. Deer Creek
37. Bass River
38. North Branch Crockery Creek
39. Crockery Creek
40. Norris Creek

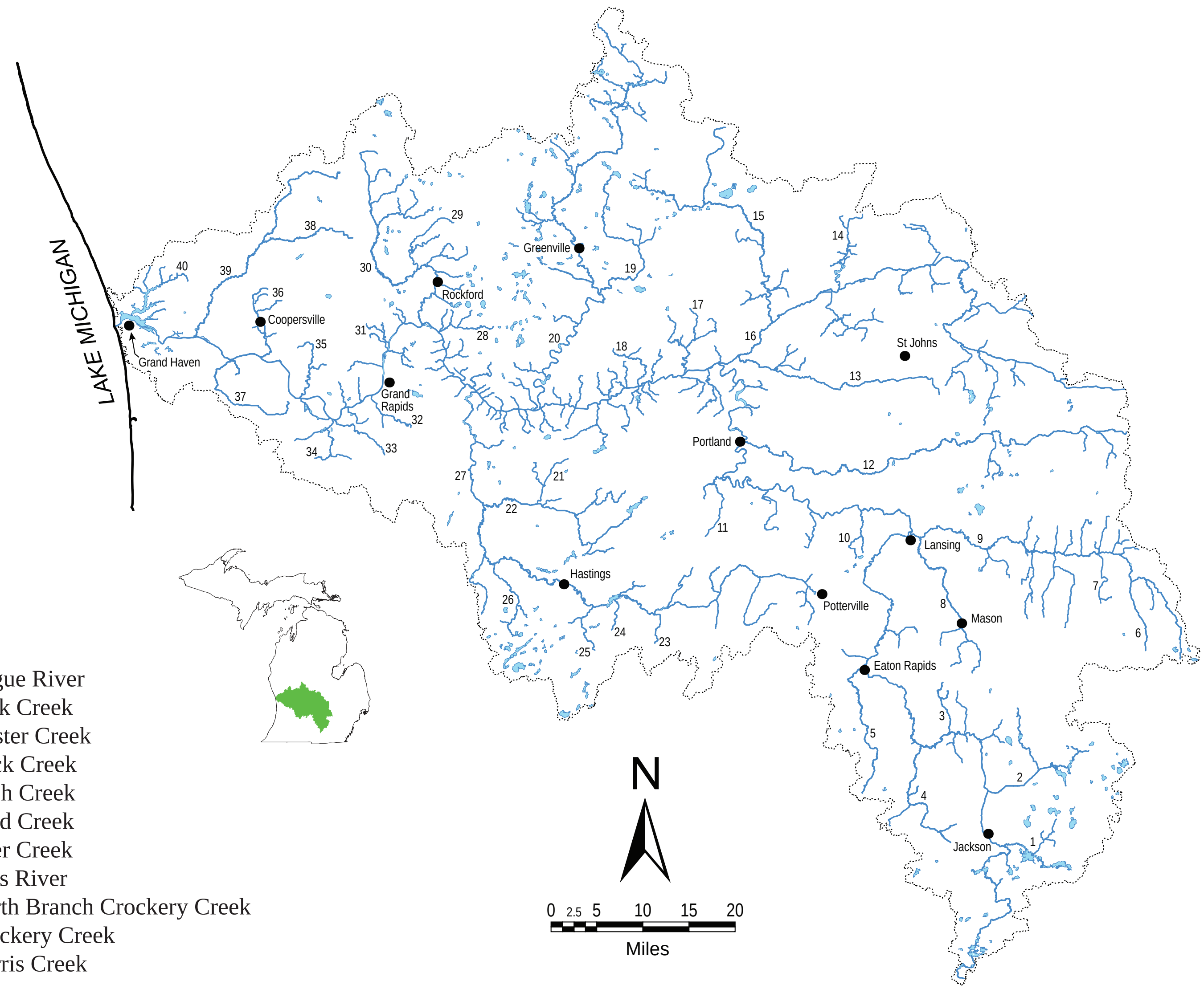

Figure 1.– Map of the Grand River main stem, major tributaries, and inland lakes greater than 20 surface acres.

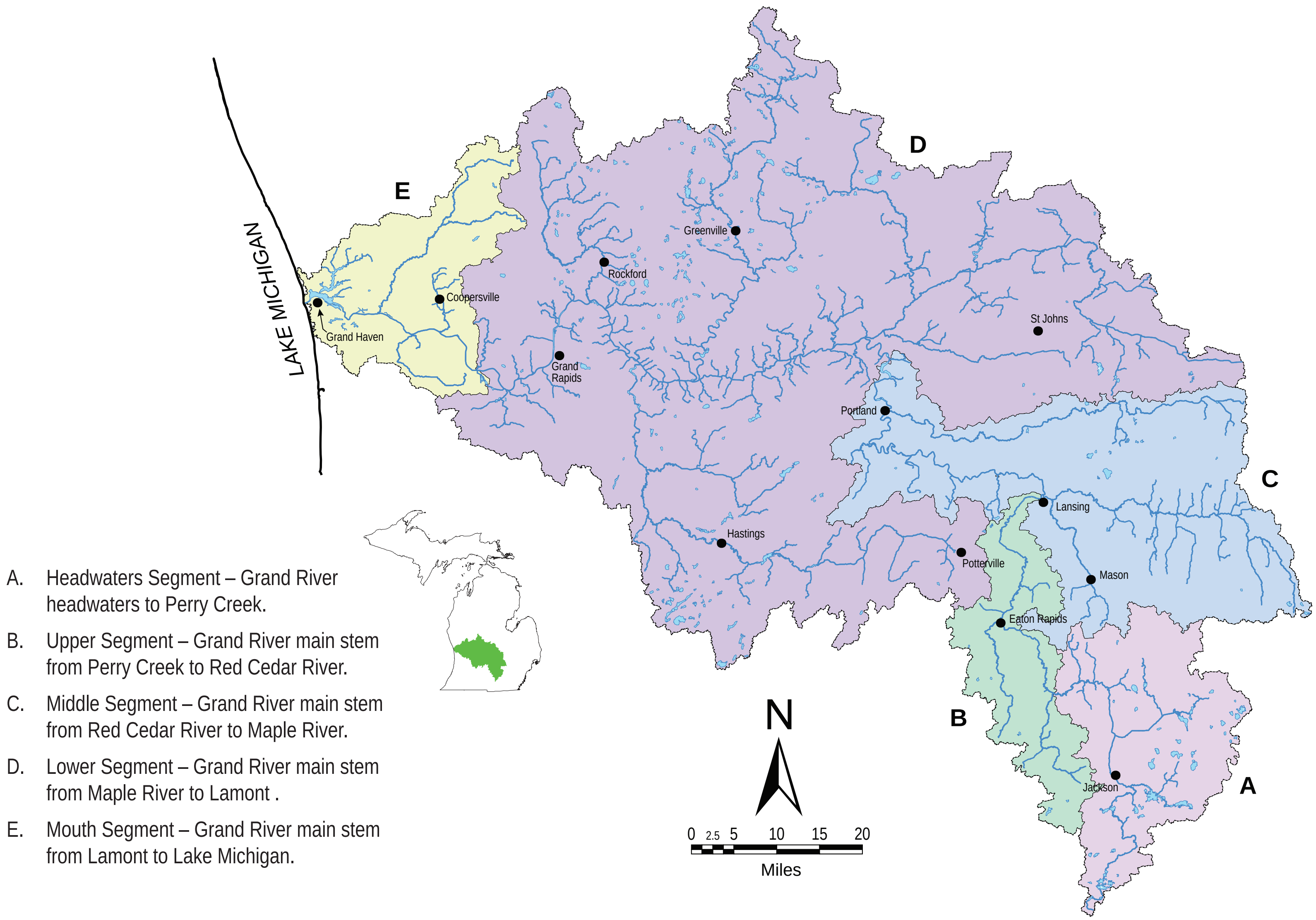

Figure 2.– Main stem river segments of the Grand River.

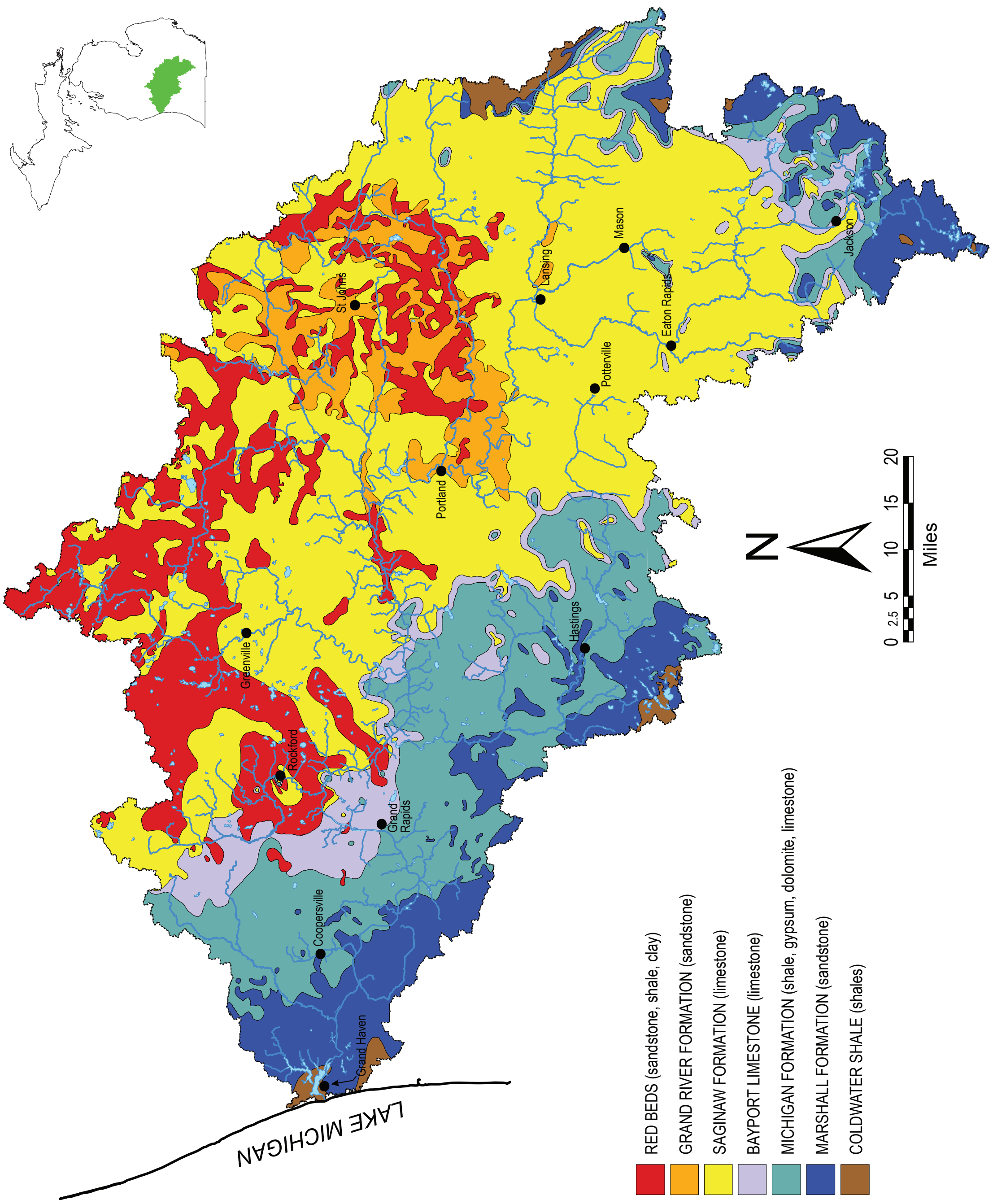

Figure 3.–Bedrock geology of the Grand River watershed.

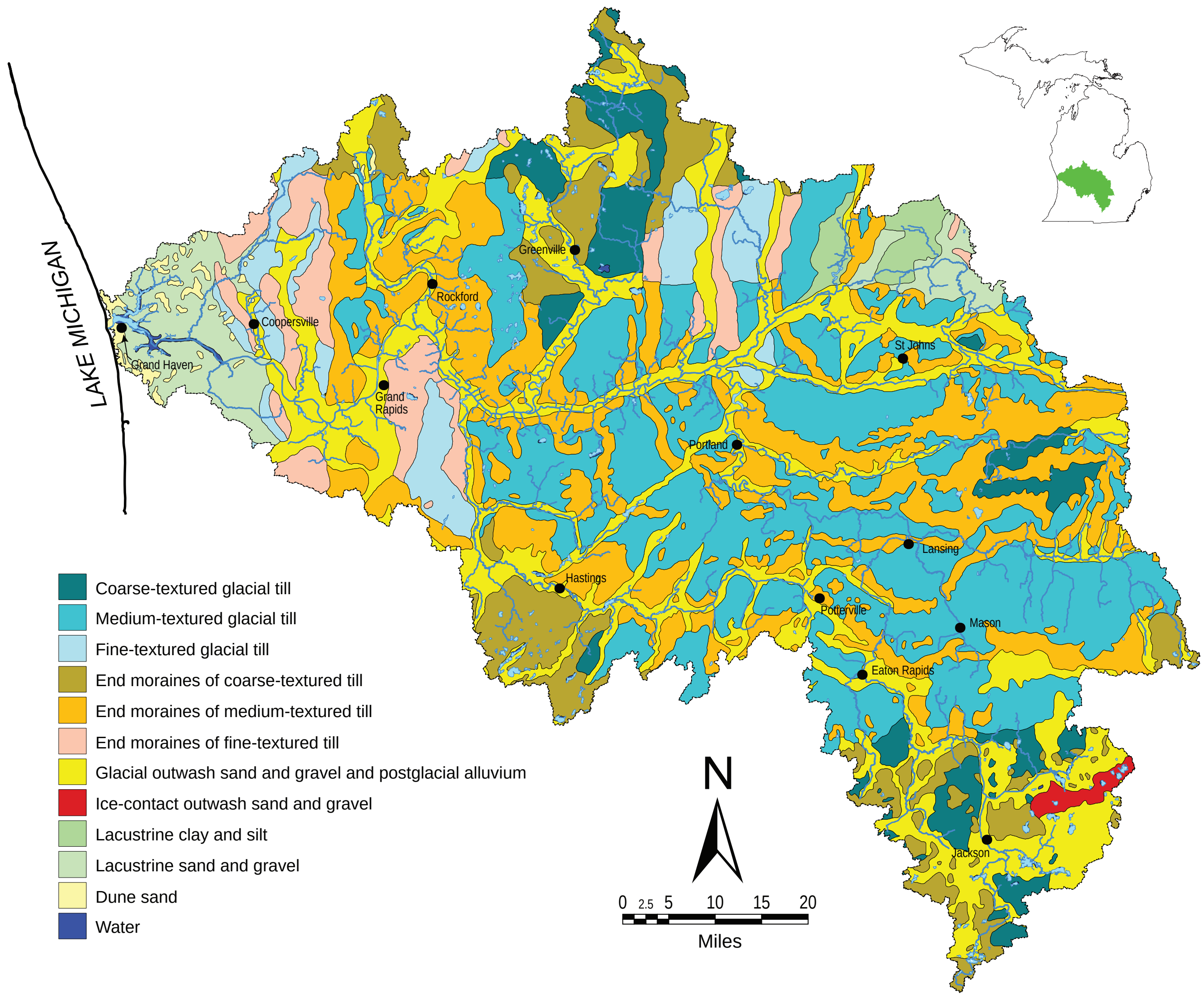

Figure 4.–Surficial geology of the Grand River watershed.

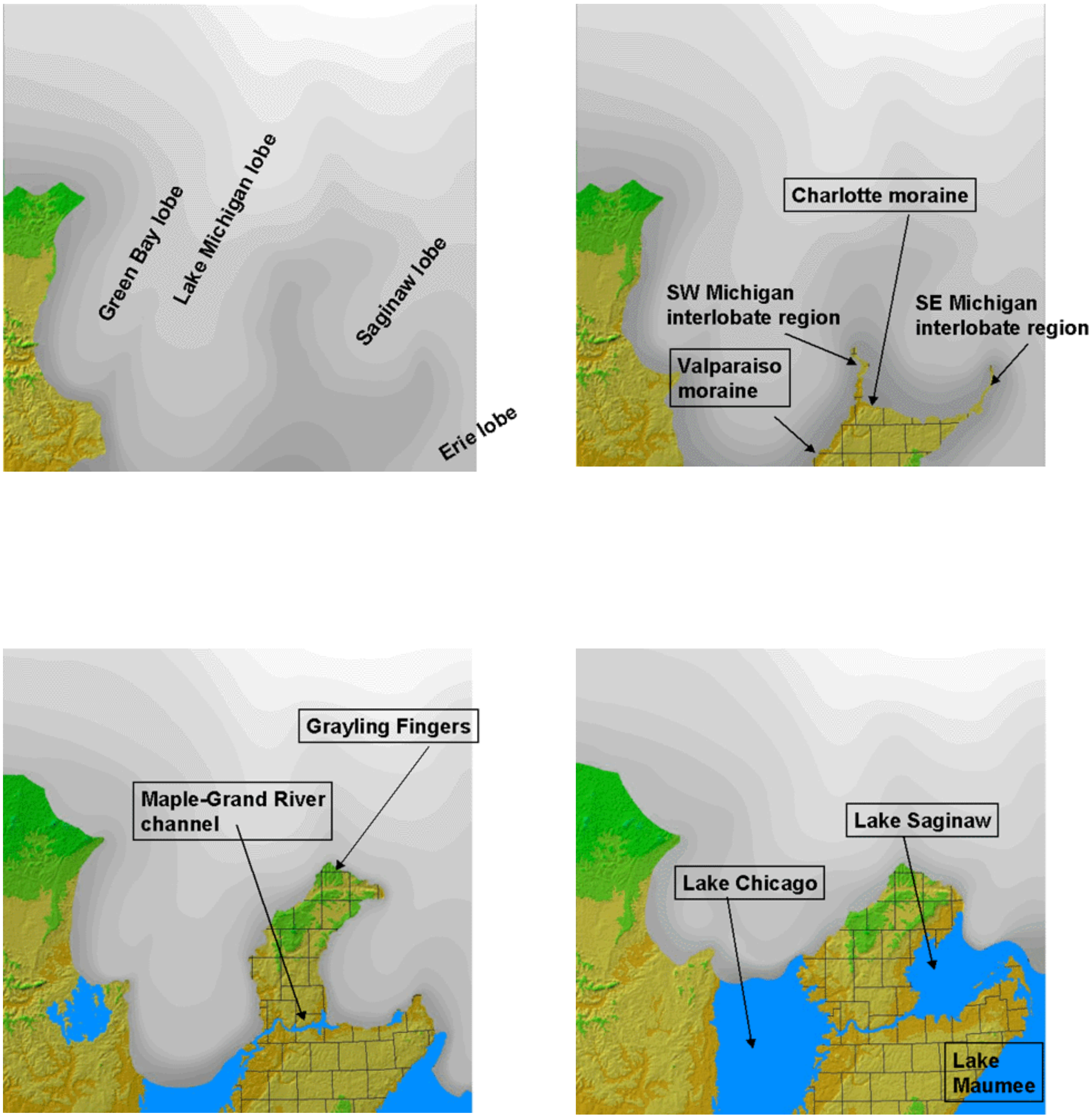

Figure 5.–Glacial stages illustrating formation of the Grand River watershed. Map A depicts major glacial ice lobes approximately 14,800 years ago. Map B indicates locations of significant interlobate regions found in the headwaters and lower segments (14,000 years ago). Maps C and D depicts the location of the Maple-Grand River channel which drained glacial Lake Saginaw into glacial Lake Chicago, approximately 13,800 years before present. These maps were modified from images on the Michigan State University Geology Department website.

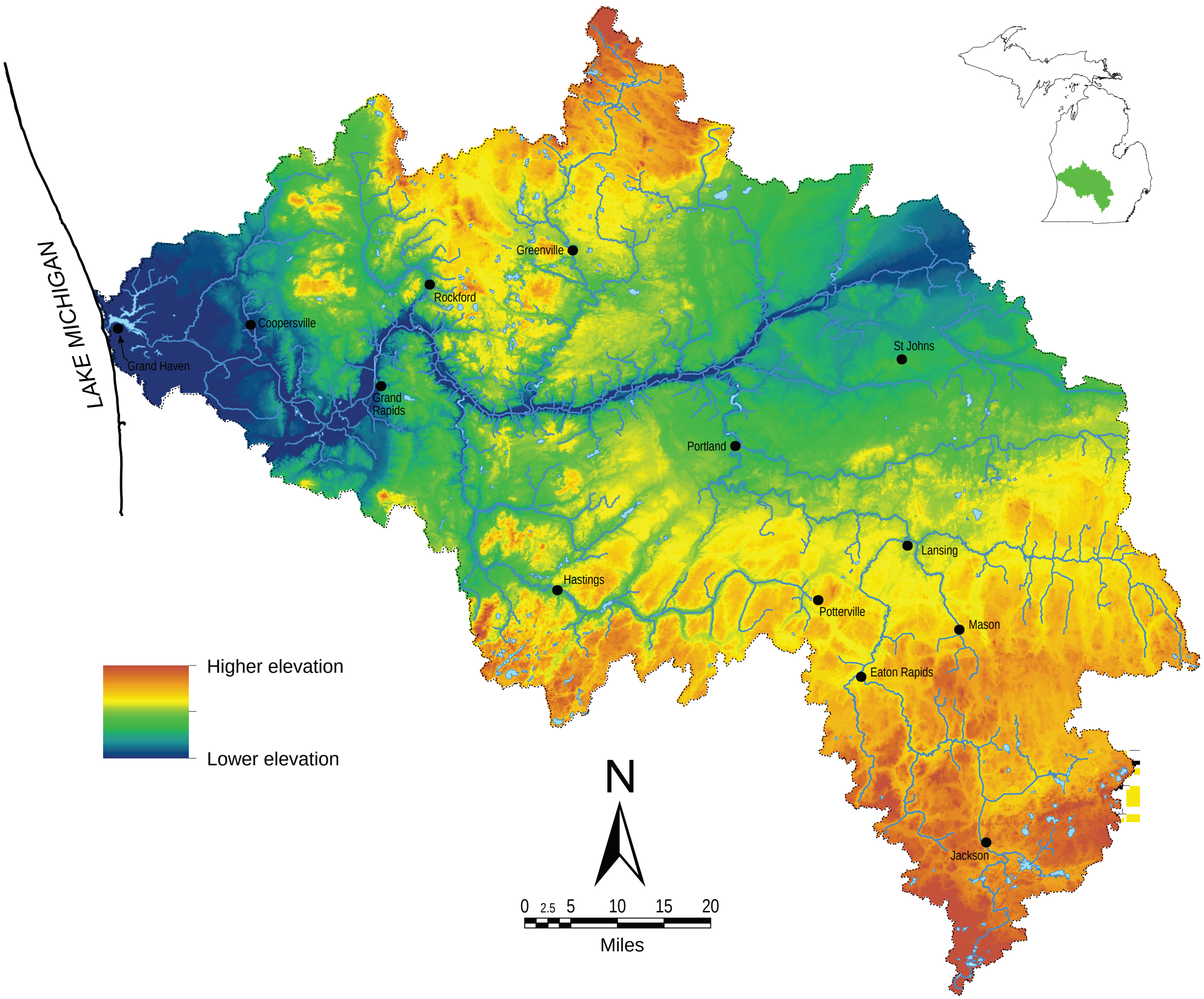

Figure 6.–Digital elevation model of the Grand River watershed.

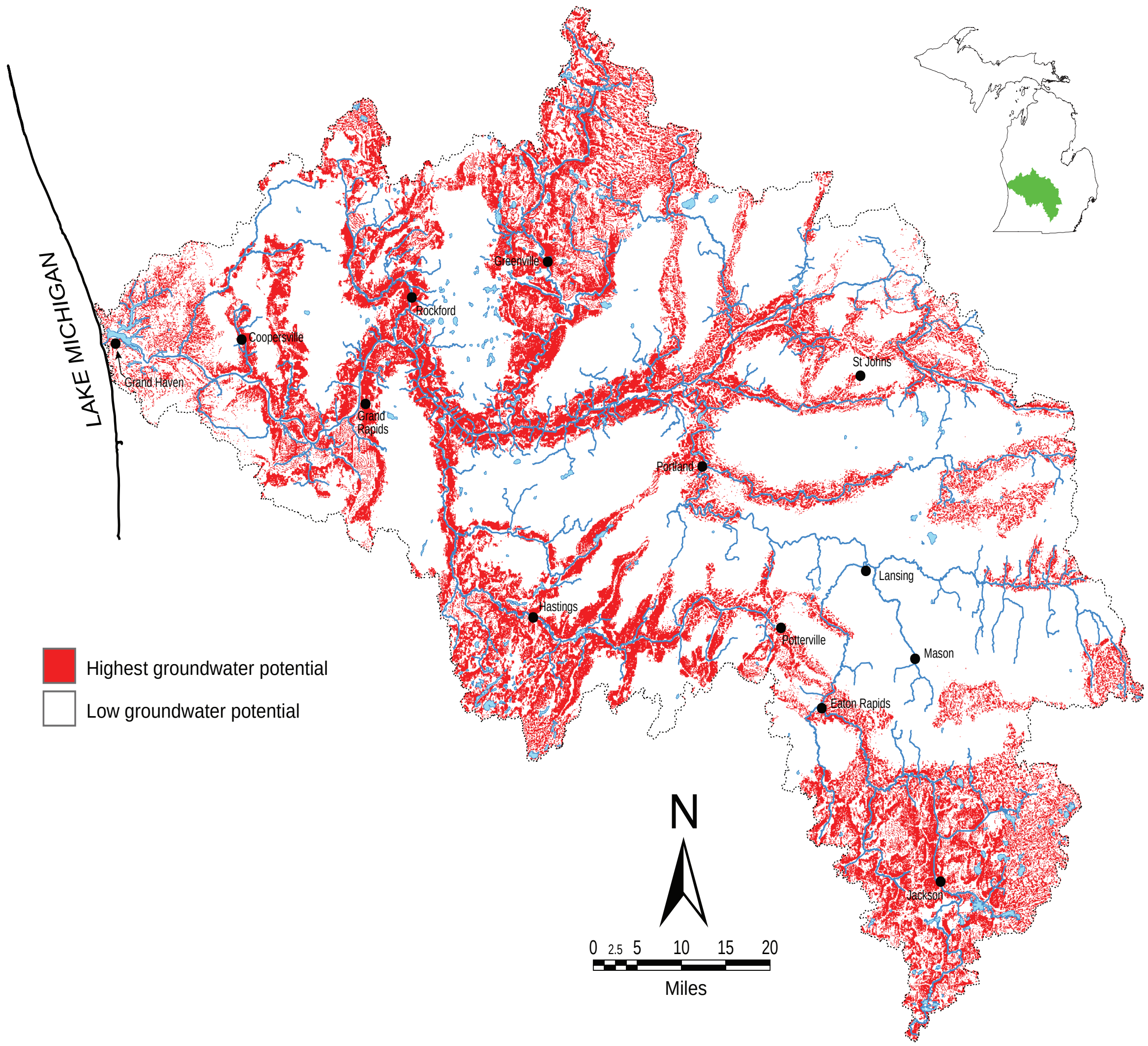

Figure 7.–Potential groundwater flux (Darcy image) in the Grand River watershed. Red areas are considered to be discharging to surface water.

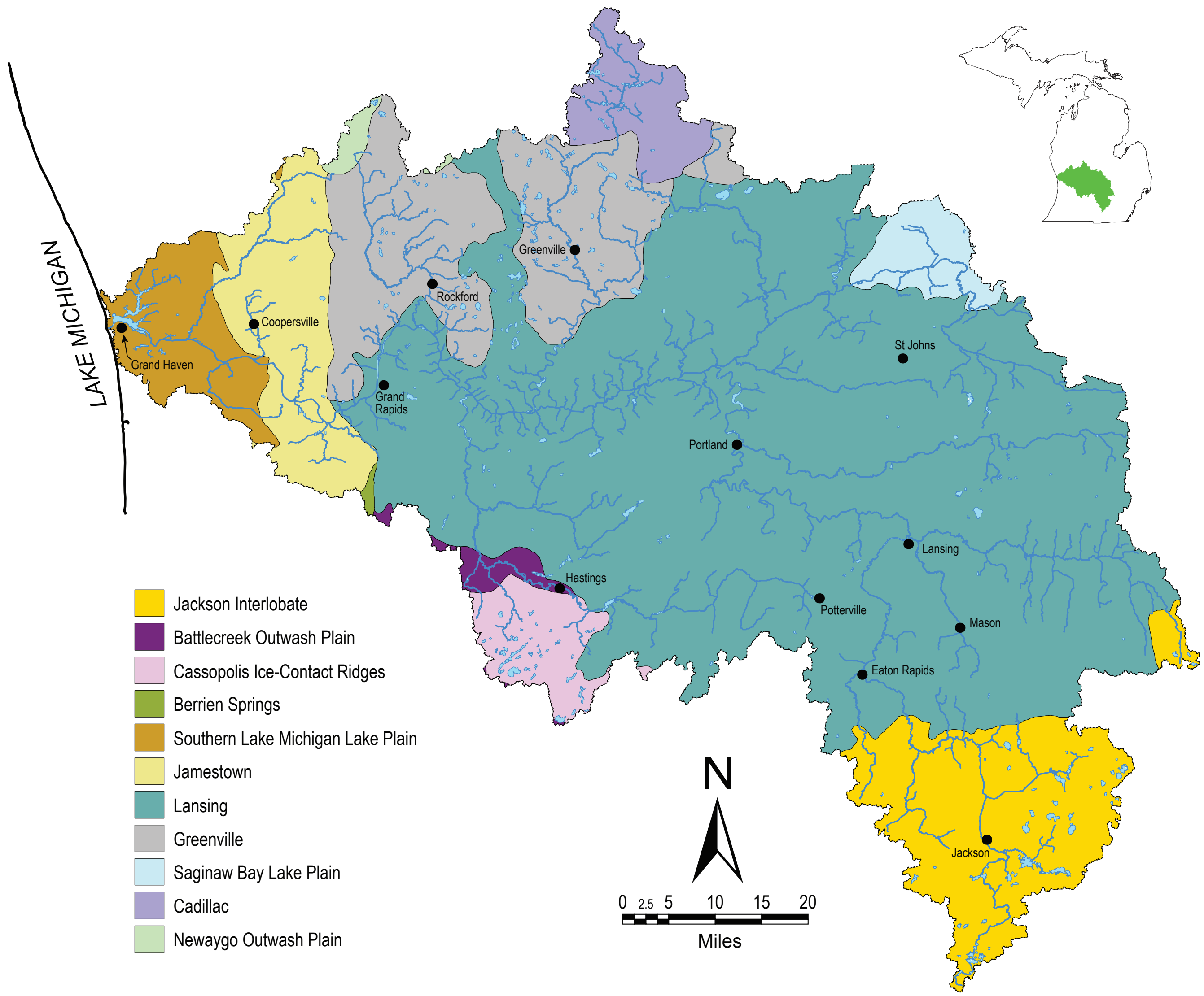

Figure 8.– Landscape ecoregions of the Grand River basin. Data from Albert et al. 1986.

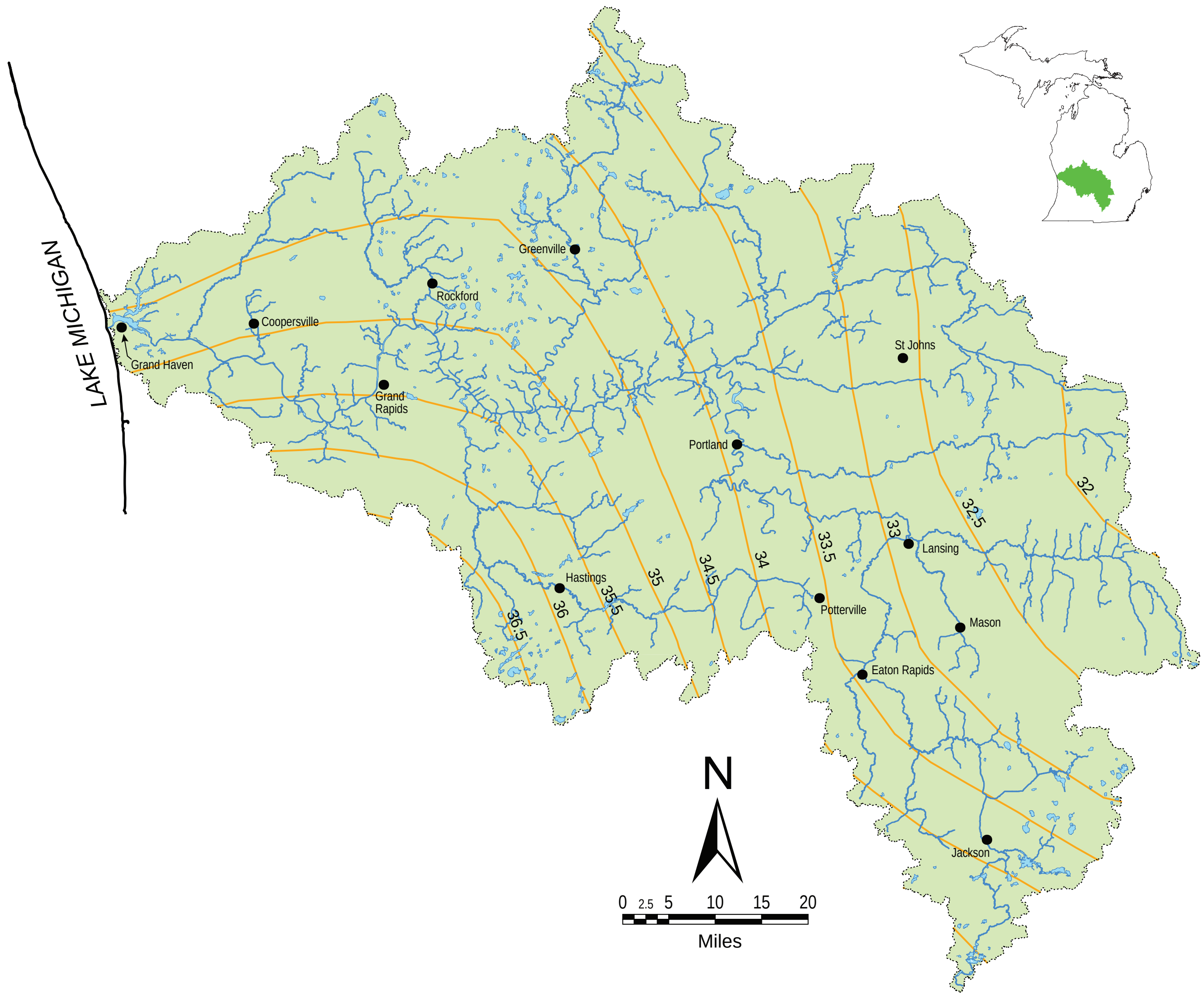

Figure 9.– Distribution of normal precipitation in the Grand River watershed for 1971-2000. Lines of equal normal precipitation in inches. Contour interval is 0.5 inch. Normal annual precipitation from Michigan Climatological Resources Program, 2004.

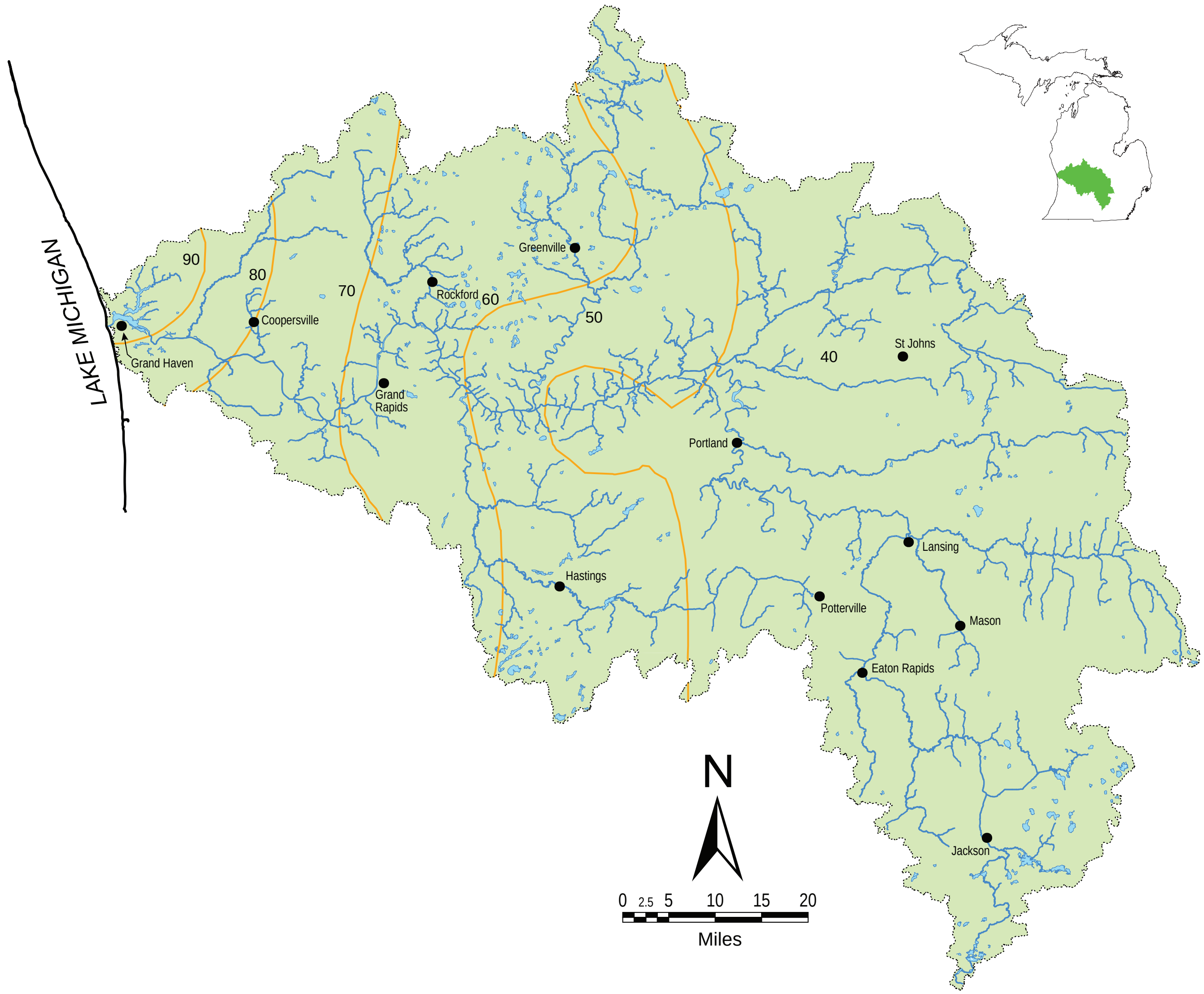

Figure 10.– Distribution of normal annual snowfall depths in the Grand River watershed for 1971-2000. Lines of equal normal snowfall in inches (not water equivalent). Contour interval is 10 inch. Snowfall depths from Michigan Climatological Resources Program, 2004.

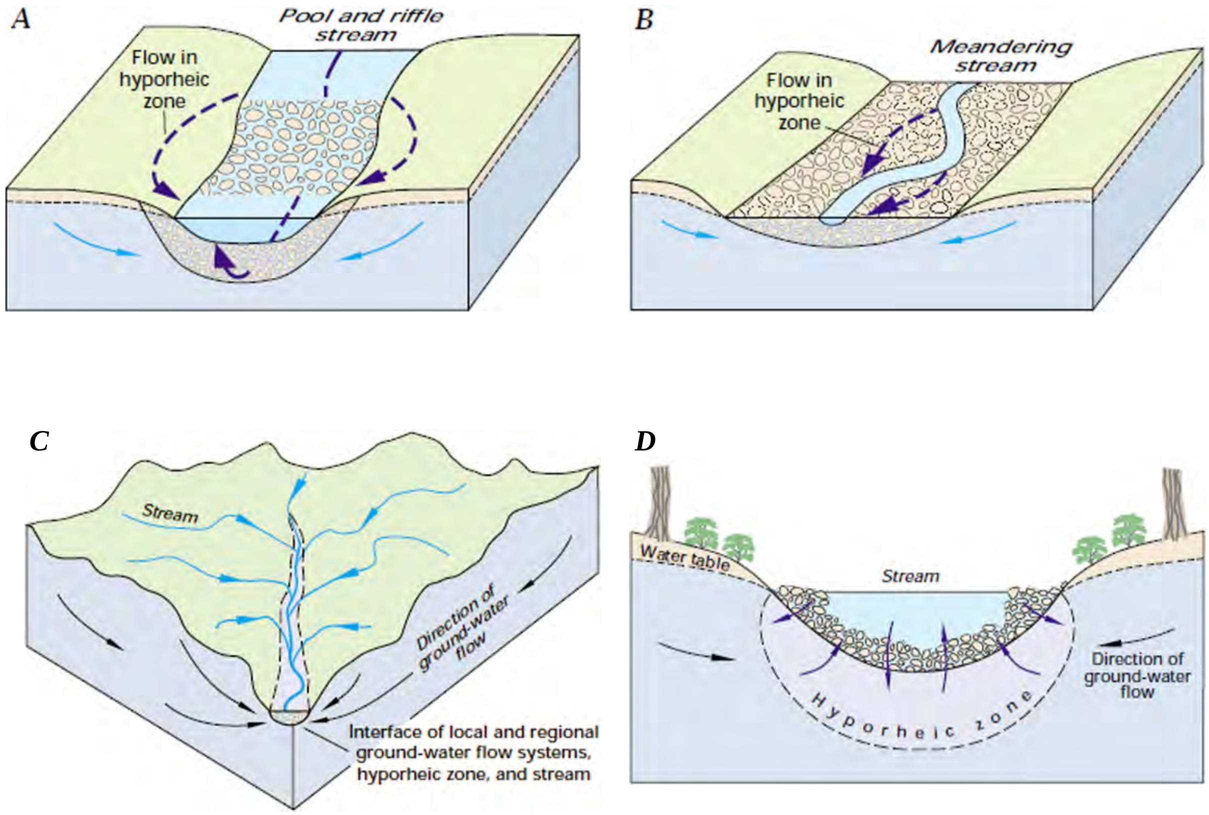

Figure 11.–Dynamic exchanges between groundwater and streams are associated with abrupt changes in channel slope (A) and streambed meanders (B). Groundwater and surface water exchange occurs at local and regional scales (C) and (D). (Modified from Winters et al. 1998)

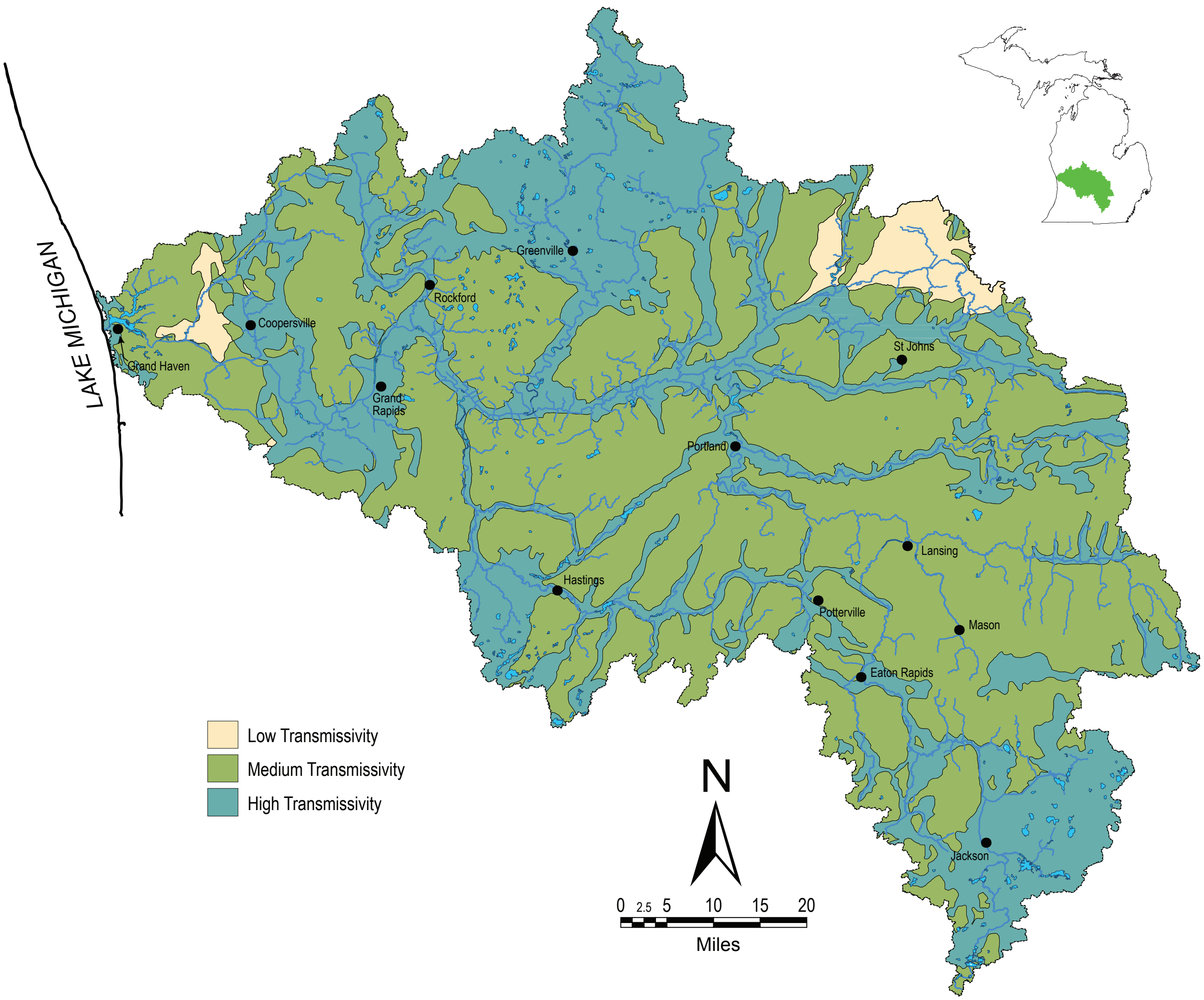

Figure 12.– Distribution of aquifer transmissivity classes in the Grand River watershed. Data from Michigan Department of Informaiton Technology, 2005b. Adapted from Hamilton et al. 2008.

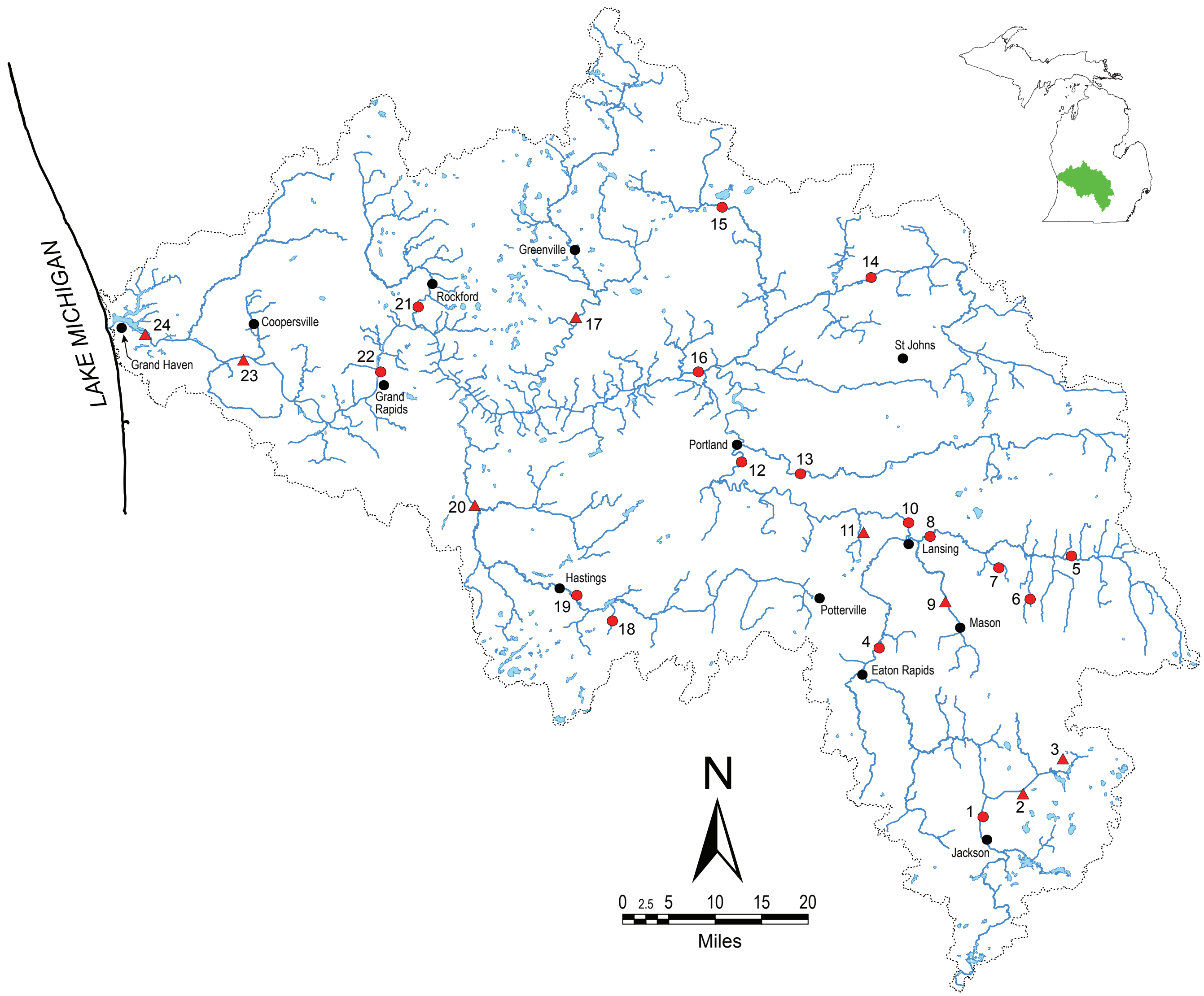

Figure 13.– Approximate locations of active (●) and retired (▲) United States Geological Survey gauge sites in the Grand River watershed. See Table 3 for specific gauge site descriptions.

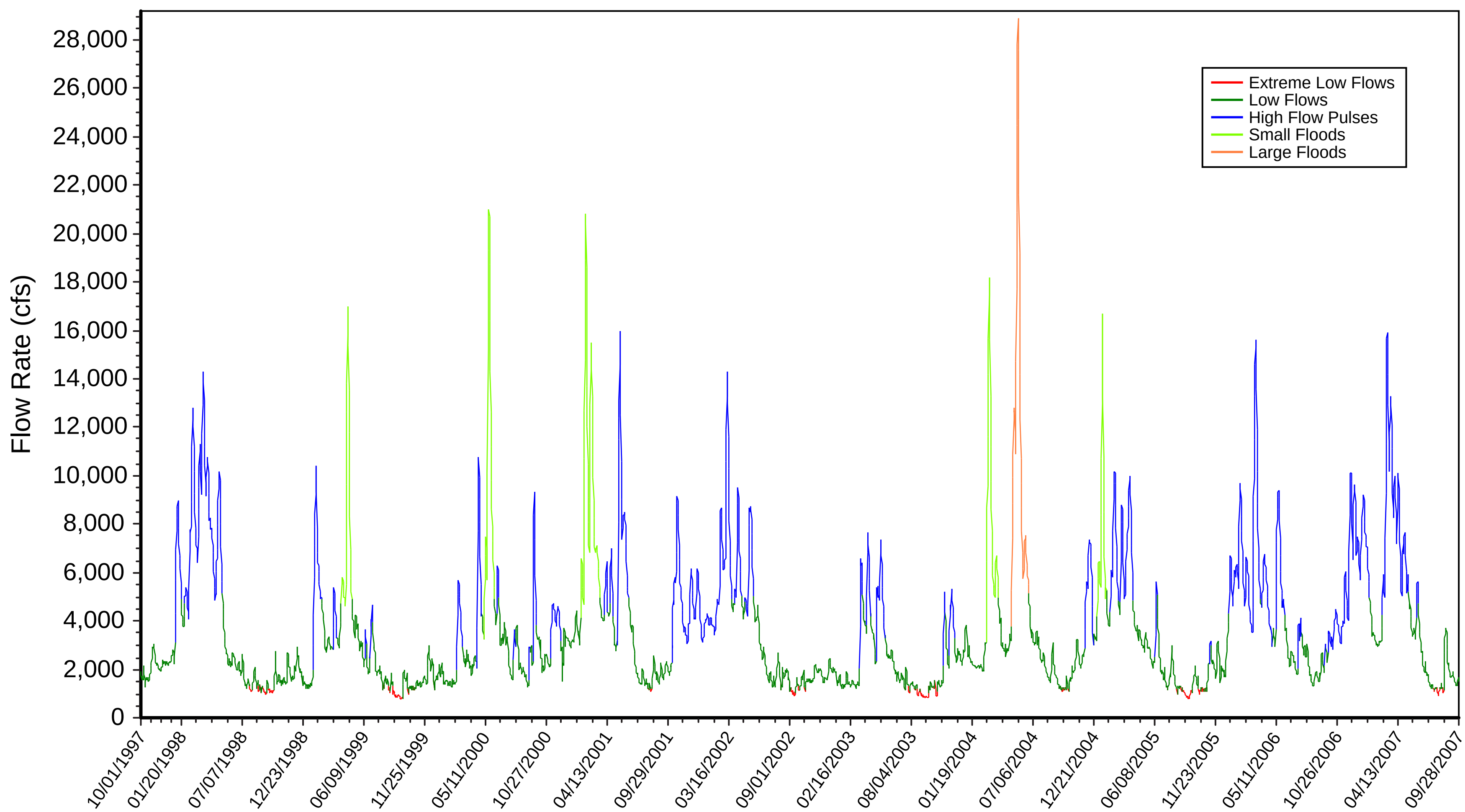

Figure 14.–Daily hydrograph of the Grand River at Grand Rapids (USGS Gauge 04119000) during 1997 through 2008. Data from the United States Geological Survey. Environmental flow classifications are based on Indicators of Hydrologic Alteration (The Nature Conservancy 2006).

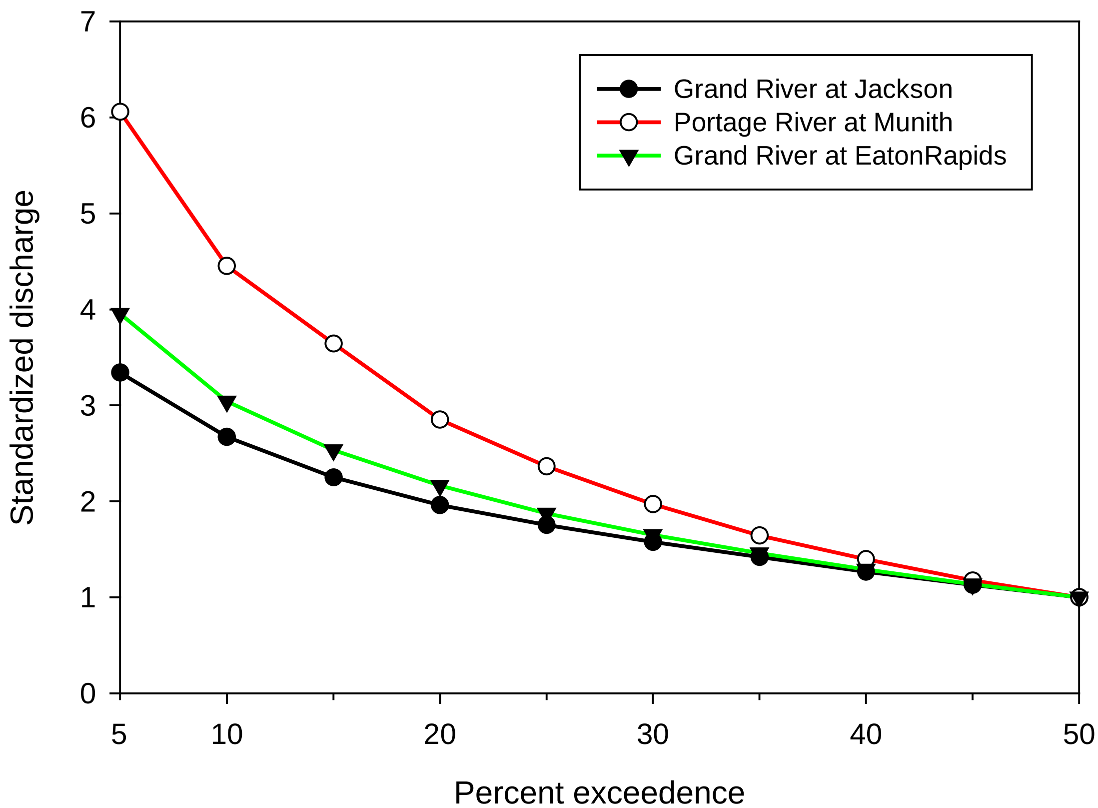

Figure 15.–Standardized high flow exceedence curves for gauged locations in the headwaters and upper main-stem segments. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for the period of record through water year 2004.

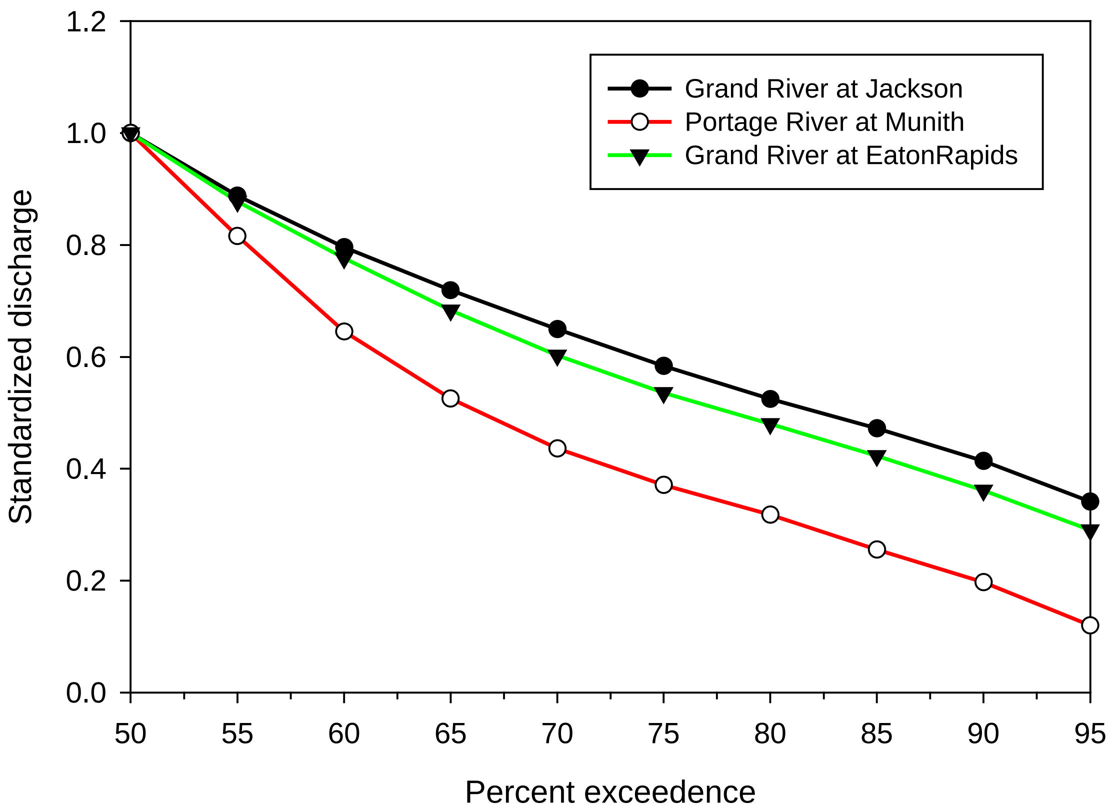

Figure 16.–Standardized low flow exceedence curves for gauged locations in the headwaters and upper main stem segments. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

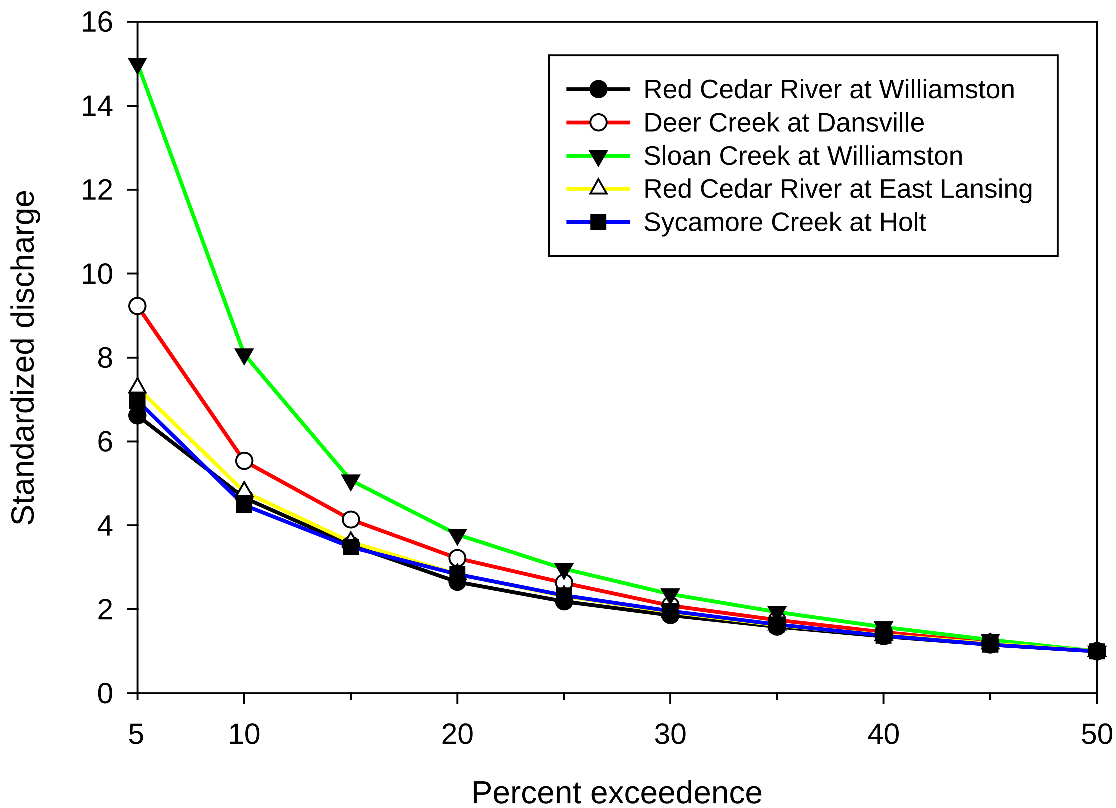

Figure 17.–Standardized high flow exceedence curves for tributaries in the middle main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

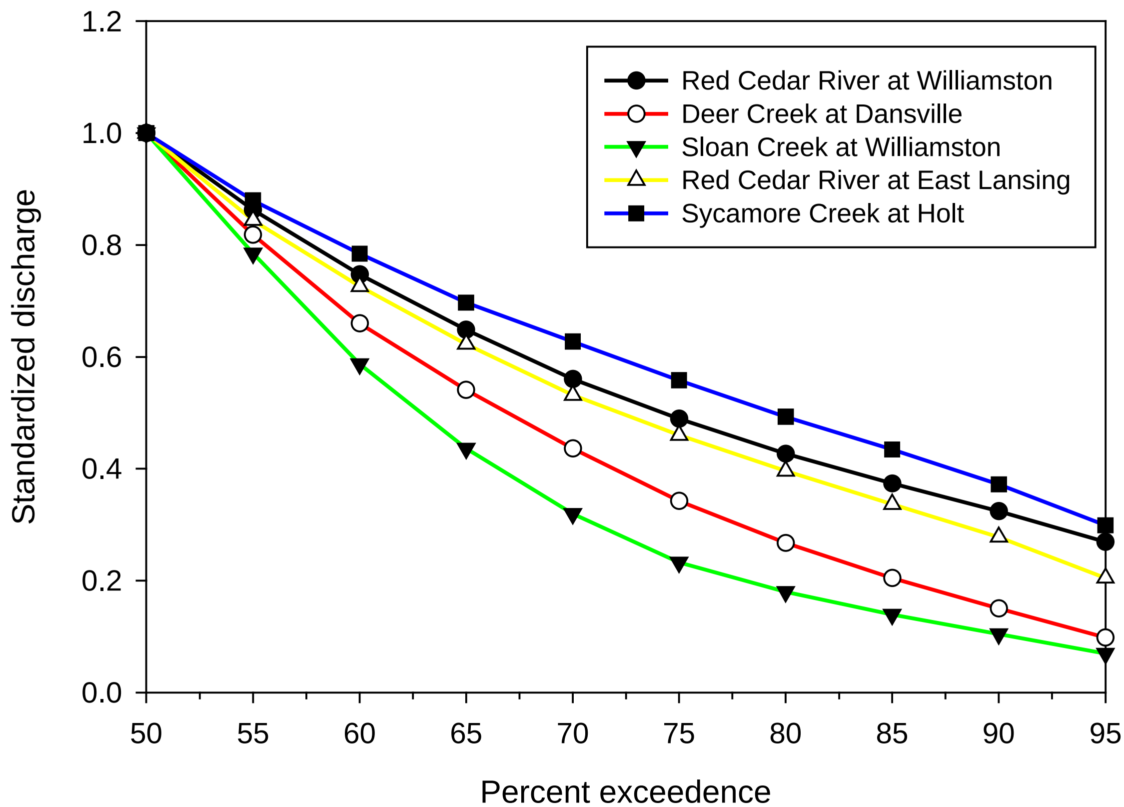

Figure 18.–Standardized low flow exceedence curves for tributaries in the middle main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

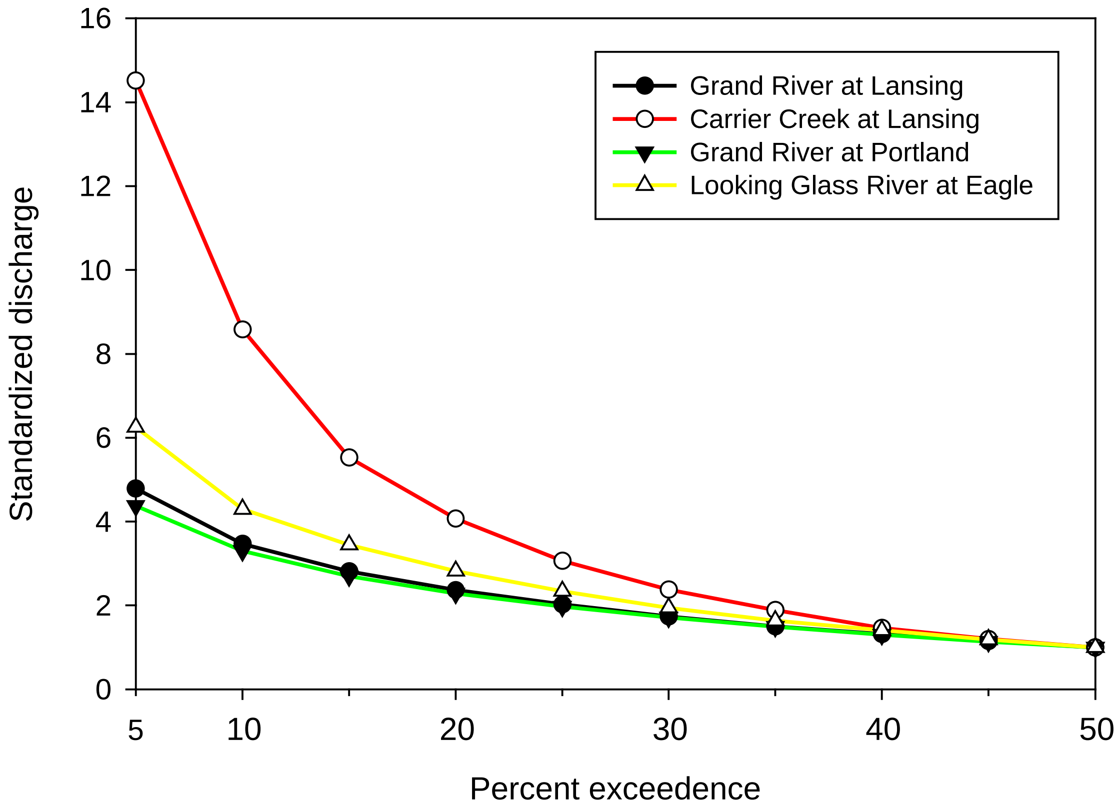

Figure 19.–Standardized high flow exceedence curves for the Grand River and tributaries within the middle main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

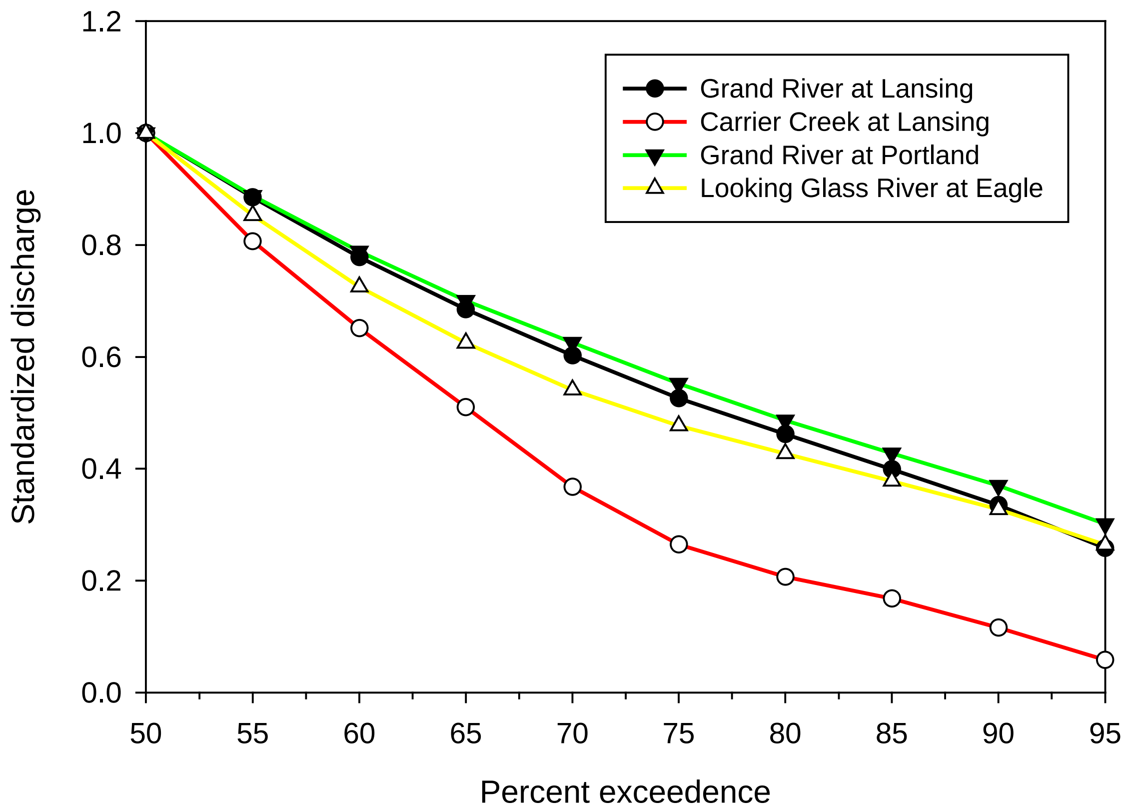

Figure 20.–Standardized low flow exceedence curves for Grand River and tributaries within the middle main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

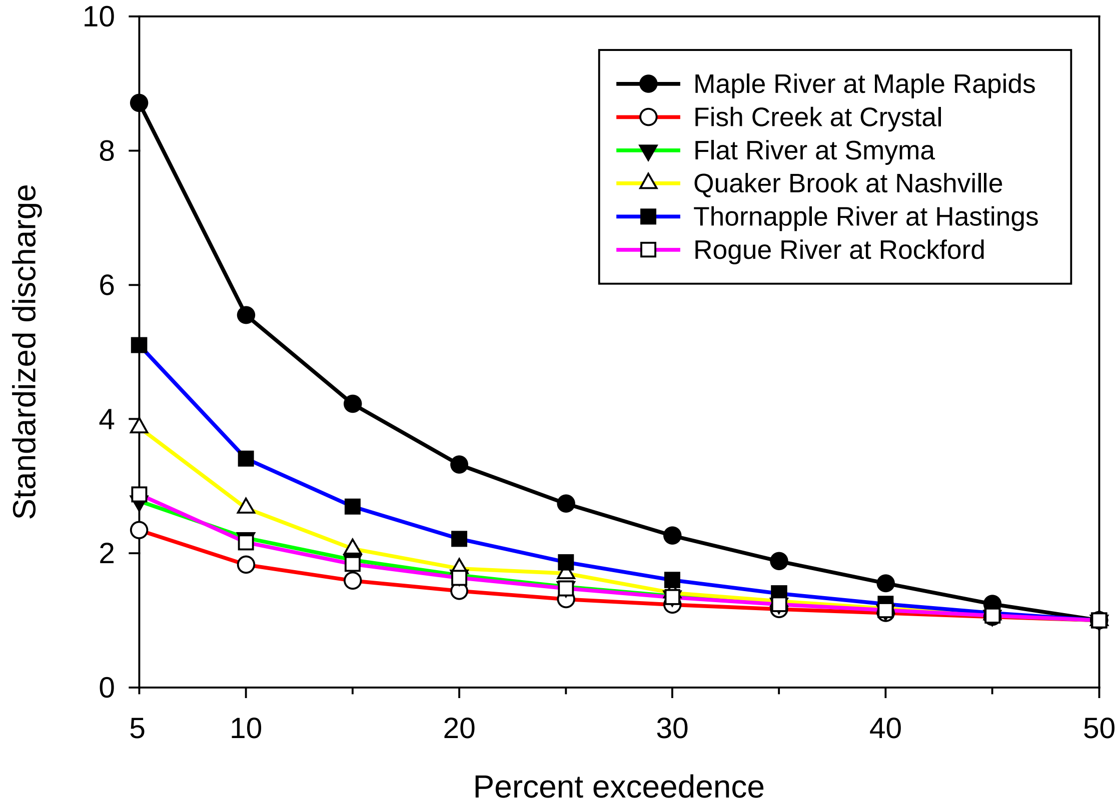

Figure 21.–Standardized high flow exceedence curves for tributaries in the lower main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

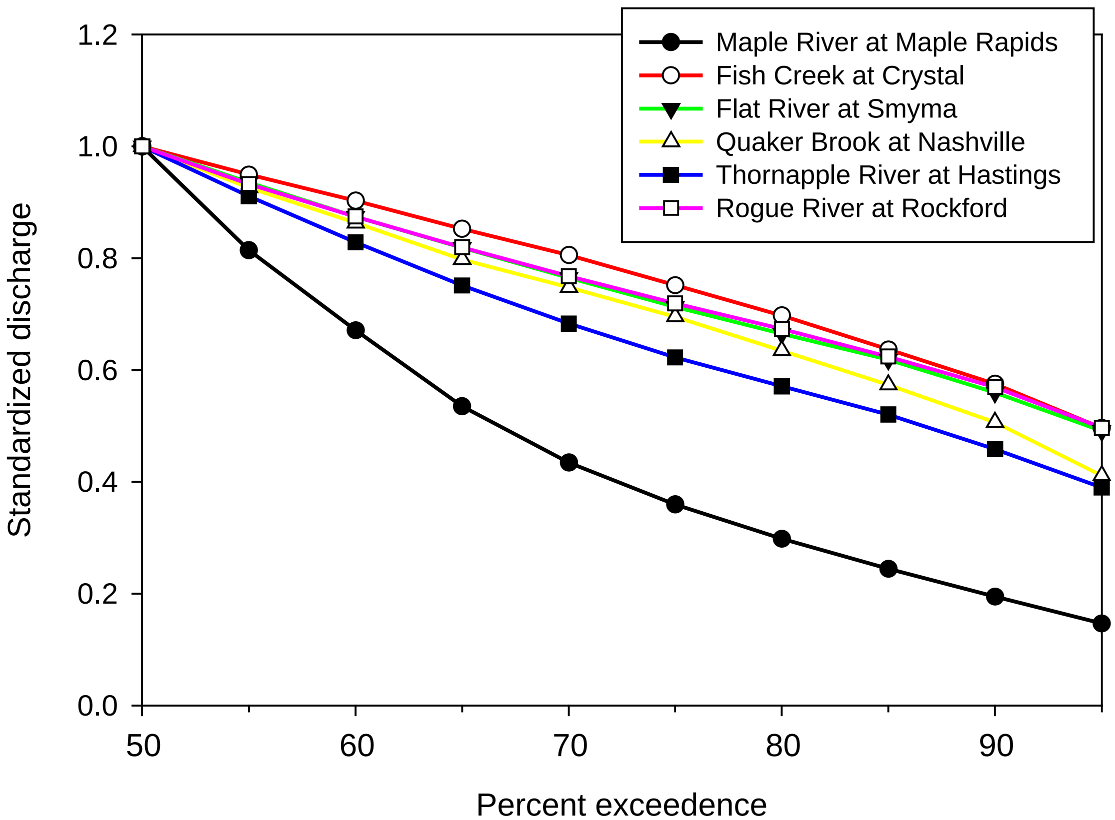

Figure 22.–Standardized low flow exceedence curves for tributaries in the lower main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

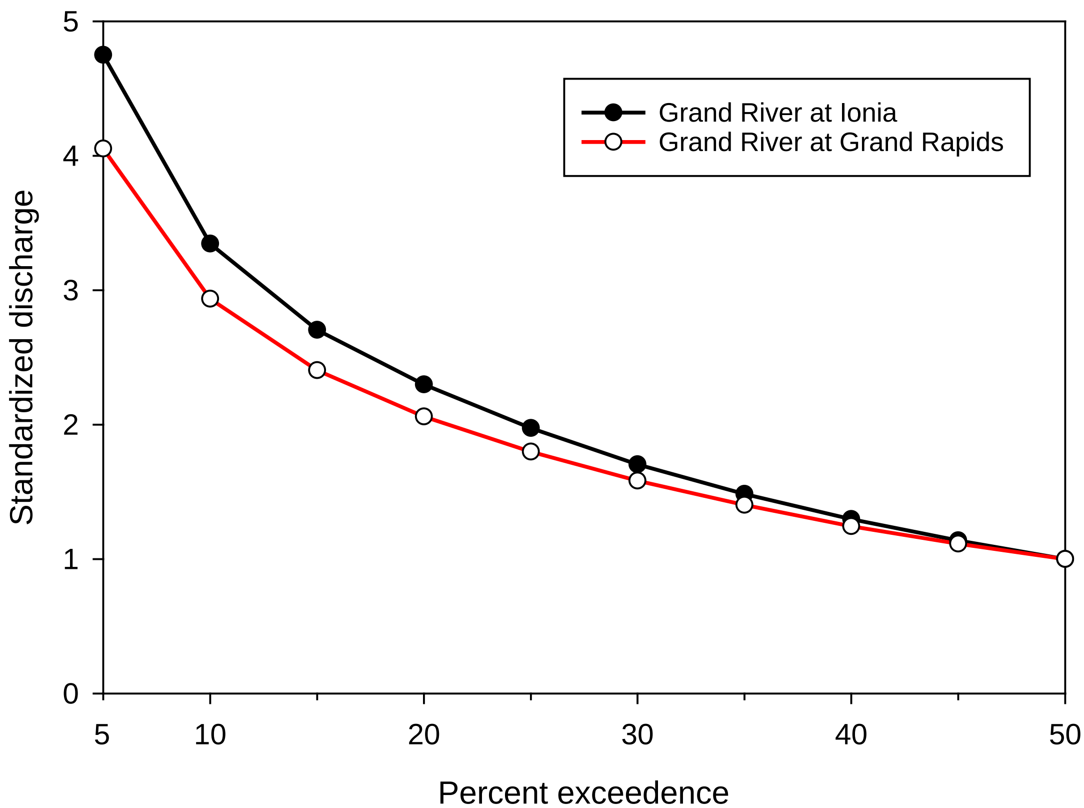

Figure 23.–Standardized high flow exceedence curves for the Grand River in the lower main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

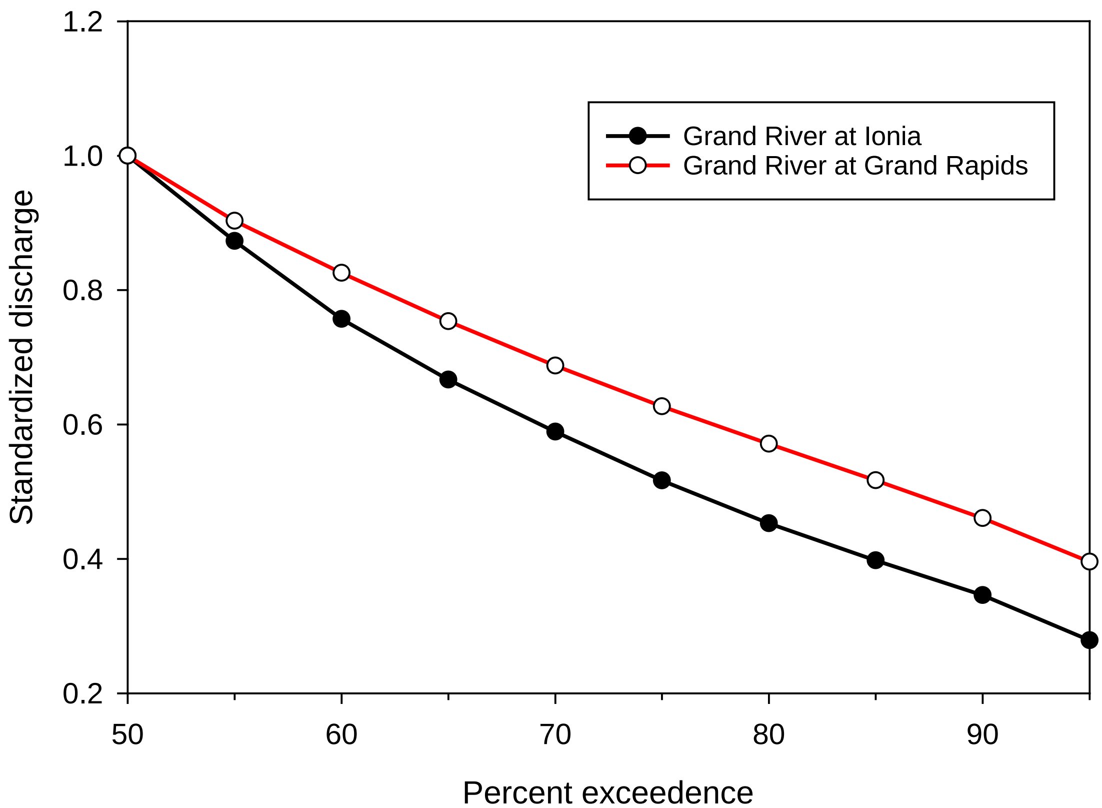

Figure 24.–Standardized low flow exceedence curves for the Grand River in the lower main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through water year 2004.

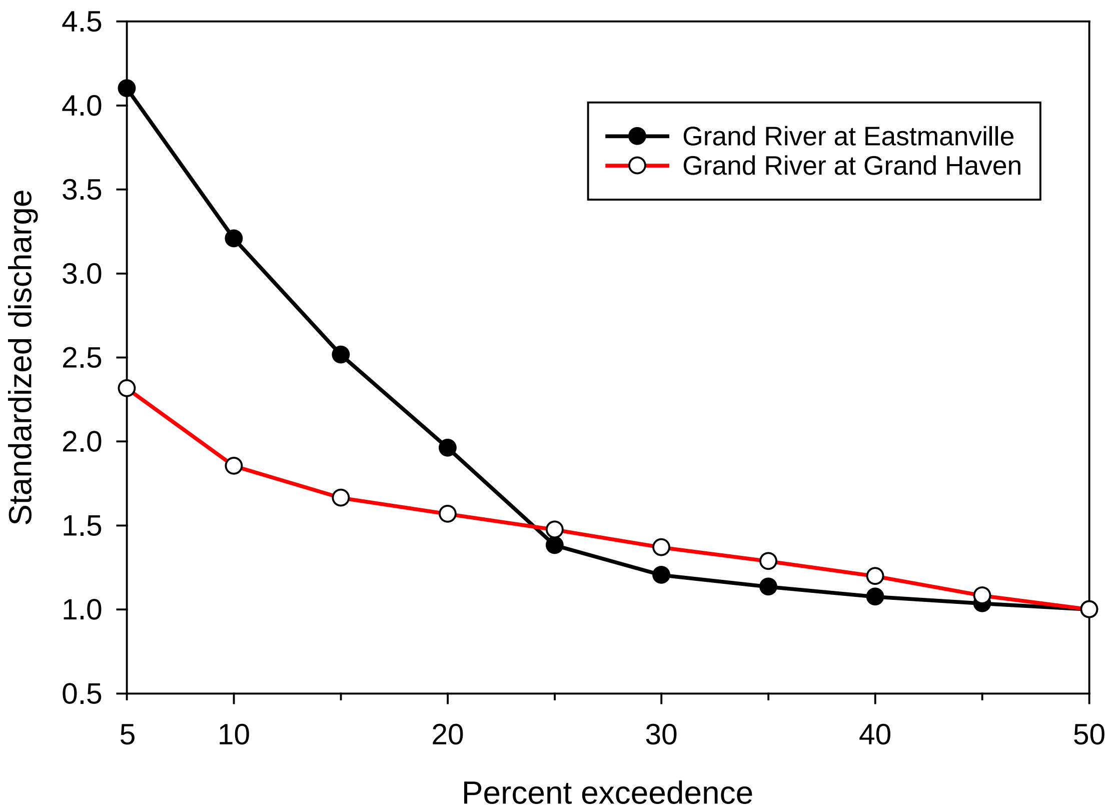

Figure 25.–Standardized high flow exceedence curves for the Grand River in the main stem mouth segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through Water Year 2004.

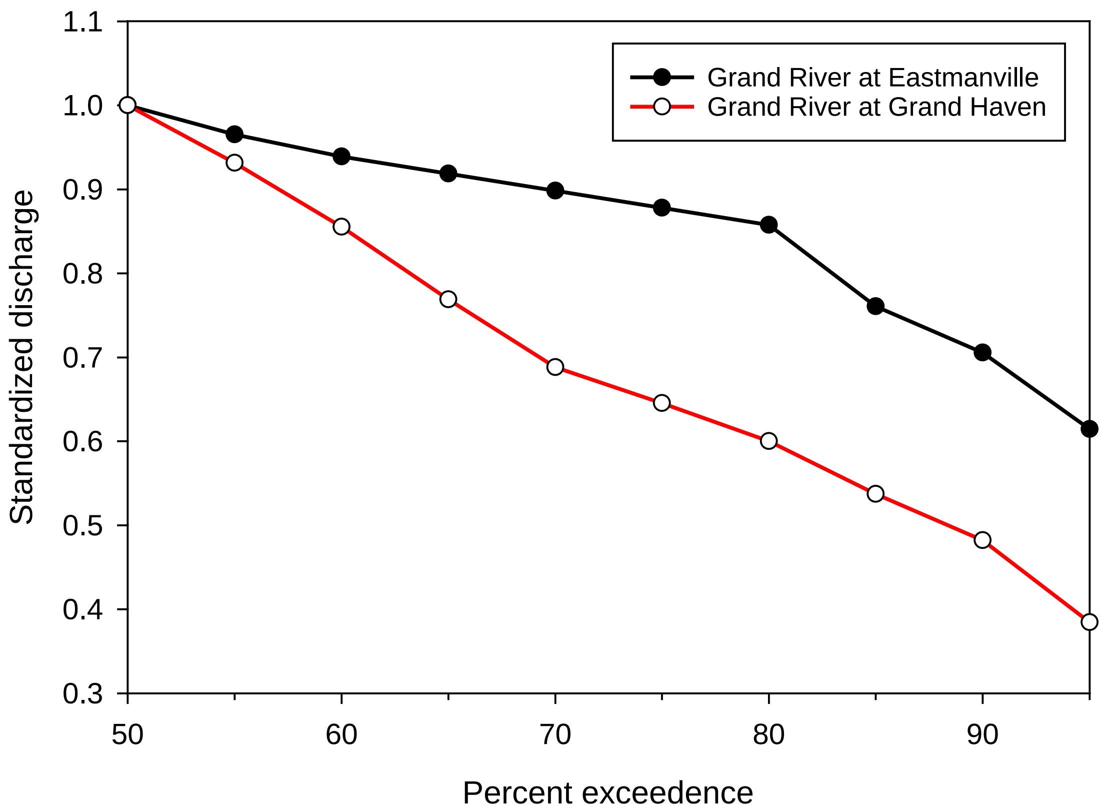

Figure 26.–Standardized low flow exceedence curves for Grand River in the mouth main stem segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record through Water Year 2004.

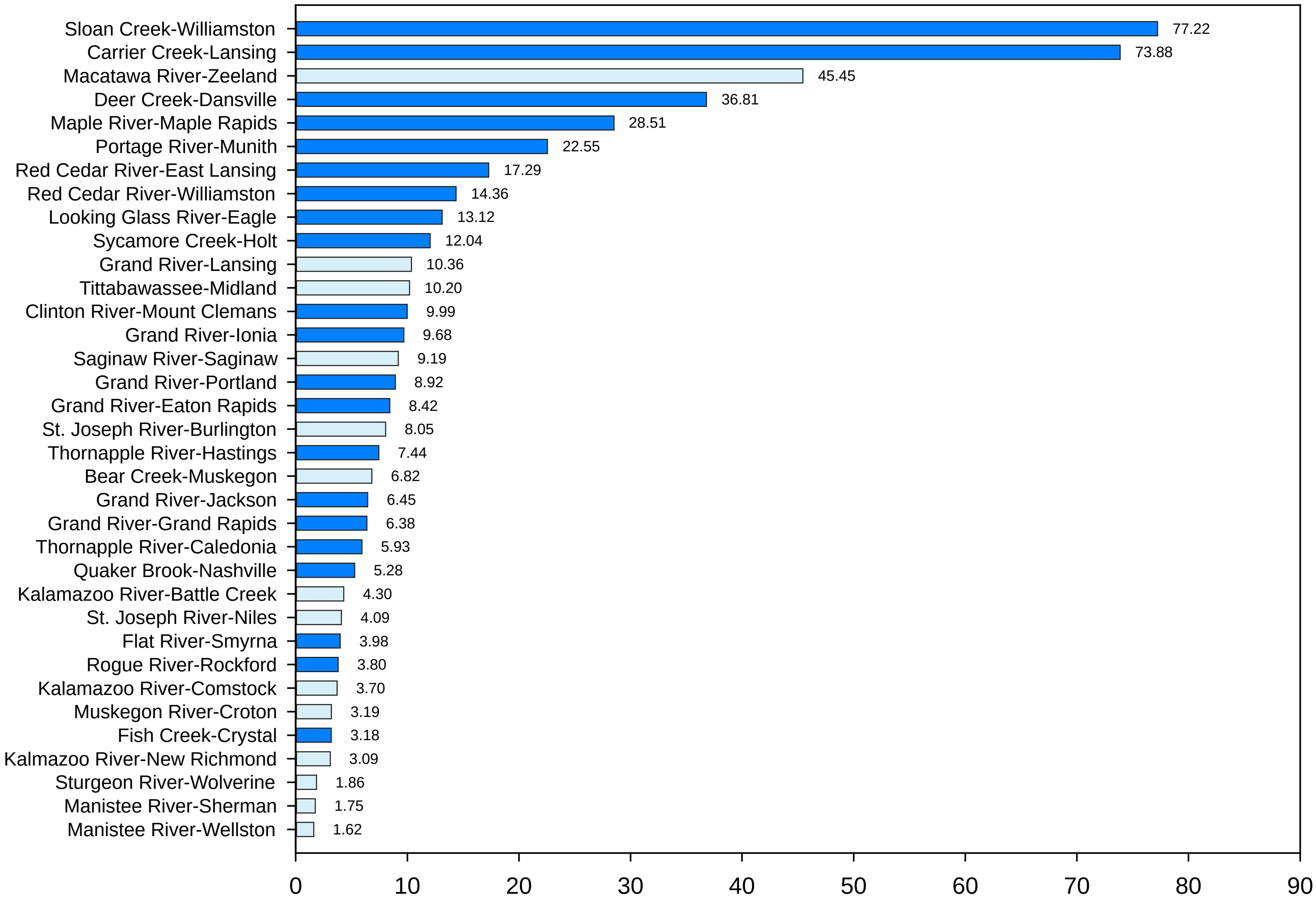

Figure 27.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of the Grand River main stem and tributaries. Flow stability of select streams outside of the Grand River watershed (represented by light blue) are provided for comparative purposes. Data from the United States Geological Survey.

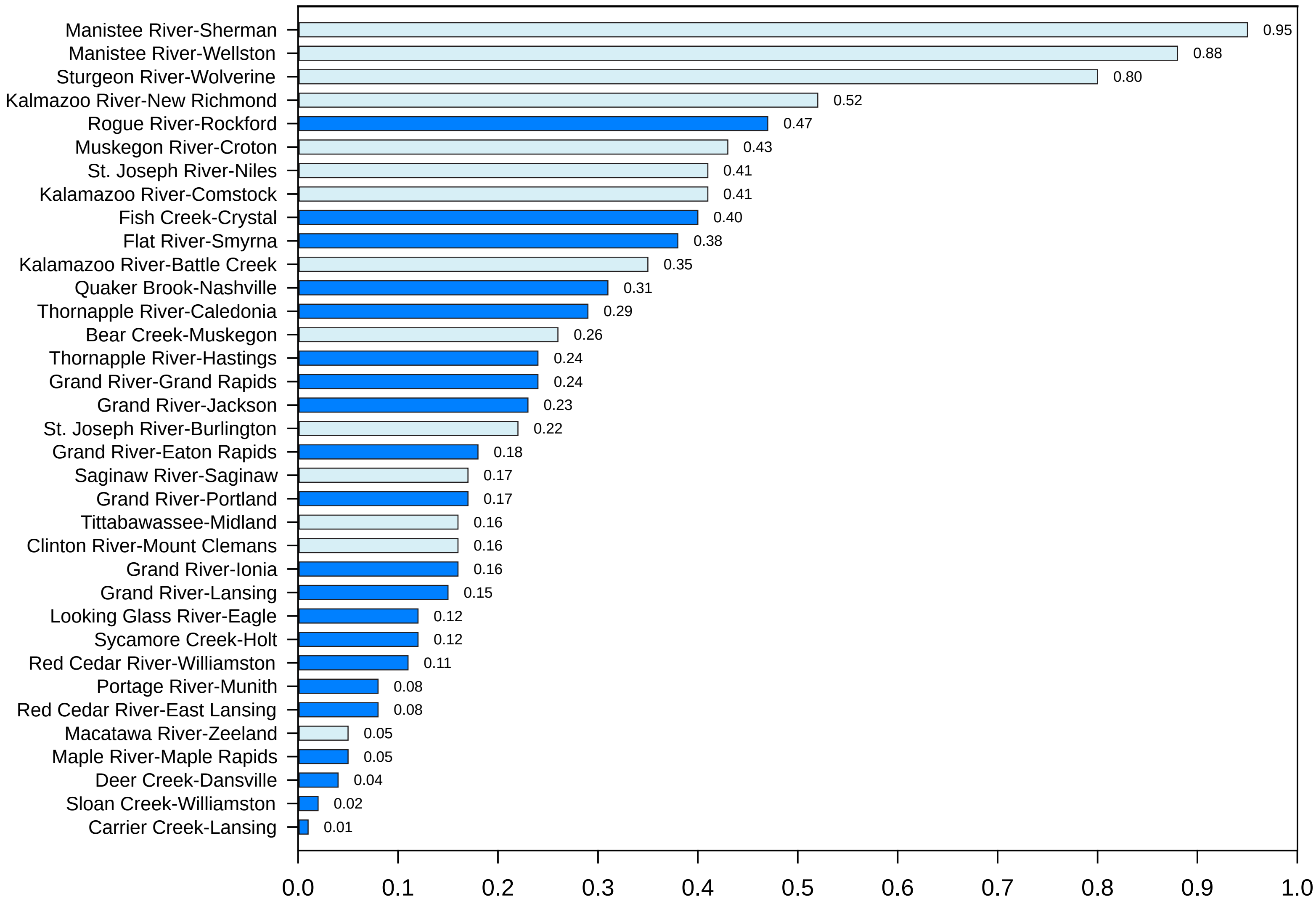

Figure 28.–Low-flow yield (90% exceedence flow divided by catchment area) expressed as cfs/square mile for the Grand River main stem and tributaries. Low-flow yield for select streams outside of the Grand River watershed (represented by light blue) are provided for comparative purposes. Data from the United States Geological Survey.

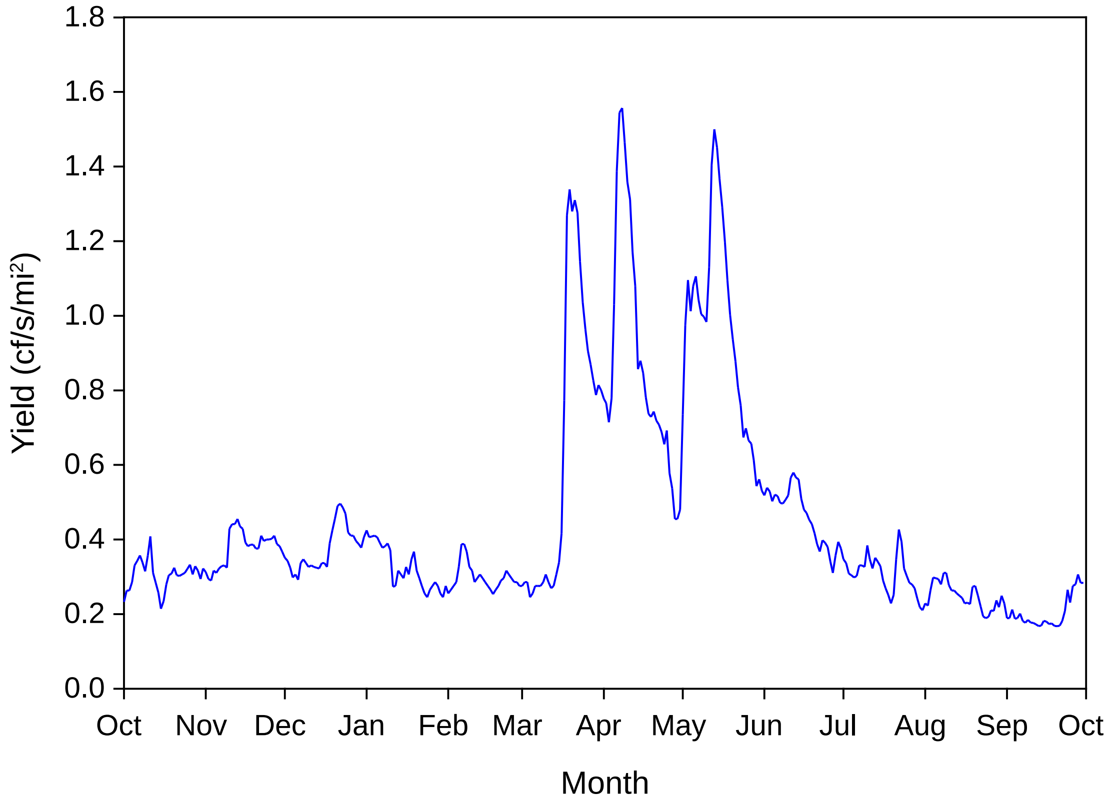

Figure 29.–Grand River yield at Grand Rapids for water year 2003. Data from United States Geological Survey.

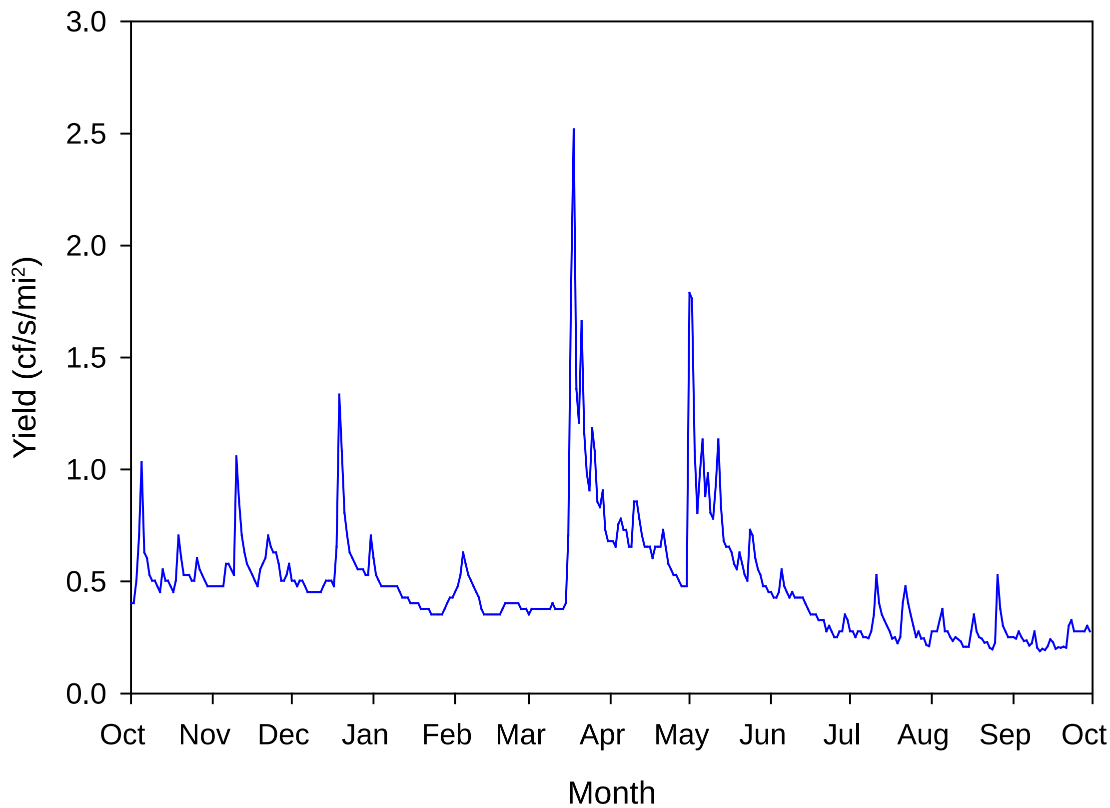

Figure 30.–Fish Creek yield at Crystal for water year 2003. Data from United States Geological Survey.

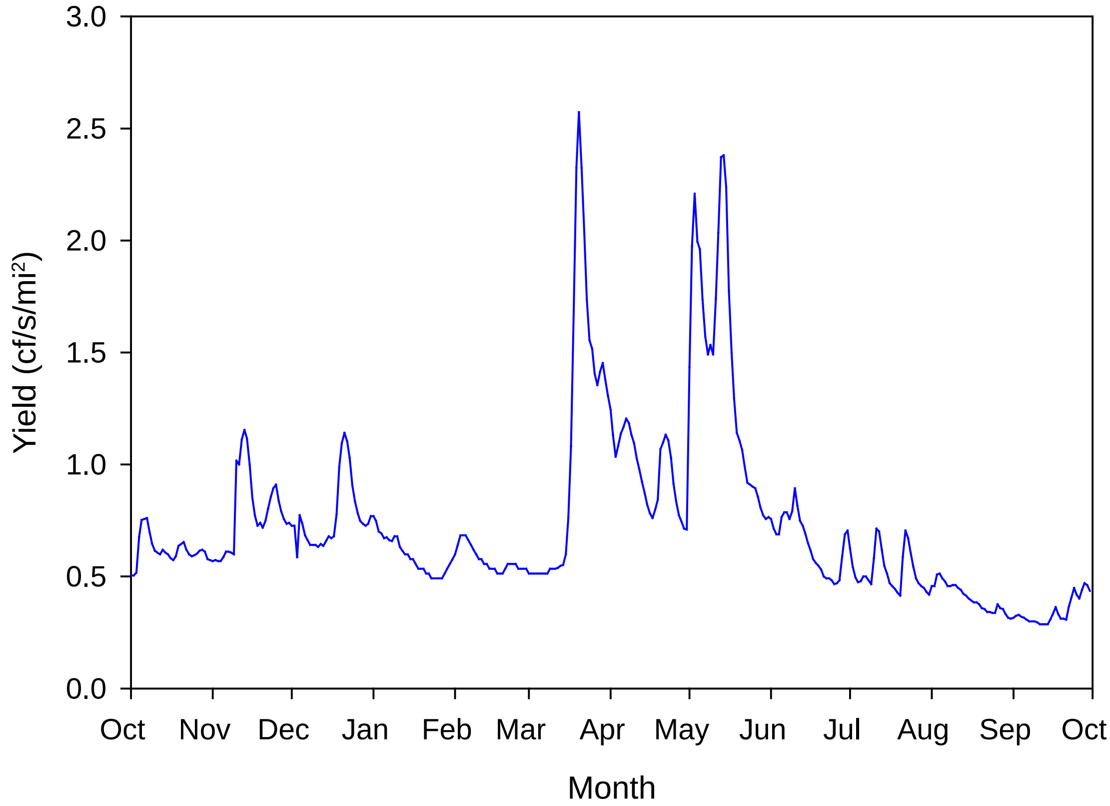

Figure 31.–Rogue River yield at Rockford for water year 2003. Data from United States Geological Survey.

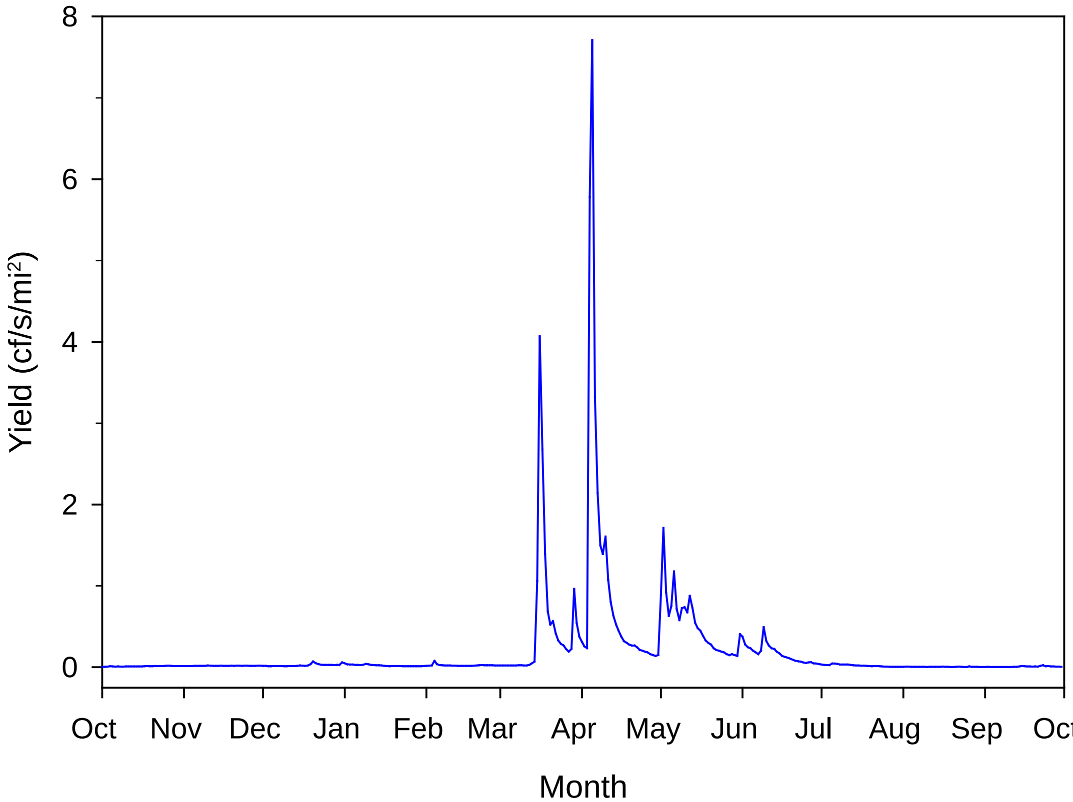

Figure 32.–Sloan Creek yield at Williamston for water year 2003. Data from United States Geological Survey.

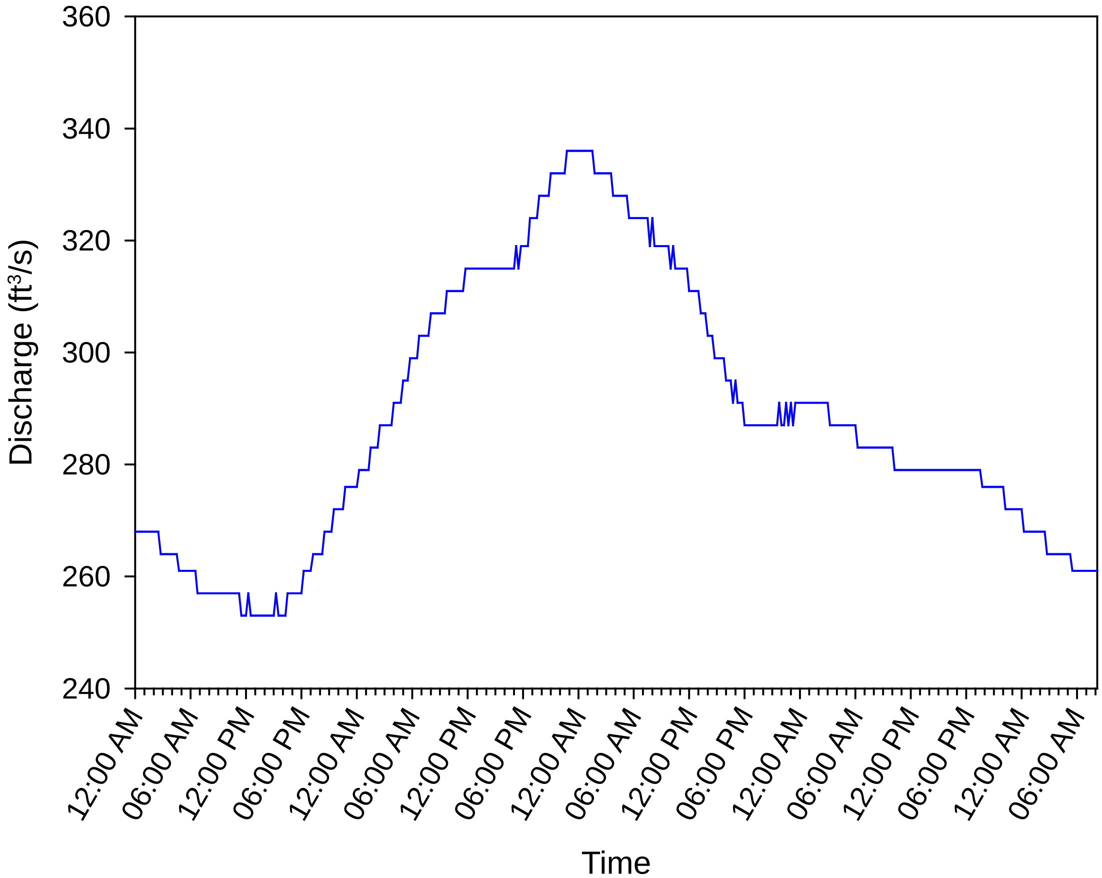

Figure 33.–Instantaneous discharge of Grand River at Portland September 21 to September 24, 2004 Data from United States Geological Survey.

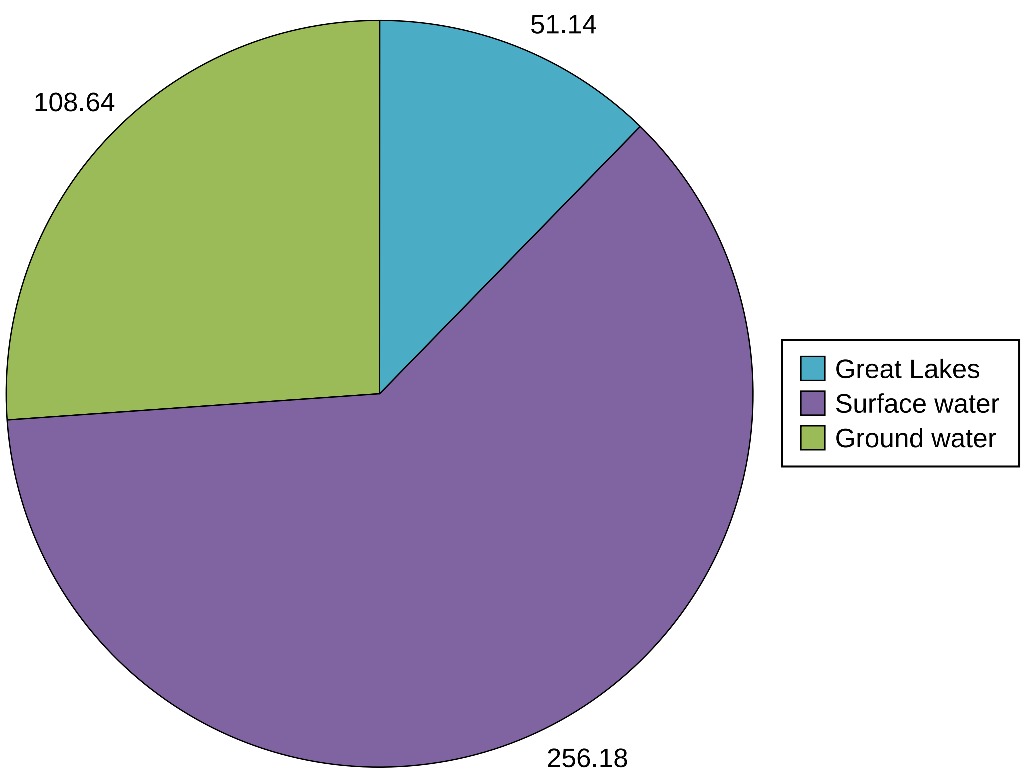

Figure 34.–Water use (million gallons per day) by source in the Grand River watershed for 2001 (MDEQ 2004).

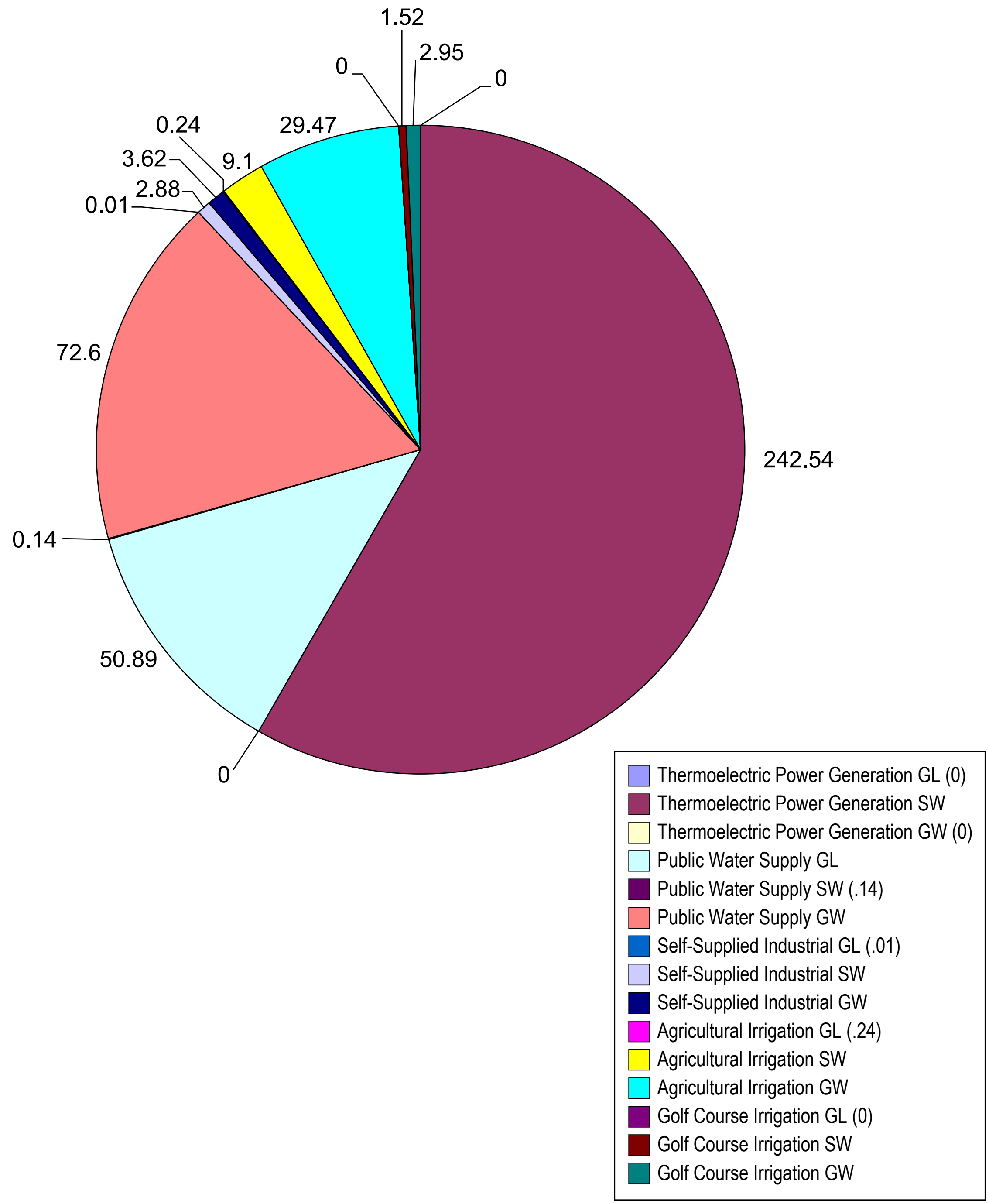

Figure 35.–Water use (million gallons per day) by category in the Grand River watershed for 2001 (MDEQ 2004).

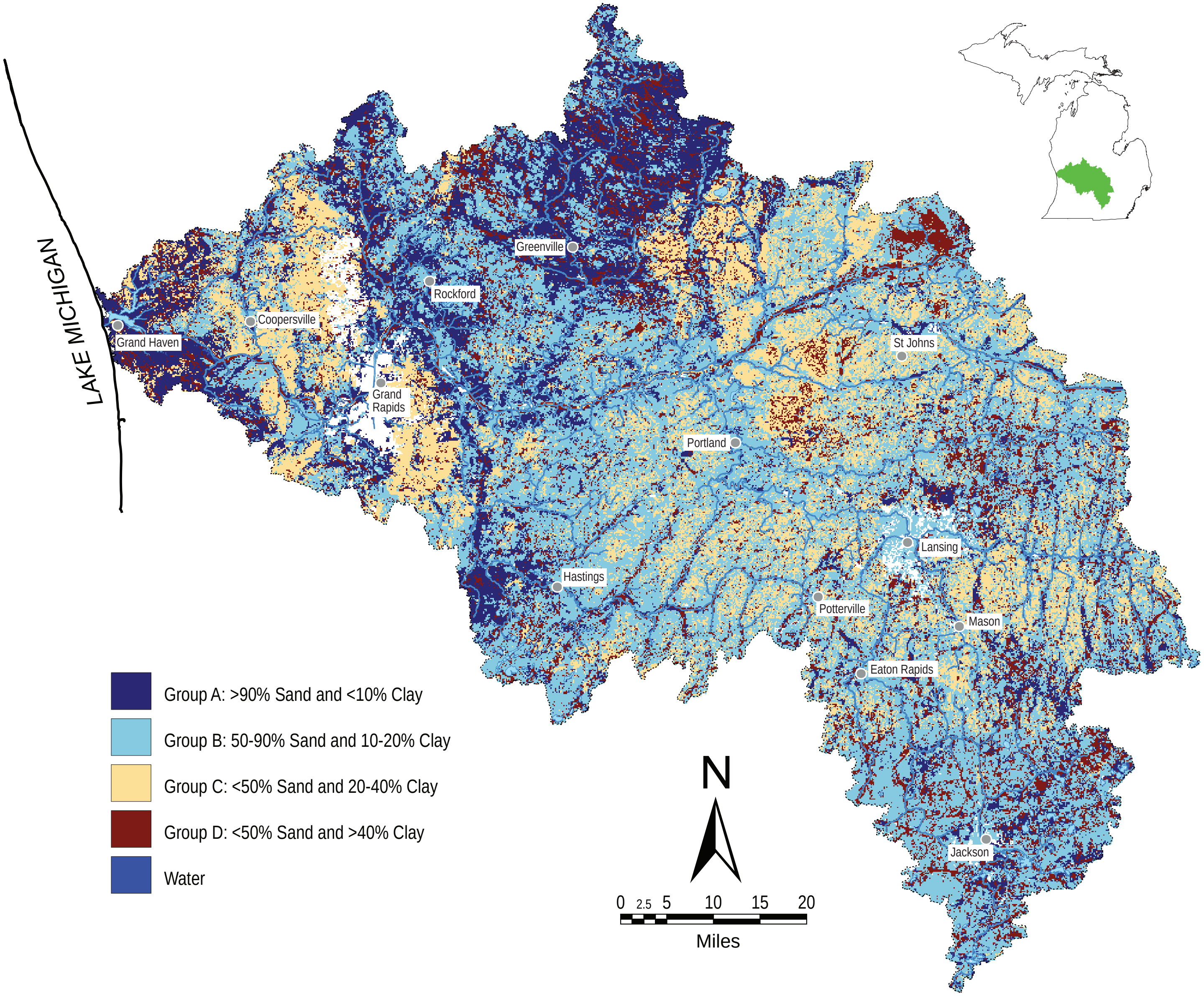

Figure 36.–Distribution of hydrologic soil groups in the Grand River watershed. Adapted from Hamilton et al. 2008.

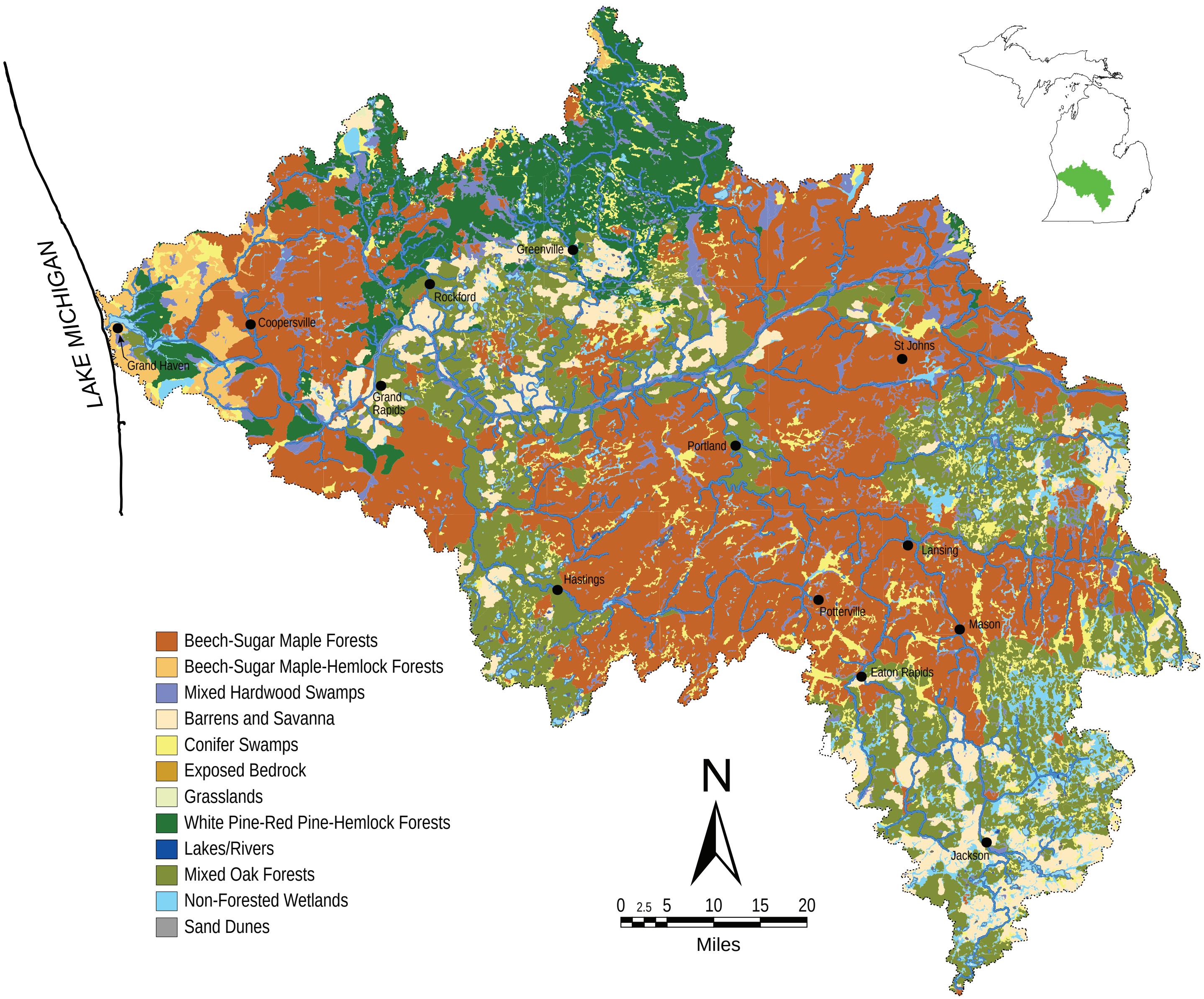

Figure 37.–Distribution of land cover types in the Grand River watershed circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

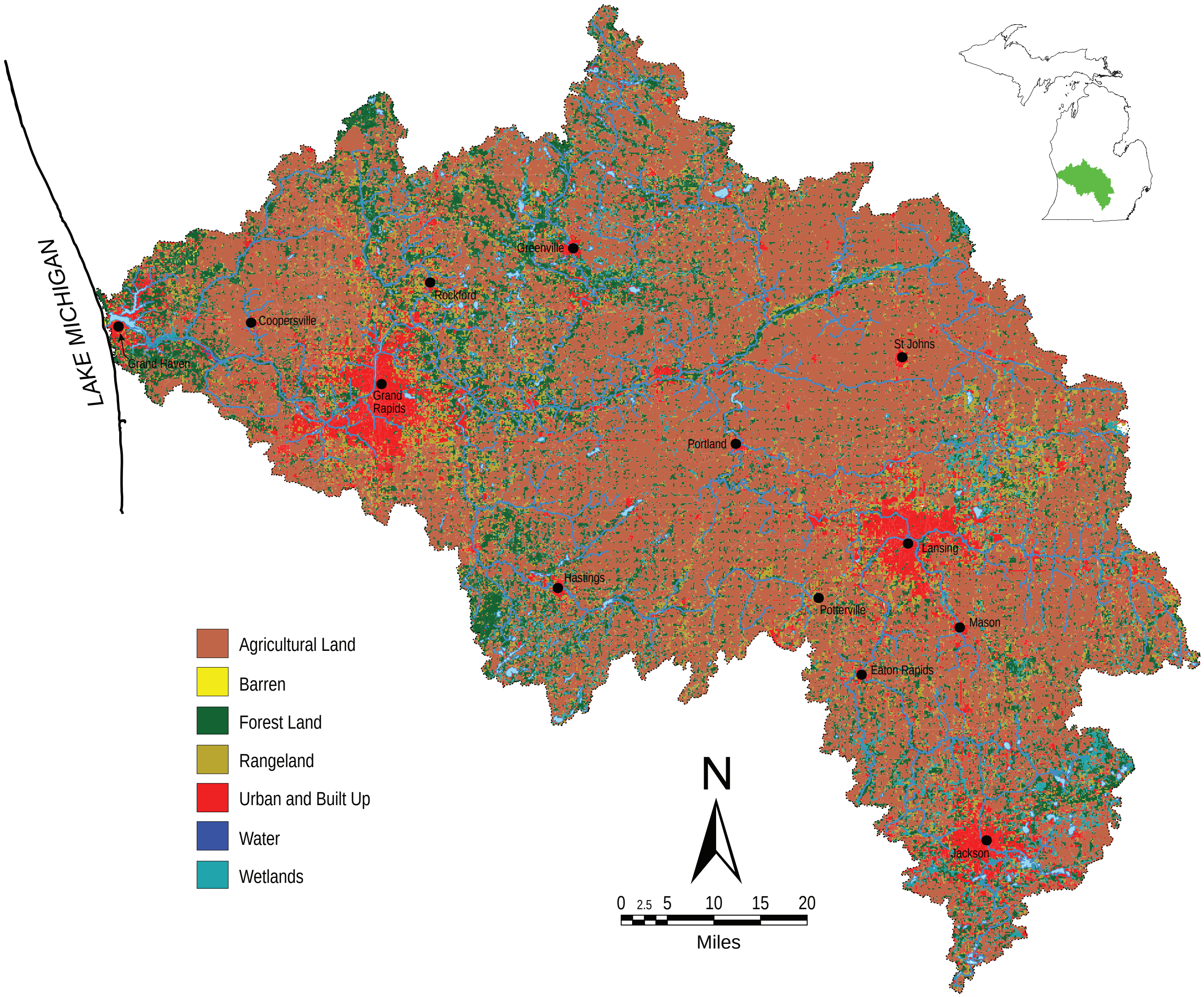

Figure 38.–Land type and use in the Grand River watershed. Data from the Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

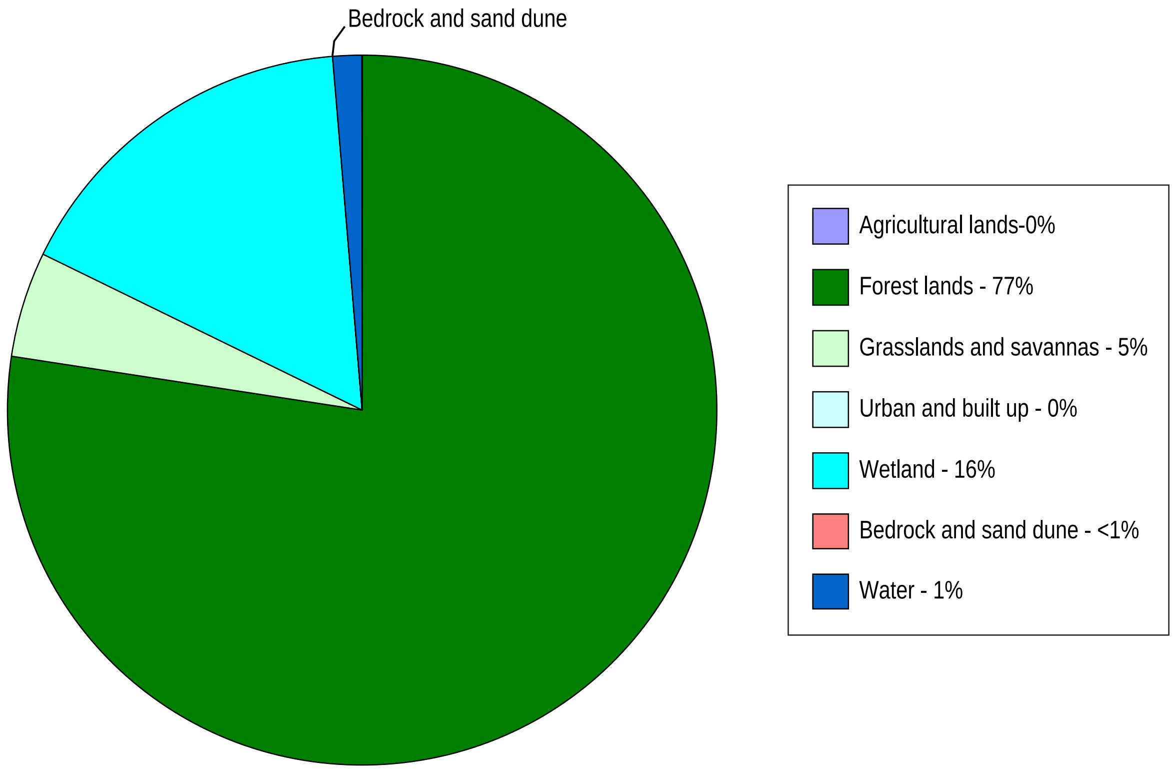

Figure 39.–Presettlement vegetation in the Grand River watershed circa 1820.

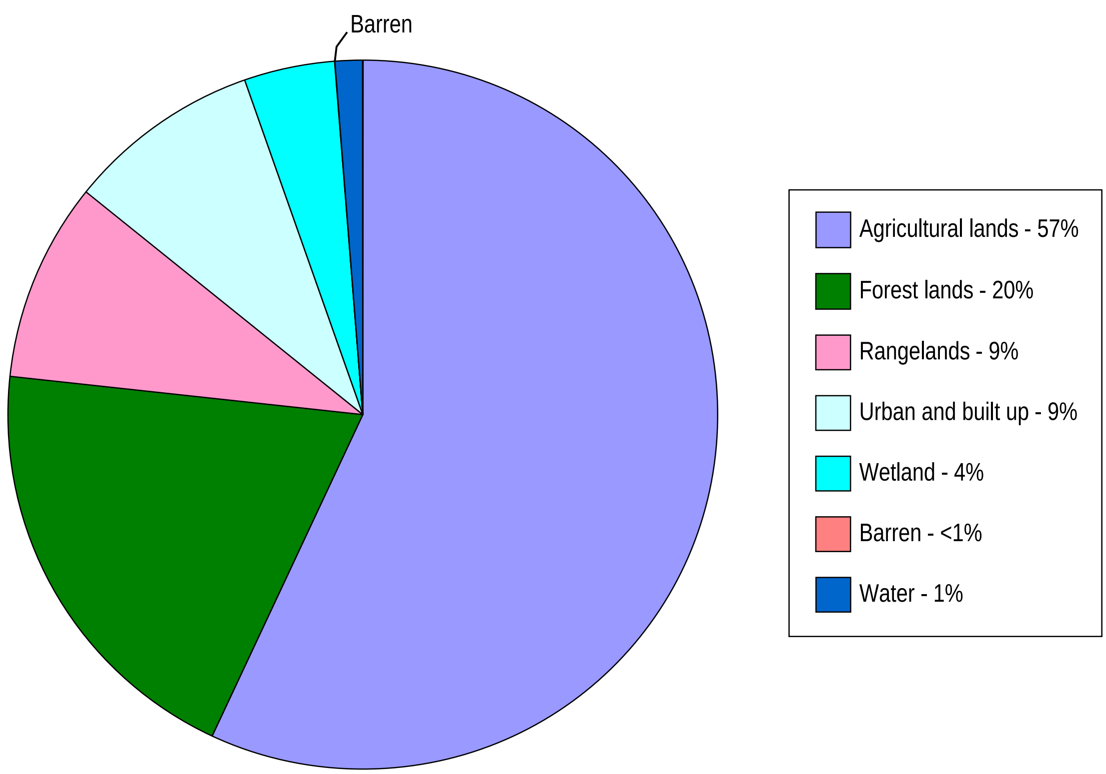

Figure 40.–Land-use and land cover in the Grand River watershed 1978.

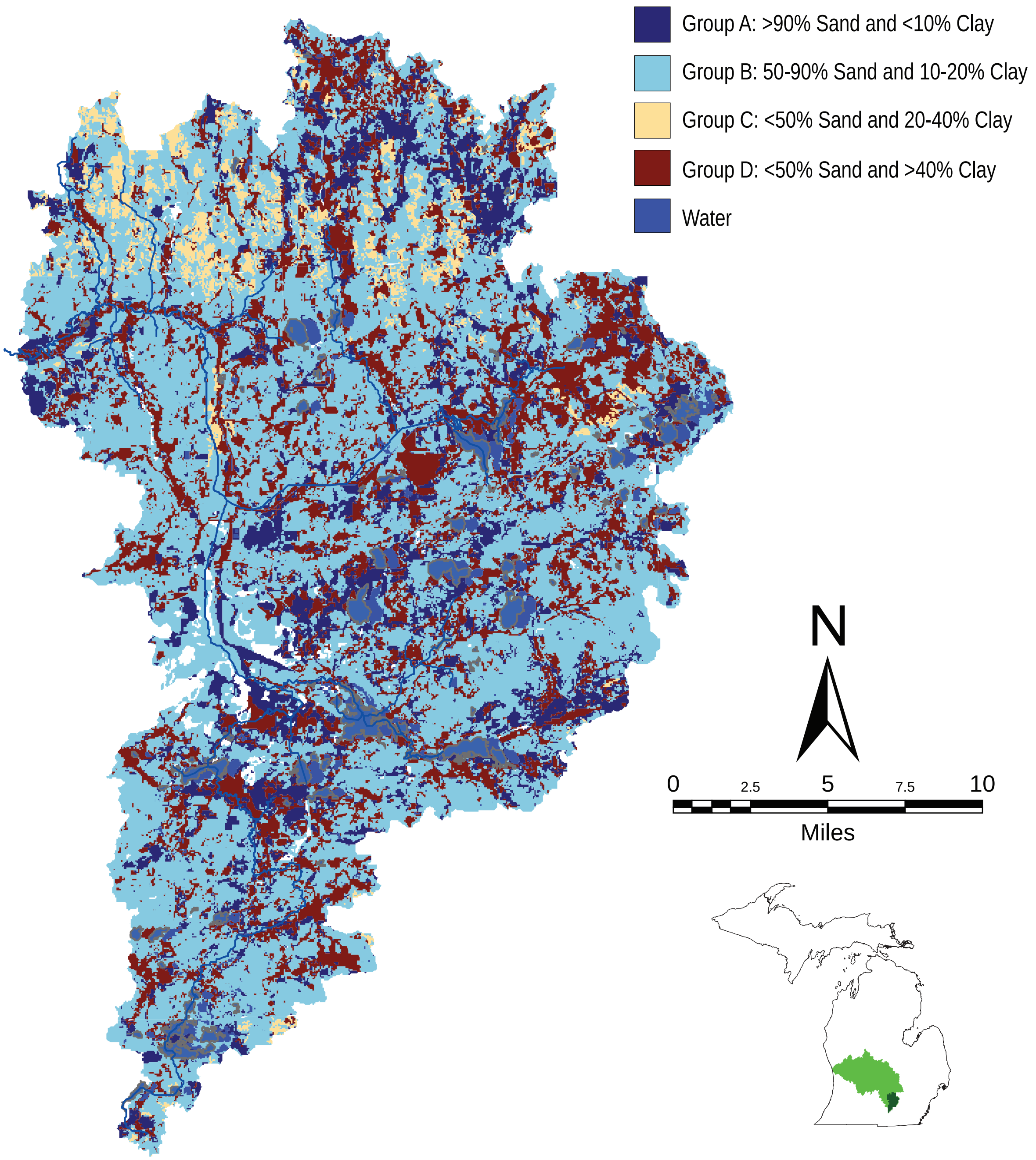

Figure 41.–Distribution of hydrologic soil groups in the headwaters segment. Adapted from Hamilton et al. 2008.

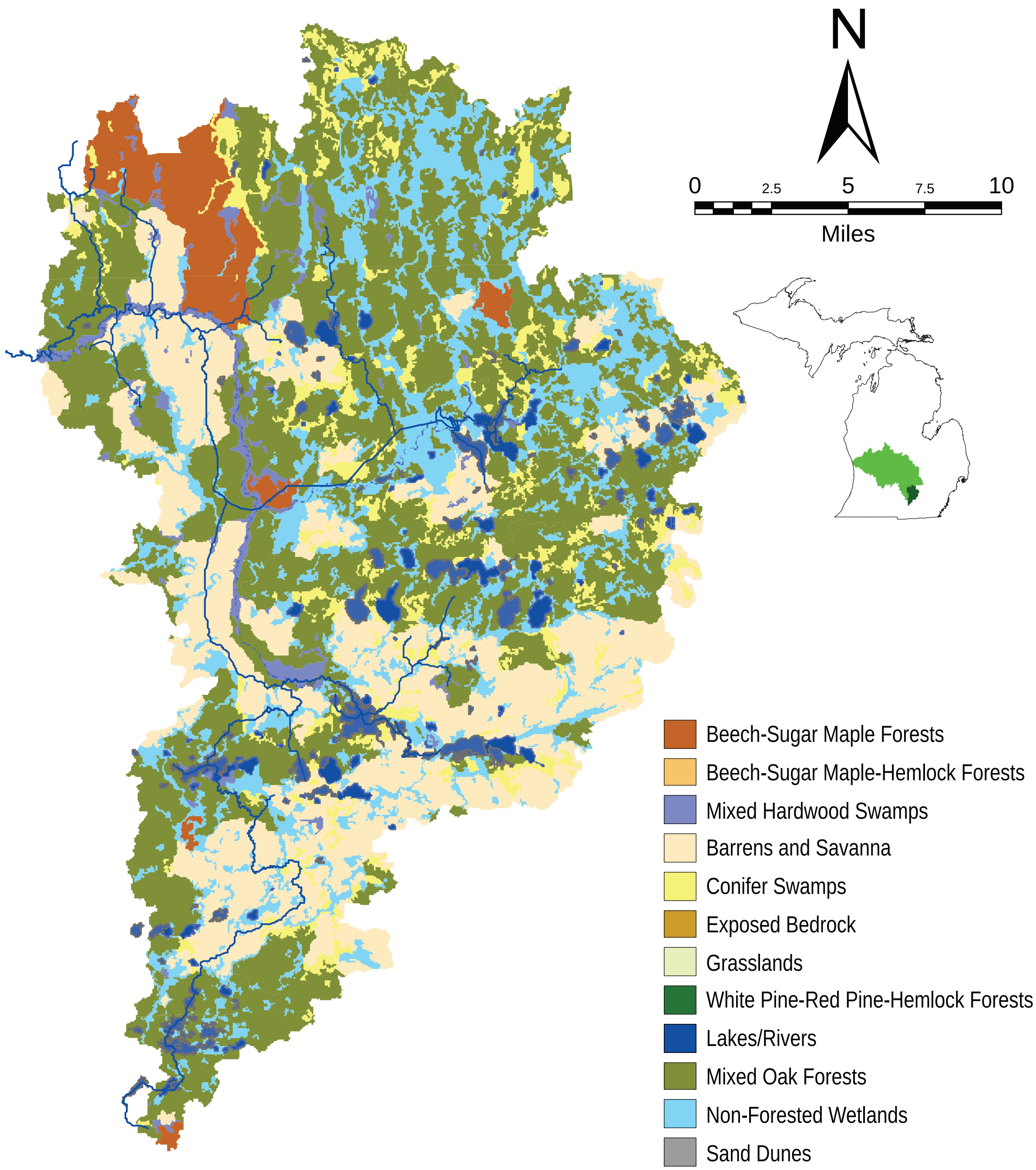

Figure 42.–Distribution of land cover types in the headwaters segment circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

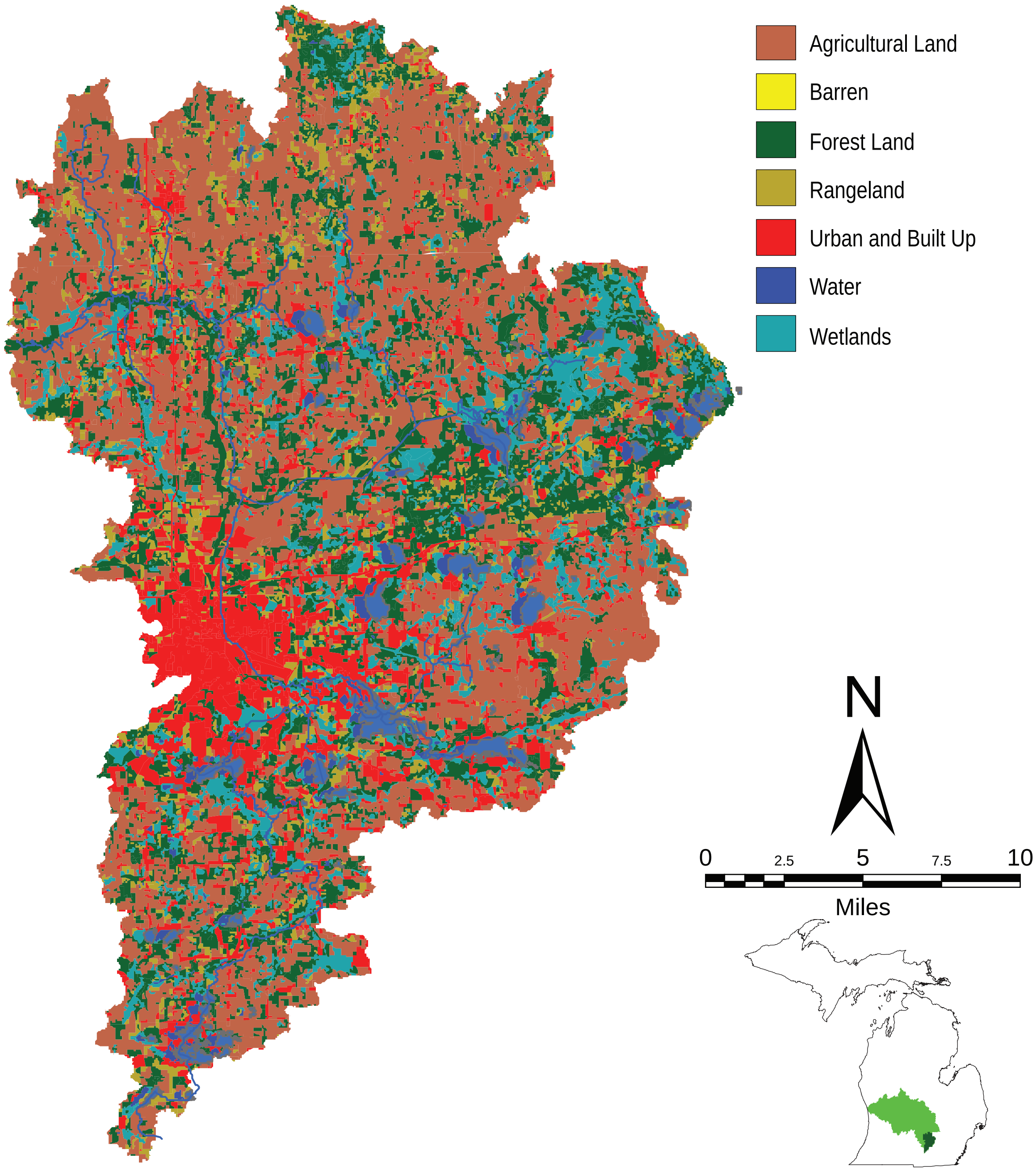

Figure 43.–Distribution of land cover and land use in the headwaters segment of the Grand River watershed. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

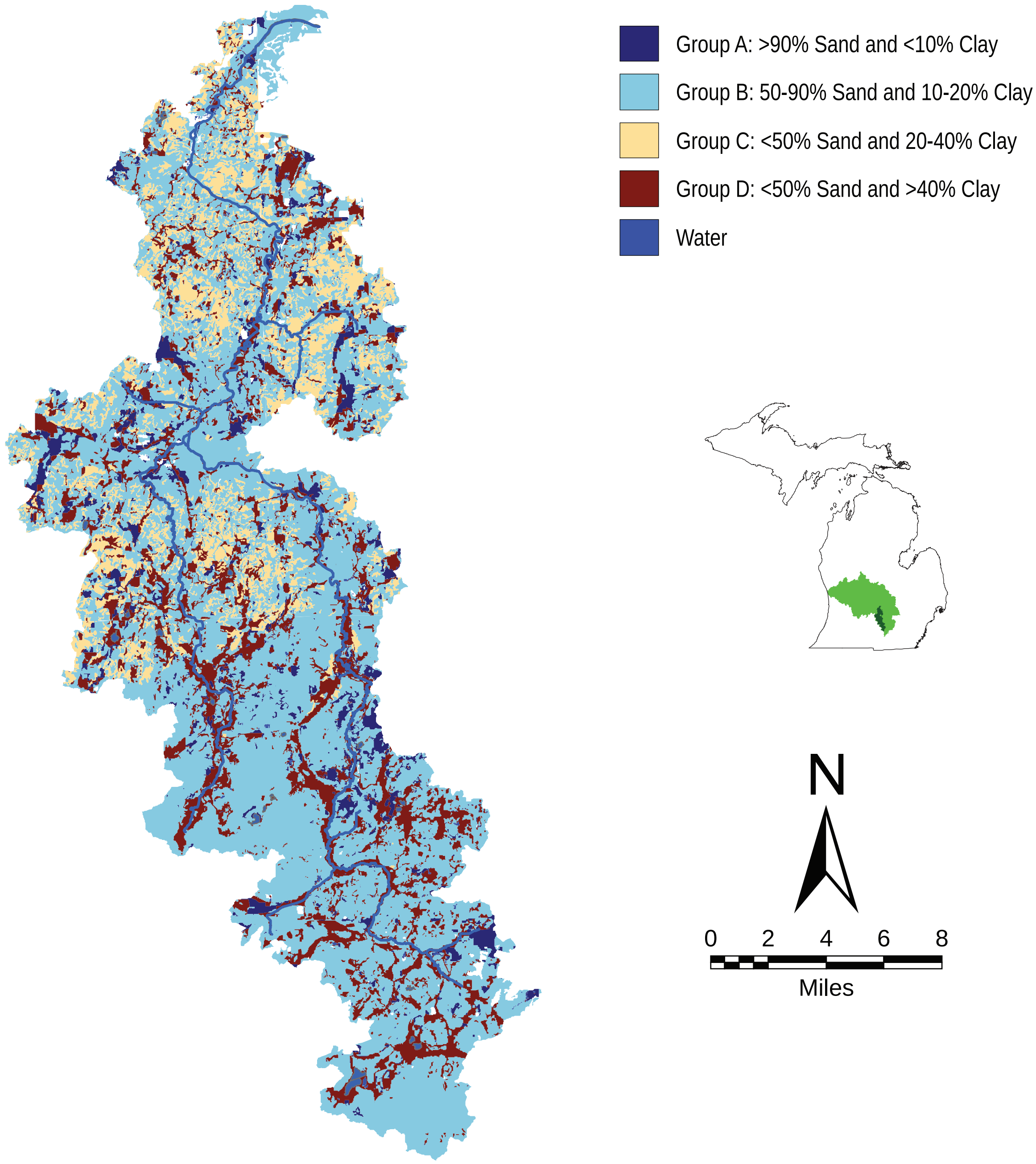

Figure 44.–Distribution of hydrologic soil groups in the upper segment. Adapted from Hamilton et al. 2008.

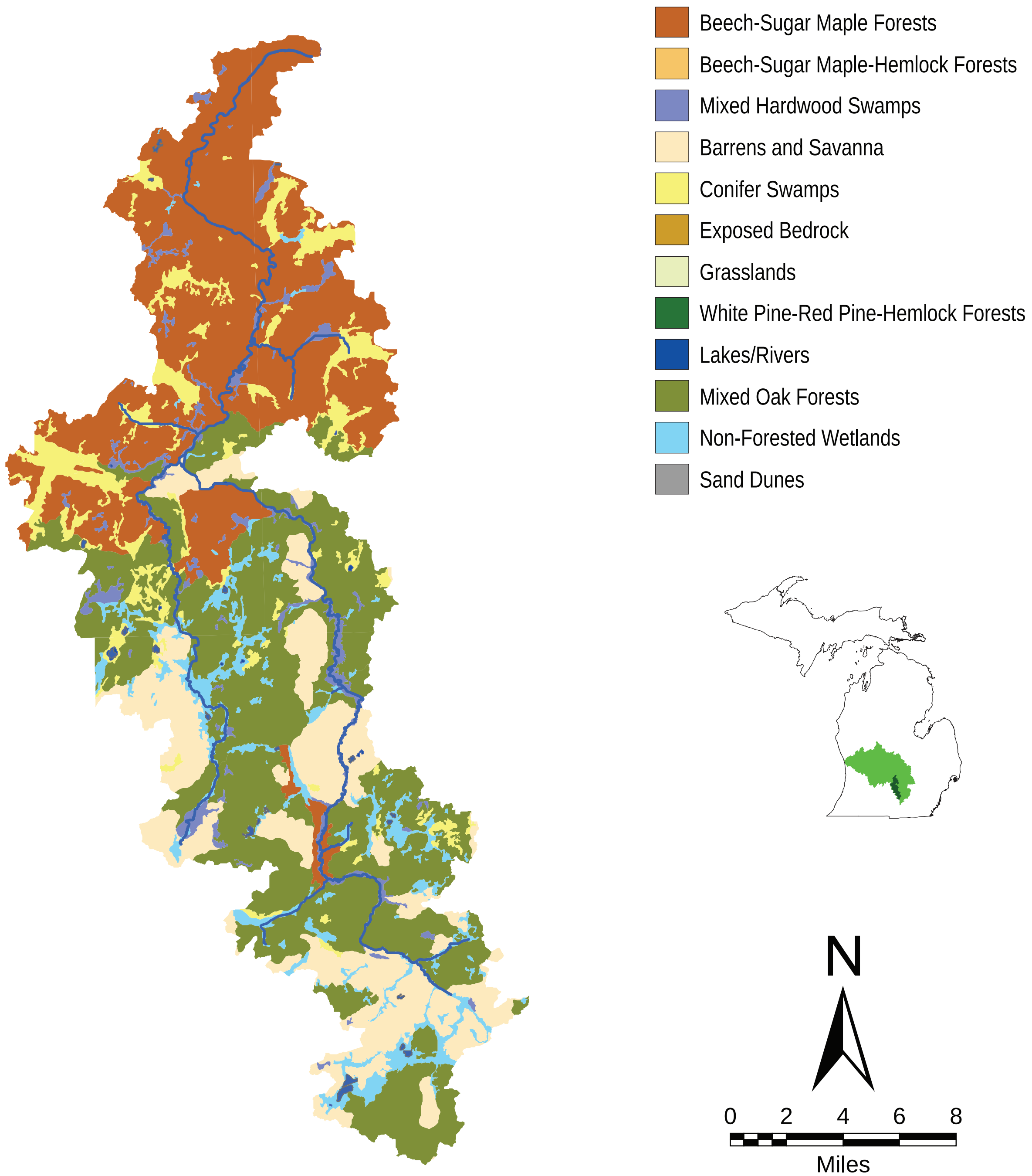

Figure 45.–Distribution of land cover types in the upper segment circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

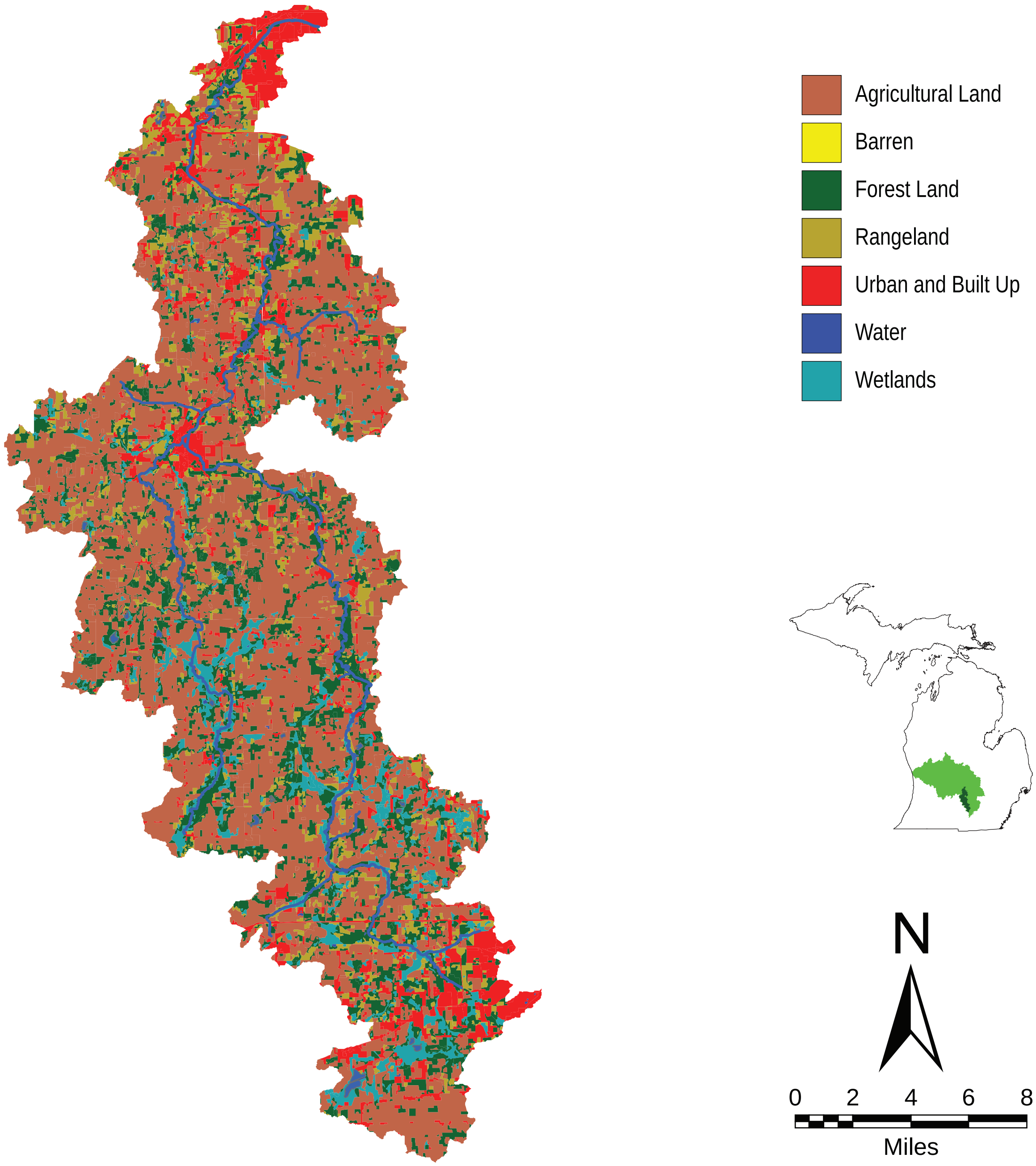

Figure 46.–Distribution of land cover and land use in the upper segment of the Grand River watershed. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

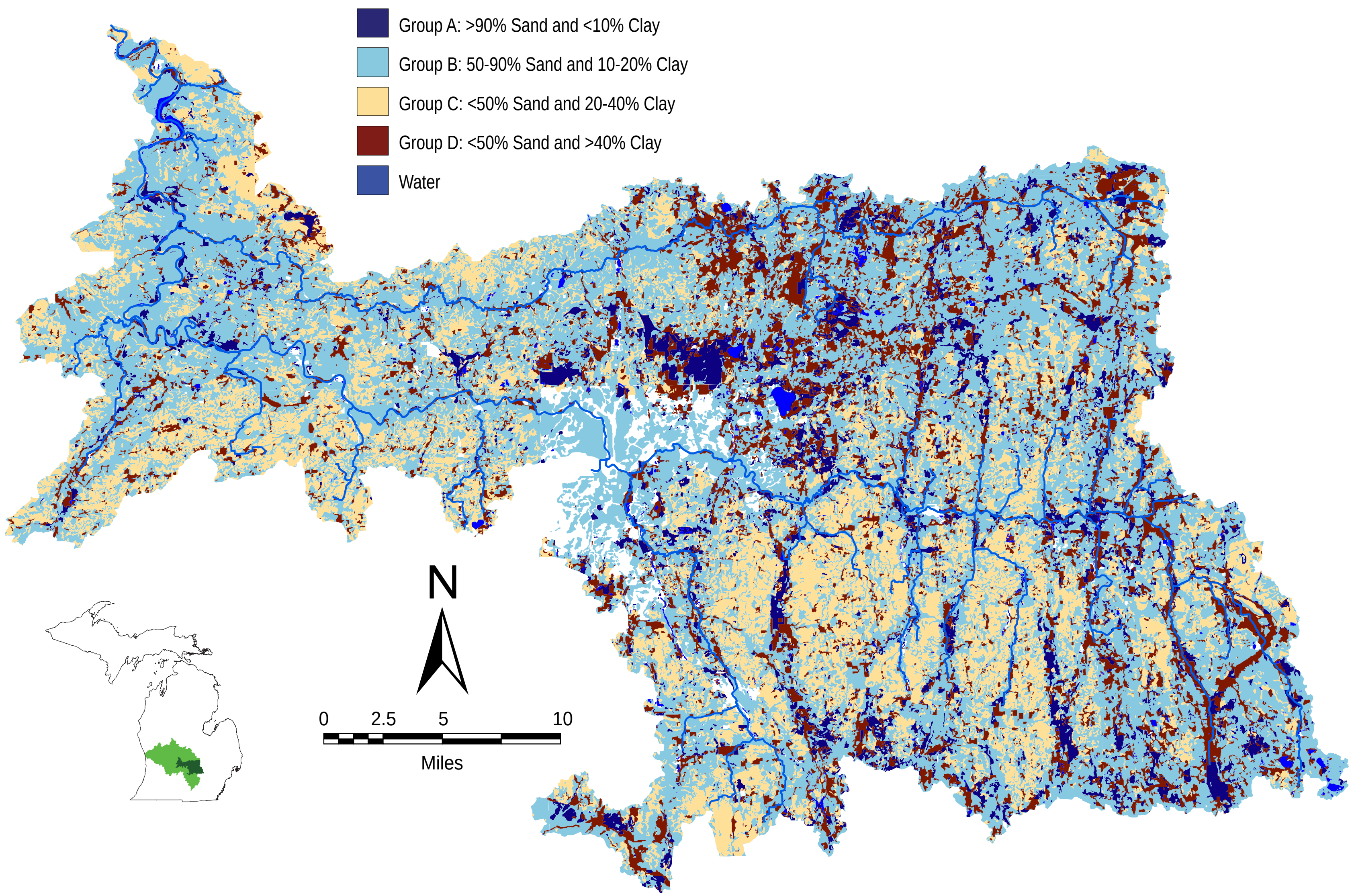

Figure 47.–Distribution of hydrologic soil groups in the middle segment. Adapted from Hamilton et al. 2008.

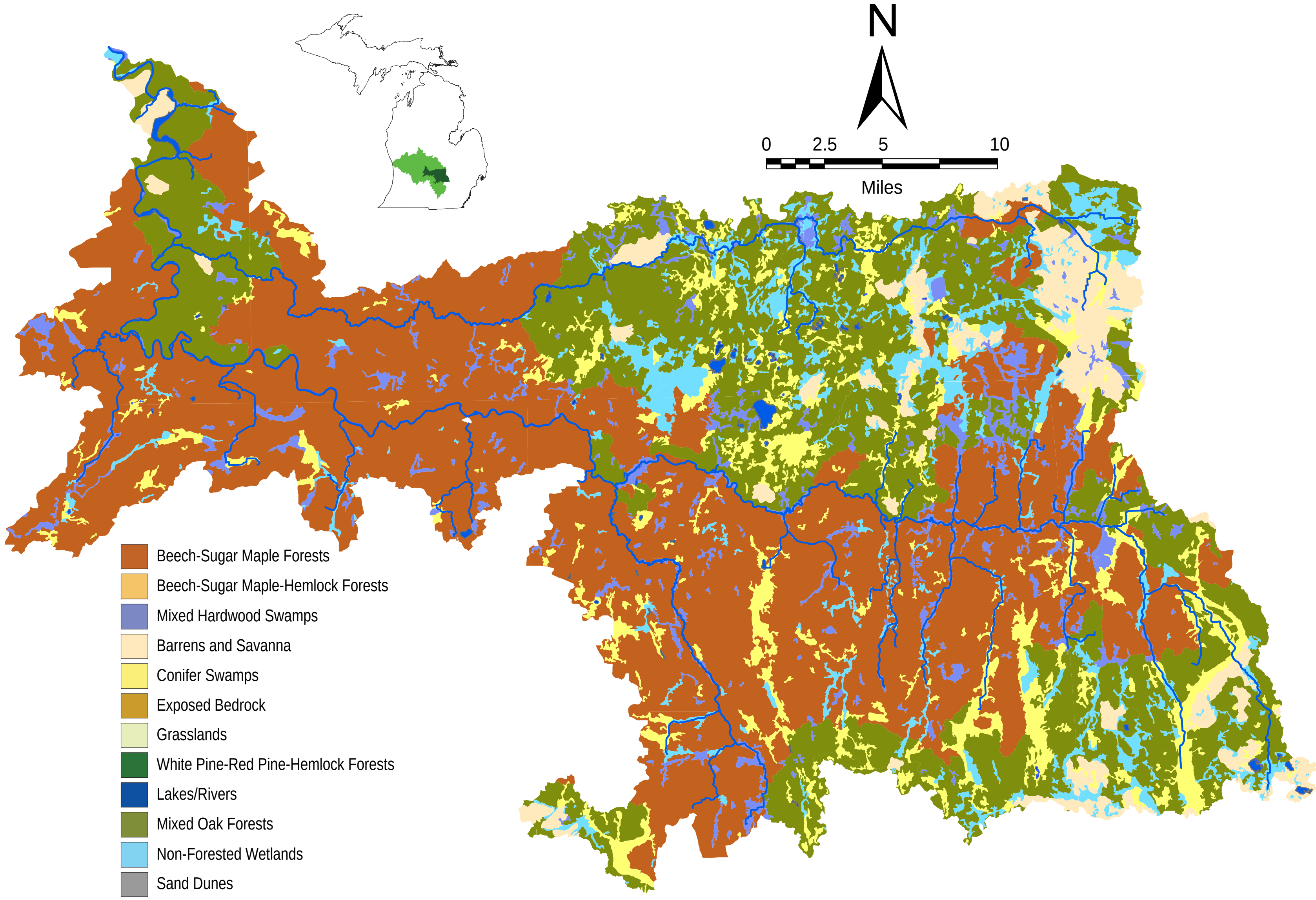

Figure 48.–Distribution of land cover types in the middle segment circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

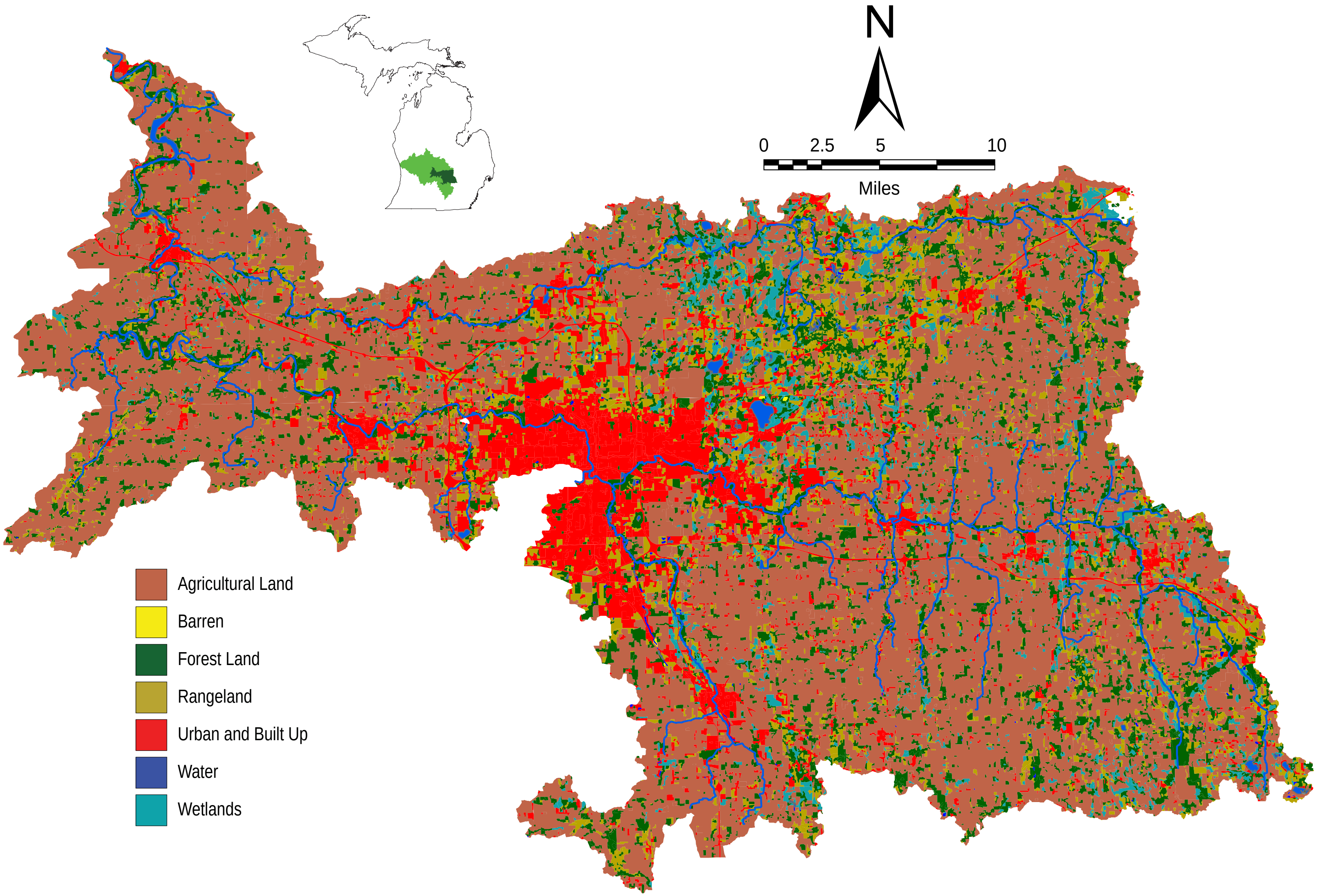

Figure 49.–Distribution of land cover and land use in the middle segment of the Grand River watershed. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

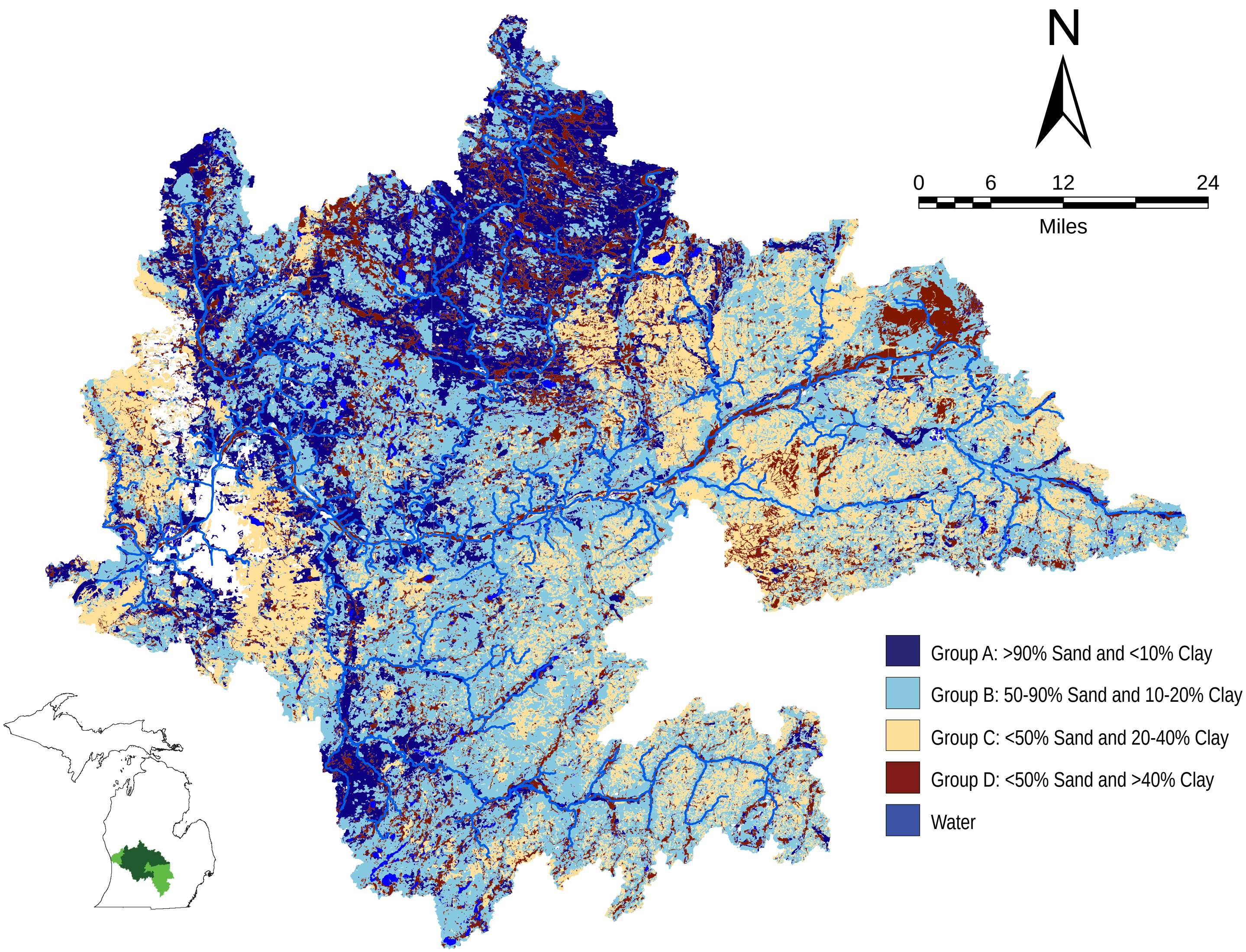

Figure 50.–Distribution of hydrologic soil groups in the lower segment. Adapted from Hamilton et al. 2008.

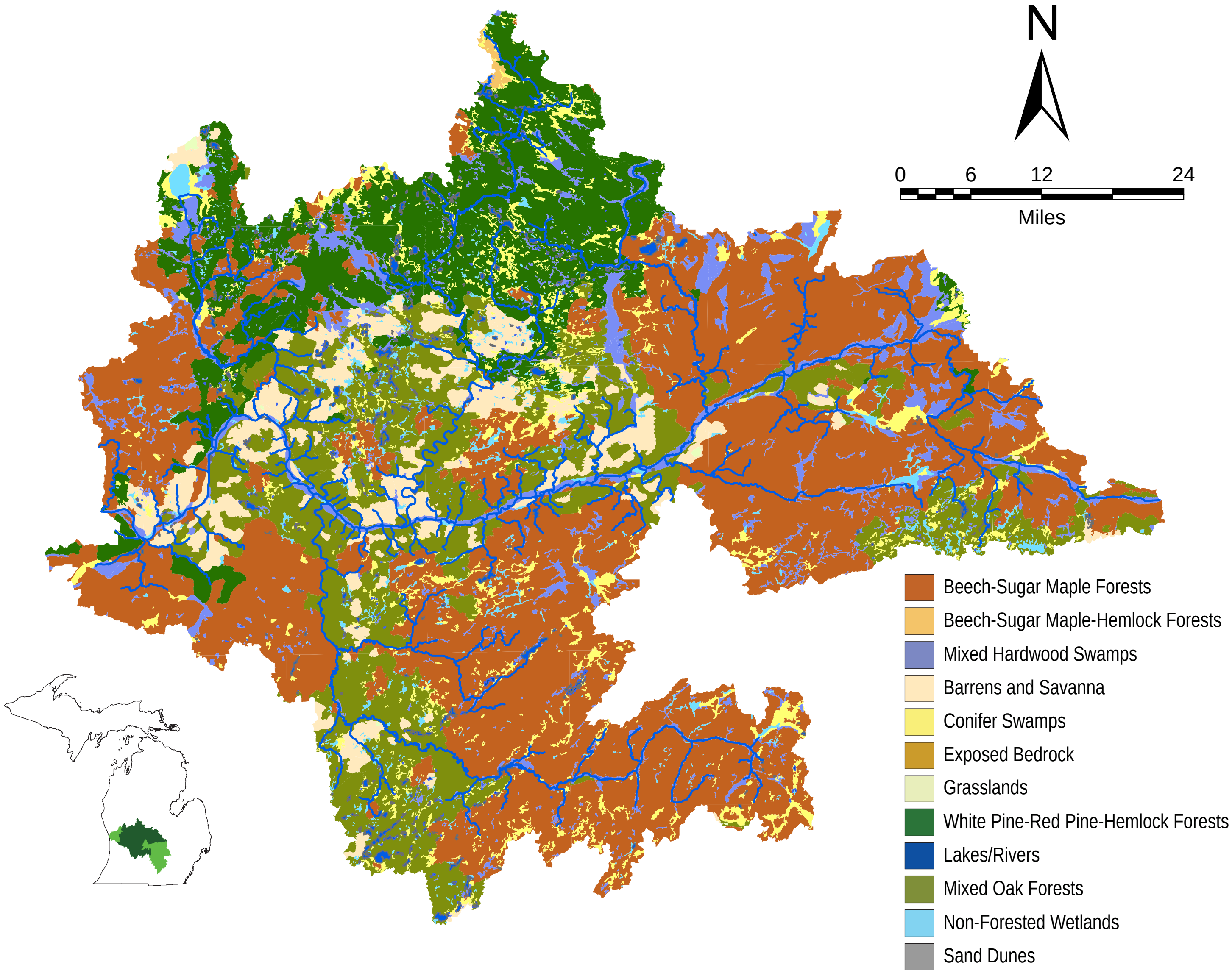

Figure 51.–Distribution of land cover types in the lower segment circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

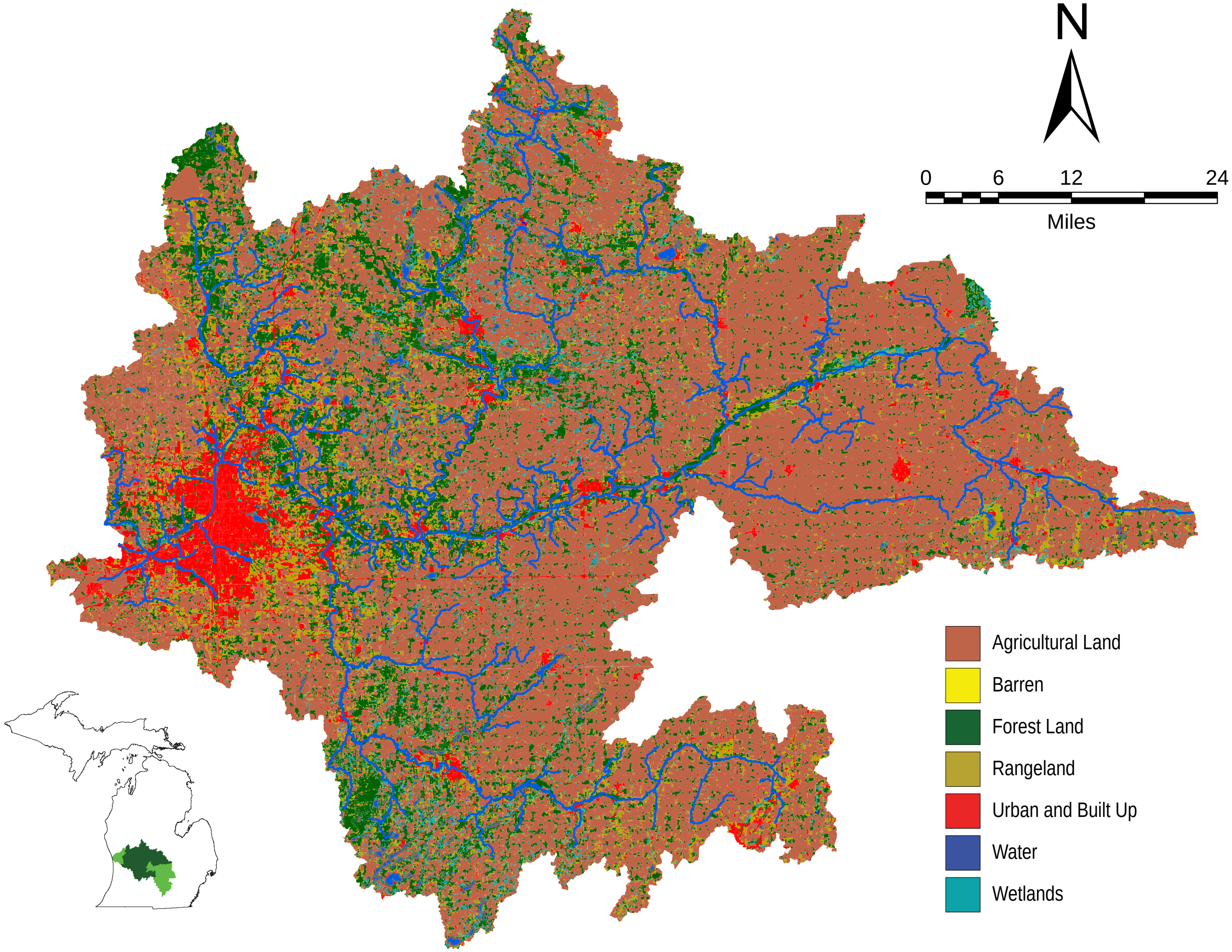

Figure 52.–Distribution of land cover and land use in the lower segment of the Grand River watershed. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

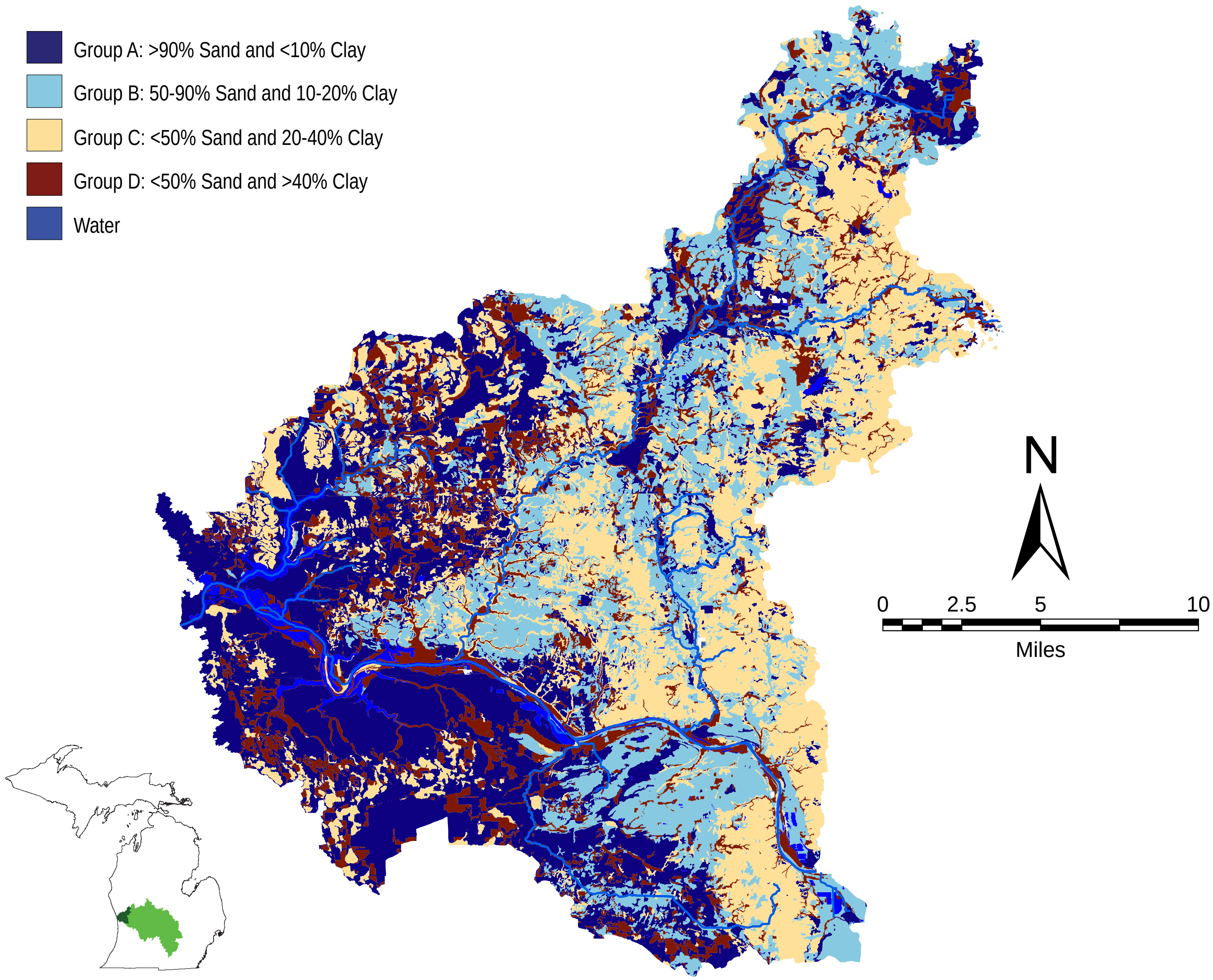

Figure 53.–Distribution of hydrologic soil groups in the mouth segment. Adapted from Hamilton et al. 2008.

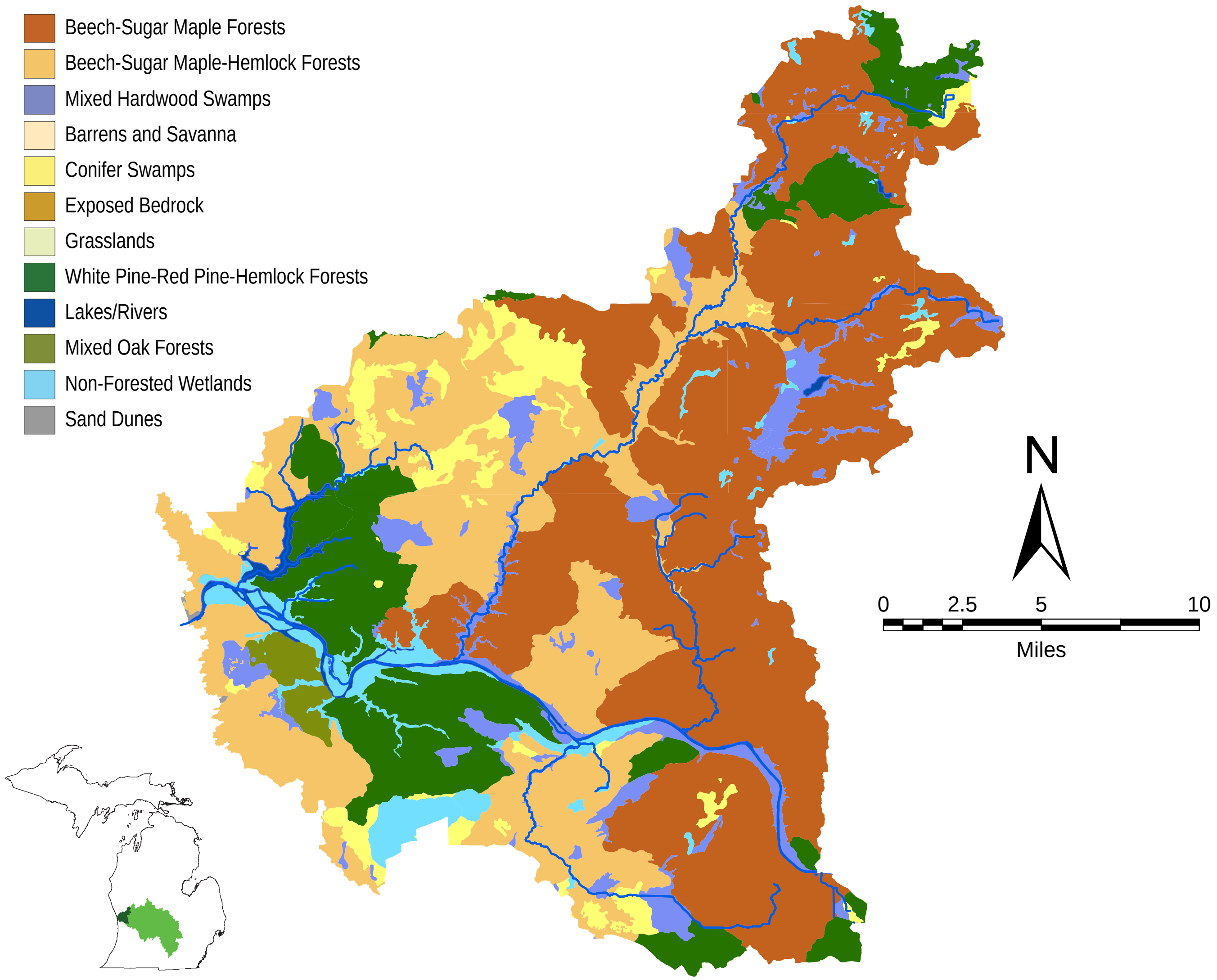

Figure 54.–Distribution of land cover types in the mouth segment circa 1800. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

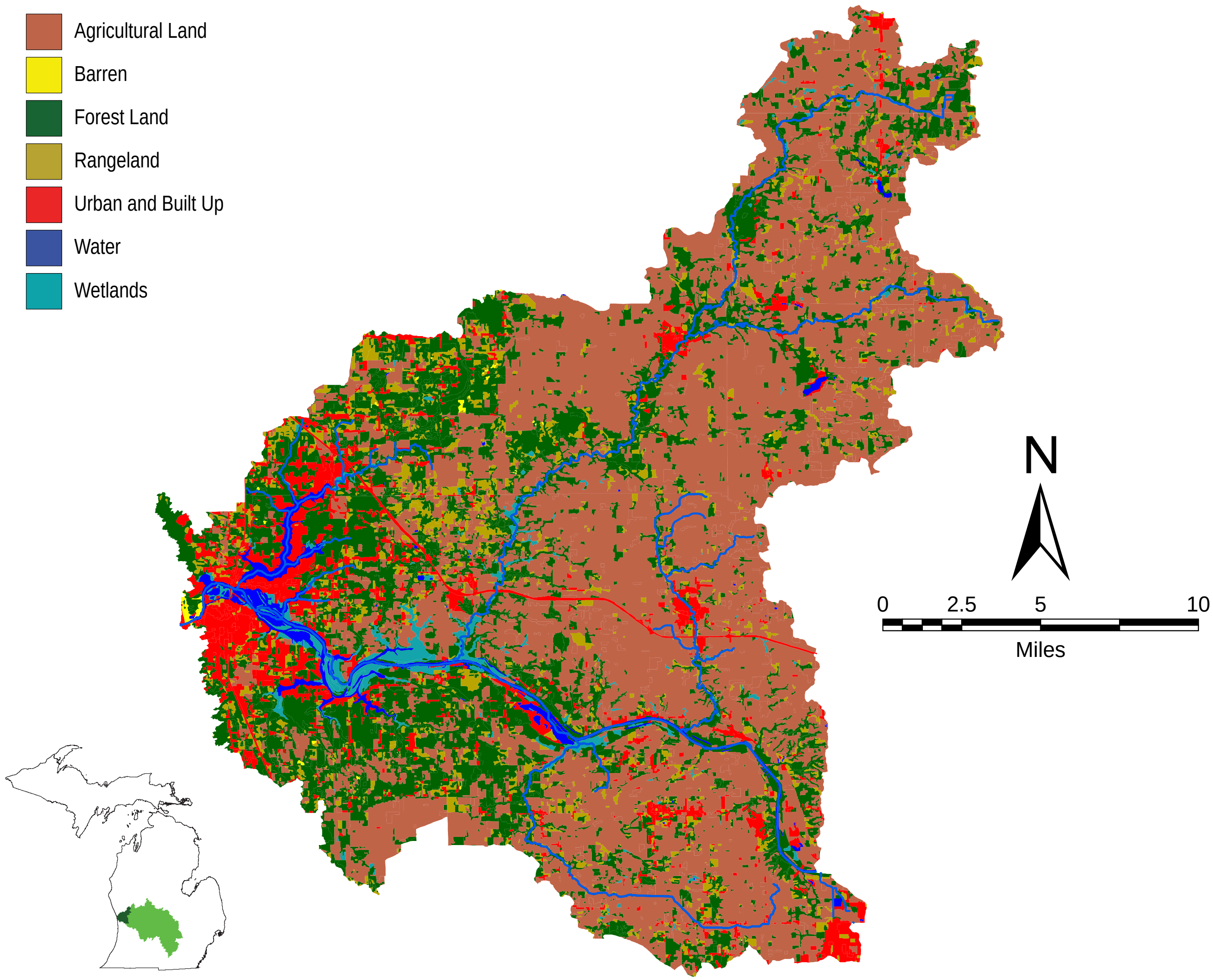

Figure 55.–Distribution of land cover and land use in the mouth segment of the Grand River watershed. Data from Michigan Department of Natural Resources, Michigan Resource Information System, 1978.

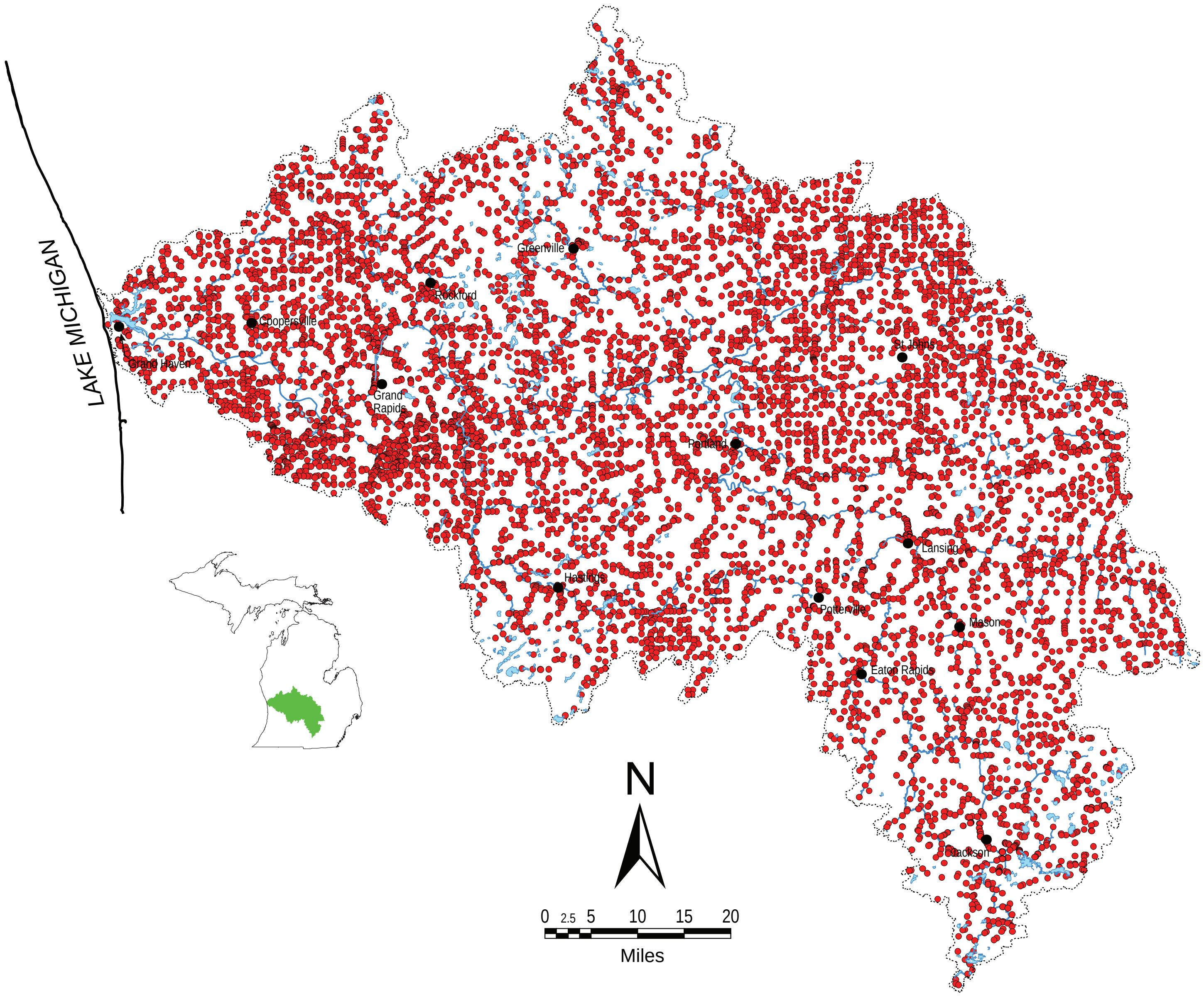

Figure 56.–Road-stream crossings in the Grand River watershed. Data from Michigan Geographic Framework 2009.

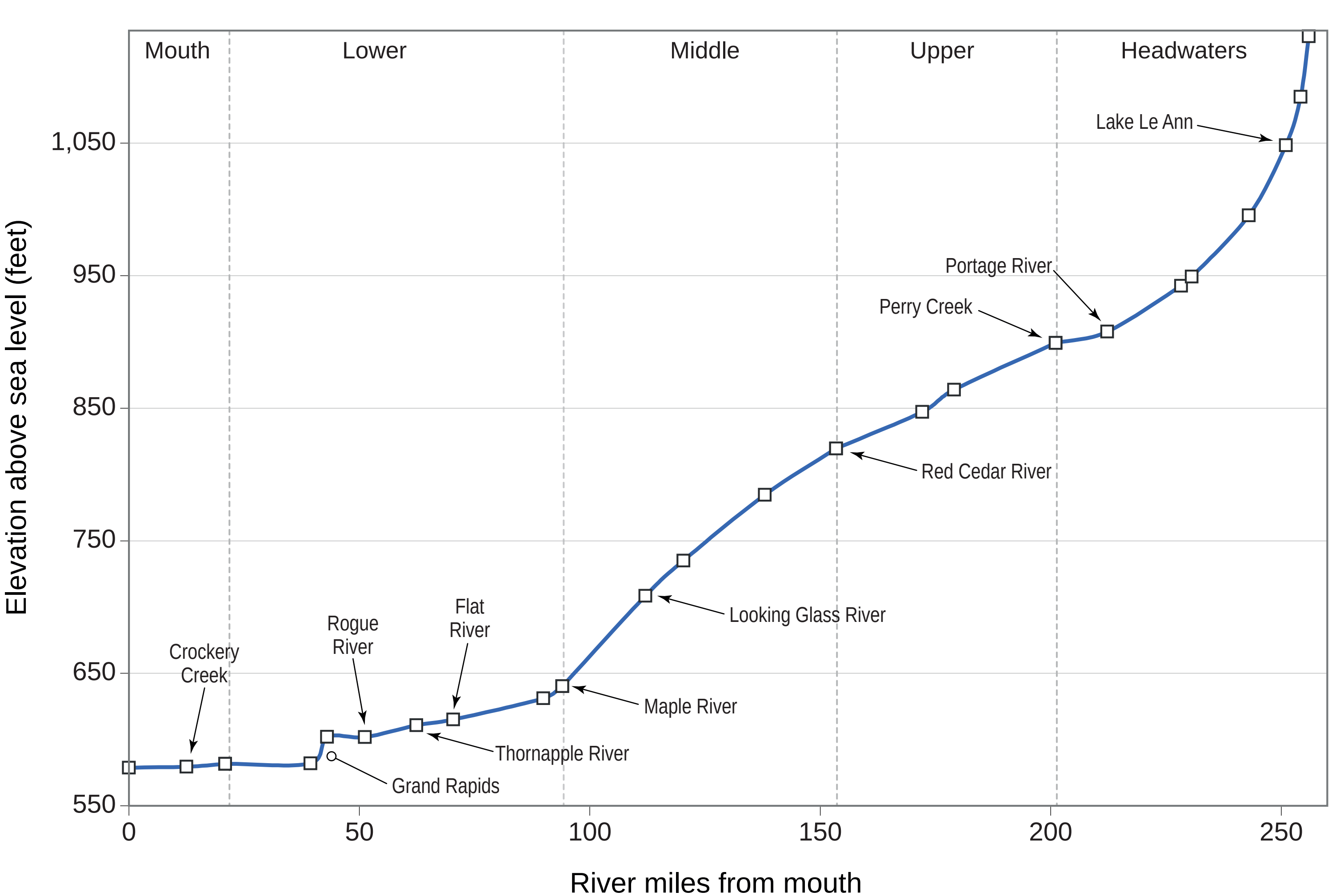

Figure 57.–Grand River main stem elevation changes from Lake Michigan to headwaters. Source: Michigan Department of Natural Resources, unpublished data.

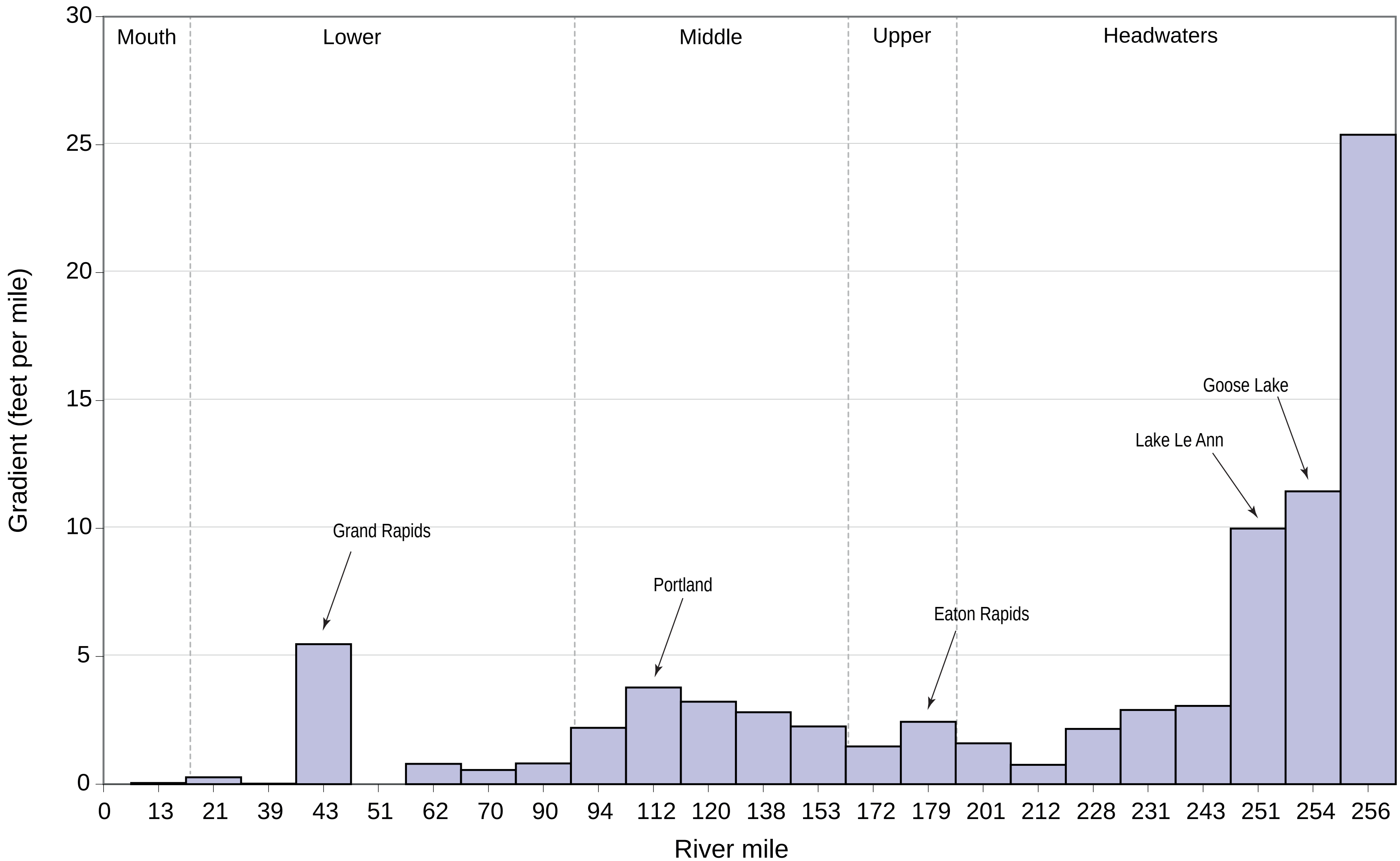

Figure 58.–Gradient (elevation change in feet per mile) of the Grand River main stem from Lake Michigan to headwaters. Source: Michigan Department of Natural Resources, unpublished data.

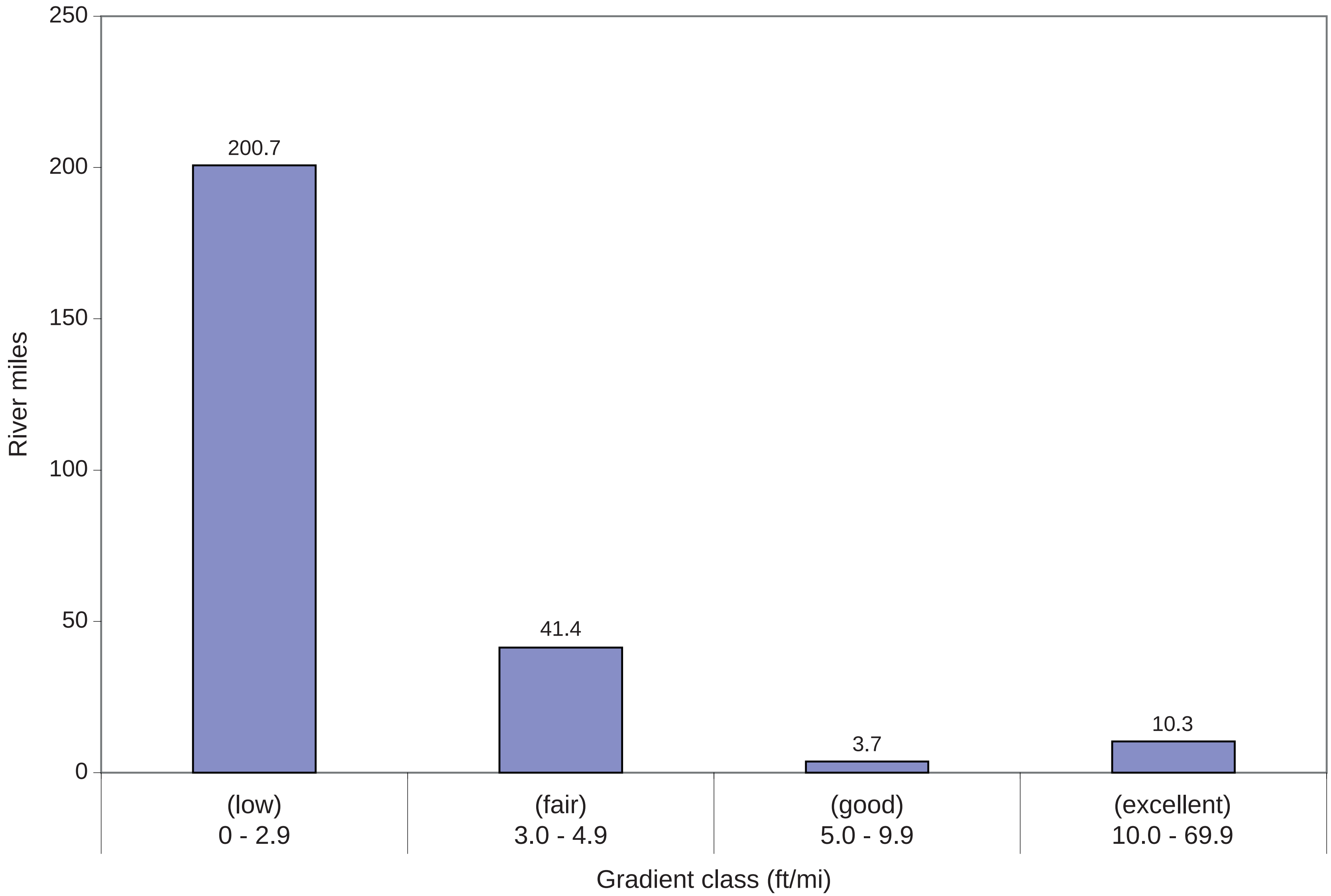

Figure 59.–River miles within each gradient class (expressed as feet per mile) of the Grand River main stem. Source: Michigan Department of Natural Resources, unpublished data.

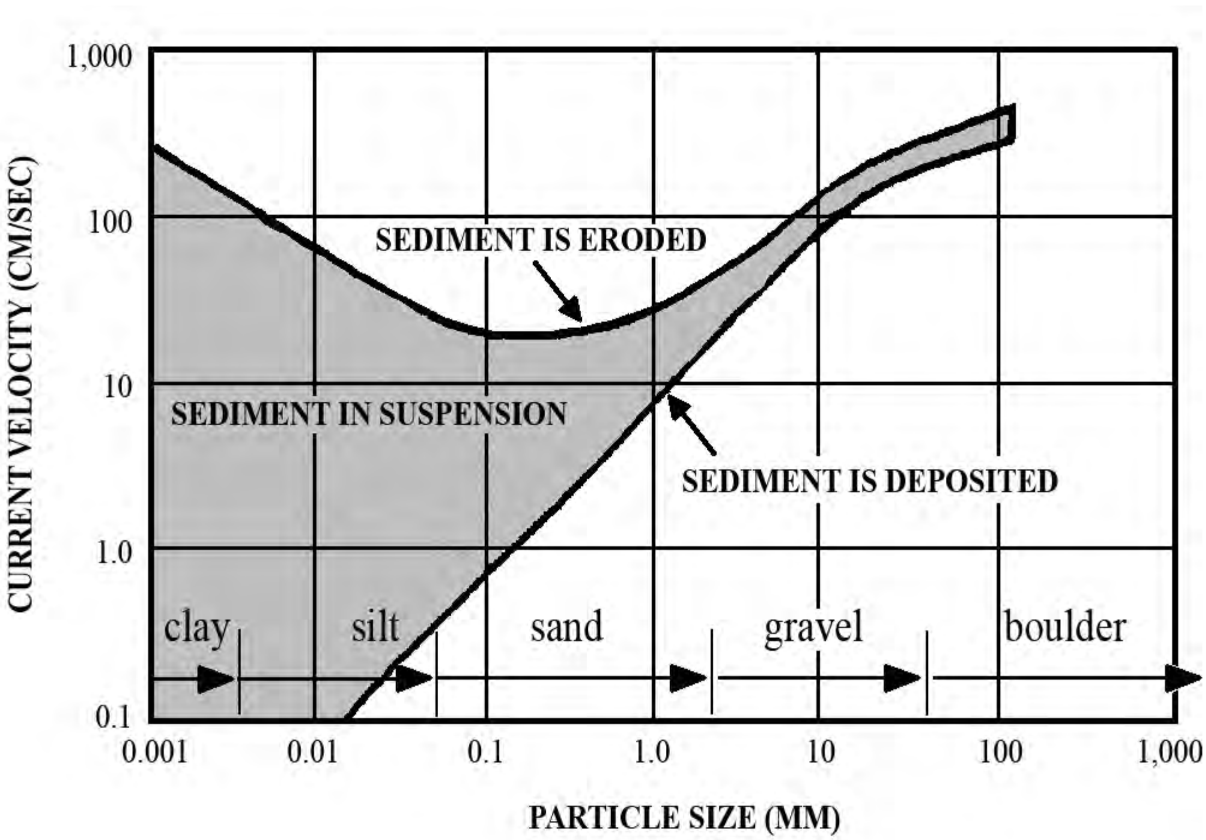

Figure 60.–Relation of mean current velocity (cm/sec) water to particle size (mm) that can be eroded and transported in suspension. Sediment deposition occurs at lower current velocities required for erosion of a particle of a given size (Adapted from Morisawa, 1968; reprinted by permission by TOMWC 2007.)

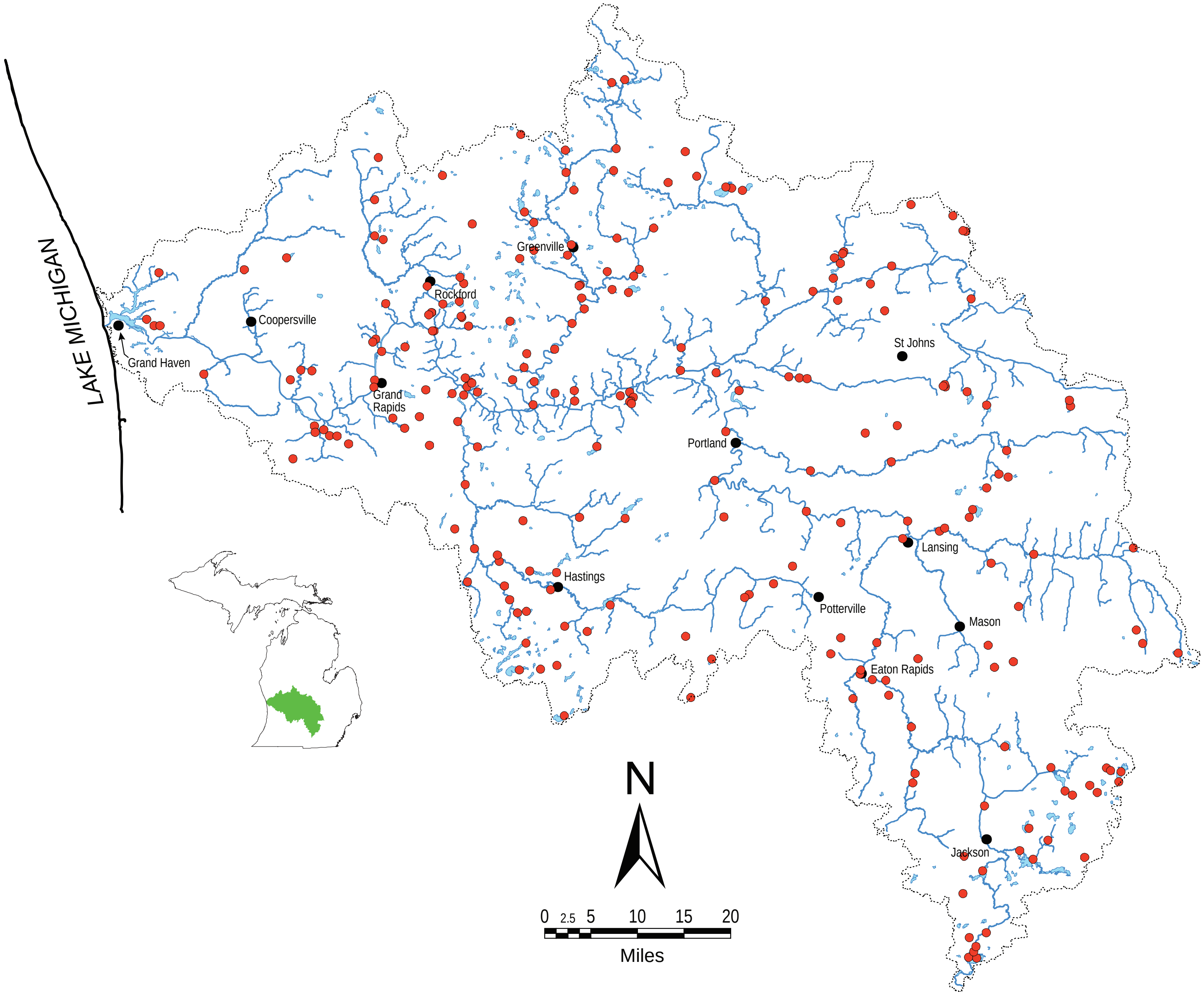

Figure 61.–Approximate location of the 228 registered dams in the Grand River watershed. Source: Michigan Department of Environmental Quality, unpublished data.

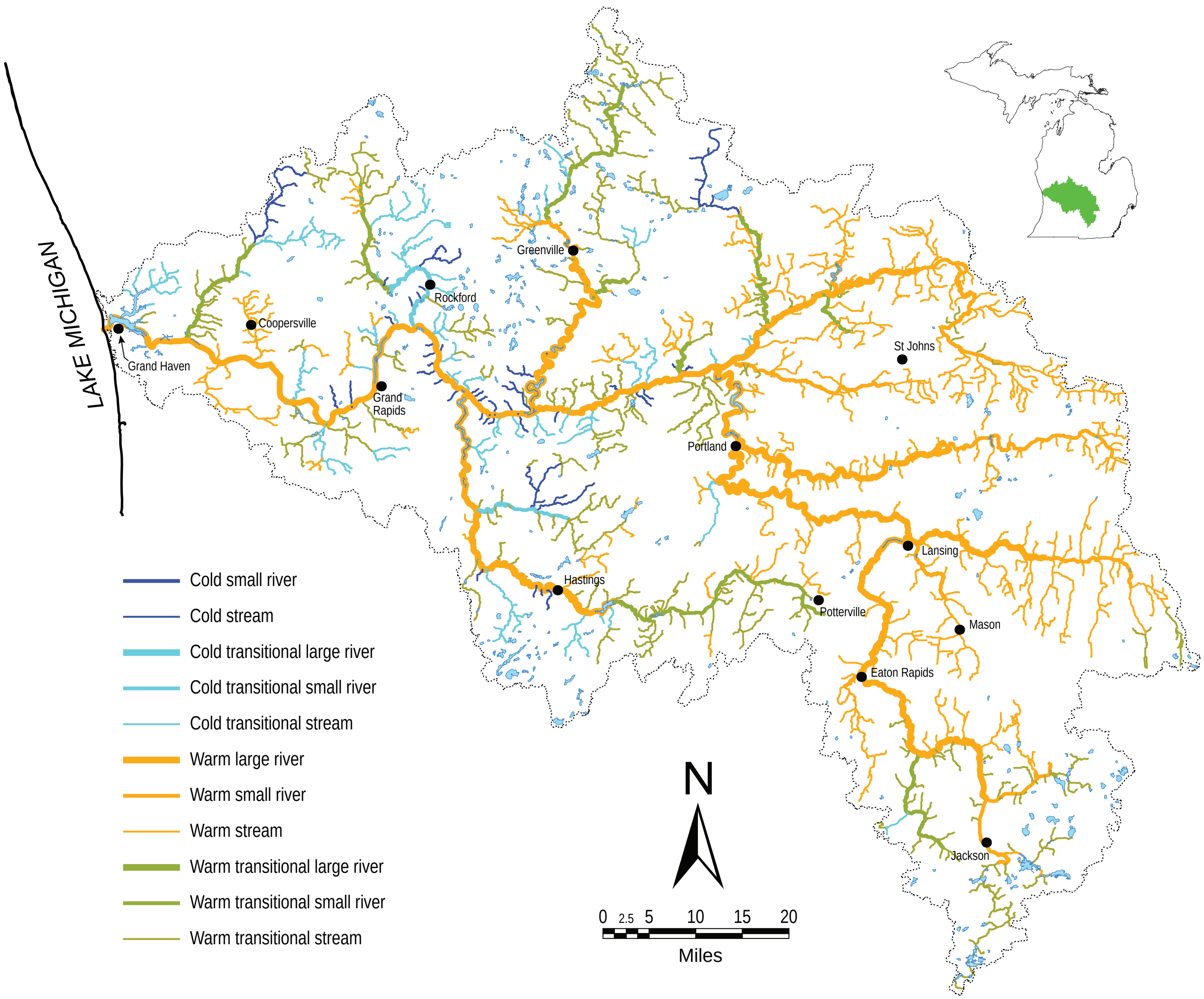

Figure 62.–Thermal classification of the Grand River main stem and tributaries. Data from Zorn et al. 2008.

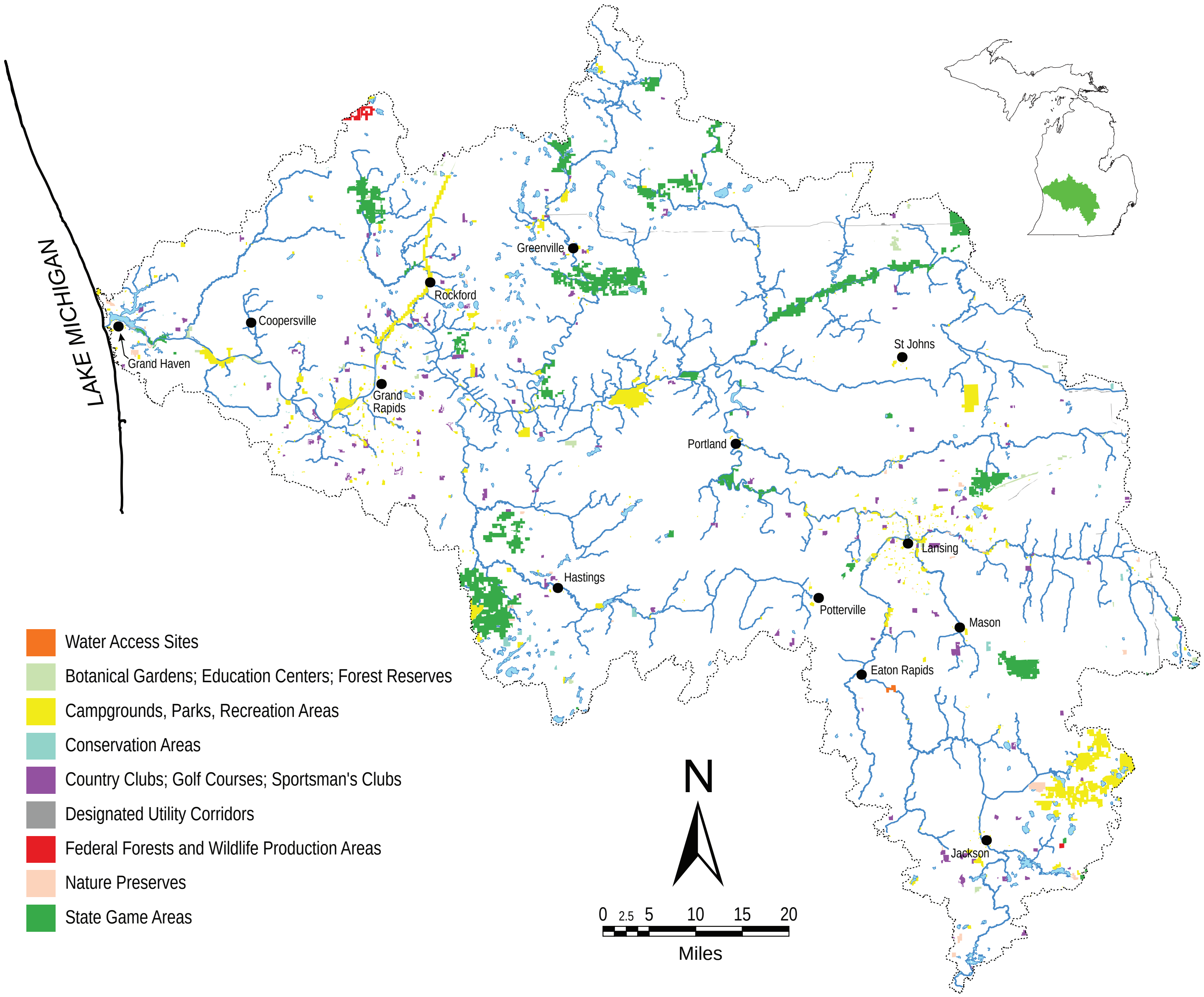

Figure 63.–Conservation and recreational lands in the Grand River watershed. Data from the Conservation and Recreational Lands Database (CARL 2008).

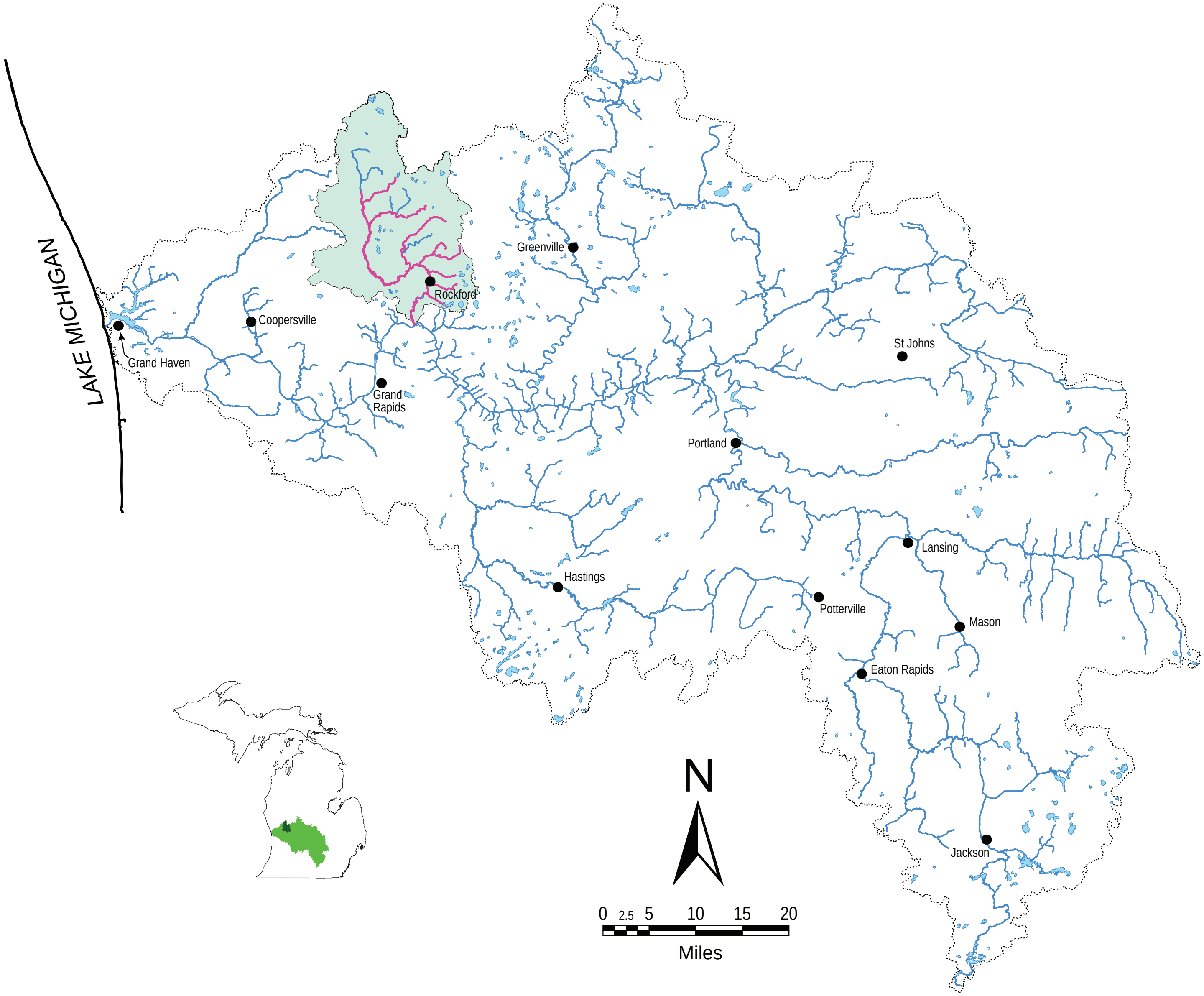

Figure 64.–Portions of the Rogue River watershed designated as Country-Scenic in the Rogue River Natural River District. Source: Michigan Department of Natural Resources Fisheries Division.

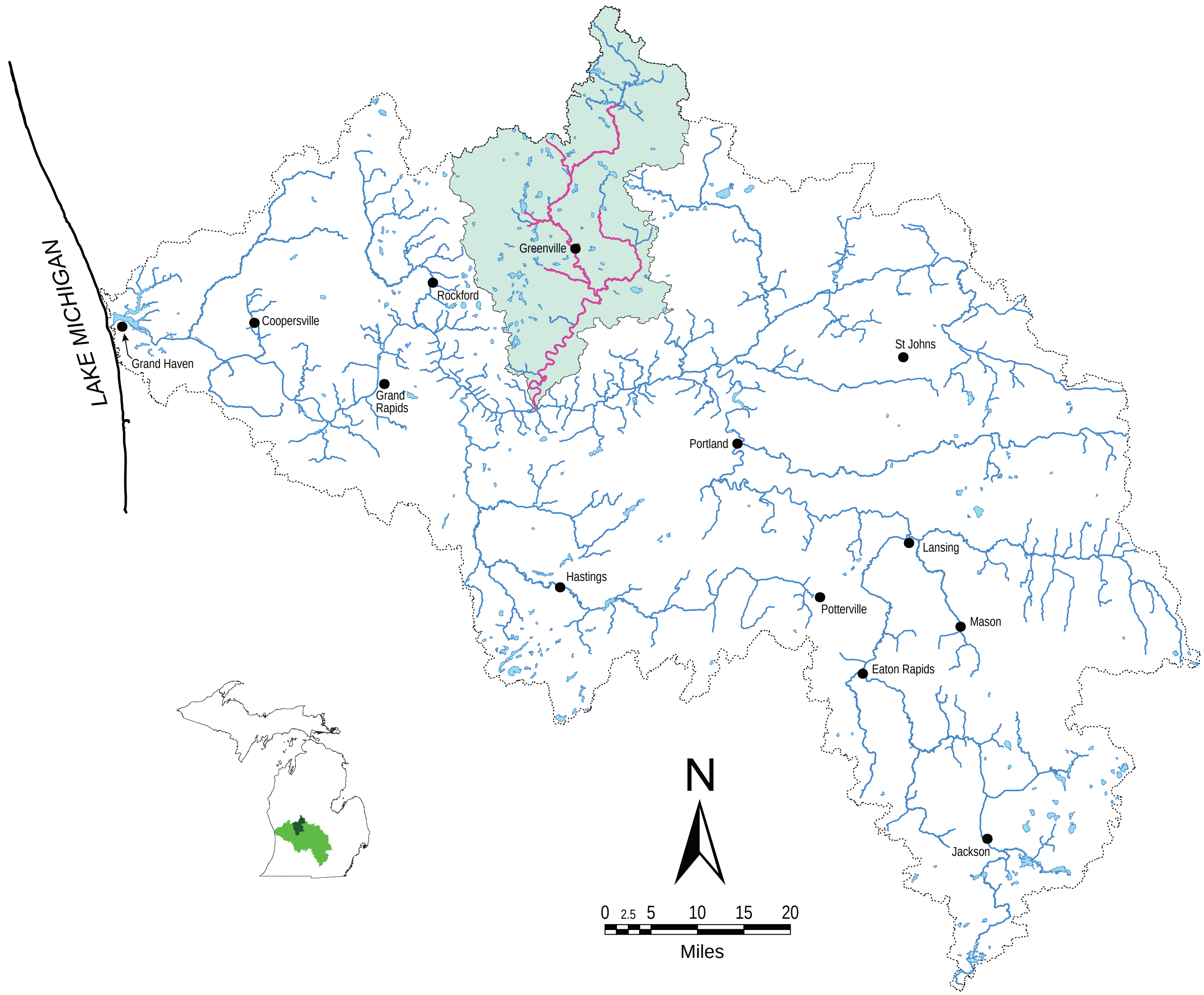

Figure 65.–Portions of the Flat River watershed designated as Country-Scenic in the Flat River Natural River District. Source: Michigan Department of Natural Resources Fisheries Division.

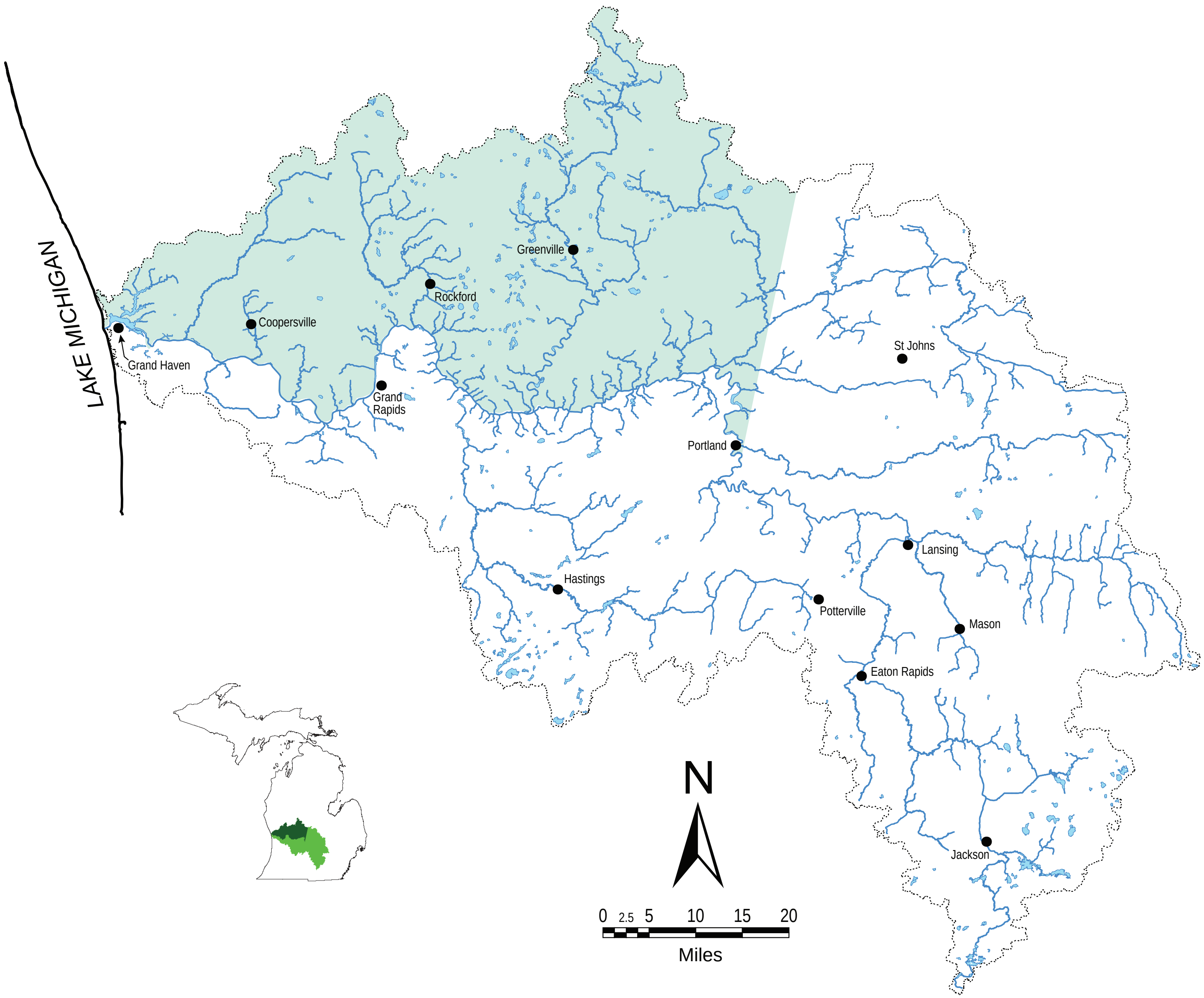

Figure 66.–Portions of the Grand River watershed within the ceded territory described by the 1836 Treaty of Washington. Shaded areas are subject to the provisions and agreements contained in the 2007 Inland Consent Decree (United States v State of Michigan 2007).

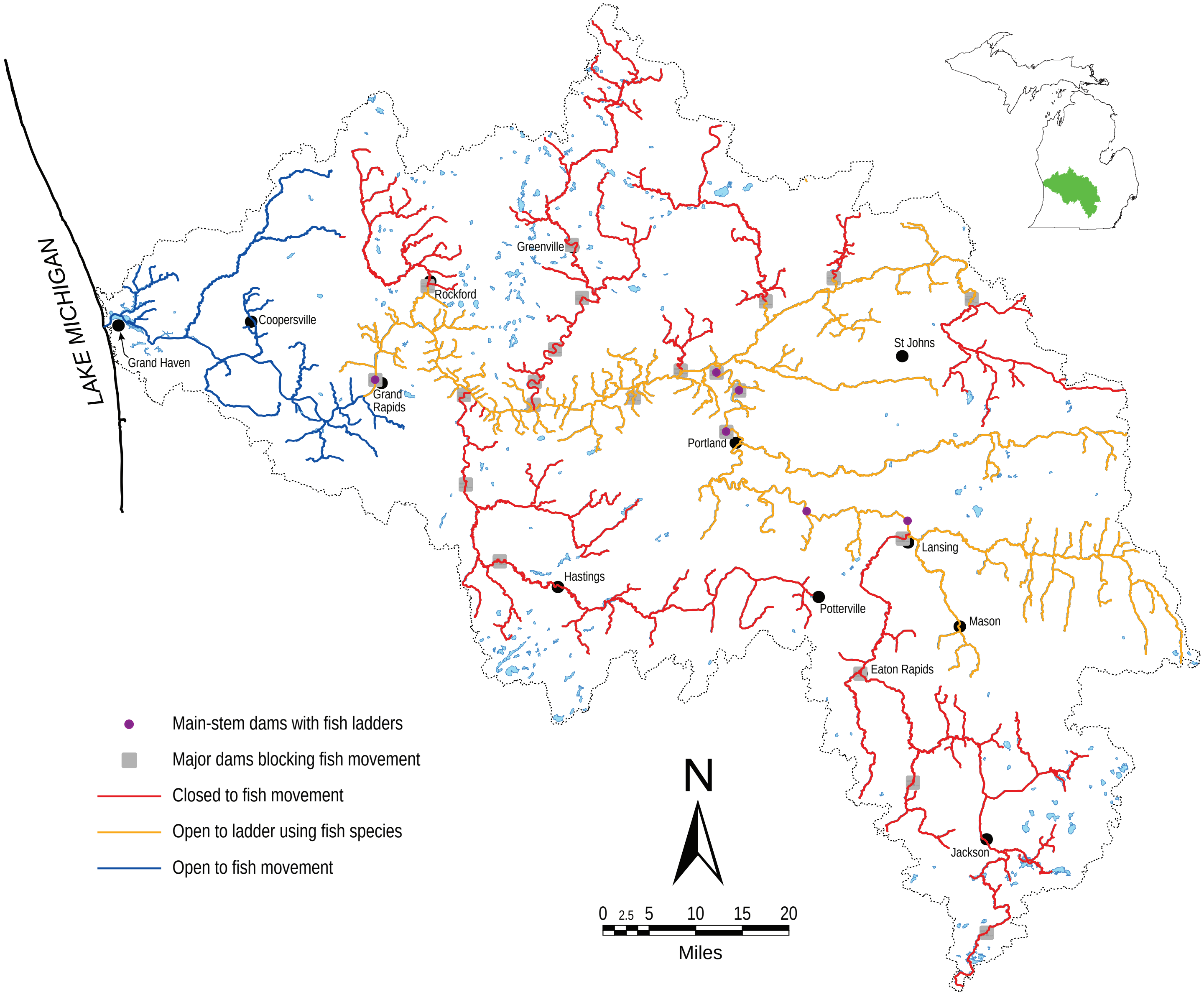

Figure 67.–Graphic illustration of the high degree of fragmentation on the Grand River watershed. Stream channels identified by blue lines are open to unimpeded fish movement, orange lines represent streams open to the movement of ladder using species (e.g., salmon, steelhead), red line represent portion of watershed isolated from the main stem Grand River and Lake Michigan.

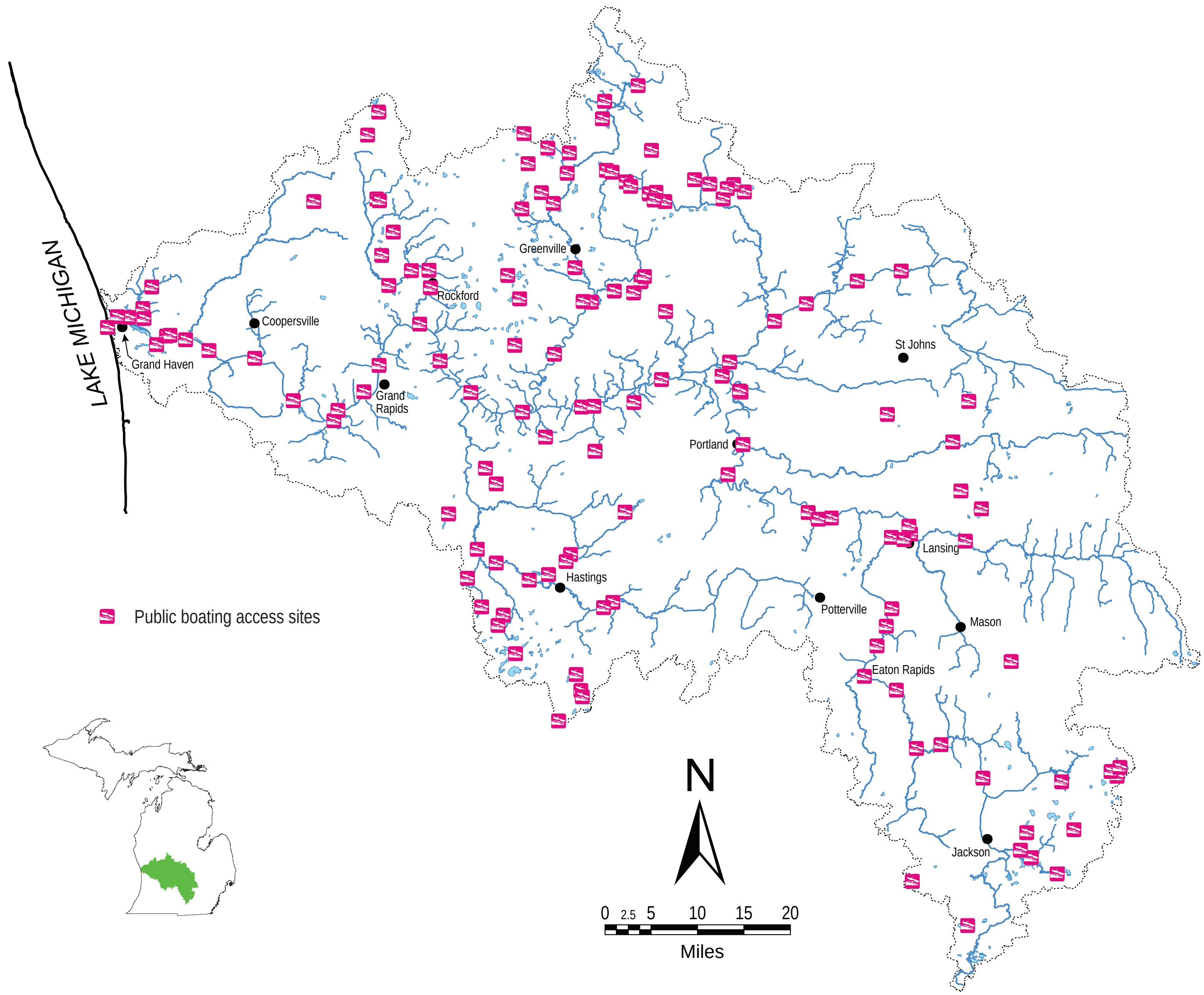

Figure 68.–Public boating access sites in the Grand River watershed. Data from the Michigan Department of Natural Resources, Michigan Recreational Boating Information System (MRBIS).

TABLES

Table 1.–Name, size and location of lakes 10 acres or greater in the Grand River watershed (alphabetical by county).

Segment	Lake	County	Latitude	Longitude	Surface acres
Headwaters	Braxee Lake	Hillsdale	42.06582	-84.45787	28.7
	Crystal Lake	Hillsdale	42.06416	-84.41204	129.6
	Goose Lake	Hillsdale	42.03943	-84.45843	83.2
	Lake Le Ann (North)	Hillsdale	42.06966	-84.43147	199.0
	Lake Le Ann (South)	Hillsdale	42.06055	-84.43363	267.7
	No Name	Hillsdale	42.03933	-84.43353	38.6
	Perch Lake	Hillsdale	42.05860	-84.41259	45.6
	Hewes Lake	Ingham	42.52332	-84.33815	12.6
	Huntoon Lake	Ingham	42.47249	-84.38565	37.5
	Jacobs Lake	Ingham	42.45749	-84.21398	14.0
	Standish Lake	Ingham	42.47749	-84.22732	11.6
	Ackerson Lake	Jackson	42.18666	-84.34926	187.1
	Bartig Lake	Jackson	42.38145	-84.22217	22.5
	Batteese Lake	Jackson	42.39860	-84.32370	106.6
	Berry Lake	Jackson	42.37138	-84.39648	23.2
	Brill Lake	Jackson	42.28721	-84.29898	136.4
	Brown Lake	Jackson	42.18777	-84.41954	146.1
	Center Lake	Jackson	42.22810	-84.32525	846.9
	Clear Lake	Jackson	42.33221	-84.14759	129.5
	Cove Lake	Jackson	42.19388	-84.40981	18.2
	Cranberry Lake	Jackson	42.17749	-84.33704	97.0
	Crispell Lake	Jackson	42.11304	-84.44370	86.1
	Dollar Lake	Jackson	42.19582	-84.28259	17.3
	Eagle Lake	Jackson	42.32388	-84.29398	48.0
	Flinton Lake	Jackson	42.18110	-84.43870	18.7
	Gilletts Lake	Jackson	42.26610	-84.31231	334.3
	Goose Lake	Jackson	42.28249	-84.25287	370.2
	Grand Lake	Jackson	42.08416	-84.42176	49.1
	Grass Lake	Jackson	42.26110	-84.21704	352.9
	Green Lake	Jackson	42.17277	-84.36065	16.6
	Leeke Lake	Jackson	42.39110	-84.14204	12.2
	Leoni Mill Pond	Jackson	42.24445	-84.26629	31.1
	Little Cranberry Lake	Jackson	42.17638	-84.33079	11.3
	Little Olcott Lake	Jackson	42.19388	-84.27926	29.0
	Little Portage Lake	Jackson	42.35221	-84.22037	89.5
	Little Wolf Lake	Jackson	42.19221	-84.22593	109.0
	Locker Lake	Jackson	42.31054	-84.15565	15.1
	Markla Lake	Jackson	42.38499	-84.17259	85.4
	Mellen Camp Lake	Jackson	42.18711	-84.21619	10.8
	Mirror Lake	Jackson	42.07749	-84.42231	65.5
	Mud Lake	Jackson	42.32638	-84.28343	10.9
	Mud Lake	Jackson	42.38166	-84.33287	17.1
	Mud Lake	Jackson	42.19431	-84.34295	27.3
	Mud Lake	Jackson	42.11277	-84.45787	77.1
	No Name	Jackson	42.24314	-84.23962	10.1
	No Name	Jackson	42.22813	-84.34316	10.1
	No Name	Jackson	42.35412	-84.14010	10.7

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Headwaters–continued	No Name	Jackson	42.31774	-84.22600	11.0
	No Name	Jackson	42.12394	-84.41911	11.0
	No Name	Jackson	42.28065	-84.14819	11.2
	No Name	Jackson	42.31818	-84.23491	12.1
	No Name	Jackson	42.33918	-84.13998	12.8
	No Name	Jackson	42.23683	-84.23865	13.1
	No Name	Jackson	42.39958	-84.48156	15.3
	No Name	Jackson	42.23589	-84.24309	15.7
	No Name	Jackson	42.21451	-84.24209	16.4
	No Name	Jackson	42.14445	-84.34015	16.7
	No Name	Jackson	42.09803	-84.44117	17.3
	No Name	Jackson	42.07881	-84.39540	22.3
	No Name	Jackson	42.32554	-84.17487	35.3
	Notten Lake	Jackson	42.30110	-84.13120	33.8
	Olcott Lake	Jackson	42.19304	-84.26926	42.4
	Peterson Lake	Jackson	42.19693	-84.45593	15.0
	Pleasant Lake	Jackson	42.39360	-84.34870	268.2
	Pond Lily Lake	Jackson	42.34407	-84.22199	35.6
	Pond Lily Lake	Jackson	42.31360	-84.14426	50.6
	Portage Lake	Jackson	42.33832	-84.23482	397.9
	Portage Pond (South)	Jackson	42.34740	-84.22549	14.9
	Price Lake	Jackson	42.20693	-84.28676	51.6
	Riley Lake	Jackson	42.27360	-84.19009	12.0
	Round Lake	Jackson	42.21999	-84.32787	45.1
	Saint John Lake	Jackson	42.31999	-84.30954	11.9
	Schoolhouse Lake	Jackson	42.19082	-84.33620	45.5
	Sharp Lake	Jackson	42.20443	-84.39593	27.2
	Skiff Lake	Jackson	42.11943	-84.40426	83.8
	Spring Lake	Jackson	42.34193	-84.16037	12.8
	Tims Lake	Jackson	42.28138	-84.21843	102.6
	Trist Millpond	Jackson	42.33433	-84.19771	10.9
	Trumbull Lake	Jackson	42.36749	-84.38343	11.8
	Twin Lake (east)	Jackson	42.37359	-84.33466	18.3
	Twin Lake (west)	Jackson	42.37310	-84.33730	10.9
	Vandercook Lake	Jackson	42.19054	-84.40370	146.9
	Welch Lake	Jackson	42.30138	-84.25009	111.7
	White Lake	Jackson	42.35860	-84.34620	70.3
	Williams Lake	Jackson	42.18999	-84.42981	23.2
	Wolf Lake	Jackson	42.19495	-84.26051	398.2
	Wyckoff Lake	Jackson	42.19403	-84.41975	12.3
	Lehman Lake	Washtenaw	42.30638	-84.12009	41.8
	Mud Lake	Washtenaw	42.34777	-84.12648	73.5
	Spruce Lake	Washtenaw	42.36860	-84.11898	23.6
	Sugarloaf Lake	Washtenaw	42.34193	-84.11426	177.3
	Winnewana Impoundment	Washtenaw	42.34983	-84.10796	281.7
	Winnewanna Lake	Washtenaw	42.35816	-84.08476	16.9

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Upper	Bly Lake	Eaton	42.46971	-84.72565	25.3
	Kettler Lake	Eaton	42.44468	-84.62776	18.9
	Loomis Lake	Eaton	42.42443	-84.69704	16.2
	No Name	Eaton	42.65648	-84.67419	11.0
	No Name	Eaton	42.67447	-84.66892	38.8
	Moores Park Hydro Elec	Ingham	42.72008	-84.56817	111.6
	No Name	Ingham	42.66321	-84.58566	10.5
	Cooper Lake	Jackson	42.41471	-84.67620	27.3
	Gurley Lake	Jackson	42.41304	-84.70676	40.4
	Lime Lake (North)	Jackson	42.19160	-84.54726	70.6
	Lime Lake (South)	Jackson	42.18777	-84.54843	91.5
	Lords Lake	Jackson	42.35717	-84.54133	19.8
	Minard Mill Pond	Jackson	42.33727	-84.54893	18.8
	Montague Lakes	Jackson	42.37943	-84.64120	17.7
	No Name	Jackson	42.32569	-84.60705	10.4
	No Name	Jackson	42.33231	-84.60251	11.5
	No Name	Jackson	42.36281	-84.59237	11.6
	No Name	Jackson	42.23368	-84.51058	14.8
	No Name	Jackson	42.31187	-84.61453	44.6
	North Lake	Jackson	42.32743	-84.51340	13.7
	South Lake	Jackson	42.32421	-84.51626	15.9
	Spring Arbor Lakes (North)	Jackson	42.20752	-84.51022	16.4
	Spring Arbor Lakes (South)	Jackson	42.20471	-84.50537	29.8
Middle	Alward Lake	Clinton	42.89527	-84.56620	22.2
	Geneva, Lake	Clinton	42.83388	-84.58315	57.9
	Mud Lake	Clinton	42.79054	-84.40509	19.6
	No Name	Clinton	42.87617	-84.82253	11.7
	No Name	Clinton	42.84514	-84.53549	15.8
	No Name	Clinton	42.79627	-84.53838	18.0
	No Name	Clinton	42.86578	-84.36734	63.5
	Park Lake	Clinton	42.78971	-84.43982	184.9
	Perch Lake	Clinton	42.79582	-84.42676	34.9
	Potter Lake	Clinton	42.79249	-84.41593	20.0
	Rose Lake	Clinton	42.79443	-84.39232	29.5
	Round Lake	Clinton	42.87749	-84.44454	87.2
	Whitman Lake	Clinton	42.86693	-84.39815	12.1
	No Name	Eaton	42.68588	-84.65790	83.1
	Dobie Lake	Ingham	42.66388	-84.40398	31.2
	Lake O' the Hills	Ingham	42.75141	-84.42139	28.3
	Lansing, Lake	Ingham	42.75804	-84.39898	455.9
	No Name	Ingham	42.65841	-84.56890	10.1
	No Name	Ingham	42.66064	-84.51215	10.2
	No Name	Ingham	42.54543	-84.38349	11.5
	No Name	Ingham	42.67933	-84.48064	11.5
	No Name	Ingham	42.63731	-84.50279	11.9
	No Name	Ingham	42.72177	-84.52094	14.5
	No Name	Ingham	42.69471	-84.50753	14.9
	No Name	Ingham	42.60775	-84.49062	15.1

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Middle–continued	No Name	Ingham	42.51206	-84.37936	15.1
	No Name	Ingham	42.71668	-84.51104	15.5
	No Name	Ingham	42.69395	-84.53191	22.7
	Three Lakes (South)	Ingham	42.76260	-84.28561	11.2
	Wildlife Lake	Ingham	42.73943	-84.39954	10.4
	Cryderman Lake	Ionia	42.77388	-84.88759	22.6
	Lyon	Ionia	42.97706	-84.95030	48.3
	Municipal	Ionia	42.88919	-84.91239	129.6
	No Name	Ionia	42.83146	-84.85855	10.4
	Wager	Ionia	42.96684	-84.91340	89.5
	Webber Impoundment	Ionia	42.95287	-84.90274	442.3
	Cedar Lake	Livingston	42.53054	-83.98982	118.6
	Grass Lake	Livingston	42.53638	-83.97009	14.9
	Lamoreaux Lake	Livingston	42.55638	-84.09926	29.9
	Pleasant Lake	Livingston	42.51443	-83.95204	85.2
	Sewage Disposal Pond	Livingston	42.66681	-84.08124	22.8
	Triangle Lake	Livingston	42.52916	-83.96065	53.2
	Colby Lake	Shiawassee	42.81138	-84.32065	35.5
	Hemingway Lake	Shiawassee	42.79193	-84.14065	17.4
	Leisure Lake (north)	Shiawassee	42.84888	-84.33698	40.8
	Leisure Lakes (southea	Shiawassee	42.84153	-84.33466	24.6
	Leisure Lakes (west)	Shiawassee	42.84497	-84.33837	11.2
	Moon Lake	Shiawassee	42.81082	-84.33120	32.2
	No Name	Shiawassee	42.82853	-84.19812	16.5
	No Name	Shiawassee	42.88999	-84.17523	17.9
	No Name	Shiawassee	42.87531	-84.14488	26.9
	Rose Lake	Shiawassee	42.81318	-84.35292	66.7
	Sauger Lake	Shiawassee	42.77999	-84.14870	20.8
	Sewage Disposal Pond	Shiawassee	42.81527	-84.24128	19.5
	Sewage Disposal Pond	Shiawassee	42.81680	-84.24492	27.5
Lower	Algonquin Lake	Barry	42.67054	-85.32787	182.3
	Aurohn	Barry	42.54794	-85.30276	18.4
	Bassett Lake	Barry	42.66249	-85.48370	42.0
	Bawker Lake	Barry	42.54721	-85.34926	34.6
	Big Cedar Lake	Barry	42.51082	-85.34982	84.3
	Black Lake	Barry	42.72388	-85.39343	11.9
	Brewster Lake	Barry	42.54165	-85.29648	13.5
	Bristol Lake	Barry	42.48693	-85.24732	140.3
	Carter Lake	Barry	42.66999	-85.31232	59.7
	Clear Lake	Barry	42.50999	-85.26482	186.8
	Cloverdale Lake	Barry	42.53860	-85.39704	133.6
	Cox Lake	Barry	42.55971	-85.33704	23.8
	Culver Lake	Barry	42.45804	-85.23509	29.8
	Dagget Lake	Barry	42.59415	-85.44176	17.0
	Deep Lake	Barry	42.62082	-85.45843	33.0
	Duncan Lake	Barry	42.75527	-85.53287	129.8
	Fine Lake	Barry	42.44443	-85.29204	323.9

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Gesler Lake	Barry	42.54527	-85.36232	15.8
	Guernsey Lake	Barry	42.55082	-85.40870	216.6
	Hall Lake	Barry	42.58527	-85.21787	24.2
	Hathaway Lake	Barry	42.66943	-85.38787	11.2
	Head Lake	Barry	42.57082	-85.38259	98.0
	Horseshoe Lake	Barry	42.54943	-85.35482	26.3
	Howard Lake	Barry	42.52749	-85.30815	10.4
	Jordan Lake	Barry	42.76999	-85.14093	417.3
	Kilpatrick Lake	Barry	42.71360	-85.08259	19.5
	Larabee Lake	Barry	42.55054	-85.33204	35.0
	Lawhead Lake	Barry	42.73999	-85.19370	15.9
	Leach Lake	Barry	42.68749	-85.28482	107.3
	Little Cedar Lake	Barry	42.52804	-85.34148	37.2
	Little Mill Lake	Barry	42.46195	-85.26072	12.3
	Little Pine Lake	Barry	42.55193	-85.31704	31.9
	Long Lake	Barry	42.59582	-85.19482	15.2
	Long Lake	Barry	42.47443	-85.24426	75.4
	Long Lake	Barry	42.55499	-85.37232	261.6
	Loomis Lake	Barry	42.55332	-85.42509	39.7
	Lower Lake	Barry	42.69582	-85.24704	36.9
	Middle Lake	Barry	42.58165	-85.22565	28.1
	Middle Lake	Barry	42.69610	-85.27009	134.7
	Mill Lake	Barry	42.45284	-85.26538	84.0
	Mill Pond	Barry	42.60971	-85.08065	73.8
	Mixer Lake	Barry	42.58221	-85.23176	31.5
	Mud Lake	Barry	42.48638	-85.27009	15.7
	Mud Lake	Barry	42.54332	-85.26537	27.6
	Myers Lake	Barry	42.58415	-85.30954	23.0
	Newton Lake	Barry	42.59027	-85.29843	13.9
	No Name	Barry	42.72255	-85.52705	10.7
	No Name	Barry	42.47404	-85.25076	11.0
	No Name	Barry	42.62994	-85.39317	11.6
	No Name	Barry	42.61226	-85.40240	11.8
	No Name	Barry	42.52213	-85.32849	12.0
	No Name	Barry	42.52459	-85.41433	12.2
	No Name	Barry	42.49508	-85.30708	12.4
	No Name	Barry	42.57066	-85.43314	12.5
	No Name	Barry	42.58987	-85.44425	13.7
	No Name	Barry	42.50502	-85.19629	14.3
	No Name	Barry	42.56123	-85.31777	15.1
	No Name	Barry	42.51362	-85.42655	17.2
	No Name	Barry	42.57202	-85.43749	21.0
	No Name	Barry	42.57034	-85.35306	22.0
	No Name	Barry	42.54424	-85.33076	35.2
	No Name	Barry	42.56658	-85.29232	61.3
	Number Twenty-one Lake	Barry	42.54193	-85.37870	63.0
	One, Lake	Barry	42.59638	-85.08176	11.5

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Otis Lake	Barry	42.60915	-85.41620	128.0
	Perch Lake	Barry	42.58554	-85.37343	21.5
	Pine Lake	Barry	42.57360	-85.39204	58.9
	Podunk Lake	Barry	42.61193	-85.34954	84.1
	Saddlebag Lake	Barry	42.72388	-85.07787	50.9
	Sewage Disposal Pond	Barry	42.72100	-85.45469	10.2
	Sewage Disposal Pond	Barry	42.71967	-85.45473	10.3
	Shallow Lake	Barry	42.52415	-85.35954	69.6
	Snow Lake	Barry	42.59665	-85.47065	11.2
	Stewart Lake	Barry	42.56832	-85.45009	51.2
	Sugarbush Lake	Barry	42.74221	-85.34676	30.0
	Tanner Lake	Barry	42.60277	-85.32815	13.6
	Thornapple Lake	Barry	42.62665	-85.18870	415.2
	Tillotson Lake	Barry	42.59443	-85.34093	27.3
	Turner Lake	Barry	42.62665	-85.45620	19.1
	Von Syckle Lake	Barry	42.46221	-85.23315	12.4
	Wall Lake	Barry	42.52138	-85.38815	557.2
	Whitefish Lake	Barry	42.54610	-85.31037	12.7
	Wilkinson Lake	Barry	42.53082	-85.41148	226.9
	Blood Lake	Clinton	42.91166	-84.38648	15.5
	Curtis Lake	Clinton	42.93471	-84.45426	10.7
	Lake Ovid	Clinton	42.94335	-84.41459	362.2
	Lake Victoria	Clinton	42.92388	-84.37732	143.3
	Muskrat Lake	Clinton	42.91110	-84.58982	43.6
	No Name	Clinton	42.96600	-84.57118	10.8
	No Name	Clinton	42.90187	-84.48574	10.8
	No Name	Clinton	43.04760	-84.48781	11.2
	No Name	Clinton	43.04180	-84.48052	12.9
	No Name	Clinton	42.90611	-84.39689	13.7
	No Name	Clinton	43.00447	-84.38950	15.5
	No Name	Clinton	43.04254	-84.49125	15.8
	No Name	Clinton	43.03722	-84.53887	19.0
	No Name	Clinton	43.05101	-84.48678	21.9
	Carr Lake	Eaton	42.71998	-85.07427	27.7
	Hart Lake	Eaton	42.73874	-85.05390	13.6
	Lacey Lake	Eaton	42.52888	-84.97093	55.2
	Looking Glass Lake	Eaton	42.73471	-85.04843	13.2
	Mud Lake	Eaton	42.71961	-85.07078	14.5
	No Name	Eaton	42.72494	-85.06930	11.2
	No Name	Eaton	42.61988	-85.03999	12.3
	No Name	Eaton	42.59522	-84.78262	13.3
	No Name	Eaton	42.72432	-85.06179	13.4
	No Name	Eaton	42.67754	-84.69420	15.2
	No Name	Eaton	42.62005	-84.75402	16.6
	No Name	Eaton	42.61285	-84.73593	17.1
	No Name	Eaton	42.57677	-84.79392	36.5
	No Name	Eaton	42.66483	-84.68610	40.4

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Saubee Lake	Eaton	42.72971	-85.05898	76.7
	Sewage Disposal Pond	Eaton	42.63431	-84.75604	15.8
	Sewage Disposal Pond	Eaton	42.62974	-84.75626	30.6
	Tamarock Lake	Eaton	42.73110	-85.05148	16.2
	Rainbow Lake	Gratiot	43.12696	-84.69879	304.2
	Saginaw #21	Gratiot	0.00000	0.00000	33.4
	Augst Lake	Ionia	42.79554	-85.09870	19.9
	Belding	Ionia	43.08984	-85.23617	14.6
	Church Lake	Ionia	42.83748	-85.28354	14.4
	Long Lake	Ionia	43.11332	-85.12259	356.8
	Lowell Impoundment	Ionia	43.02069	-85.29227	125.6
	Marker Lake	Ionia	42.88360	-85.21565	10.1
	Morrison Lake	Ionia	42.86082	-85.21176	314.8
	No Name	Ionia	43.06705	-85.12289	10.1
	No Name	Ionia	42.88206	-85.06272	15.6
	No Name	Ionia	42.98113	-85.01311	16.9
	No Name	Ionia	43.11225	-85.16883	20.0
	Peck Lake	Ionia	42.89888	-85.17148	18.6
	Peddler Lake	Ionia	42.82749	-85.28370	33.9
	Sessions Lake	Ionia	42.94400	-85.12609	138.7
	Sewage Disposal Pond	Ionia	42.78973	-85.08816	10.6
	Sewage Disposal Pond	Ionia	42.99136	-84.92964	10.8
	Sewage Disposal Pond	Ionia	43.08067	-85.23741	13.4
	Sewage Disposal Pond	Ionia	42.99140	-84.93200	13.8
	Sewage Disposal Pond	Ionia	43.07904	-85.24020	18.4
	Tupper Lake	Ionia	42.78443	-85.11565	95.9
	Woodard Lake	Ionia	43.08138	-85.06232	69.7
	Ada Impoundment	Kent	42.94890	-85.48560	241.9
	Angel Lake	Kent	43.17110	-85.40926	44.1
	Austin Lake	Kent	43.04082	-85.48676	14.8
	Bailey Lake	Kent	42.97888	-85.41704	50.4
	Banks Lake	Kent	43.20277	-85.33343	27.2
	Barber Lake	Kent	42.79332	-85.44787	16.6
	Bass Lake	Kent	43.26471	-85.32509	188.1
	Bearslee Lake	Kent	43.14770	-85.31512	11.9
	Big Crooked Lake	Kent	43.05721	-85.39426	144.5
	Big Pine Island Lake	Kent	43.10138	-85.36593	194.5
	Black Lake	Kent	43.22332	-85.62926	12.0
	Black Lake	Kent	43.25943	-85.35732	33.5
	Blodgett Lake	Kent	42.80027	-85.45204	10.4
	Blue Lake	Kent	43.16415	-85.33204	28.0
	Blue Lake	Kent	43.26471	-85.35759	50.5
	Bostwick Lake	Kent	43.09138	-85.45898	213.2
	Bowen Lake	Kent	43.23499	-85.34204	29.1
	Brower Lake	Kent	43.12193	-85.48065	76.8
	Brown Lake	Kent	43.15915	-85.40759	14.6
	Buck Lake	Kent	42.83527	-85.43815	27.8

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Byrne Lake	Kent	43.05082	-85.37426	26.3
	Camp Lake	Kent	43.17665	-85.66593	134.7
	Campau Lake	Kent	42.84027	-85.44787	82.5
	Campbell Lake	Kent	42.81138	-85.42565	46.5
	Cascade Impoundment	Kent	42.90646	-85.50125	316.5
	Chapin Lake	Kent	43.11221	-85.37537	24.2
	Chase Lake	Kent	43.01471	-85.46565	36.0
	Church Lake	Kent	42.96499	-85.59454	20.1
	Clear Bottom Lake	Kent	43.11277	-85.62759	26.2
	Cook and White Lake	Kent	43.29304	-85.62287	52.5
	County Line Lake	Kent	43.15388	-85.31482	11.5
	Cowan Lake	Kent	43.11582	-85.42343	68.5
	Crawford Lake	Kent	43.18665	-85.39704	32.9
	Dean Lake	Kent	43.02971	-85.60954	76.5
	Deer Lake	Kent	43.15360	-85.32398	20.0
	Duitelmans Lake	Kent	43.26221	-85.77093	12.7
	Emerald Lake	Kent	43.02082	-85.62176	14.7
	Emmons Lake	Kent	42.79388	-85.51343	24.8
	Fisk Lake	Kent	42.95610	-85.62037	29.6
	Flat Iron Lake	Kent	43.12388	-85.38426	24.3
	Freska Lake	Kent	43.11193	-85.63982	59.5
	Gavin Lake	Kent	43.05527	-85.40759	29.5
	Gidding Lake	Kent	43.28082	-85.56787	32.7
	Grand River	Kent	42.97444	-85.67457	372.3
	Grass Lake	Kent	43.09082	-85.51482	204.1
	Green Lake	Kent	43.08971	-85.32787	32.3
	Halfmile Lake	Kent	43.21304	-85.33426	54.9
	Hanna Lake	Kent	42.79304	-85.57870	13.4
	Hart Lake (northwest)	Kent	43.12027	-85.35926	31.9
	Hart Lake (southeast)	Kent	43.11824	-85.35650	14.8
	Harvard Lake	Kent	43.18915	-85.40815	15.7
	Helena Lake	Kent	43.26665	-85.50315	16.7
	High Lake	Kent	43.15638	-85.64732	17.2
	Hilton Lake	Kent	42.78804	-85.69509	12.8
	Horseshoe Lake	Kent	43.19471	-85.34371	43.3
	Hull Lake	Kent	43.12165	-85.37315	12.1
	Indian Lakes (east)	Kent	43.19213	-85.66450	20.8
	Indian Lakes (west)	Kent	43.19395	-85.67008	21.1
	Kettle Lake	Kent	42.83360	-85.44926	28.6
	Ke-wag-a-wan Lake	Kent	43.20582	-85.66287	30.8
	King's Mill	Kent	42.92333	-85.34998	44.0
	Krafts Lake	Kent	42.84610	-85.52120	18.1
	LaBarge	Kent	42.81183	-85.48395	20.1
	Lake Eastbrook	Kent	42.91740	-85.57456	18.5
	Lake Number Ten	Kent	42.83638	-85.35954	10.0
	Lamberton Lake	Kent	43.02082	-85.62926	27.7
	Laraway Lake	Kent	42.92971	-85.50954	11.2

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Lim Lake	Kent	43.20665	-85.63732	34.5
	Lincoln Lake	Kent	43.24415	-85.36037	416.7
	Little Brower Lake	Kent	43.12804	-85.48537	24.6
	Little Muskrat Lake	Kent	43.11110	-85.38454	25.4
	Little Myers Lake	Kent	43.14027	-85.49148	49.0
	Little Pine Island Lake	Kent	43.09277	-85.65509	110.1
	Little Wabasis Lake	Kent	43.15388	-85.35954	34.6
	Logan Lake	Kent	42.81249	-85.31732	16.6
	Long Lake	Kent	43.21249	-85.66204	53.8
	Lowell	Kent	42.94474	-85.34343	93.3
	Lowell	Kent	42.96923	-85.33494	216.9
	Maston Lake	Kent	43.27499	-85.35565	99.9
	McCarthy Lake	Kent	43.05554	-85.42370	28.7
	McEwen Lake	Kent	42.86527	-85.39398	35.7
	Mead Lake	Kent	43.09971	-85.67037	21.1
	Mid Lake	Kent	42.96610	-85.60232	17.6
	Middle Lake	Kent	43.28415	-85.58509	42.5
	Morgan Lake	Kent	43.15915	-85.33454	72.8
	Morse Lake	Kent	42.86888	-85.40898	11.2
	Murray Lake	Kent	43.03999	-85.37954	312.5
	Muskrat Lake	Kent	43.10082	-85.39037	74.4
	Myers Lake	Kent	43.13665	-85.48704	88.6
	No Name	Kent	42.92254	-85.73467	10.2
	No Name	Kent	42.93277	-85.74615	10.3
	No Name	Kent	42.85793	-85.36018	10.7
	No Name	Kent	42.96616	-85.41309	10.7
	No Name	Kent	43.26077	-85.73457	10.7
	No Name	Kent	43.11549	-85.36785	10.8
	No Name	Kent	43.29067	-85.53824	11.7
	No Name	Kent	43.16097	-85.36519	12.0
	No Name	Kent	43.01041	-85.46714	13.5
	No Name	Kent	42.93063	-85.73042	14.1
	No Name	Kent	42.92138	-85.52386	14.8
	No Name	Kent	42.92655	-85.73701	14.8
	No Name	Kent	43.21474	-85.36971	16.5
	No Name	Kent	42.91641	-85.75687	17.1
	No Name	Kent	42.93049	-85.70936	17.4
	No Name	Kent	42.93738	-85.73311	19.2
	No Name	Kent	42.96089	-85.48656	20.2
	No Name	Kent	43.24270	-85.54971	22.2
	No Name	Kent	43.06030	-85.58335	23.7
	No Name	Kent	43.00739	-85.67017	24.6
	No Name	Kent	42.92695	-85.35495	27.0
	No Name	Kent	43.10160	-85.57693	31.5
	No Name	Kent	42.91892	-85.74138	35.0
	No Name	Kent	42.94396	-85.74761	37.2
	No Name	Kent	43.27688	-85.35064	45.7

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	No Name	Kent	43.05844	-85.57666	52.6
	Olin Lakes	Kent	43.20693	-85.65315	31.4
	Perch Lake	Kent	43.02221	-85.60732	10.8
	Pickerel Lake	Kent	43.07499	-85.46565	67.4
	Pine Lake	Kent	43.21915	-85.46815	56.6
	Pratt Lake	Kent	42.88138	-85.32259	172.2
	Quiggle Lake	Kent	42.89999	-85.45565	17.4
	Ratigan Lake	Kent	43.03471	-85.43037	71.7
	Reeds Lake	Kent	42.95054	-85.60343	269.6
	Riley Lake	Kent	42.80138	-85.42843	13.8
	Round Lake	Kent	43.06277	-85.37759	83.2
	Sand Lake	Kent	43.29499	-85.52843	93.1
	Sandbottom Lake	Kent	43.18309	-85.38767	24.4
	Saugage Lake	Kent	43.21165	-85.37121	41.1
	Scally Lake	Kent	43.06582	-85.36565	41.2
	Scott Lake	Kent	43.08582	-85.64426	16.7
	Scram Lake	Kent	43.16443	-85.41121	79.9
	Sewage Disposal Pond	Kent	43.21126	-85.56249	12.0
	Sewage Disposal Pond	Kent	43.21127	-85.56490	12.2
	Sewage Disposal Pond	Kent	43.21038	-85.55986	13.0
	Shadow Lake	Kent	43.00527	-85.60787	16.4
	Silver Lake	Kent	43.09138	-85.49148	188.0
	Slayton Lake	Kent	43.07138	-85.34315	88.7
	Soft Water Lake	Kent	43.02193	-85.63982	10.6
	Spring Lake	Kent	43.25995	-85.67714	10.4
	Squaw Lake	Kent	43.19999	-85.67232	12.1
	Stoner Lake	Kent	43.14888	-85.47537	75.5
	Sunfish Lake	Kent	43.08165	-85.48482	15.2
	Tamarack Lake	Kent	43.13138	-85.46065	23.6
	Tek-E-Nink Lake	Kent	43.12804	-85.35482	46.9
	Thomas Lake	Kent	43.20693	-85.33898	62.0
	Toohey Lake	Kent	43.08777	-85.40287	15.2
	Tower Lake	Kent	43.08610	-85.35982	16.2
	Twin Lake	Kent	42.97193	-85.58343	12.4
	Upper Lake	Kent	43.28804	-85.59121	35.2
	Wabasis Lake	Kent	43.13804	-85.37732	404.2
	Walden Lake	Kent	42.92888	-85.52565	11.4
	Ware Lake	Kent	43.29304	-85.50148	22.3
	Wolf Lake	Kent	43.09027	-85.38621	11.1
	Wood Lake	Kent	42.92554	-85.52926	12.6
	Woodbeck Lake	Kent	43.19304	-85.33621	85.2
	Ziegenfuss Lake	Kent	43.17749	-85.33843	45.4
	Baldwin Lake	Montcalm	43.16388	-85.26982	61.7
	Barnard Lake	Montcalm	43.32777	-85.37315	45.5
	Bass Lake	Montcalm	43.45249	-85.18732	32.9
	Big Brimmer Lake	Montcalm	43.41860	-85.22871	20.5
	Black Lake	Montcalm	43.33554	-85.33843	17.3

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Bradley Lake	Montcalm	43.30054	-85.49898	18.3
	Burgess Lake	Montcalm	43.15527	-85.29176	88.7
	Cedar Lake	Montcalm	43.23804	-84.98982	21.9
	Churchill Lake	Montcalm	43.21144	-85.23661	24.5
	Clear Lake	Montcalm	43.12749	-85.10982	18.2
	Clifford Lake	Montcalm	43.30832	-85.18954	194.8
	Coady Lake	Montcalm	43.36499	-85.37759	51.5
	Colby Lake	Montcalm	43.26721	-85.07926	20.8
	Como Lake	Montcalm	43.16082	-85.26426	18.4
	County Farm Pond	Montcalm	43.19358	-85.16355	23.3
	Cowden Lake	Montcalm	43.35388	-85.35621	111.1
	Crooked Lake	Montcalm	43.23749	-85.00259	46.6
	Crystal Lake	Montcalm	43.26193	-84.93148	708.6
	Derby Lake	Montcalm	43.27499	-85.12704	113.6
	Dickerson Lake	Montcalm	43.29388	-85.16704	227.4
	Duck Lake	Montcalm	43.26832	-84.87676	301.1
	Dutchman Lakes	Montcalm	43.32554	-85.28148	15.4
	Farnsworth Lake	Montcalm	43.35249	-85.24843	25.0
	Fifth Lake	Montcalm	43.43527	-85.11037	77.7
	First Lake	Montcalm	43.43804	-85.14371	41.6
	Fish Lake	Montcalm	43.23138	-85.21343	71.1
	Flat River	Montcalm	43.18398	-85.26045	94.8
	Forest, Lake	Montcalm	43.38471	-85.20648	11.4
	Fourth Lake	Montcalm	43.43554	-85.12315	43.6
	Gould Lake	Montcalm	43.29638	-85.49926	14.0
	Grass Lake	Montcalm	43.26304	-85.09176	33.7
	Grass Lake	Montcalm	43.13360	-85.10232	39.2
	Gray Lake	Montcalm	43.27915	-85.10676	12.9
	Half Moon Lake	Montcalm	43.25221	-85.05982	51.4
	Hammell Lake	Montcalm	43.15166	-84.98093	15.2
	Harlow Lake	Montcalm	43.19860	-85.30315	29.3
	Hemmingway Lake	Montcalm	43.33388	-85.08176	38.1
	Hisington Lake	Montcalm	43.22082	-85.06315	12.7
	Holland Lake	Montcalm	43.23082	-85.04509	76.9
	Horseshoe Lake	Montcalm	43.12943	-85.09065	16.0
	Horseshoe Lake	Montcalm	43.35471	-85.29621	43.9
	Horseshoe Lake	Montcalm	43.40777	-85.18343	97.2
	Hunter Lake	Montcalm	43.30054	-85.27009	59.9
	Kirby Lake	Montcalm	43.44804	-85.08482	19.5
	Lampman Lake	Montcalm	43.21915	-85.09176	14.1
	Little Bass Lake	Montcalm	43.43721	-85.15426	16.0
	Little Lake	Montcalm	43.33777	-85.30676	13.7
	Little Mud Lake	Montcalm	43.22638	-85.19482	15.7
	Little Penny Lake	Montcalm	43.40693	-85.14287	26.5
	Loon Lake	Montcalm	43.15499	-85.19343	48.0
	Loon Lake	Montcalm	43.27721	-84.95787	65.7
	Lossin Lake	Montcalm	43.33221	-85.32037	37.5

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Mahaney Lake	Montcalm	43.33082	-85.35898	12.7
	Manoka Lake	Montcalm	43.16670	-85.26450	10.6
	Middle Lake	Montcalm	43.32332	-85.29954	37.0
	Mill Pond	Montcalm	43.17961	-84.85518	14.7
	Mitchell Lake	Montcalm	43.22582	-85.06093	22.0
	Montcalm, Lake	Montcalm	43.38082	-85.18926	84.5
	Moore Lake	Montcalm	43.33536	-85.29471	15.6
	Mud Lake	Montcalm	43.28221	-85.26732	10.2
	Mud Lake	Montcalm	43.42721	-85.17121	27.7
	Mud Lake	Montcalm	43.37062	-85.18161	51.4
	Mud Lake	Montcalm	43.23971	-84.97315	60.4
	Mud Lake	Montcalm	43.24165	-85.18871	73.7
	Mud Lake	Montcalm	43.27384	-84.91803	98.6
	Muskellunge Lake	Montcalm	43.31777	-85.34676	137.1
	Nelson Lake	Montcalm	43.28554	-85.13176	23.9
	Nevins Lake	Montcalm	43.28082	-85.13843	55.2
	No Name	Montcalm	43.15249	-85.23459	10.4
	No Name	Montcalm	43.31643	-85.36447	11.4
	No Name	Montcalm	43.38858	-85.19366	11.6
	No Name	Montcalm	43.24026	-85.29458	11.8
	No Name	Montcalm	43.22058	-85.24487	12.0
	No Name	Montcalm	43.16982	-85.16580	12.1
	No Name	Montcalm	43.16491	-85.15039	12.2
	No Name	Montcalm	43.36260	-85.16762	13.9
	No Name	Montcalm	43.17280	-85.03773	14.6
	No Name	Montcalm	43.42925	-85.24820	14.9
	No Name	Montcalm	43.15894	-85.29882	15.2
	No Name	Montcalm	43.14717	-85.14626	16.2
	Norton Lake	Montcalm	43.25860	-85.30732	26.9
	Paulson Lake	Montcalm	43.34915	-85.31009	11.4
	Pearl Lake	Montcalm	43.20943	-85.07676	36.5
	Penny Lake	Montcalm	43.39721	-85.14926	43.7
	Perch Lake	Montcalm	43.24027	-85.28371	55.4
	Picnic Lake	Montcalm	43.31832	-85.40204	23.2
	Rainbow Lake	Montcalm	43.33193	-85.30621	167.8
	Rosa Lake	Montcalm	43.22304	-85.08315	33.4
	Sanderson Lake	Montcalm	43.17860	-85.21315	101.9
	School Section Lake	Montcalm	43.25860	-85.26843	10.6
	Sealey Lake	Montcalm	43.29689	-85.50842	22.1
	Second & Third Lake	Montcalm	43.43610	-85.13509	54.1
	Sixth Lake	Montcalm	43.44027	-85.10121	36.9
	Snow Lake	Montcalm	43.13471	-85.05426	23.9
	Spring Lake	Montcalm	43.33082	-85.25343	56.5
	Spruce Lake	Montcalm	43.36100	-85.41034	14.9
	Tacoma Lake	Montcalm	43.32360	-85.26371	24.6
	Thorland Lake	Montcalm	43.14638	-85.19787	26.7
	Townline Lake	Montcalm	43.45527	-85.20426	288.8

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Lower–continued	Turk Lake	Montcalm	43.26632	-85.25387	160.6
	Twin Lakes	Montcalm	43.25860	-85.10259	12.6
	Twin Lakes	Montcalm	43.20110	-85.13009	18.2
	Twin Stone Lakes (east)	Montcalm	43.25629	-85.08232	23.8
	Twin Stone Lakes (west)	Montcalm	43.25493	-85.08582	19.1
	West Lake	Montcalm	43.32777	-85.25898	46.4
	Bills Lake	Newaygo	43.39388	-85.66148	200.2
	Butler Lake	Newaygo	43.34165	-85.63315	12.6
	Frey Lake	Newaygo	43.30332	-85.66426	11.6
	No Name	Newaygo	43.40164	-85.67589	12.4
	No Name	Newaygo	43.30574	-85.57091	19.3
	Pettit Lake	Newaygo	43.41138	-85.67843	172.1
	Ransom Lake	Newaygo	43.35860	-85.69037	34.1
	Cranberry Lake	Ottawa	43.10610	-85.79120	119.9
	Fennessy Lake	Ottawa	42.95249	-85.78954	62.5
	Kenowa Lake	Ottawa	42.89359	-85.78487	27.4
	No Name	Ottawa	42.93903	-85.81042	13.1
	No Name	Ottawa	42.88287	-85.83196	15.0
	No Name	Ottawa	42.89476	-85.79644	15.2
	No Name	Ottawa	42.89635	-85.79334	17.7
	No Name	Ottawa	42.89670	-85.79960	28.4
	No Name	Ottawa	42.91300	-85.81297	33.4
	No Name	Ottawa	42.89297	-85.80600	39.3
	Stafford Lake	Ottawa	42.95943	-85.79315	15.3
	Cummings Lake (east)	Shiawassee	42.91756	-84.19875	29.6
	Cummings Lake (south)	Shiawassee	42.91117	-84.20322	22.9
	Cummings Lake (west)	Shiawassee	42.91783	-84.20490	19.7
	Manitou Lake	Shiawassee	42.92554	-84.20315	71.8
	No Name	Shiawassee	43.00156	-84.35612	16.2
Mouth	Half Moon Lake	Muskegon	43.25860	-85.81037	63.7
	Lake Lorraine	Muskegon	43.11999	-86.20815	13.2
	Ovidhall Lake	Muskegon	43.26999	-85.82343	12.3
	Bruce Bayou	Ottawa	43.04399	-86.12576	94.2
	Crockery Lake	Ottawa	43.16860	-85.85148	103.7
	Eastmanville Bayou	Ottawa	43.01125	-85.96773	19.5
	Jubb Bayou	Ottawa	43.03511	-86.04645	22.1
	Lamont Bayou	Ottawa	43.00575	-85.92513	14.1
	Lloyd Bayou	Ottawa	43.06490	-86.18651	138.2
	Millhouse Bayou	Ottawa	43.02298	-86.15874	59.9
	No Name	Ottawa	43.08520	-86.04788	11.9
	No Name	Ottawa	43.00990	-86.00495	12.8
	No Name	Ottawa	43.03941	-86.07023	13.3
	No Name	Ottawa	42.95596	-85.86628	13.5
	No Name	Ottawa	43.05409	-86.07507	21.5
	No Name	Ottawa	43.07995	-86.09973	21.9
	No Name	Ottawa	43.07335	-86.22844	25.3
	No Name	Ottawa	42.92380	-85.82965	48.2

Table 1.–Continued.

Segment	Lake	County	Latitude	Longitude	Surface acres
Mouth–continued	No Name	Ottawa	42.93024	-85.84007	57.4
	Grand River Mouth	Ottawa	43.05534	-86.18396	1,188.7
	Pottawattomie Bayou	Ottawa	43.02828	-86.18771	159.6
	Sewage Disposal Pond	Ottawa	43.04951	-85.92317	10.2
	Spring Lake	Ottawa	43.09249	-86.18426	1,096.8
	Stearn's Bayou	Ottawa	43.02522	-86.13704	90.5
	The Sag	Ottawa	43.07729	-86.23518	56.7

Table 2.–Archaeological sites within the Grand River basin sorted by county of occurrence. Data from B. Mead, Office of the State Archaeologist, personal communication.

County	Twp/Range	No. of sites
Barry	01N 08W	1
Barry	01N 09W	3
Barry	01N 10W	5
Barry	02N 07W	2
Barry	02N 09W	6
Barry	03N 07W	29
Barry	03N 08W	40
Barry	03N 09W	17
Barry	03N 10W	9
Barry	04N 07W	12
Barry	04N 04W	7
Barry	04N 09W	5
Barry	04N 10W	14
Clinton	05N 01W	19
Clinton	05N 02W	24
Clinton	05N 03W	12
Clinton	05N 04W	7
Clinton	06N 01W	37
Clinton	06N 02W	26
Clinton	06N 03W	3
Clinton	07N 01W	13
Clinton	07N 02W	29
Clinton	07N 03W	3
Clinton	07N 04W	3
Clinton	08N 01W	16
Clinton	08N 02W	29
Clinton	08N 03W	18
Clinton	08N 04W	8
Eaton	01N 03W	4
Eaton	01N 04W	1
Eaton	02N 03W	4
Eaton	02N 04W	2
Eaton	02N 05W	1
Eaton	02N 06W	4
Eaton	03N 03W	6
Eaton	03N 04W	7
Eaton	03N 05W	2
Eaton	03N 06W	4
Eaton	04N 03W	17
Eaton	04N 04W	15
Eaton	04N 05W	6
Eaton	04N 06W	36
Gratiot	09N 01W	26
Gratiot	09N 02W	23

County	Twp/Range	No. of sites
Gratiot (Continued)	09N 03W	4
Gratiot	10N 01W	1
Gratiot	10N 02W	7
Gratiot	10N 03W	6
Gratiot	10N 04W	5
Hillsdale	05N 01W	1
Ingham	01N 01E	5
Ingham	01N 01W	6
Ingham	01N 02E	2
Ingham	01N 02W	8
Ingham	02N 01E	3
Ingham	02N 02E	5
Ingham	02N 02W	8
Ingham	03N 01E	9
Ingham	03N 01W	4
Ingham	03N 02E	9
Ingham	03N 02W	4
Ingham	04N 01E	16
Ingham	04N 01W	20
Ingham	04N 02E	3
Ingham	04N 02W	18
Ionia	05N 05W	26
Ionia	05N 06W	11
Ionia	05N 07W	14
Ionia	05N 08W	6
Ionia	06N 05W	19
Ionia	06N 06W	4
Ionia	06N 07W	19
Ionia	06N 08W	25
Ionia	07N 05W	66
Ionia	07N 06W	23
Ionia	07N 07W	29
Ionia	07N 08W	10
Ionia	08N 05W	41
Ionia	08N 07W	2
Ionia	08N 08W	5
Jackson	01S 01E	18
Jackson	01S 02W	21
Jackson	01S 02E	8
Jackson	01S 02W	18
Jackson	01S 03W	3
Jackson	02S 01E	16

Table 2.–Continued.

County	Twp/Range	No. of sites
Jackson (Continued)	02S 01W	18
Jackson	02S 02E	8
Jackson	02S 02W	5
Jackson	03S 01E	1
Jackson	03S 01W	3
Jackson	03S 02E	7
Jackson	03S 02W	2
Jackson	04S 01W	5
Jackson	04S 02E	1
Kent	05N 09W	2
Kent	05N 10W	10
Kent	05N 11W	22
Kent	05N 12W	29
Kent	06N 09W	16
Kent	06N 10W	29
Kent	06N 11W	10
Kent	06N 12W	22
Kent	07N 09W	11
Kent	07N 10W	13
Kent	07N 11W	6
Kent	07N 12W	19
Kent	08N 09W	3
Kent	08N 10W	10
Kent	08N 11W	10
Kent	08N 12W	3
Kent	09N 09W	31
Kent	09N 10W	3
Kent	09N 11W	3
Kent	09N 12W	2
Kent	10N 09W	8
Kent	10N 11W	2
Kent	10N 12W	3
Livingston	01N 04E	1
Livingston	02N 03E	5
Livingston	02N 04E	3
Livingston	03N 03E	12
Livingston	03N 04E	6
Livingston	03N 05E	2
Livingston	04N 03E	2
Mecosta	13N 07W	2
Montcalm	09N 05W	1
Montcalm	09N 07W	4
Montcalm (Continued)	09N 08W	11
Montcalm	10N 05W	4
Montcalm	10N 06W	3
Montcalm	10N 07W	3
Montcalm	10N 08W	5
Montcalm	11N -7W	3
Montcalm	11N 08W	1
Montcalm	11N 09W	2
Montcalm	12N 07W	5
Muskegon	09N 14W	4
Muskegon	09N 15W	3
Muskegon	10N 13W	6
Newaygo	11N 11W	3
Newaygo	11N 12W	9
Newaygo	11N 13W	2
Ottawa	05N 13W	4
Ottawa	05N 14W	4
Ottawa	05N 15W	3
Ottawa	06N 13W	11
Ottawa	06N 14W	1
Ottawa	06N 15W	4
Ottawa	06N 16W	2
Ottawa	07N 13W	32
Ottawa	07N 14W	18
Ottawa	07N 15W	7
Ottawa	07N 16W	1
Ottawa	08N 13W	2
Ottawa	08N 14W	1
Ottawa	08N 15W	97
Ottawa	08N 16W	24
Ottawa	09N 13W	2
Shiawassee	05N 01E	13
Shiawassee	05N 02E	4
Shiawassee	06N 01E	2
Shiawassee	06N 02E	8
Shiawassee	06N 03E	2
Shiawassee	07N 01E	9
Shiawassee	07N 02E	1
Shiawassee	08N 01E	3
Washtenaw	01S 03E	4
Washtenaw	02S 03E	6

Table 3.–Grand River and tributary average discharge summary. Drainage area corresponds to area upstream of each gauge location. Data from United States Geological Survey for active and retired gauges except as noted. Asterisk (*) denotes miscellaneous discharge measurements (Holtschlag and Eagle 1985).

Segment and water body	Location	USGS station number	Latitude Longitude (dd)	Period of record	Average discharge (cfs)	Drainage area (mi^2)	Discharge ($cf/s/mi^2$)
Headwaters							
1. Grand River	Jackson	04109000	42.28365 N 84.40885W	1935–2004	128.0	174.0	0.74
2. Portage River	Munith	04109500	42.34948 N 84.22885W	1944–1956	41.6	55.0	0.76
3. Orchard Creek	Munith	04110000	42.39365 N 84.26496W	1944–1956	37.1	49.0	0.76
Upper							
4. Grand River	Eaton Rapids	04111000	42.53476 N 84.62304W	1950–2004	472.0	661.0	0.71
Huntoon Creek*	Leslie	04110650	42.43667 N 84.43667W	1955–1967	3.8	11.2	0.33
Sandstone Creek*	Tompkins Center	04110700	42.37306 N 84.54500W	1955–1967	26.6	91.2	0.29
Middle							
5. Red Cedar River	Williamston	04111379	42.68309 N 84.21913W	1975–2004	103.0	163.0	0.63
6. Deer Creek	Dansville	04111500	42.60837 N 84.32080W	1954–2004	11.5	16.3	0.70
7. Sloan Creek	Williamston	04112000	42.67587 N 84.36386W	1954–2004	5.8	9.3	0.62
8. Red Cedar River	East Lansing	04112500	42.72781 N 84.47775W	1902–2004	216.0	355.0	0.61
9. Sycamore Creek	Holt	04112850	42.64031 N 84.48275W	1975–1997	57.3	80.6	0.71
10. Grand River	Lansing	04113000	42.75059 N 84.55526W	1901–2004	875.0	1,230.0	0.71
11. Carrier Creek	Lansing	04113097	42.75559 N 84.65276W	1975–1980	6.1	12.1	0.50

Table 3.–Continued.

Segment and water body	Location	USGS station number	Latitude Longitude (dd)	Period of record	Average discharge (cfs)	Drainage area (mi^2)	Discharge (cf/s/mi^2)
Middle–continued							
12. Grand River	Portland	04114000	42.85642 N 84.91222W	1952–2004	992.0	1,385.0	0.72
13. Looking Glass River	Eagle	04114498	42.82809 N 84.75943W	1944–2004	184.0	281.0	0.66
Lower							
14. Maple River	Maple Rapids	04115000	43.10975 N 84.69305W	1944–2004	276.0	434.0	0.63
15. Fish Creek	Crystal	04115265	43.24975 N 84.98112W	1987–2004	31.2	39.7	0.79
16. Grand River	Ionia	04116000	42.97198 N 85.06917W	1931–2004	2,042.0	2,840.0	0.72
17. Flat River	Smyrna	04116500	43.05281 N 85.26474W	1950–1986	440.0	528.0	0.83
18. Quaker Brook	Nashville	04117000	42.56587 N 85.09361W	1954–2004	6.6	7.6	0.86
19. Thornapple River	Hastings	04117500	42.61587 N 85.23639W	1944–2004	329.0	385.0	0.85
20. Thornapple River	Caledonia	04118000	42.81114 N 85.23639W	1951–1994	664.0	773.0	0.86
21. Rogue River	Rockford	04118500	43.08225 N 85.59086W	1952–2003	241.0	234.0	1.03
22. Grand River	Grand Rapids	04119000	43.01474 N 85.95588W	1901–2003	3,769.0	4,900.0	0.77
Mouth							
23. Grand River	Eastmanville	04119300	43.01475 N 85.95588W	1976–1977	3,466.0	5,230.0	0.66
24. Grand River	Grand Haven	04120250	43.06040 N 86.24038W	1994–1996	5,221	5,518.0	0.95

Table 4.–Seasonal flow stability attributes for the Grand River main stem and tributaries and selected Michigan river catchments of similar sizes as calculated from USGS streamflow data. Low-flow yield (LFY) is calculated as 90% exceedence flow/mi^2 and the 10:90% exceedances flow ratio (10:90 ratio) is calculated as 10% exceedance flow divided by the 90% exceedance flow. Qualitative ratings for the 10:90 ratio are: Very good is 1.0–2.0, good is 2.1–5.0, fair is 5.1–10.0, and poor is >10.0 (P. Seelbach, Michigan Department of Natural Resources, Fisheries Division, personal communication).

Water body	Location	Size (mi^2)	LFY	10:90 ratio
Grand River	Jackson	174	0.23	6.45
Portage River	Munith	55	0.08	22.55
Grand River	Eaton Rapids	661	0.18	8.42
Red Cedar River	Williamston	163	0.11	14.36
Deer Creek	Dansville	16.3	0.04	36.81
Sloan Creek	Williamston	9.3	0.02	77.22
Red Cedar River	East Lansing	355	0.08	17.29
Sycamore Creek	Holt	80.6	0.12	12.04
Grand River	Lansing	1,230	0.15	10.36
Carrier Creek	Lansing	12.1	0.01	73.88
Grand River	Portland	1,385	0.17	8.92
Looking Glass River	Eagle	280	0.12	13.12
Maple River	Maple Rapids	434	0.05	28.51
Fish Creek	Crystal	39.7	0.40	3.18
Grand River	Ionia	2,840	0.16	9.68
Flat River	Smyrna	528	0.38	3.98
Quaker Brook	Nashville	7.6	0.31	5.28
Thornapple River	Hastings	385	0.24	7.44
Thornapple River	Caledonia	773	0.29	5.93
Rogue River	Rockford	234	0.47	3.80
Grand River	Grand Rapids	4,900	0.24	6.38
Bear Creek	Muskegon	16.7	0.26	6.82
Macatawa River	Zeeland	68.5	0.05	45.45
Sturgeon River	Wolverine	198	0.80	1.86
Clinton River	Mount Clemans	734	0.16	9.99
Kalamazoo River	Battle Creek	824	0.35	4.30
Kalamazoo River	Comstock	1,010	0.41	3.70
Muskegon River	Croton	2,313	0.43	3.19
St. Joseph River	Niles	3,666	0.41	4.09
Saginaw River	Saginaw	6,060	0.17	9.19

Table 5.–Communities participating in the National Flood Insurance Program. Data from Federal Insurance Administration, Federal Emergency management Agency (2004).

Segment and Community name	County	ID number	Date of current map
Headwaters			
Blackman Township	Jackson	260714	1984
City of Jackson	Jackson	260273	1984
Leoni Township	Jackson	260930	1984
City of Leslie	Ingham	260091	1979
Summit Township	Jackson	260575	1982
Upper			
Carmel Township	Eaton	260682	
Village of Dimondale	Eaton	260333	1980
City of Eaton Rapids	Eaton	260067	1982
Eaton Rapids Township	Eaton	260319	1983
City of Lansing	Clinton Eaton Ingham	260090	1990
Lansing Township	Ingham	260632	1981
Windsor Township	Eaton	260071	1981
Middle			
Alaiedon Township	Ingham	260670	1979
City of DeWitt	Clinton	260060	1979
DeWitt Township	Clinton	260631	1980
Delhi Township	Ingham	260088	1990
Delta Township	Eaton	260066	1999
City of East Lansing	Ingham	260089	1980
Village of Fowlerville	Livingston	260439	1987
City of Grand Ledge	Eaton	260068	1981
City of Laingsburg	Shiawassee	260950	
Lansing Township	Ingham	260632	1981
Leroy Township	Ingham	260906	
Locke Township	Ingham	260671	1982
City of Mason	Ingham	260092	1982
Meridian Township	Ingham	260093	2000
Oneida Township	Eaton	260070	1981
Putnam Township	Livingston	260442	1988
Shiawassee Township	Shiawassee	260523A	1986
Victor Township	Clinton	260720	1989
Watertown Township	Clinton	260291	1982
Village of Webberville	Ingham	260416	1983
White Oak Township	Ingham	260417A	1990
City of Williamston	Ingham	260094	1982
Williamston Township	Ingham	260095	1982
Lower			
Ada Township	Kent	260248	1980
Algoma Township	Kent	260738	1985
Alpine Township	Kent	260961	2002
Ashland Township	Newaygo	260694	1989

Table 5.–Continued.

Segment and Community name	County	ID number	Date of current map
Lower– continued			
Baltimore Township	Barry	260666	1985
City of Belding	Ionia	260096B	1986
Caledonia Township	Kent	260693	1981
Cannon Township	Kent	260734	1988
Cascade Township	Kent	260814	1991
Castleton Township	Barry	260641	1988
City of Charlotte	Eaton	260065	1981
Croton Township	Newaygo	260468	1988
City of East Grand Rapids	Kent	260105	1980
Easton Township	Ionia	260727	
Village of Elsie	Clinton	260725	1987
Ensley Township	Newaygo	261042	1999
Eureka Township	Montcalm	260735	1984
Fulton Township	Gratiot	261028	
City of Grand Rapids	Kent	260106	1982
City of Grandville	Kent	260271	1982
City of Greenville	Montcalm	260158	1983
City of Hastings	Barry	260314	1981
Hastings Township	Barry	260648	1981
Hope Township	Barry	260681	1984
Village of Hubbardston	Ionia	260418A	1995
City of Hudsonville	Ottawa	260493	1984
City of Ionia	Ionia	260097	1983
Ionia Township	Ionia	260832	1999
Irving Township	Barry	260354B	1992
Jamestown Township	Ottawa	261001	
Johnstown Township	Barry	260355A	1986
City of Kentwood	Kent	260107	1981
Village of Lake Odessa	Ionia	260419A	1986
City of Lowell	Kent	260108	1983
Maple Grove Township	Barry	260644	1986
Village of Maple Rapids	Clinton	260384A	1986
Village of Middleville	Barry	260356A	1986
Village of Muir	Ionia	260916	1996
Village of Nashville	Barry	260902	1999
Village of Ovid	Clinton	260318	1993
Plainfield Township	Kent	260109	1981
City of Portland	Ionia	260574	1984
Portland Township	Ionia	260841	1992
City of Potterville	Eaton	260711	1979
Robinson Township	Ottawa	260913	
Rush Township	Shiawassee	260522	1986
Rutland Township	Barry	260656	1986
Village of Saranac	Ionia	260421C	1987
Sparta Township	Kent	260741	1985
Village of Sparta	Kent	260336	1983

Table 5.–Continued.

Segment and Community name	County	ID number	Date of current map
Lower– continued			
City of St. Johns	Clinton	260726	
Tallmadge Township	Ottawa	260494	1983
Thornapple Township	Barry	260630	1986
Victor Township	Clinton	260720	1989
City of Walker	Kent	260110	1982
City of Wyoming	Kent	260111	1992
Mouth			
Allendale Township	Ottawa	260490	1982
Blendon Township	Ottawa	261005	
Chester Township	Ottawa	260829	1991
Village of Coopersville	Ottawa	260491	1983
Crockery Township	Ottawa	260981	
City of Ferrysburg	Ottawa	260184	1978
Georgetown Township	Ottawa	260589	1992
City of Grand Haven	Ottawa	260269	1978
Grand Haven Township	Ottawa	260270	1981
Polkton Township	Ottawa	260923	
Ravenna Township	Muskegon	260731	1989
Spring Lake Township	Ottawa	260281	1978
Village of Spring Lake	Ottawa	260282	1978
Wright Township	Ottawa	260495	

Table 6.–Presettlement and modern wetland acreage by county and wetland type in the Grand River watershed. Asterisk (*) denotes counties not wholly within the watershed (adapted from Comer 1996).

	Wetland type							
	Lowland hardwoods		Lowland conifers		Shrub swamp		Emergent wetland	
County	1800s	1980	1800s	1980	1800s	1980	1800s	1980
Allegan*	42,869	54,699	32,918	499	2,202	10,598	3,797	2,948
Barry*	7,608	30,147	21,394	589	539	13,826	9,598	8,484
Calhoun*	20,446	50,386	32,039	749	660	23,085	85,697	3,897
Clinton	24,875	20,110	17,187	113	3,886	6,786	11,171	3,189
Eaton	18,972	27,372	35,164	323	3,740	3,560	1,987	1,637
Gratiot*	54,138	42,763	16,092	653	132	1,038	2,258	400
Hillsdale*	23,758	45,215	10,460	42	1,181	7,381	15,584	5,988
Ingham*	16,781	30,259	35,347	454	3,947	6,349	22,125	5,822
Ionia	21,144	26,138	16,279	39	4,361	10,699	4,109	310
Jackson*	10,978	38,652	20,985	1,054	642	45,264	67,918	3,545
Kent	37,697	43,285	15,834	1,387	3,609	8,695	8,534	3,081
Livingston*	14,906	31,720	25,125	569	314	19,324	39,787	6,119
Mecosta*	5,725	38,274	38,583	10,630	1,074	8,457	1,321	4,443
Montcalm*	30,202	36,930	40,455	7,971	1,097	20,493	4,377	5,127
Muskegon*	21,977	16,241	23,384	2,327	582	3,829	11,594	2,936
Newaygo*	17,624	31,480	54,406	3,321	2,261	12,144	8,794	1,531
Ottawa*	24,928	14,560	17,163	9	11,022	3,748	5,784	2,008
Shiawassee*	37,032	24,215	19,826	248	99	711	16,446	4,241
Washtenaw*	41,265	22,923	13,031	227	1,861	14,756	41,655	4,265

Table 7.–Number of road-stream crossings, by county, for the Grand River basin. Data from Michigan Geographic Framework county transportation and hydrography data (MCGI, SDL 2004).

County	Number of crossings	Percentage of total
Allegan	15	<1
Barry	509	6
Calhoun	2	<1
Clinton	990	11
Eaton	567	>6
Gratiot	439	5
Hillsdale	12	<1
Ingham	752	9
Ionia	871	10
Jackson	591	>6
Kent	1,698	20
Livingston	175	2
Mecosta	14	<1
Montcalm	608	7
Muskegon	192	2
Newaygo	79	<1
Ottawa	759	>9
Shiawassee	361	4
Washtenaw	5	<1
Total	8,639	100

Table 8.–Predicted fish habitat quality and channel characteristics for various gradient classes. G. Whelan, MDNR, Fisheries Division, unpublished data.

Gradient class	Fish habitat	Channel characteristics
0.0–2.9 ft/mi	low	Mostly run habitat with low hydraulic diversity
3.0–4.9 ft/mi	fair	Some riffles with modest hydraulic diversity
5.0–9.9 ft/mi	good	Riffle-pool sequences with good hydraulic diversity
10.0–69.9 ft/mi	excellent	Established, regular riffle-pool sequences with excellent hydraulic diversity
70.0–149.9 ft/mi	fair	Chute and pool habitats with only fair hydraulic diversity
>150 ft/mi	poor	Falls and rapids with poor hydraulic diversity

Table 9.–Measured and expected channel widths for United States Geological Survey gauge sites in the Grand River watershed at average discharge. Status indicates measured channel widths are outside the expected range; W is too wide and N is too narrow. Expected mean width, and upper and lower 95% widths were calculated using equations developed by Leopold and Maddock (1953), and Leopold and Wolman (1957).

	Expected width at average discharge					
Segment/Site	Discharge (ft3/s)	Width (ft)	Lower bound	Expected mean width	Upper bound	Status
Headwaters segment						
Grand River at Jackson	128	47.1	45.3	61.9	84.6	
Upper segment						
Grand River at Eaton Rapids	472	111.6	83.9	118.7	167.9	
Middle segment						
Grand River at Lansing	875	178.4	112.2	161.4	232.2	
Grand River at Portland	992	262	119.1	171.8	248	W
Red Cedar River at Williamston	103	59.7	40.9	55.6	75.4	
Red Cedar River at E. Lansing	216	82.1	58	80.4	111.3	
Deer Creek	11.5	17.5	14.6	18.6	23.8	
Sloan Creek	5.8	15.5	10.5	13.2	16.6	
Looking Glass River	184	82.7	53.8	74.2	102.3	
Lower segment						
Grand River at Ionia	2,042	232.8	167.4	246.3	362.4	
Grand River at Grand Rapids	3,769	444.7	223.4	334.3	500	
Maple River	276	95.3	65.1	90.8	126.6	
Fish Creek	31.2	30.3	23.3	30.6	40.3	
Flat River	440	90.3	81.2	114.6	161.8	
Thornapple River	329	110.5	70.8	99.1	138.9	
Quaker Brook	6.6	11.2	11.2	14.1	17.8	
Rogue River	241	82	61.1	84.9	117.9	
Mouth segment						
Grand River at Eastmanville	4,032.8	481.6	230.7	345.7	518.1	

Table 10.–Measured and expected channel widths for United States Geological Survey gauge sites in the Grand River watershed at 95% exceedence. Status indicates measured channel widths are outside the expected range; W is too wide and N is too narrow. Expected mean width, and upper and lower 95% widths were calculated using equations developed by Leopold and Maddock (1953), and Leopold and Wolman (1957).

	Expected width at 95% exceedence discharge					
Segment/Site	Discharge (ft3/s)	Width (ft)	Lower bound	Expected mean width	Upper bound	Status
Headwaters segment						
Grand River at Jackson	33.3	40.4	24	31.6	41.7	
Upper segment						
Grand River at Eaton Rapids	96.7	84	39.7	53.8	73	W
Middle segment						
Grand River at Lansing	142.6	131	47.7	65.3	89.5	W
Grand River at Portland	196.6	205	55.5	76.7	105.9	W
Red Cedar River at Williamston	14.7	36	16.3	21.1	27.1	W
Red Cedar River at E. Lansing	22	70.8	19.8	25.7	33.5	W
Deer Creek	0.47	4.6	3.2	3.8	4.4	W
Sloan Creek	0.12	2.6	1.7	1.9	2.2	W
Looking Glass River	26.5	74.2	21.6	28.2	37	W
Lower segment						
Grand River at Ionia	368.5	225.8	74.6	104.9	147.4	W
Grand River at Grand Rapids	1,025.8	428	121	147.7	252.4	W
Maple River	17.7	34.5	17.8	23.1	29.9	W
Fish Creek	13.8	25.4	15.9	20.4	26.2	
Flat River	174.3	71.1	52.4	72.2	99.5	
Thornapple River	78.2	96.8	35.9	48.4	65.3	W
Quaker Brook	1.89	9	6.2	7.6	9.2	
Rogue River	95.8	73.8	39.6	53.6	72.6	W
Mouth segment						
Grand River at Eastmanville	1,097.6	459.3	124.9	180.7	261.5	W

Table 11.–Measured and expected channel widths for United States Geological Survey gauge sites in the Grand River watershed at 5% exceedence. Status indicates measured channel widths are outside the expected range; W is too wide and N is too narrow. Expected mean width, and upper and lower 95% widths were calculated using equations developed by Leopold and Maddock (1953), and Leopold and Wolman (1957).

	Expected width at 5% exceedence discharge					
Segment/Site	Discharge (ft3/s)	Width (ft)	Lower bound	Expected mean width	Upper bound	Status
Headwaters segment						
Grand River at Jackson	326.2	55.4	70.5	98.7	138.2	N
Upper segment						
Grand River at Eaton Rapids	1,318.8	140	136.2	198	288	
Middle segment						
Grand River at Lansing	2,646.4	191.3	189.1	280.2	415.3	
Grand River at Portland	2,854.1	209.7	196	291	432.1	
Red Cedar River at Williamston	361	110	73.9	103.8	145.8	
Red Cedar River at E. Lansing	783.4	91.7	106.5	152.8	219	N
Deer Creek	44.2	20.8	27.5	36.4	48.4	N
Sloan Creek	25.8	19.4	21.3	27.9	36.4	N
Looking Glass River	628.3	91	96	136.9	195.1	N
Lower segment						
Grand River at Ionia	6,279.4	303.4	284.2	431.1	653.9	
Grand River at Grand Rapids	10,507.4	439	362.3	557.2	857	
Maple River	1,051.2	171	122.4	176.9	255.6	
Fish Creek	65.2	33.5	33	44.2	59.3	
Flat River	984.7	85.8	118.7	171.2	247	N
Thornapple River	1,024.3	115	120.9	174.9	252.2	N
Quaker Brook	17.8	12.9	17.9	23.2	30	N
Rogue River	554.9	79.3	90.5	128.6	182.7	N
Mouth segment						
Grand River at Eastmanville	11,242.9	483.3	374.1	576.4	888	

Table 12.–Information on Grand River dams and impoundments. Dam purpose: flood control (C), hydroelectric (H), retired hydroelectric (RH), recreation (R), water supply (S), or other (O). Hazard type: 1=high, 2=significant, and 3=low. High hazard means loss of life would occur; significant hazard is large amounts of property damage would occur. Dash (–) indicates no data available. Data from MDNRE Water Resources Division dam safety database.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Headwaters										
Baldwin Flooding	Trist Creek	Earth	1960	O	State	3	35	145	4	3
Center Lake Dam	Tributary to Grand River	Other	1973	R	State	2	12	40	3	3
Crystal Lake	Grand River	Other	–	R	–	–	125	–	–	3
Dansville State Game Area Dam	Bateese Creek	Earth	1986	O	State	3	24	45	2	3
Gillettes Lake Dam	Gillettes Lake outlet	Other	1965	R	Private	3	340	–	–	3
Holton Dam (Removed in 2001)	Grand River	Gravity	1936	RH	Local gov	NA	NA	NA	NA	NA
Jackson Prison Ponds Dam	Tributary to Grand River	Earth	1970	O	State	6	16	145	9	3
Lake Le Ann-North	Grand River	Earth	1961	R	Private	19	200	1,200	6	2
Lake Le Ann-South	Grand River	Earth	1960	R	Private	7	275	1,000	4	3
Leoni Mill Dam	Grass Lake Drain	Earth	1913	R	Local gov	3	30	130	4	3
Liberty Dam	Grand River	Earth	1848	RH, R	Private	7	11	72	7	2
Mercedes Dam	Sharp Creek	Earth	–	R	Private	–	9	–	–	3
Michigan	Grand River	Gravity	1911	R	Local gov	7	2,160	8,000	4	2
Mirror Lake	Grand River	Earth	1966	R	Private	15	61	745	12	2
Mud Lake Dam	Mud Lake outlet	Gravity	1840	R	State	3	250	184	1	3
Petterson Dam	Trist Creek	Earth	1962	O	Private	10	4	–	–	3
Pleasant Lake Dam	Western Creek	Other	1980	O	Private	1	269	215	1	3
Portage Creek Dam	Portage Creek	Earth	1938	R	State	6	13	60	5	3
Portage Lake Dam	Portage River	Earth	1957	R	State	4	400	6,500	16	3
Putney Dam	Mill Creek	Earth	1848	R	Private	7	6	80	13	3
Schroen Dam	Willow Creek	Earth	1961	O	Private	6	2	–	–	3
Stoker Dam	Tributary to Portage Lake	Earth	1987	R	State	2	6	15	3	3
Sylvan Trout Pond Dam	Tributary to Portage Creek	Other	1945	O	State	7	2	6	3	3
Upper Sylvan (Removed in 2000)	Tributary	Other	1987	R	State	NA	NA	NA	NA	NA
Waterloo Dam	Tributary to Portage River	Earth	1963	R	Private	–	15	110	7	3
Winnewanna Dam	Portage Creek	Earth	1956	R	State	9	280	1,560	6	2
Upper										
Hall Dam	Spring Brook	Earth	1967	R	Private	–	1	39	39	3
Hawkins Dam	E Br Columbia Creek	Earth	1954	O	Private	2	1	–	–	3
Lords Lake Dam	Sandstone Creek	–	–	–	Private	–	4	–	–	3
Minard's Mill Dam	Sandstone Creek	Earth	1944	R	Local gov	5	41	170	4	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Upper–continued										
State Street Dam	Grand River	Earth	1933	H	Private	9	53	340	6	3
Moore's Park Dam	Grand River	Gravity	1908	H	Public Ut	15	240	2,500	10	1
Sanitation Dam	Grand River	Gravity	1918	O	Local gov	2	3	–	–	3
Mix Dam	Spring Brook	Gravity	1933	–	Private	–	1	–	–	3
Smithville	Grand River	Gravity	1887	H	Private	13	29	330	11	1
Spark Foundry	Tributary to Sandstone	–	–	–	Private	–	2	–	–	3
VFW Dam	Tributary to Grand River	Earth	1956	O	Local gov	7	2	–	–	3
Van Aken Dam	Tributary to Grand River	Earth	1965	R	Private	–	1	24	24	3
Wilson Dam (Removed in 2005)	Grand River	Earth	1880	R	Local gov	NA	NA	NA	NA	NA
Middle										
Cameron Dam	Tributary M.B. Red Cedar	Gravity	1957	R	Private	2	1	–	–	3
Cedar Lake Dam	Tributary to Red Cedar	Gravity	1964	R	Private	1	117	140	1	3
Cornell's Dam	Handy-Iosco Drain	Earth	1961	R	Private	5	4	–	–	3
Deer Creek Dam	Deer Creek	Other	1954	O	Private	–	1	–	–	3
Grand Ledge Dam	Grand River	Gravity	1900	R	Local gov	5	1	1,200	1,200	3
Hunters Hollow Hunt Club	Mud Creek	Earth	1975	R	Private	5	29	–	–	3
Kreeger Dam	Tributary to Red Cedar	Earth	1964	R	Private	3	1	–	–	3
Lake Geneva Dam	Tributary to Looking Glass	Earth	1955	R	Private	14	300	350	1	2
Lake Lansing Dam	Lake Lansing Outlet	Gravity	1970	R	Private	5	453	360	1	3
Lake of the Hills Dam	Tributary to Red Cedar	Earth	1967	R	Private	5	32	144	5	3
Lowry Dam	Willow Creek	Earth	1963	O	Private	1	1	–	–	3
Lyons Dam	Grand River	Gravity	1900	RH	Local gov	8	120	1,820	15	3
Mason Wil Dam	Mud Creek	Earth	1960	R	State	8	19	150	8	3
Moon Lake Dam	Tributary to Looking Glass	Earth	–	R	Private	4	32	64	2	3
Myers-Hen Dam	Miller Creek	Earth	1992	C, S	Private	2	28	150	5	1
North Lansing Dam	Grand River	Gravity	1936	RH	Public	8	92	1,810	20	1
Portland Dam	Grand River	Gravity	1896	H	Local gov	11	104	625	6	3
Red Cedar –MSU Weir	Red Cedar River	Other	–	O	Private	2	5	–	–	3
Rose Lake Dam	Tributary to Looking Glass	Earth	1960	O	State	7	68	160	2	3
Rose Lake Dam	Tributary to Vermillion Cr.	Earth	–	O	State	2	32	640	20	3
Ryon Dam	Tributary to Looking Glass	Earth	–	R	Private	10	4	–	–	3
Scenic Lake Dam	Tributary to Looking Glass	Earth	1964	R, O	Private	9	174	3,136	18	3
Sloan Creek Dam	Sloan Creek	Other	1954	–	Private	–	1	–	–	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Middle–continued										
Webber Dam	Grand River	Gravity	1907	H	Private	33	660	8,900	13	1
Weippert Dam	Sebewa Creek	Earth	1840	R	Private	6	14	60	4	3
Williamston Dam	Red Cedar River	Earth	1880	R	Private	9	–	640	–	3
Lower										
Ada Dam	Thornapple River	Gravity	1926	H	Private	23	318	4,400	14	1
Albion Dam	Tributary to Glass Creek	Earth	1949	R	State	3	17	65	4	3
Algonquin Lake Dam	Kurtz Creek	Earth	1927	R	Private	12	271	1,070	4	2
Alward Lake Dam	Alward Lake Creek	Gravity	1950	O	Local gov	1	19	–	–	3
Augustine Dam	Tributary to Bear Creek	–	1957	O	Private	–	2	–	–	3
Beautific Dam	Wadell Creek	Other	–	R	Private	2	2	–	–	3
Belding Dam	Flat River	Gravity	1887	H	Private	11	110	900	8	3
Big Brower Lake Dam	Big Brower Lake Outlet	Gravity	1965	O	Private	1	85	105	1	3
Big Crooked Lake Dam	Tributary to Seely Creek	Other	1963	–	Private	1	157	180	1	3
Blythefield Dam	Tributary to Bear Creek	Earth	–	O	Private	3	1	1	1	3
Blythefield Dam	Tributary to Bear Creek	Earth	–	O	Private	6	1	2	2	3
Cannon Creek Dam	Cannon Creek	Earth	1930	R	Private	10	3	70	23	3
Cannonville Dam	Tributary to Flat River	Earth	–	R	State	5	7	24	3	3
Cascade Dam	Thornapple River	Gravity	1926	H	Local gov	28	270	3,600	13	1
Cedar Creek Dam	Cedar Creek	Earth	1900	R	Private	10	25	135	5	3
Chou-Cann Dam	Bear Creek	Earth	1846	O	Private	10	2	12	6	3
Clear Lake Dam	Tributary to Spring Creek	Gravity	1967	R	Private	1	8	10	1	3
Comstock Dam	Mill Creek	Earth	–	O	Local gov	11	2	11	6	3
County Farm Dam	Dickerson Creek	Gravity	1926	R	Private	9	23	300	13	3
County Line Dam	Tributary to Wabasis Creek	Earth	1968	R	State	5	29	220	8	3
Cowden Lake Dam	Seepage Lake (no outlet)	–	–	–	–	–	108	–	–	3
Cross Creek Dam	Tributary to Plaster Creek	Earth	1988	C, S	Private	3	3	12	4	3
Crystal Lake Dam	Crystal Lake Outlet	Gravity	1932	R	Private	1	724	640	1	3
Crystal S Dam	Rush Creek	–	–	–	–	–	5	–	–	–
Cummings Dam	Springbrook Creek	Earth	1970	R	Private	15	11	230	21	2
Deadwood Dam	Tributary to Glass Creek	Earth	–	R	State	3	11	22	2	3
Dean Lake Dam	Tributary to Grand River	–	–	–	–	–	74	–	–	3
Deweerd Dam	Rush Creek	Earth	1983	C, S	Local gov	18	13	172	13	3
Dills Dam	Tributary to Thornapple	Earth	1968	R	Private	17	3	49	16	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Lower–continued										
Duck Lake Dam	Tributary to Crystal Lake	Gravity	1963	O	Private	1	306	240	1	3
Duncan Lake Dam	Duncan Creek	Earth	–	O	Private	5	1	15	15	3
Eastbrook Dam	Whiskey Creek	Earth	1965	R	Private	10	17	136	8	3
Echo Lake Dam	Tributary to Plaster Creek	Earth	1969	R	Private	1	15	12	1	3
Elsie Dam	Maple River	Concrete	1840	R	Local gov	8	32	80	3	3
Enness Dam	Tributary to Flat River	Earth	–	–	Private	10	2	–	–	3
Falconcrest Dam	Plaster Creek	Earth	1989	C, S	Private	1	–	–	–	2
Fallasburg Dam	Flat River	Gravity	1900	H	Local gov	35	259	3,300	13	2
Ferris Dam	Toles Creek	–	–	–	Private	–	1	–	–	3
Fine Lake Dam	Fine Lake Outlet	Earth	1959	R	Private	1	320	640	2	3
Five Lake Dam	Black Creek	Other	1966	R	Private	1	264	–	–	3
Giesler Dam	Lacey Creek	Earth	1968	C, S	Private	–	4	65	16	3
Good Point Dam	Tributary to Dickerson Creek	Earth	–	O	State	7	60	316	5	3
Grand Rapids (6^{th} Street) Dam	Grand River	Gravity	1917	RH	Local gov	8	–	–	–	3
Grand River	Grand River	Gravity	–	R	Local gov	2	–	–	–	3
Grass Lake Dam	Barkley Creek	Earth	1969	R	Private	23	75	5,917	79	2
Gratiot-Saginaw SGA Dam	Tributary to Maple River	Earth	–	O	State	2	60	–	–	3
Gratiot-Saginaw SGA Dam	Tributary to Maple River	Earth	1961	O	State	1	20	–	–	3
Gratiot-Saginaw SGA Dam	Tributary to Maple River	Earth	–	O	State	1	21	–	–	3
Greens Flooding Dam	Tributary to Dickerson Creek	Earth	–	O	State	5	13	95	7	3
Greenville Dam	Flat River	Gravity	1914	RH	Local gov	8	149	3,000	20	2
Haas Dam	Thornapple Drain	Earth	1965	O	Private	–	3	45	15	3
Hanson Dam	Indian Lake	Gravity	–	R	Private	5	–	–	–	3
Hartwell Lake Dam	Tributary Sessions Creek	Earth	1988	O	State	–	36	36	1	3
Harwell Lake Dam	Costen Drain	–	–	–	Private	–	4	–	–	3
Hastings Dam	West Creek	Gravity	1920	O	Local gov	3	4	–	–	3
Hecht Dam	Tributary to Coldwater River	–	–	–	Private	–	2	–	–	3
Honey Creek Dam	Honey Creek	Gravity	1930	R	Private	12	3	–	–	3
Honey Creek Dam	Honey Creek	Gravity	–	R	Private	2	1	–	–	3
Hubbardston Dam	Fish Creek	Gravity	1850	H	Private	15	35	420	12	3
Hubbell Dam (Removed in 2003)	Tributary to Glass Creek	Earth	1961	O	Private	10	NA	NA	NA	NA
Hulsebos Dam	Shanty Creek	–	1981	R	Private	6	–	25	–	3
Humany Dam	Tributary to Dickerson Creek	Earth	1932	R	State	5	18	102	6	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Lower–continued										
Hunter Lake Dam	Tributary to Flat River	Earth	1964	R	Private	3	46	140	3	3
Irving Hydroelectric Dam	Thornapple River	Gravity	1939	H	Private	16	32	235	7	3
Johnson E Dam	Rush Creek	Other	1981	R	Private	1	3	4	1	3
Johnson's Dam	Tributary to Thornapple	Earth	1947	R	Private	–	–	–	–	3
Jordan Lake Dam	Little Thornapple River	Gravity	1958	R	Private	1	198	240	1	3
Jordan Lake Dam	Tributary Lake Thornapple	Earth	1988	R	State	1	12	60	5	3
Jousma Dam	Tributary to Grand River	Earth	1972	R	Private	7	4	–	–	3
Kenowa Lake Dam	Rush Creek	Earth	1975	R	Private	3	11	95	9	3
King Mill Dam	Flat River	Earth	1942	O, R	Private	14	53	645	12	2
LaBarge Dam	Thornapple River	Gravity	1901	H	Private	19	100	5,250	53	1
Lacey Lake Dam	Lacey Creek	Gravity	1972	R	Private	3	56	140	3	3
Lake Manitou Dam	Tributary to Springbrook	Earth	1973	R	Private	10	80	470	6	3
Lake Victoria	Alder Creek	Earth	1961	R	Private	20	52	600	12	3
Laraway Creek Dam	Tributary to Plaster Creek	Earth	1980	C, S	Private	–	3	12	4	3
Lenhert Dam	Bad Creek	Earth	–	R	Private	6	1	1	1	3
Lincoln Lake Dam	Clear Creek	Other	1963	R	Private	1	411	490	1	3
Little Pine Island Lake Dam	Tributary to Mill Creek	Other	1964	R	Private	1	120	100	1	3
Little Rainbow Lake Dam	Tributary to Pine Creek	Earth	1972	R	Private	30	17	305	18	3
Little Twin Lake Dam	Little Twin Lake Outlet	Gravity	1965	R	Private	–	1	–	–	3
Long Lake Dam	Tributary to Fall Creek	Earth	1966	R	State	3	4	9	2	3
Long Lake Dam	Ravels Creek		1929	O	Private	1	356	285	1	3
Manoka Lake Dam	Tributary to Flat River	Gravity	1928	O	Local gov	4	9	–	–	3
Markman Dam	Tributary to Little Maple River	Earth	1978	R	Private	4	4	–	–	3
McCaul Dam	Tributary to Grand River	–	–	–	Private	–	4	–	–	3
Middleville Dam	Thornapple River	Gravity	1938	H	Private	12	35	270	8	2
Miel Dam	Townline Creek	–	–	–	Private	–	1	–	–	3
Milli-Anderson Wildlife Flooding	Collier Creek	Earth	1983	R	State	2	140	490	4	3
Morgan Dam	Highbanks Creek	Gravity	1870	O	Private	10	–	–	–	3
Morrison Lake Dam	Lake Creek	Gravity	1962	R	Local gov	1	330	–	–	3
Muskrat Flooding (Removed in 2010)	Cain Creek	Earth	1962	O	State	NA	NA	NA	NA	NA
Myers Lake Dam	Myers Lake Outlet	–	–	–	–	–	88	–	–	3
Nashville Dam (Removed in 2009)	Thornapple River	Earth	1874	R	Local gov	NA	NA	NA	NA	NA

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Lower–continued										
Nichols Dam	Armstrong Creek	Concrete	1992	R	Private	–	4	–	–	3
No Name	Tributary to Grand River	–	–	–	Private	–	1	–	–	3
North Branch Dam	North Branch Cedar Creek	Earth	1967	R	Private	12	7	77	11	3
North Branch Dam	North Branch Rush Creek	Earth	1978	O	Local gov	14	54	375	7	3
Parmalee Dam	Cain Creek	Earth	1988	R	State	4	4	12	3	3
Pearl Lake Dam	Prairie Creek	Gravity	1969	R	Private	2	30	35	1	3
Perrington Dam	Pine Creek	Earth	1965	O	Private	8	1	–	–	3
Phillips Dam	Cox Drain	Earth	–	R	Private	3	3	–	–	3
Pine Lake Dam	Coopers Creek	–	–	–	–	–	–	–	–	3
Podunk Lake Dam	Podunk Creek	Gravity	1958	R	Local gov	1	81	48	1	3
Pond 2 Dam	Tributary Sessions Creek	Earth	1981	O	State		1	1	1	3
Pond 3 Dam	Tributary Sessions Creek	Earth	1981	O	State	5	1	3	3	3
Pond 4 Dam	Tributary Sessions Creek	Earth	1981	R	State	3	1	7	7	3
Prairie Dam	Prairie Creek	Earth	–	–	Local gov	4	1	–	–	3
Rainbow Lake Dam	Pine Creek	Earth	1962	R	Private	42	238	5,400	23	2
Reith Dam	Lee Creek	–	–	–	Private	–	2	–	–	3
Robinson Dam	Tributary to Thornapple R.	Earth	1990	O	Private	5	12	39	3	3
Rockford Dam	Rogue River	Gravity	1888	RH	Local gov	12	23	180	8	2
Rooker Dam	Tributary to Thornapple	–	–	–	Private	–	1	–	–	3
Root Dam	Sand Creek	Earth	1860	RH	Private	–	–	60	–	3
Rushmore Dam	Rush Creek	–	–	–	–	4	38	–	–	3
Sackett Dam	Tributary to Fish Creek	Earth	1960	O	Private		–	–	–	3
Sadilek Dam	Tributary to Pine Creek	Earth	1960	R	Private	8	8	180	23	3
Sam Dix Dam	Tributary to Bear Creek	Earth	1989	O	Private	10	1	5	5	3
Sand Lake Dam	Duck Creek	Other	1968	R	Private	1	96	–	–	3
Sarniak Dam	Tributary to Page Creek	–	–	–	Private	–	3	–	–	3
Schlarf Dam	Maple River	Earth	–	R	Private	8	1	–	–	3
Schutz Dam	Tributary to Turner Creek	Earth	1962	O	Private	15	4	–	–	3
Secluded Dam	Tributary to Bear Creek	Earth	1967	O	Private	16	6	50	8	2
Sessions Lake Dam	Sessions Lake	Earth	1981	R	State	57	110	3,500	32	2
Shook Dam	Tributary to Pine Creek	Earth	1975	–	Private	8	4	–	–	3
Silver Lake Dam	Silver Lake Outlet	–	–	–	–	–	189	–	–	3
Simmon Dam	Stoney Creek	Earth	–	R	Private	6	2	–	–	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Lower–continued										
Simmon Dam	Stoney Creek	Earth	–	R	Private	6	2	–	–	3
Six Lakes (Taggart) Dam	Tributary to Black Creek	Earth	1976	O	Private	2	6	–	–	3
Slamka Dam	Little Maple	Earth	–	R	Private	20	1	–	–	3
Sleepy Hollow Dam	Ferdon Creek	Earth	1965	R	Private	12	2	–	–	3
Sleepy Hollow/Lake Ovid	Little Maple	Earth	1974	C, S	State	20	413	7,919	19	2
Smith Pond Dam	Tributary to Podunk Creek	Other	1967	O	Private	5	1	–	–	3
Smyrna Dam	Flat River and Seely Creek	Earth	1908	RH	Private	23	12	100	8	3
Snaky Run Dam	Tributary to Dickerson Creek	Earth	1966	O	State	5	31	110	4	3
Spitzley Dam	Stoney Creek	Earth	–	R	Private	2	1	–	–	3
Squaw Lake Dam	Squaw Lake	Gravity	–	R	Private	3	10	20	2	3
Stanton Lake	Tributary to Dickerson Cr.	Earth	1970	R	Private	10	34	352	10	3
Sterner Dam	Prairie Creek	Gravity	1921	RH	Private	5	4	85	21	3
Sutter Dam	Tributary to Sand Creek	Earth	1971	R	Private	15	1	–	–	3
Swan Lake Dam	Tributary to Crystal Lake	–	–	O	–	1	96	–	–	3
Terry Wal Dam	Tributary to Flat River	Earth	1973	R	Private	5	45	293	7	3
Thunder Head Dam	Tributary to Maple River	Earth	1966	R	Private	24	8	91	11	3
Topski Dam	Cedar Creek	Earth	1970	R	Private	10	7	76	11	3
Townwood Dam	Buck Creek	Earth	1978	R	Private	9	3	19	6	3
Turk Lake Dam	Turk Lake Outlet	–	–	–	–	–	153	–	–	3
Twork Dam	Thornapple Drain	Earth	1965	O	Private	7	3	–	–	3
Wabasis Lake Dam	Wabasis Creek	Other	1864	R	Private	5	11	60	5	3
Wall Lake Dam	Wall Lake Outlet	Concrete	1956	R	Private	1	540	215	–	3
Walma Dam	Tributary to Grand River	–	–	–	Private	–	2	–	–	3
Wargess Dam	Tributary to Cedar Creek	Earth	1950	O	Private	8	1	–	–	3
Wellman Dam	Tributary to Fish Creek	Earth	–	R	Private	4	1	–	–	3
Westdale Dam	Tributary to Grand River	Earth	1974	R	Private	19	4	53	13	3
Whitaker Dam	Little Maple	Earth	–	R	Private	4	3	–	–	3
Whites Bridge Dam	Flat River	Gravity	1929	H	Private	16	91	1,500	16	3
Whitneyville Dam	McCords Creek	Earth	–	R	Private	15	3	25	8	3
Wilmore Dam	Little Thornapple	Earth	1968	R	Private		2	26	13	3
Wittenbac Dam	Tributary to Flat River	Gravity	–	O	Private	4	3	–	–	3
York Creek Dam	York Creek	Earth	1989	C, S	Private		1	–	–	3
Ziegenfus Lake Dam	Tributary to Wabasis Creek	–	–	–	–	–	46	–	–	3

Table 12.–Continued.

Segment Name	Stream	Type	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Mouth										
Bruce Bayou Dam	Tributary to Bruce Bayou	–	–	–	Private	–	1	–	–	3
Crockery Lake Dam	Tribuatary to North Branch Crockery Creek	Gravity	1977	R	Local gov	2	104	90	1	3
Dermo Bayou Dam	Tributary to Dermo Bayou	–	–	–	Private	–	2	–	–	3
Hoffman Dam	Tributary to Spring Lake	–	–	–	Private	–	3	–	–	3
Motman Dam	Tributary to Sand Creek	–	–	–	Private	–	1	–	–	3
No Name	Tributary to Norris Creek	Earth	–	R	Private	4	1	–	–	3
Patterson Dam	Rio Grande Creek	Gravity	–	R	Private	2	1	–	–	3
VanSloote Dam	Tributary to Bass Creek	–	–	–	Private	–	1	–	–	3

Table 13.–Designated trout streams in the Grand River watershed. Streams are designated upstream of the town, range, and section number unless specified otherwise.

Stream name	County
Norris Creek and tributaries (T9N, R16W, S36)	Muskegon, Ottawa
Crockery Creek from T9N, R14W, S11 (Ravenna Bridge) upstream to T10N, R13W, S4	Muskegon, Ottawa
Sand Creek from its confluence with the Grand River (T7N, R13W, S33)	Ottawa
All tributaries to Lloyd's, Dean's, Pottawatomie, Millhouse, Sterns and Robinson bayous	Ottawa
All tributaries to Grand River in Kent County *EXCEPT: Flat and Thornapple rivers and Plaster and Rush creeks*	Kent
All tributaries to Grand River in Ionia County *EXCEPT: Stony, Sessions and Libhard creeks and Flat, Maple and Looking Glass rivers*	Ionia
Spires Creek (T7N, R5W, S18)	Ionia
Prairie Creek from its confluence with the Grand River (T7N, R6W, S21)	Ionia, Montcalm
Fish Creek from its confluence with the Maple River (T8N, R5W, S25)	Ionia, Montcalm
Mackey Brook upstream from confluence with Sandstone Creek (T2S, R2W, S16)	Jackson
Sebewa Creek from confluence with Grand River in Ionia County upstream to St. Joe Road Bridge (T4N, R6W, S14, 23)	Ionia, Eaton
Unnamed tributary (a.k.a. Schoolhouse, School, Cascade Creek) on west bank (T6N, R10W, S10) of Thornapple River, originating as outlets from Wood and Walden lakes	Kent
Coldwater River (mainstream only) (T5N, R10W, S35) to M-43 bridge (T4N, R8W, S16)	Barry, Kent
Unnamed Tributary (T5N, R9W, S31)	Kent, Barry
Unnamed Tributary (T5N, R10W, S36)	Kent, Barry
Tyler Creek (T5N, R9W)	Kent
Bear Creek (T5N, R8W; T5N, R9W)	Kent, Ionia
Duck Creek (T5N, R8W; T5N, R9W)	Kent, Ionia
Cain Creek (T4N, R9W, S4)	Barry
Unnamed tributary on north bank of Coldwater River (T4N, R7W, S18)	Barry
Bassett Creek from Baker Lake to confluence with Thornapple River	Barry
Turner Creek from confluence with Baker Creek (T3N, R10W, S9) upstream to T3N, R10W, S23	Barry
Hill Creek (T3N, R10W, S2)	Barry
Glass Creek (T3N, R10W, S1)	Barry
Cedar Creek (T3N, R8W, S26)	Barry
High Banks Creek (T3N, R7W, S30) upstream to Lawrence Road (T2N, R8W, S12)	Barry
Buckson Creek (T3N, R7W, S34)	Barry
Quaker Brook (T3N, R7W, S35)	Barry
West Branch Creek (T10N, R8W, S4)	Montcalm
Dickerson Creek from T8N, R8W, S1 upstream to T9N, R7W, S5	Ionia, Montcalm
Butternut Creek (T10N, R9W, S34)	Kent
Page Creek (T7N, R9W, S24)	Kent

Table 14a.–Monthly maximum river temperatures allowed in selected streams. Data from Michigan Department of Environmental Quality, Water Bureau.

	Month											
Stream	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Coldwater streams	38	38	43	54	65	68	68	68	63	56	48	40
Warmwater streams	41	40	50	63	76	84	85	85	79	68	55	43

Table 14b.–Dissolved oxygen and temperature standards for designated uses of the Grand River and tributaries. Temperatures represent allowable degrees of increase from the monthly river maximum. Data from Michigan Department of Environmental Quality, Water Bureau.

Designated use	Minimum dissolved oxygen (mg/l)	Temperature (°F)
Warmwater fish	5.0	5
Coldwater fish		
Designated trout	7.0	2
Designated migratory route	5.0	5

Table 15.–Water quality assessment and water quality attainment categories used for reporting the status of the waters in Michigan. Modified from Wolf and Wuycheck 2004.

Category	Description
1	All designated uses are being supported.
2	Some designated uses are supported but there is insufficient data to determine if all are attained.
3	Insufficient data to determine whether any designated uses are supported.
4a	Water Quality Standards nonattained, USEPA has approved Total Maximum Daily Load (TMDL) but unverified Water Quality Standard restoration.
4b	Water Quality Standards are nonattained, other corrective action used but unverified Water Quality Standard restoration.
4c	Water Quality Standards are nonattained, highly modified water body.
5	Water is impaired or threatened and TMDL is needed.

Table 16.–Status of designated use attainment of assessed waterbodies in the Grand River watershed by valley segment. Acronyms: Attainment Status 2=attaining, 3=requires additional study, 4a=nonattaining with approved TMDL, 4b=nonattaining with approved restoration plan, 4c=nonattaining due to channel modification, 5=nonattaining needs TMDL; Problems: BD=biological degradation, NPS=nonpoint source pollution, PCB=polychlorinated biphenyl, DO=dissolved oxygen, Rule 100 Pathogens*i*=bacteria associated with human and animal fecal waste, CSO=combine sewer overflow. Data from Michigan 2004 303(d) and 305(b) reports to USEPA (Wolf and Wuycheck 2004).

Water body	County	Attainment status	Area assessed	Description of attainment status
Headwaters				
Huntoon Creek	Ingham/Jackson	2	16 mi	Supporting some designated uses
Clear Lake	Jackson	2	136 acres	Supporting some designated uses
Gilletts Lake	Jackson	2	350 acres	Supporting some designated uses
Grand River	Jackson	2	42 mi	Supporting some designated uses
Grass Lake	Jackson	2	348 acres	Supporting some designated uses
Little Wolf Lake	Jackson	2	106 acres	Supporting some designated uses
Mirror Lake	Jackson	2	66 acres	Supporting some designated uses
Ackerson Marsh	Jackson	3	0.25 mi	Biological degradation, sediment contaminants
Pleasant Lake	Jackson	3	269 acres	D.O. violation
Perry Creek	Ingham/Jackson	3	10 mi	Background for Sycamore Creek study
Grand and Portage rivers	Jackson	4a	25 mi	Untreated sewage discharge, pathogens (Rule 100); WQS exceedances for D.O.; Macroinvertebrate and fish communities rated poor
Albrow Creek	Jackson	5	1 mi	Untreated sewage discharge, pathogens (Rule 100)
Grand River	Jackson	5	1 mi	WQS exceedances for mercury
Portage Lake	Jackson	5	360 acres	Fish tissue-mercury
Vandercook Lake	Jackson	5	144 acres	Fish tissue-mercury
Upper				
Lime Lake	Jackson	2	96 acres	Supporting some designated uses
Sandstone Creek	Jackson	2	42 mi	Supporting some designated uses
Spring Brook	Jackson	2	44 mi	Supporting some designated uses
South Lime Lake	Jackson	3	96 acres	D.O. violation
Columbia Creek	Ingham	4c	7 mi	Highly modified; biological degradation
Moores Park Impoundment	Ingham	5	110 acres	Fish tissue-Mercury
Middle				
Kramer Drain	Clinton	2	7 mi	Supporting some designated uses
Vermilion Creek	Clinton	2	10 mi	Supporting some designated uses
Sebewa Creek	Eaton/Ionia	2	9 mi	Supporting some designated uses

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Middle–continued				
Deer Creek	Ingham	2	8 mi	Supporting some designated uses
Red Cedar River	Ingham	2	17 mi	Supporting some designated uses
W.B. Red Cedar River	Ingham	2	7 mi	Supporting some designated uses
Sloan Creek	Ingham	2	2 mi	Supporting some designated uses
Looking Glass River	Ionia/Clinton/Shiawassee	2	57 mi	Supporting some designated uses
Red Cedar River	Livingston	2	9 mi	Supporting some designated uses
Perry Drain	Shiawassee	2	4 mi	Supporting some designated uses
Sandstone Creek	Eaton	3	6 mi	Biological degradation, NPS
Carrier Creek	Eaton	4a	4 mi	Macroinvertebrate community rated poor
Havens Drain	Ingham	4b	3 mi	WQS exceedances–D.O. violations
Mud Creek	Ingham	4b	16 mi	WQS exceedances for D.O.
Sycamore Creek	Ingham	4b	23 mi	Fish community rated poor
Talmadge Drain	Ingham	4b	5 mi	Fish community rated poor
Willow Creek	Ingham	4b	5 mi	WQS exceedance for D.O.; biological degradation
Sebewa Creek	Eaton	4c	8 mi	Highly modified
Deer Creek	Ingham	4c	8.5 mi	Highly modified
Doan Creek	Ingham	4c	40 mi	Highly modified
Kalamink Creek	Ingham	4c	12 mi	Highly modified
W.B. Red Cedar River	Ingham	4c	15 mi	Highly modified
Squaw Creek	Ingham	4c	3 mi	Highly modified
Wolf Creek	Ingham	4c	7 mi	Highly modified; biological degradation
Goose Creek	Ionia	4c	13 mi	Highly modified
Red Cedar River	Livingston	4c	6 mi	Highly modified
M.B. Red Cedar River	Livingston	4c	17 mi	Highly modified
Looking Glass River	Shiawassee	4c	50 mi	Highly modified; macroinvertebrate community rated poor
Perry Drain No. 2	Shiawassee	4c	9 mi	Highly modified
Grand River	Eaton	5	0.5 mi	CSO, pathogens (Rule 100)
Grand and Red Cedar rivers	Ingham	5	12 mi	CSO, pathogens (Rule 100); WQS exceedances for D.O.; fish kills
Red Cedar River	Ingham	5	1 mi	Pathogens (Rule 100); Fish and macroinveretbrate communities rated poor
Red Cedar River	Ingham	5	3 mi	FCA-PCBs; WQS exceedances for D.O.; CSOs, untreated sewage discharge, pathogen (Rule 100); fish kills
Sycamore Creek	Ingham	5	52 mi	WQS exceedances for D.O.
Vermilion Creek	Shiawassee/Ingham	5	6.5 mi	Untreated sewage discharge, pathogens (Rule 100)

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Lower				
Bassett Creek	Barry	2	4 mi	Supporting some designated uses
Cedar Creek	Barry	2	11 mi	Supporting some designated uses
Duncan Creek	Barry	2	4.4 mi	Supporting some designated uses
Fall Creek	Barry	2	4 mi	Supporting some designated uses
Fine Lake	Barry	2	320 acres	Supporting some designated uses
Glass Creek	Barry	2	15 mi	Supporting some designated uses
High Banks Creek	Barry	2	8 mi	Supporting some designated uses
Quaker Brook	Barry	2	5 mi	Supporting some designated uses
Thornapple River	Barry/Eaton	2	31 mi	Supporting some designated uses
Cox Drain	Clinton	2	5.7 mi	Supporting some designated uses
Little Maple River	Clinton	2	9.5 mi	Supporting some designated uses
Maple River	Clinton/Shiawassee	2	20 mi	Supporting some designated uses
Lacey Creek	Eaton	2	7 mi	Supporting some designated uses
Scipio Creek	Eaton	2	6 mi	Supporting some designated uses
Maple River	Gratiot/Clinton	2	10 mi	Supporting some designated uses
Stony Creek	Ionia	2	2 mi	Supporting some designated uses
Stoughton Creek	Ionia	2	2 mi	Supporting some designated uses
Bellamy Creek	Ionia	2	5 mi	Supporting some designated uses
Lake Creek	Ionia	2	6 mi	Supporting some designated uses
Prairie Creek	Ionia	2	28 mi	Supporting some designated uses
Unnamed tributary to Dickerson Creek	Ionia	2	2 mi	Supporting some designated uses
Duck Creek	Ionia/Kent	2	15 mi	Supporting some designated uses
Fish Creek	Ionia/Montcalm	2	21 mi	Supporting some designated uses
Flat River	Ionia/Montcalm	2	72 mi	Supporting some designated uses
Ball Creek	Kent	2	3 mi	Supporting some designated uses
Barkley Creek	Kent	2	3 mi	Supporting some designated uses
Bear Creek	Kent	2	3 mi	Supporting some designated uses
Beaver Dam Creek	Kent	2	2 mi	Supporting some designated uses
Becker Creek	Kent	2	3 mi	Supporting some designated uses
Butternut Creek	Kent	2	4 mi	Supporting some designated uses
Cedar Creek	Kent	2	12 mi	Supporting some designated uses
Coopers Creek	Kent	2	10 mi	Supporting some designated uses
Duke Creek	Kent	2	11 mi	Supporting some designated uses

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Lower–continued				
Frost Creek	Kent	2	4 mi	Supporting some designated uses
Lee Creek	Kent	2	4 mi	Supporting some designated uses
Long Lake	Kent	2	48 acres	Supporting some designated uses
Mill Creek	Kent	2	13 mi	Supporting some designated uses
Myers Lake	Kent	2	85 acres	Supporting some designated uses
Nash Creek	Kent	2	21 mi	Supporting some designated uses
Page Creek	Kent	2	5 mi	Supporting some designated uses
Rum Creek	Kent	2	5.1 mi	Supporting some designated uses
Seeley Creek	Kent	2	8 mi	Supporting some designated uses
Shaw Creek	Kent	2	3 mi	Supporting some designated uses
Spring Creek	Kent	2	5.4 mi	Supporting some designated uses
Stegman Creek	Kent	2	4.5 mi	Supporting some designated uses
White Creek	Kent	2	4 mi	Supporting some designated uses
McCord's Creek	Kent	2	3 mi	Supporting some designated uses
Pratt Lake Creek	Kent	2	4.4 mi	Supporting some designated uses
Unnamed tributary to Thornapple River	Kent	2	4.3 mi	Supporting some designated uses
Coldwater River	Kent/Barry	2	8 mi	Supporting some designated uses
Black Creek	Kent/Montcalm	2	14 mi	Supporting some designated uses
Rogue River	Kent/Newaygo	2	35 mi	Supporting some designated uses
Black Creek	Mecosta/Montcalm	2	5 mi	Supporting some designated uses
Crystal Lake	Montcalm	2	724 acres	Supporting some designated uses
Fish Creek	Montcalm	2	15 mi	Supporting some designated uses
W.B. Fish Creek	Montcalm	2	0.5 mi	Supporting some designated uses
Unnamed tributary to Dickerson Creek	Montcalm	2	15 mi	Supporting some designated uses
Unnamed tributary to Six Lakes	Montcalm	2	5.4 mi	Supporting some designated uses
Unnamed tributary to Flat River	Montcalm	2	10 mi	Supporting some designated uses
Dickerson Creek	Montcalm/Ionia	2	27 mi	Supporting some designated uses
Wabasis Creek	Montcalm/Kent	2	6 mi	Supporting some designated uses
Rush Creek	Ottawa/Kent	2	15 mi	Supporting some designated uses
Bear Creek	Shiawassee	2	40 mi	Supporting some designated uses

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Lower–continued				
Carter Lake	Barry	3	70 acres	Needs further assessment
Clear Lake	Barry	3	184 acres	Needs further assessment
Duncan Creek	Barry	3	130 acres	Needs further assessment
Leach Lake	Barry	3	109 acres	Needs further assessment
Thornapple Lake	Barry	3	409 acres	Nutrient enrichment, phosphorus
Lake Ovid	Clinton	3	412 acres	Nuisance aquatic plant and algal growths, phosphorus
Maple River	Gratiot/Clinton/Ionia	3	21 mi	Elevated nutrients, excessive turbidity; sedimentation is evident at some locations
Sessions Lake	Ionia	3	135 acres	Needs further assessment
Woodard Lake	Ionia	3	73 acres	Needs further assessment
Bass Lake	Kent	3	184 acres	Needs further assessment
Big Myers Lake	Kent	3	85 acres	Needs further assessment
Big Pine Island Lake	Kent	3	223 acres	Needs further assessment
Egypt Creek	Kent	3	3.5 mi	Water withdrawals, surface or aquifer
Honey Creek	Kent	3	7 mi	Development impacts
Indian Mill Creek	Kent	3	3 mi	Fish community sparse but contained some trout
Lime Lake	Kent	3	36 acres	Needs further assessment
Litte Cedar Creek	Kent	3	6 mi	Needs further assessment
Scott Creek	Kent	3	2.5 mi	Urbanization, development, wetland filling, erosion, sedimentation
Unnamed tributary to Rogue River	Kent	3	0.03 mi	Needs further assessment
Krafts lake Outlet	Kent	3	3 mi	Stream was highly turbid shortly after a rain storm
Thornapple Lake	Kent	3	37 mi	Exhibits hypereutrophic characteristics and requires further evaluation
Unnamed tributary to Thornapple River	Kent	3	1.5 mi	Needs further assessment
Baldwin Lake	Montcalm	3	72 acres	Needs further assessment
Clifford Lake	Montcalm	3	200 acres	Needs further assessment
Cowden Lake	Montcalm	3	128 acres	Needs further assessment
Dickerson Creek	Montcalm	3	225 acres	Needs further assessment
Montcalm Lake	Montcalm	3	68 acres	Needs further assessment
Nevins Lake	Montcalm	3	53 acres	Needs further assessment
Townline Lake	Montcalm	3	247 acres	Needs further assessment
Plaster Creek	Kent	4a	12 mi	Fish and macroinvertebrate communities rated poor; pathogens (Rule 100)

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Lower–continued				
Butler Creek	Barry	4c	5.4 mi	Highly modified
Duncan Creek	Barry	4c	4.1 mi	Highly modified
Mud Creek	Barry	4c	12 mi	Highly modified
Pratt Creek	Barry	4c	2 mi	Highly modified
Little Thornapple River	Barry/Ionia	4c	6 mi	Highly modified
Baker Creek	Clinton	4c	36 mi	Highly modified
Hayworth Creek	Clinton	4c	14 mi	Highly modified; biological degradation
S. Fork Hayworth Creek	Clinton	4c	8 mi	Highly modified; biological degradation
Spaulding Creek	Clinton	4c	7 mi	Highly modified
Stony Creek	Clinton	4c	84 mi	Highly modified; biological degradation
Butternut Creek	Eaton	4c	8.8 mi	Highly modified
Church Drain	Eaton	4c	3.5 mi	Highly modified; macroinvertebrate community rated poor
Cole-Wright-Helms Drain	Eaton	4c	3 mi	Highly modified
Darken-Boyer Drain	Eaton	4c	5 mi	Highly modified
Little Thornapple River	Eaton	4c	8 mi	Highly modified
Thompson Creek	Eaton	4c	4.6 mi	Highly modified
Thornapple Drain	Eaton	4c	13 mi	Highly modified; fish community rated poor
Mud Creek	Eaton/Barry	4c	10 mi	Highly modified
Bear Creek	Gratiot	4c	7 mi	Highly modified; fish community rated poor
North Shade Drain	Gratiot	4c	30 mi	Highly modified
Otter Creek	Gratiot	4c	21 mi	Highly modified
River Styx	Gratiot	4c	13 mi	Highly modified; macroinvertebrate community rated poor
Halterman Creek	Gratiot/Clinton	4c	9 mi	Highly modified
Pine Creek	Gratiot/Clinton	4c	11 mi	Highly modified
Bear Creek	Ionia	4c	10 mi	Highly modified
Duck Creek	Ionia	4c	6 mi	Highly modified; fish community rated poor
Fifield Creek	Ionia/Clinton/Gratiot	4c	5 mi	Highly modified; macroinvertebrate community rated poor
Walter Creek	Kent	4c	7.2 mi	Highly modified
Clark-Bunker Drain	Kent	4c	6.5 mi	Highly modified
Pratt Lake Creek	Kent	4c	6 mi	Highly modified
Butternut Creek	Montcalm	4c	8.5 mi	Highly modified
Tributary to Little Penny Lake	Montcalm	4c	13 mi	Highly modified
Tributary to Dickerson Lake	Montcalm	4c	4 mi	Highly modified

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Lower–continued				
N. B. Crockery Creek	Muskegon/Ottawa	4c	11 mi	Highly modified
Rogue River	Newaygo	4c	14 mi	Highly modified; biological degradation
Maple River	Shiawassee	4c	18 mi	Highly modified; macroinvertebrate community rated poor
Jordan Lake	Barry/Ionia	5	430 acres	Fish tissue-mercury
Alder Creek	Clinton	5	3 mi	Nuisance algal growths, phosphorus
Lost Creek	Clinton	5	2.5 mi	Fish and macroinvertebrate communities rated poor; nuisance algal growths, phosphorus; bacterial slimes
Maple River	Clinton	5	6 mi	Nuisance plant growths, phosphorus
Peet Creek	Clinton	5	6 mi	Nuisance plant growths, phosphorus
St. Johns Big Ditch	Clinton	5	3 mi	Comprehensive plan facility for D.O.
Maple River	Gratiot	5	6 mi	Nuisance plant growths, phosphorus
Grand River	Ionia	5	1 mi	WQS exceedances for mercury
Long Lake	Ionia	5	356 acres	Fish tissue-mercury
Morrison Lake	Ionia	5	330 acres	FCA-PCBs; nuisance algal blooms, phosphorus
Buck Creek	Kent	5	10 mi	pathogens (Rule 100)
Flat River	Kent	5	35 mi	FCA-PCBs
Grand River	Kent	5	1 mi	CSO, pathogens (Rule 100)
Lincoln Lake	Kent	5	411 acres	Fish tissue-mercury, pathogens (Rule 100)
Mill Creek	Kent	5	7 mi	Fish community rated poor
Reeds Lake	Kent	5	265 acres	FCA-PCBs; fish tissue-mercury
Strawberry Creek	Kent	5	3 mi	Fish community rated poor
Unnamed tributary to Grand River	Kent	5	3 mi	Fish community rated poor
Wabasis Lake	Kent	5	418 acres	Fish tissue-mercury
York Creek	Kent	5	4 mi	Fish community rated poor
Bear Creek	Kent	5	7.6 mi	Pathogens (Rule 100)
Coldwater River	Kent	5	6 mi	Pathogens (Rule 100)
Rainbow Lake	Montcalm	5	155 acres	Fish tissue-mercury
Sand Creek	Ottawa	5	16 mi	Fish community rated poor

Table 16.–Continued.

Water body	County	Attainment status	Area assessed	Description of attainment status
Mouth				
Norris Creek	Muskegon	2	16 mi	Supporting some designated uses
N. B. Crockery Creek	Muskegon/Ottawa	2	5 mi	Supporting some designated uses
Crockery Creek	Newaygo/Muskegon	2	24 mi	Supporting some designated uses
Half-Moon Lake	Muskegon	3	58 acres	D.O. violation
Crockery Creek	Muskegon/Ottawa	3	15 mi	Nonwadable sections–impaired macroinvertebrates
Fellows Drain	Newaygo	3	1 mi	Needs further assessment
Crockery Lake	Ottawa	3	108 acres	D.O. violation
Spring Lake	Ottawa	3	1047 acres	Needs further assessment
Rio Grande Creek	Ottawa	4a	8 mi	Untreated sewage discharge, pathogens (Rule 100)
N. B. Crockery Creek	Muskegon/Ottawa	4c	11 mi	Highly modified
Crockery Creek	Newaygo/Kent	4c	5 mi	Highly modified
Bills Lake	Newaygo	5	204 acres	Fish tissue-mercury
Bass River	Ottawa	5	66 mi	Pathogens (Rule 100); fish and macroinvertebrate communities rated poor
Deer Creek	Ottawa	5	47 mi	D.O. violations; Fish and macroinvertebrate communities rated poor; fish kills; nuisance plant growths, phosphorus; untreated sewage discharge, pathogens (Rule 100)
Grand River	Ottawa	5	1 mi	WQS exceedances for mercury
Grand and Red Cedar rivers	Ottawa/Jackson	5	235 mi	FCA-PCBs; WQS exceedances for PCBs

Table 17a.–National Pollution Discharge Elimination System permits issued (as of 2005) in the Grand River watershed by Michigan Department of Environmental Quality, Water Bureau. (Web: http://www.deq.state.mi.us/swq/permits/active/active.htm). CAFO = concentrated animal feeding operation.

Permittee	Receiving water	City	Discharge type
Headwaters			
ADCO Products, Incorporated	Grand River	Michigan Center	noncontact cooling water
City of Leslie	Grand River	Leslie	treated sanitary wastewater
City of Jackson	Grand River	Jackson	treated sanitary wastewater
Quanex Corporation	Grand River	Jackson	storm water
Marathon Ashland Petroleum LLC	Grand River	Jackson	hydrostatic pressure test water
Marathon Petroleum Company LLC	Grand River	Jackson	storm water
Leoni Township	unnamed tributary of the Grand River	Michigan Center	treated municipal wastewater
Citgo Petroleum Corporation	Tobin Snyder Drain	Jackson	secondary containment area water
Mechanical Products	Grand River	Jackson	other
Michigan Department of Corrections	Grand River	Jackson	treated groundwater
TRW, Incorporated	Grand River	Jackson	treated groundwater
Wolverine Pipeline Company	Tobin Snyder Drain	Jackson	treated groundwater
Industrial Steel Treating Company	Grand River	Jackson	noncontact cooling water
Lefere Forge and Machine Company	Grand River	Jackson	noncontact cooling water
Mid-American Products	Grand River	Jackson	noncontact cooling water
B & H Machine, Incorporated	Tobin Snyder Drain	Jackson	noncontact cooling water
Sun Communities, Incorporated	Grand River	Jackson	treated sanitary wastewater
Upper			
Lansing Board of Water and Light	Grand River	Lansing	boiler blowdown
City of Mason	Sycamore Creek	Mason	treated sanitary wastewater
Village of Fowlerville	Middle Branch Red Cedar River	Fowlerville	treated municipal wastewater
City of Williamston	Red Cedar River	Williamston	treated sanitary wastewater
City of Eaton Rapids	Grand River	Eaton Rapids	treated sanitary wastewater
Village of Dimondale	Grand River	Dimondale	treated sanitary wastewater
The Johnson Company	Whitman Drain	Springport	noncontact cooling water
River Rock Landing Condominium	Grand River	Dimondale	treated sanitary wastewater
Veterans of Foreign Wars National Home	Grand River	Eaton Rapids	treated sanitary wastewater
Neil Fetter	Huntington Drain	Dimondale	treated sanitary wastewater

Table 17a.–Continued.

Permittee	Receiving water	City	Discharge type
Middle			
Lansing Board of Water & Light	Grand River	Lansing	process wastewater
City of Portland	Grand River	Portland	treated sanitary wastewater
City of Grand Ledge	Grand River	Grand Ledge	treated sanitary wastewater
Southern Clinton County Municipal Utilities Authority	Looking Glass River	DeWitt	treated municipal wastewater
Delhi Charter Township	Grand River	Holt	treated sanitary wastewater
Delta Township	Grand River	Lansing	treated sanitary wastewater
City of East Lansing	Red Cedar River	East Lansing	treated sanitary wastewater
City of Lansing	Grand River	Lansing	treated sanitary wastewater
Sun Communities, Incorporated	Perry Drain No. 2	Perry	treated sanitary wastewater
The Franklin Group	Sycamore Creek	Mason	treated sanitary wastewater
Michigan Department of Transportation	Whaley Drain	Lansing	treated groundwater
The Goodyear Tire & Rubber Company	Grand River	Lansing	treated groundwater
Savoy Construction Company	Moyer Drain	Eagle	treated sanitary wastewater
Handy Township	Middle Branch Red Cedar River	Fowlerville	treated municipal wastewater
Columbia Lakes Investment Group, LLC	Townsend Drain	Mason	treated sanitary wastewater
Michigan Department of Environmental Quality	Sandstone Creek	Grand Ledge	treated groundwater
General Motors Corporation	Grand River	Lansing	treated groundwater
PCC Olofsson	Sycamore Creek	Lansing	noncontact cooling water
R. N. Fink Manufacturing Company, Incorporated	Frost Drain	Williamston	noncontact cooling water
Kubiak Farms		Webberville	CAFO
E. T. Mackenzie Company	Vermillion Creek	Haslett	mine dewatering water
Weaver Gravel Company, Incorporated	Doan and Deer Creek	Dansville	mine dewatering water
Aggregate Industries	Mud Creek	Mason	mine dewatering water
Herbison Road Sand Pit	Looking Glass River	DeWitt	mine dewatering water
Carl Schlegel, Incorporated	Hayhoe Drain	Dansville	mine dewatering water
Warden Development Company	Looking Glass River	DeWitt	mine dewatering water
William Rogers	Willow Creek	Mason	mine dewatering water
E. T. MacKenzie	Vermillion Creek	Grand Ledge	mine dewatering water
L.D. Clark Companies	Looking Glass River	DeWitt	mine dewatering water
Village of Mulliken	Cryderman Creek	Mulliken	treated sanitary wastewater
City of Laingsburg	Looking Glass River	Laingsburg	treated sanitary wastewater
Village of Webberville	Kalamink Creek	Webberville	treated sanitary wastewater
Sun Communities, Incorporated	Wallace Drain	Webberville	treated sanitary wastewater
Kenneth B.C. Jensen	Aldrich Drain	Grand Ledge	treated sanitary wastewater

Table 17a.–Continued.

Permittee	Receiving water	City	Discharge type
Middle–continued			
City of Perry	Perry Drain No. 2	Perry	treated sanitary wastewater
Lower	Hogle & Miller Drain	Springport	
Delphi Automotive Systems LLC	Plaster Creek	Wyoming	noncontact cooling water
White Consolidated Industries	Flat River	Greenville	storm water
TBG Incorporated	Flat River	Belding	noncontact cooling water
Federal Mogul Corporation	Flat River	Greenville	storm water
MichCon/DTE Energy	Flat River	Six Lakes	noncontact cooling water
City of Lowell	Flat River	Lowell	treated sanitary wastewater
City of Greenville	Flat River	Greenville	treated sanitary wastewater
Village of Sparta	Rogue River	Sparta	treated municipal wastewater
City of Belding	Flat River	Belding	treated municipal wastewater
City of Belding	Flat River	Belding	treated municipal wastewater
City of Ionia	Grand River	Ionia	treated sanitary wastewater
City of Coopersville	Grand River	Coopersville	treated sanitary wastewater
Village of Kent City	Ball Creek	Kent City	treated sanitary wastewater
City of Wyoming	Grand River	Wyoming	
City of Grand Rapids	Grand River	Grand Rapids	treated municipal wastewater
Kent County Department of Public Works	unnamed tributary to Rogue River	Rockford	Other
Lower			
Steelcase Incorporated	Plaster Creek	Kentwood	coal pile runoff
General Motors Corporation	Cole Drain	Wyoming	treated groundwater
Ingersoll-Rand Company	Grand River	Saranac	treated groundwater
Miller Springs Remediation Management, Incorporated	Grand River	Lowell	other
Michigan Department of Corrections	Inman Drain	Ionia	iron filter backwash
Michigan Department of Environmental Quality	Rush Creek	Jenison	treated groundwater
City of Grand Rapids		Grand Rapids	
Piano Factory, LLC	Grand River	Grand Haven	treated groundwater
Root-Lowell Manufacturing Company	Flat River	Lowell	treated groundwater
Eastbrook Development Company	Rogue River	Rockford	treated sanitary wastewater
Willow Point Dairy LLC		Orleans	CAFO
Budget Rent-A-Car Systems	unnamed tributary to Plaster Creek	Grand Rapids	treated petroleum contaminated wastewater

Table 17a.–Continued.

Permittee	Receiving water	City	Discharge type
Lower–continued			
Crystal Flash Limited Partnership	Lake Creek	Saranac	treated petroleum contaminated wastewater
Speedway SuperAmerica LLC	Heyboer Drain	Kentwood	treated petroleum contaminated wastewater
Speedway SuperAmerica LLC	Buck Creek	Wyoming	treated groundwater
Speedway SuperAmerica LLC	Buck Creek	Wyoming	treated groundwater
Russells Auto Parts	Pearl Lake	Sheridan	treated petroleum contaminated wastewater
Chevron Environmental Management Company	Reeds Lake	Grand Rapids	treated petroleum contaminated wastewater
J & H Oil Company	Grand River	Grand Rapids	treated petroleum contaminated wastewater
Tri City Oil Company, Incorporated	Grand River	Spring Lake	treated petroleum contaminated wastewater
Exit 76 Corporation	Wenger and Nulty Drain	Grand Rapids	treated petroleum contaminated wastewater
Keebler Company	Plaster Creek	Grand Rapids	noncontact cooling water
Blackmer	Plaster Creek	Grand Rapids	noncontact cooling water
Welcome Home For The Blind	Grand River	Grand Rapids	noncontact cooling water
Clarion Technologies, Incorporated	unnamed tributary to Plaster Creek	Caledonia	noncontact cooling water
Hope Network Rehabilitation Services	Reeds Lake	Grand Rapids	noncontact cooling water
De Jager Construction Incorporated	Buck Creek	Wyoming	noncontact cooling water
Betz Industries	Indian Mill Creek	Grand Rapids	noncontact cooling water
Yamaha Corporation of America, Incorporated	Little Plaster Creek	Grand Rapids	noncontact cooling water
Center Manufacturing Incorporated	Buck Creek	Byron Center	noncontact cooling water
R. L. Adams Plastics, Incorporated	unnamed tributary to Buck Creek	Wyoming	noncontact cooling water
Tower Automotive	Flat River	Greenville	noncontact cooling water
Center Manufacturing Incorporated	Buck Creek	Byron Center	noncontact cooling water
Mizkan Americas Incorporated	Flat River	Belding	noncontact cooling water
Steelcase Incorporated	Heyboer Drain	Grand Rapids	noncontact cooling water
River Ridge Farms, Incorporated		Coopersville	CAFO
River Ridge Dairy Company, Incorporated		Allendale	CAFO
Allendale Charter Township	Grand River	Allendale	treated sanitary wastewater
Wastewater Management, LLC	Grand River	Lyons	treated sanitary wastewater
Village of Casnovia	Ball Creek	Casnovia	treated sanitary wastewater
Village of Sheridan	unnamed tributary to Prairie Creek	Sheridan	treated sanitary wastewater
Village of Saranac	Grand River	Saranac	treated sanitary wastewater
Indian Trails Childrens Camp	unnamed tributary to Sand Creek	Grand Rapids	treated sanitary wastewater
Wright Township	unnamed tributary to Sand Creek	Marne	treated sanitary wastewater

Table 17a.–Continued.

Permittee	Receiving water	City	Discharge type
Lower–continued			
Michigan Department of Natural Resources	Grand River	Ionia	treated sanitary wastewater
Orleans Township	Woodard Creek	Orleans	treated sanitary wastewater
Sun Communities Operating Limited Partnership	Grand River	Portland	treated sanitary wastewater
Clarksville-Morrison Lake Sewer Authority	Lake Creek	Saranac	treated sanitary wastewater
Matthews Pickle Company	Fish Creek	Carson City	storm water
City of Carson City	Fish Creek	Carson City	treated sanitary wastewater
City of St. Johns	St. Johns Big Ditch Drain	Saint Johns	treated municipal wastewater
Sunoco Partners Marketing Terminals L.P.	McKenzie Dwyer Drain	Owosso	storm water
Michigan Milk Producers Association	Maple River	Ovid	process wastewater
Village of Elsie	Maple River	Elsie	treated sanitary wastewater
Renaissance Power, LLC	Fish Creek	Carson City	air conditioning condensate
Montcalm County Drain Commissioner	Smith Drain	Crystal	treated sanitary wastewater
Michigan Department of Environmental Quality	Fish Creek	Carson City	treated groundwater
Superior Environmental Corporation	Rice Drain	Crystal	treated petroleum contaminated wastewater
Dana Corporation	Doty Brook	Saint Johns	noncontact cooling water
Becks Development Company	Ferdon Creek	Saint Johns	treated sanitary wastewater
Village of Ashley	Schollenbarger Drain (tributary to Bear Creek)	Ashley	treated sanitary wastewater
Village of Fowler	Maple River	Fowler	treated sanitary wastewater
Village of Ovid	Maple River	Ovid	treated sanitary wastewater
Village of Muir	Maple River	Muir	treated sanitary wastewater
Village of Pewamo	Stoney Creek	Pewamo	treated sanitary wastewater
Village of Perrinton	Pine Creek	Perrinton	treated sanitary wastewater
Spring Vale Academy	Maple River	Owosso	treated sanitary wastewater
Village of Maple Rapids	Maple River	Maple Rapids	treated sanitary wastewater
James Hengesbach	Kloekner Creek	Portland	treated sanitary wastewater
Michigan Department of Transportation	unnamed tributary to Hamilton Drain	DeWitt	treated sanitary wastewater
Michigan Department of Natural Resources	Little Maple River	Laingsburg	treated sanitary wastewater
Owens-Brockway Glass Container, Incorporated	Butternut Creek	Charlotte	storm water
Bradford-White Corporation	Thornapple River	Middleville	treated groundwater
Village of Nashville	Thornapple River	Nashville	treated sanitary wastewater
City of Potterville	Thornapple River	Potterville	treated sanitary wastewater
City of Hastings	Thornapple River	Hastings	treated sanitary wastewater
Village of Sunfield	Mud Creek	Sunfield	treated sanitary wastewater

Table 17a.–Continued.

Permittee	Receiving water	City	Discharge type
Lower–continued			
Village of Vermontville	Thornapple River	Vermontville	treated sanitary wastewater
Lakewood Wastewater Authority	Little Thornapple River	Lake Odessa	treated sanitary wastewater
C & M Produce Limited	Thornapple Drain	Grand Ledge	vegetable wash water
City Environmental Services Landfill, Inc. of Hastings	Tributary to Carter Lake	Hastings	treated groundwater
Bowne Township	Clark and Bunker Drain	Alto	treated sanitary wastewater
Gerald R. Ford International Airport	Tributary to Thornapple River	Grand Rapids	other
Lakewood Public Schools	Mud Creek	Sunfield	treated groundwater
R & J, Incorporated	Fall Creek	Hastings	treated petroleum contaminated wastewater
Freeport Dairy LLC		Freeport	CAFO
Brandon and Darren Van Elst	Duck Creek	Lake Odessa	CAFO
Thornapple Township	Duncan Creek	Middleville	treated sanitary wastewater
Mouth			
Grand Haven Board of Light and Power	Grand River	Grand Haven	noncontact cooling water
Johnston Boiler Company	Spring Lake	Ferrysburg	other
Grand Haven-Spring Lake Sewer Authority	Grand River	Grand Haven	treated sanitary wastewater
City of Grandville	Grand River	Grandville	treated municipal wastewater
City of Grant	Fellows Drain	Grant	
Albert Trostel & Sons Company	Grand River	Grand Haven	boiler blowdown
Ottawa County Road Commission	Black Creek	Nunica	treated municipal wastewater
North Kent Sewer Authority	Grand River	Grand Rapids	treated municipal wastewater
Tri City Oil Company	S. Channel of Grand River	Grand Haven	treated petroleum contaminated wastewater
Solar of Michigan, Incorporated	Deer Creek	Coopersville	noncontact cooling water
Rogers Printing, Incorporated	Crockery Creek	Ravenna	noncontact cooling water
City of Grand Haven	Grand River	Grand Haven	noncontact cooling water
Holland Plastics Corporation	Vincent Drain	Grand Haven	noncontact cooling water
Metal Technologies, Incorporated	Crockery Creek	Ravenna	noncontact cooling water
Construction Aggregates Corporation	Grand River	Ferrysburg	mine dewatering water
Metron Integrated Health Systems	Grand River	Lamont	treated sanitary wastewater
River Haven Operating Company LLC	Grand River	Grand Haven	treated sanitary wastewater
Village of Ravenna	Dry Drain	Ravenna	treated sanitary wastewater
Crockery Mobile Home Park	Black Creek	Nunica	treated sanitary wastewater
Ottawa County Road Commission	Fryer and Dinkle Drain	Conklin	treated sanitary wastewater

Table 17b.–Storm water permits issued by Michigan Department of Environmental Quality, Water Bureau, in the Grand River watershed (Web: http://www.deq.state.mi.us/swq/permits/active/active.htm).

Permittee	Receiving water(s)	Location
Headwaters		
ADCO Products, Incorporated	Grand River	Michigan Center
Leoni Township	Decker Drain, Page Avenue Lateral, Gregory Drain, Kennedy Drain, Gilletts Lake, Bliss Drain	Michigan Center
Napoleon Township	Russell Drain, Winchell & Townsend Drain, East Cranberry Lake Drain, Stoney Lake Drain, Ackerson Lake Drain, Townsend Drain	Napoleon
Blackman Charter Township	Wheeler Drain, B.B. Taylor Drain, Hurd Marvin Drain, Chanter Drain, Rives-Blackman Drain, Tobin Snyder Drain	Jackson
Summit Township	Grand River, Finton Lake, Robinson Drain, Ferguson Lake, Sharp Drain, Kirby Drain	Jackson
Rives Township	Twin Lakes Drain, Grand River	Jackson
City of Jackson	Grand River, McCain Drain, Sharp Drain	Jackson
County of Jackson	Spring Arbor-Concord Drain, Gilletts Lake, Tobin Snyder Drain, B.B. Taylor Drain, Winchell & Townsend Drain, Ackerson Lake	Jackson
Buckeye Terminals, LLC	Rives-Blackman Drain	Jackson
Marathon Ashland Petroleum LLC	Looking Glass River	Lansing
Marathon Ashland Pipe Line LLC		Stockbridge
Michigan Center School District		Michigan Center
Department of Corrections		Grass Lake
Hydraulic Systems Incorporated	Grand River	Jackson
Clarklake Machine Incorporated	Grand River	Clarklake
South Street Auto	Grand River	Jackson
Linear Automatic Systems	Grand River	Jackson
Sams Iron and Metal Company, Incorporated	Grand River	Jackson
Miller Industrial Products	Grand River	Jackson
Professional Assemby Corporation	Grand River	Jackson
The Molton Group LLC	Price Lake	Jackson
Leslie Property LLC	on-site wetlands	Leslie
Bullinger & Perticone LLC	Ricks Drain	Jackson
RSW Development LLC	Grass Lake	Grass Lake

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Headwaters–continued		
Allied Chucker & Engr Company	Wheeler Drain	Jackson
International Foam & Trim	Grand River	Jackson
Miller Tool & Die Company	Grand River	Jackson
Riverside Grinding Company	Grand River	Jackson
Orbitform	Grand River	Jackson
Willbee Transit Mix	Grand River	Jackson
Michigan Paving & Materials Company	Unnamed drain tributary to Gilletts Lake	Jackson
John Crowley Incorporated	Grand River	Jackson
Michigan Seat Company	Grand River	Jackson
Lefere Forge & Machine Company	Grand River	Jackson
Production Engineering Incorporated	Grand River	Jackson
O'Brien's Trading Post	Center Lake	Michigan Center
Pioneer Foundry Company Incorporated	Grand River	Jackson
Crankshaft Machine Group	Grand River	Jackson
Yo Manufacturing Company	Grand River	Jackson
Mid-American Products	Grand River	Jackson
Boone's Welding & Fabrication	Grand River	Jackson
Dawn Food Products	Grand River	Jackson
Michigan Department of Military and Veterans Affairs	Grand River	Jackson
Camshaft Machine Company	Grand River	Jackson
CertainTeed Corporation, DBA Wolverine Siding Systems	Grand River	Jackson
Con-Way Transportation Services	unnamed ditch	Jackson
Miller Truck & Storage	Grand River	Jackson
Fourway Machine	adjacent wetland > 5 acres	Jackson
Mag-Tec Casting Corporation	Grand River	Jackson
Advance Packaging Corporation	Grand River	Jackson
Mullins Auto Parts and Towing	Huntoon Creek	Leslie
Jackson County Dalton Road LF	Portage River	Jackson
Jackson County RRF	Portage River	Jackson
Lansing Board of Water and Light	Grand River	Lansing
McGill Road Landfill	Thompson Lake Drain	Jackson
Way Bakery Division	Grand River	Jackson

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Headwaters–continued		
Michner Plating Company	Grand River	Jackson
B & H Machine Incorporated	Grand River	Jackson
Eaton Aeroquip Incorporated	Grand River	Jackson
C & K Box Company	Grand River	Jackson
Liberty Environmentalists	Grand River	Clarklake
Edscha, Incorporated	Grand River	Jackson
Worthington Specialty Processing	Ackerson Lake	Jackson
Midbrook Incorporated	Grand River	Jackson
United Metal Technology Incorporated	Grand River	Jackson
Tenneco Automotive	Tims Lake	Grass Lake
OmniSource Corporation	Grand River	Jackson
OmniSource Corporation	Grand River	Jackson
OmniSource Corporation	Grand River	Jackson
Eaton Corporation	Sandstone Creek	Jackson
Pleasant Lake Sand & Gravel	Batteese Creek	Pleasant Lake
FedEx Freight East Incorporated	Gillette Drain	Jackson
Nalco Company	Grand River	Jackson
Bailey Sand & Gravel Company	Grand River	Jackson
Elm Plating Company	Grand River	Jackson
Storey Stone Company	Grand River	Jackson
Dawlen Corporation	Grand River	Jackson
Kaneka Texas Corporation	Grand River	Jackson
Elm Plating Company	Grand River	Jackson
Industrial Steel Treating Company	Grand River	Jackson
Andy's Airport Auto Parts	Grand River	Jackson
Norfolk Southern Railway Company	Grand River	Jackson
Messner's Auto Salvage	unnamed tributary of Orchard Creek	Stockbridge
Consumers Concrete Corporation	Grand River	Jackson
Michigan Extruded Aluminum	Grand River	Jackson
Emmons Service, Incorporated	Grand River	Jackson
Mac's All Car Service Incorporated	Grand River	Lansing
Rock Solid Quarries	Grand River	Jackson

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Headwaters–continued		
Michner Plating Company	Grand River	Jackson
United Parcel Service	Grand River	Jackson
Bailey Sand & Gravel Company	County Drain	Grass Lake
Hydraulic Systems Incorporated	Grand River	Jackson
AlphaGen Power LLC	Grand River	Jackson
Upper		
Village of Dimondale	Grand River, Murrary Drain, Dimondale Estates Drain	Dimondale
Windsor Charter Township	Willis Shaw Drain, Hull Drain, Grand River, Bronson, Rodgers Drain, Smith Extension Drain, Huntington Creek Drain	Dimondale
Eaton County Drain Commissioner	Miller Drain, Gilbert Intercounty Drain, unnamed tributary to the Grand River, Dimondale Farms Drain, Orphan Drain, Sandstone Creek	Charlotte
Spring Arbor Township	McCain Drain, Bateman Drain, Dolbee Branch Drain, Sandstone Creek, Spring Arbor-Concord Drain, Lime Lake	Spring Arbor
Oneida Development Company	Henderson Drain	Lansing
City of Eaton Rapids	Grand River	Eaton Rapids
Waverly Community Schools	Michigan Avenue Drain, Bogus Swamp Drain	Lansing
Jackson Auto Salvage	Sandstone Creek	Jackson
S & S Die Company	Grand River	Lansing
Martin Block Company	Grand River	Lansing
Demmer Corporation	Grand River	Lansing
C & H Stamping Incorporated	Sandstone Creek	Jackson
Precision Prototype & Manufacturing, Incorporated	Grand River	Eaton Rapids
Michigan Department of Military & Veterans Affairs	Grand River	Lansing
USF Holland Incorporated	Blackman Sandstone Drain	Jackson
Wolverine Metal Specialties	Sandstone Creek	Jackson
Mich Auto Compressor Incorporated	Sandstone Creek	Parma
Magnesium Products of America, Incorporated	Grand River	Eaton Rapids
Jackson County Airport	Sandstone Blackman Drain	Jackson
Specialty Castings Incorporated	Whitman Drain	Springport

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Upper–continued		
H & M Welding & Fabricating	Page Drain	Jackson
FASCO D. C. Motors Division	Grand River	Eaton Rapids
FASCO D. C. Motors Division	Grand River	Eaton Rapids
FASCO D. C. Motors Division	Grand River	Eaton Rapids
Biewer Lumber	Grand River	Lansing
Norfolk Southern Railway Company	Grand River	Lansing
Rolling Frito-Lay Sales LP	Sandstone Creek	Jackson
Rapids Tumble Finish, Incorporated	Hobart Drain	Eaton Rapids
Buckeye Terminals, LLC	Rives-Blackman Drain	Jackson
General Motors Corporation	Moon & Hamilton Drain	Lansing
Middle		
Prudden Place Partners LLC	storm sewer	Lansing
Kelly Ridge LLC	County Drain 53 & 20A	Holland
Ermanco, Incorporated	Little Black Lake	Spring Lake
City of East Lansing	Red Cedar River	East Lansing
Bath Charter Township	Park Lake, Remey Chandler Drain	Bath
Capital Region Airport Authority	Reynolds Drain, Edwards Drain	Lansing
DeWitt Charter Township	Reynolds Drain, Prairie Creek and Gunderman Drain	DeWitt
Delta Charter Township	Hunter Drain, Underhill Drain, Miller Creek, Briggs Extension, Squire Drain, Carrier Creek	Lansing
Meridian Charter Township	Lake Lansing, Red Cedar River	Okemos
Delhi Charter Township	Grovenburg Drain, Root Drain	Holt
Lansing Charter Township	Red Cedar River, Grand River	Lansing
City of DeWitt	Looking Glass River, John Volz Drain, Lake Geneva, Prairie Creek Drain	DeWitt
City of Lansing	Reynolds Drain, Gilkey Drain, Red Cedar River, Grand River, Johnsons Drain, Jones Lake	Lansing
City of Mason	Willow Creek, Sycamore Creek Drain, Rayner Creek Drain, Shaffer Creek Drain	Mason

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Middle–continued		
City of Grand Ledge	Grand River, Waldo Drain, Sandstone Creek Drain, Woodview Briaies Drain, John Earl Drain, Besore and Maier Drain	Grand Ledge
Vevay Township	Kipp/Tuttle Creek Drain, Tomlinson Creek Drain, Sycamore Creek, Columbia/Sitts Creek Drain	Mason
Watertown Charter Township	Looking Glass River, Rhine Drain, Durham Extension Drain, Pierce Dr. Drain, Tibbets Extension Drain, Grand River	Grand Ledge
Michigan State University	Red Cedar River	East Lansing
Oneida Charter Township	John Earl Drain, Porter Drain, Johnson Drain, John Earl Extension, Patterson and Dub Drain, Grand River	Grand Ledge
Ingham County Drain Commissioner	Remy Chandler Drain, Kierstead Drain, Smith Drain, Lakeview Drain, Lake Lansing Dam Drain, Burgess Drain	Mason
Clinton County Drain Commissioner	Edward No. 462 Drain, Looking Glass River Drain, Prairie Creek and Gunderman Drain, Kittle Drain, Grand River Drain, Summer Drain	Saint Johns
Clinton County Road Commission	Clise Drain, Unnamed tributary to Looking Glass River, Prairie Creek, unnamed tributary to Remey Chandler Drain, Remey Chandler Drain, Mud Creek	Saint Johns
City of East Lansing Public Schools	Red Cedar River	East Lansing
Holt Public Schools	county drain tributary to Sycamore Creek, Mud Lake Drain, county drain tributary to Grand River	Holt
Marion Township	Red Cedar River	Howell
Contech Construction Products	Sycamore Creek	Mason
Sun Communities Operating Limited Partnership	Grand River	Portland
Schonsheck Incorporated	Red Cedar River	Fowlerville
Diversified Financial	Prairie Creek Drain	DeWitt
Pinehill Partnership	Sycamore Creek	Mason
Maguire Development Group Incorporated	Meyers and Henderson Drain	Grand Ledge
Land Equities Corporation	Existing Wetlands	unknown
Eyde Company	Haron Creek Drain	East Lansing
Land Equities	Herron Creek	East Lansing
Land Equities	Smith Drain	Okemos

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Middle–continued		
Nixon Road Holding Company LLC	Miller Drain	Grand Ledge
4 M's Partnership	Woodview Drain	Grand Ledge
City of Portland	Looking Glass River	Portland
The Wieland Davco Corporation	Looking Glass River	DeWitt
Grand Ledge Public Schools	Sandstone Creek, Miller Creek, Grand River	Grand Ledge
Woodhull Township	Shaw Drain	Laingsburg
DeWitt Public Schools	Looking Glass River, Schultz Drain, Lake Geneva, John Voltz Drain	DeWitt
Okemos Public Schools	unnamed tributary to the Red Cedar River	Okemos
Haslett Public Schools	Mud Lake Outlet, Mud Lake Drain, Mud Lake, Pine Lake Outlet, Jeffries Drain	Haslett
Williamstown Township	Vermillion Creek, Shaw Extension Drain, Andrews Drain, McKeon Randall Drain	Williamston
ADL Systems, Incorporated	Friend Creek	Portland
Capital Area Transportation Authority	Sycamore Creek	Lansing
Pratt & Whitney AutoAir, Incorporated	Pulaski Creek	Lansing
Enprotech Mechanical Services	Grand River	Lansing
Huntsman Advanced Materials Americas Incorporated	Red Cedar River	East Lansing
Slicks Great Lakes Salvage	Sycamore Creek	Mason
Boichot Concrete Corporation	Grand River	Lansing
Plastech Engineered Products Incorporated	Red Cedar River	Fowlerville
Spartan Oil Corporation	Grand River	Lansing
Summertime Concrete Incorporated	Grand River	Lansing
Gestamp	Sycamore Creek	Mason
Superior Brass & Aluminum Casting Company	Red Cedar River	East Lansing
May & Scofield, Incorporated	Middle Branch Red Cedar River	Fowlerville
East Jordan Iron Works	Reeder and Chamblin Drains	Sunfield
FedEx Ground	Jones Lake	Lansing
Michigan State University	Red Cedar River	East Lansing
Michigan State University	Red Cedar River	East Lansing
Heart Truss & Engineering Corporation	Grand River	Lansing
Roadway Express, Incorporated	Grand River	Lansing

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Middle–continued		
Triton Industries, Incorporated	Moon & Hamilton Drain	Lansing
Modern Metal Processing	Red Cedar River	Williamston
Shroyer Auto Parts, Incorporated	South Town Creek	Lansing
Bioport Corporation	Jones Lake	Lansing
United Parcel Service, Incorporated	Sycamore Creek	Lansing
Efficiency Production, Incorporated	Sycamore Creek	Mason
Atmosphere Annealing Incorporated	Grand River	Lansing
Molded Plastic Industries, Incorporated	Sycamore Creek	Holt
Ambassador Steel Company	Sweeney Drain	Lansing
Lansing Board of Water and Light	Grand River	Lansing
CorrChoice LLC	Sycamore Creek	Mason
Leaseway Motorcar Transport Company	Upper Grand River	Lansing
Penske Logistics	Grand River	Lansing
US Postal Service	Banta Drain	Lansing
Land O'Lakes, Farmland Feed, LLC	Grand River	Lansing
Lansing Forge, Incorporated	Sycamore Creek	Lansing
Aggregate Industries	Sycamore Creek	Mason
Asahi Kasei Plastics North America Incorporated	Red Cedar River	Fowlerville
D & J Gravel Company, Incorporated	Red Cedar River	Howell
Roberts Sinto Corporation	Grand River	Grand Ledge
CNF Transportation, Incorporated	Sycamore Creek	Mason
Franchino Mold & Engineering Company	Edwards Drain	Lansing
Franchino Mold & Engineering Company	Edwards Drain	Lansing
Capital Region Airport Authority	Reynolds Drain	Lansing
General Motors Corporation	Grand River	Lansing
General Motors Corporation	Grand River	Lansing
Waste Management of Michigan	Grand River	Lansing
Capital Region Airport Authority	Sycamore Creek	Mason
Part-S-Mart Auto Salvage	Grand River	Lansing
Collins & Aikman	Red Cedar River	Williamston
Demmer Corporation	Red Cedar River	Williamston
General Motors Corporation	Grand River	Lansing

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Middle–continued		
General Motors Corporation	Carrier Creek	Lansing
General Motors Corporation	Grand River	Lansing
Quinns Auto Parts	Grand River	Grand Ledge
USA Lamp & Ballast Recycling Inc, dba Cleanlites Recycling	Sycamore Creek	Mason
Collins & Aikman	Deer Creek	Williamston
Behr America Incorporated	Dietz Creek	Webberville
Jet Engineering, Incorporated	Sycamore Creek	Lansing
ASC Incorporated	Grand River	Lansing
Schultz Snyder & Steele	Sycamore Creek	Mason
Avis Industrial Corporation	Grand River	Lansing
Thomas Fabrication, Incorporated	Sycamore Creek	Mason
Grand Trunk Western Railroad	Grand River	Lansing
Meijer, Incorporated	Grand River	Lansing
Cardinal Fabricating Incorporated	Red Cedar River	Williamston
E-T-M Enterprises	Grand River	Grand Ledge
Friedland Industries, Incorporated	Grand River	Lansing
RSDC of Michigan LLC	Sycamore Creek	Holt
Dakkota Integrated Systems LLC	Cook & Thornburn Drain	Holt
Synagro Midwest Incorporated	Grand River	Lansing
Universal Forest Products Eastern Division Incorporated	Grand River	Lansing
Layne Christensen Company	Grand River	Lansing
TRW Automotive	Red Cedar River	Fowlerville
Bavarian Motor Transport, LLC	Red Cedar River	Williamston
Contech Construction Products Incorporated	Sycamore Creek	Mason
Langenberg Machine Products, Incorporated	Grand River	Lansing
Schram Auto & Truck Parts Lansing, Incorporated	Gilette & Hancock Drain	Mason
Quality Dairy Company	Grand River	Lansing
ASC Lansing Assembly	Edwards Drain	Lansing
Michigan Department of Military & Veterans Affairs	Reynolds Drain	Lansing
Demmer Corporation	Grand River	Lansing
Americhem Sales Corporation	Sycamore Creek	Mason

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Middle–continued		
Dart Container Corporation	Sycamore Creek	Mason
Louis Padnos Iron & Metal Company	Grand River	Lansing
Michigan Paving & Materials	Melvin Drain	Lansing
Michigan Department of Military & Veterans Affairs	Reed Drain	Grand Ledge
Granger Land Development Company	Openlander Drain	Grand Ledge
Granger Waste Management Company	unnamed pond, a tributary to the Looking Glass River	Lansing
ADM Alliance Nutrition, Incorporated	Looking Glass River	Portland
T & D Partners	Looking Glass River	DeWitt
Franchino Mold & Engineering Company	Watson and Summers Drain	Lansing
Michigan Department of Military & Veterans Affairs	Reed Drain	Grand Ledge
Marathon Ashland Petroleum LLC	Looking Glass River	Lansing
Lower		
Cascade Charter Township	unnamed drain to Grand River, Apple Hills Drain, Little Plaster Creek, unnamed wetland tributary to Grand River, unnamed drain to Plaster Creek, Thornapple River	Grand Rapids
Ada Township	Thornapple River, Martin and Bear Drain, Egypt Creek, Carl Creek, unnamed Creek tributary to the Grand River, Adacroft Drain	Ada
Algoma Township	Stegman Creek, Shaw Creek, unnamed creek	Rockford
Allendale Charter Township	Ottawa Creek, Latham Drain, Draght Drain, Allendale Drain, Meyers Drain, Sevey Drain	Allendale
Alpine Township	Strawberry Creek, Hopkins Lake Drain, York Creek, Mill Creek, Indian Creek, Alpine-Walker Drain	Comstock Park
Byron Township	Buck Creek, Goose Creek Drain, Warner Drain, Pleasant Glen Drain, Rush Creek, 76th Street Industrial Park Drain	Byron Center
City of Grandville	Huizenga Drain, Roys Creek Drain, Buck Creek, Behan & Foley Drain, Lake Sanford, Grand River	Grandville
Cannon Township	Barkley Creek, Grass Lake, Silver Lake, Bostwick Lake	Rockford
Courtland Township	Rum Creek, Brower Lake, Little Myers Lake, Myers Lake, Little Brower Lake	Rockford
City of East Grand Rapids	Reeds Lake, Fisk Lake, Silver Creek	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Gaines Charter Township	Plaster Creek, Waterman Drain, Van Oosten Drain, Wenger & Nulty Drain, Anderson Drain, Cutlerville Drain	Caledonia
Grand Rapids Charter Township	Sunny Creek, Perch Lake, Little Plaster Lake, Echo Lake, Shadow Lake, Dean Lake	Grand Rapids
Kent County Road Commission	Barkley Creek, Campau Lake, Pebble Plains Drain, Plaster Creek, Evergreen Meadows Drain, Grand River	Grand Rapids
Kent County Drain Commissioner	Silver Lake, Plat Drain, Grand River, Van Mannen Drain, Hey Boer Drain #2, Rogue River	Grand Rapids
City of Kentwood	Buck Creek, Pine Creek Drain, Whiskey Creek, Little Plaster Creek, Pine Hill Creek, Plaster Creek	Kentwood
Kentwood Public Schools	Buck Creek, The Crossings Drain, Cutlerville Drain, Crippen Branch Drain	Caledonia
Plainfield Charter Township	Dean Lake, Rogue River, Grand River, Sub Plain North #1 Drain, Pine Creek, Scotch Creek	Belmont
City of Rockford	Rum Creek, Shaw Creek, Rogue River	Rockford
Sparta Township	Mill Creek, Rogue River	Sparta
Village of Sparta	Carpenter Drain, Mengs Branch Drain, Nash Creek	Sparta
City of Walker	unnamed Creek tributary to the Grand River, South Drain, Brandywine Creek, Alpine Estates Drain, Vista View Drain, Grand River	Grand Rapids
City of Wyoming	Sharps Creek, Roys Creek, Buck Creek, Beman & Foley Drain, Allen Road Drain, Heyboer Drain	Wyoming
City of Cedar Springs		Cedar Springs
Wright Township		Marne
Dix Farm LLC	Armstrong Creek	Belmont
B & G Development LLC	Warner County Drain	Byron Center
City of Grand Rapids	Grand River	Grand Rapids
Grand Oaks Association LLC	Grand River	unknown
Dykema Excavators Incorporated	Plaster Creek	Grand Rapids
D & A Partnership	Goose Creek	Byron Center
Jade Pig Ventures-Rivertown LLC	County Drain	Grandville
Dykema LP	Cottonwood County Drain to Grand River	Jenison

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Algoma Group No 10 LLC	unnamed creek	unknown
O E Bieri Ind Park LLC	unnamed drain	unknown
Insites LLC	Friar and Kimble Drains	Walker
Sunset Hills LLC	Worden County Drain	Walker
Dykema Excavators Incorporated	unnamed tributary to Grand River	Belmont
Dykema Excavators Incorporated	Clear Creek	Gowen
Langlois-Vineyards Phase II	storm sewer	Grand Rapids
JMR Development	Rush Creek	Hudsonville
Creekwood Village LLC	Crippen Branch Drain	Wyoming
Copperwood LLC	Grand River	Grand Rapids
Newline Development LLC	Plaster Creek	Grand Rapids
Kokomo Development, LLC	Grand River	Rockford
Bob Deppe	Goose Creek	Byron
Dykema Excavators Incorporated	Grand River	Grand Rapids
Dykema Excavators Incorporated	Grand River	Belmont
Dykema Excavators Incorporated	unnamed tributary to Rush Creek	Jamestown
Grand Valley Land Development	on-site ditch leading to Rogue River	Sparta
Allendale Partners LLC	Tributaries of Grand River	Allendale
City of Greenville	Flat River	Greenville
Pulte Land Company, LLC	Walden Lake drain	Grand Rapids
Katerberg Verhage Incorporated	Thornapple River	Grand Rapids
Greenstone Holdings, LLC	Plaster Creek	Grand Rapids
Eastbrook Development	Existing Wetlands	Grand Rapids
Ironwood Land LLC	Fryar & Kimball Drain	Grand Rapids
Penny Lambert	Dean Lake	Grand Rapids
Grand Rapids Printing Company Incorporated	Grand River	Grand Rapids
Micron Manufacturing Company	Indian Mill Creek	Grand Rapids
USF Holland Incorporated	Buck Creek	Wyoming
Louis Padnos Iron & Metal Company	Plaster Creek	Grand Rapids
Meijer	Indian Creek	Grand Rapids
Imperial Metal Products Company, LLC	Grand River	Grand Rapids
Midwest Bumper Company	Silver Creek	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Cascade Die Casting-Mid State	Grand River	Grand Rapids
Market Development Corporation	Buck Creek	Grand Rapids
Thompson-McCully Company	Plaster Creek	Grand Rapids
The DECC Company	Grand River	Grand Rapids
Kentwood Packaging-Powder	Plaster Creek	Grand Rapids
Gelock Transfer Line Incorporated	Grand River	Grand Rapids
Evans Tempcon Incorporated	Grand River	Grand Rapids
RailAmerica-GDR Eastern RR	Indian Mill Creek	Grand Rapids
Valley City Sign	Grand River	Comstock Park
Mitco Incorporated	Plaster Creek	Grand Rapids
Walker Tool & Die Incorporated	Indian Mill Creek	Grand Rapids
Ranger Tool & Die	Brandywine	Grand Rapids
P & K Steel Service Incorporated	Plaster Creek	Wyoming
Vans Delivery-Turner	Grand River	Grand Rapids
Thierica Incorporated	Coldbrook Drain	Grand Rapids
Grandville Printing Company	East Branch of Rush Creek	Grandville
Grand Rapids Carvers, Incorporated	Plaster Creek	Grand Rapids
Die Matic Tool & Die Incorporated	Grand River	Grand Rapids
Arvron Incorporated	Buck Creek	Grand Rapids
Holland American Wafer Company	Buck Creek	Grand Rapids
Paulstra CRC	Grand River	Grand Rapids
Meridian Automotive Systems Incorporated	Prairie Creek	Ionia
Consumers Concrete Corporation	Grand River	Ionia
Brown Corporation of Ionia Incorporated	Grand River	Ionia
Midwest Bumper Group	Grand River	Saranac
Prins Trucking Incorporated-Jenison	Rush Creek	Jenison
Nicholas Plastic Incorporated	Grand River	Allendale
Kerkstra Precast Incorporated	Rush Creek	Jenison
ALTL Incorporated	Buttermilk Creek	Hudsonville
Ottawa Aggregates Incorporated	Grand River	Grand Rapids
Ottawa Aggregates Incorporated	Grand River	Hudsonville
Piedmont of Michigan Incorporated	Buck Creek	Byron Center

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
ABF Freight System, Incorporated	Grand River	Grand Rapids
Clarion Technologies, Incorporated	Plaster Creek	Caledonia
Waste Management of Michigan	Grand River	Grand Rapids
Waltz-Holst Company	Grand River	Ada
Woodland Paving Company	Indian Mill Creek	Comstock Park
Maghielse Tool Corporation	Grand River	Grand Rapids
Tabletting, Incorporated	Plaster Creek	Kentwood
Suspa Incorporated	Grand River	Grand Rapids
Cascade Engineering	Plaster Creek	Grand Rapids
State Heat Treat, Incorporated	Plaster Creek	Grand Rapids
State Spring Service	Buck Creek	Grand Rapids
Stagood Metal Components, Incorporated	Plaster Creek	Grand Rapids
Yellow Freight System, Incorporated	Crockery Creek	Wyoming
United Parcel Service, Incorporated	Buck Creek	Wyoming
United States Postal Service	Plaster Creek	Grand Rapids
Stephenson & Lawyer, Incorporated	Plaster Creek	Grand Rapids
Spectrum Industries, Incorporated	Coldbrook Drain	Grand Rapids
Schupan Recycling	Plaster Creek	Wyoming
Roman Manufacturing, Incorporated	Buck Creek	Grand Rapids
Riveria Tool Company	Plaster Creek	Grand Rapids
Reliance Finishing Company	Plaster Creek	Grand Rapids
Rapid Die & Engineering, Incorporated	Plaster Creek	Grand Rapids
Price Industries, Incorporated	Plaster Creek	Dutton
Caraustar Custom Packaging	Grand River	Wyoming
Grand River Infrastructure, Incorporated	Grand River	Grand Rapids
Covanta Energy	Grand River	Grand Rapids
Franklin Partners, LLC	Grand River	Kentwood
Structural Standards, Incorporated	Nash Creek	Sparta
Michigan Packaging, a division of CorrChoice LLC	Little Plaster Creek	Kentwood
Michigan Certified Concrete Products Incorporated	Plaster Creek	Grand Rapids
Midwest Vibro, Incorporated	Grand River	Grandville
Norfolk Southern Railway Company	Plaster Creek	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Nova Plastic Technologies	Grand River	Grandville
Louis Padnos Iron & Metal Company	Grand River	Grand Rapids
Knoll Incorporated	Plaster Creek	Kentwood
Klise Manufacturing Company	Coldbrook Creek	Grand Rapids
Key Plastics, LLC	Plaster Creek	Grand Rapids
Kamps Pallets, Incorporated	Indian Mill Creek	Grand Rapids
Irwin Seating	Sand Creek	Grand Rapids
Hansen Balk Steel Treating Company	Grand River	Grand Rapids
Hill Machinery Company, Incorporated	Plaster Creek	Kentwood
Hager Wood Preserving, Incorporated	Grand River	Wyoming
Hekman Furniture Company	Grand River	Grand Rapids
Grand Rapids Auto Parts Incorporated	Indian Mill Creek	Grand Rapids
Grand Rapids Gravel Company	Grand River	Dutton
Grand Rapids Gravel Company	Roys Creek	Grandville
Atlas Roofing Corporation	Warner Creek	Byron Center
Frost Incorporated	Indian Mill Creek	Grand Rapids
Behr Industries Corporation	Strawberry Creek	Comstock Park
Christopher Metal Fabricating	Plaster Creek	Grand Rapids
Columbian Distribution Services Incorporated	Grand River	Grand Rapids
Crystal Flash	Indian Mill Creek	Grand Rapids
Spectrum/Wealthy, Incorporated	Grand River	Grand Rapids
Electro Chemical Finishing Company	Grand River	Wyoming
Die Dimensions Corporation	Plaster Creek	Kentwood
Blackmer, A Dover Resources Company	Plaster Creek	Grand Rapids
Cascade Engineering	Little Plaster Creek	Grand Rapids
Haviland Products Company	Indian Mill Creek	Grand Rapids
Helen Incorporated	Plaster Creek	Caledonia
Country Fresh Incorporated	Plaster Creek	Grand Rapids
Dyna Plate Incorporated	Plaster Creek	Grand Rapids
Gainey Corporation	Buck Creek	Grand Rapids
Hi Tec-Laser Die & Engineering	Plaster Creek	Kentwood
Imperial Sheet Metal	Plaster Creek	Wyoming

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Imperial Graphics Incorporated	Indian Mill Creek	Grand Rapids
Louis Padnos Iron & Metal Company	Grand River	Grand Rapids
Keebler Company	Plaster Creek	Grand Rapids
Coca-Cola Bottling Company of Michigan	Grand River	Grand Rapids
Consumers Concrete	Plaster Creek	Kentwood
CSX Transportation	Plaster Creek	Grand Rapids
Lear Corporation	Cogswell Drain	Grand Rapids
Roadway Express	Grand River	Grand Rapids
Mannesmann Dematic Rapistan Systems		Grand Rapids
Haworth, Incorporated	Whiskey Creek	Kentwood
Meridian Automotive Systems	Grand River	Grand Rapids
Meridian Automotive Systems	Plaster Creek	Grand Rapids
Meridian Automotive Systems	Plaster Creek	Grand Rapids
Meridian Automotive Systems	Plaster Creek	Kentwood
Bauer Products	Grand River	Grand Rapids
Decorative Castings Incorporated	Plaster Creek	Kentwood
BMC Bil-Mac Corporation	Buck Creek	Grandville
Bell Packaging Corporation	Grand River	Wyoming
Bissell Incorporated	Indian Mill Creek	Grand Rapids
Auto Cast Incorporated	Buck Creek	Grandville
American Litho Incorporated	Plaster Creek	Grand Rapids
Alexis Manufacturing	Sand Creek	Grand Rapids
ADAC Plastics, Incorporated	Plaster Creek	Grand Rapids
Advance Plating & Finishing	Grand River	Grand Rapids
Autocam Corporation	Plaster Creek	Kentwood
Advance Packaging Corporation	Plaster Creek	Grand Rapids
American Seating Company	Grand River	Grand Rapids
Amerikam	Plaster Creek	Wyoming
JELD-WEN Incorporated	Heyboer Drain	Grand Rapids
Amway Corporation	Grand River	Ada
A & K Finishing Incorporated	Plaster Creek	Grand Rapids
A & K Finishing Incorporated	Plaster Creek	Kentwood

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Michigan Department of Military & Veterans Affairs	Buck Creek	Wyoming
Benteler Automotive	Grand River	Grand Rapids
Electro Chemical Finishing Company	Plaster Creek	Wyoming
Detroit Diesel Remanufacturing	Plaster Creek	Kentwood
West Michigan Recycled Aggregates	Grand River	Grandville
Packaging Corporation of America	Grand River	Grandville
Spectrum/Cubic Incorporated	Grand River	Grand Rapids
Metokote Corporation	Indian Mill Creek	Grand Rapids
MC Van Kampen Trucking	Plaster Creek	Wyoming
Monarch Hydraulics Incorporated	Grand River	Grand Rapids
Topcraft Metal Products, Incorporated	Rush Creek	Hudsonville
Center Manufacturing Incorporated	Buck Creek	Byron Center
Farmland Dairies	Buck Creek	Grand Rapids
H. B. Fuller Company	Nolan Drain	Grand Rapids
Burke E. Porter Machinery Company	Coldbrook Creek	Grand Rapids
Miscellaneous Steel Fabricators Incorporated	Buck Creek	Dutton
Plastech Engineered Products, Incorporated	Grand River	Grandville
Northwest Tool & Die	Indian Mill Creek	Grand Rapids
Weller Auto Parts Incorporated	Grand River	Grand Rapids
Venture Grand Rapids LLC	Plaster Creek	Grand Rapids
Reliance Plastisol Coating Company	Plaster Creek	Wyoming
HS Die & Engineering, Incorporated	Little Sand Creek	Grand Rapids
GR Diecraft Incorporated	Plaster Creek	Kentwood
Plasma-Tec Incorporated	Buck Creek	Grand Rapids
Grand Rapids Transport Incorporated	Rush Creek	Jenison
G R Central Iron & Steel Corporation	Indian Mill Creek	Grand Rapids
Autodie International Incorporated	Grand River	Grand Rapids
H S Die	Indian Mill Creek	Grand Rapids
Knape & Vogt Manufacturing Company	Maryland Creek storm sewer	Grand Rapids
Reliance Spray Mask Company	Indian Mill Creek	Grand Rapids
Paladin Ind Incorporated	Plaster Creek	Grand Rapids
Pitsch-Concrete Crushing	York Creek	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Team Industries	Plaster Creek	Grand Rapids
Rowe International Incorporated	Grand River	Grand Rapids
BorgWarner Automotive	Grand River	Grand Rapids
Plastic Mold Technology Incorporated	Plaster Creek	Grand Rapids
Cook Composites and Polymers	Grand River	Grand Rapids
Yamaha Musical Products	Little Plaster Creek	Grand Rapids
Dry-Mix Crete & Supply Company	York Creek	Comstock Park
Litehouse Incorporated	Grand River	Lowell
Van Manen Oil & Propane Incorporated	Little Sand Creek	Grand Rapids
Alvan Motor Freight Incorporated	Buck Creek	Grand Rapids
M & E Manufacturing	Plaster Creek	Grand Rapids
Betz Industries	Grand River	Grand Rapids
Miller Products	Grand River	Grand Rapids
Van Dellen Steel Incorporated	Buck Creek	Dutton
Pitsch Salvage	Indian Mill Creek	Grand Rapids
Pinnacle LLC	Grand River	Grand Rapids
MacDonalds Industrial Products, Incorporated	Plaster Creek	Kentwood
Sterk Brothers Redi-Mix	Buck Creek	Wyoming
Williams Distributing	Indian Mill Creek	Grand Rapids
Bouma Furniture Express	Buck Creek	Grand Rapids
Light Metals Corporation	Roys Creek	Wyoming
Dietool Engineering	Indian Mill Creek	Grand Rapids
John Widdicomb Corporation	Grand River	Grand Rapids
Proos Manufacturing Company	Coldbrook Drain	Grand Rapids
Great Lakes Motorcoach Incorporated	Nolan Drain	Grand Rapids
Mannesmann Dematic Rapistan Corporation	Grand River	Wyoming
Harlo Products Corporation	Grand River	Grandville
D & M Metal Products Company	Grand River	Comstock Park
American Metal & Plastics	Plaster Creek	Grand Rapids
Master Finish Company	Plaster Creek	Grand Rapids
Progressive Technologies	Grand River	Grand Rapids
Pridgeon & Clay Incorporated	Grand River	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Apex Rack & Coating Company	Grand River	Grandville
Volcor Finishing Incorporated	Grand River	Ionia
Valley City Plating	Grand River	Grand Rapids
Dubois Production Services	York Creek	Comstock Park
Midwest Plating Company Incorporated	Coldbrook Creek	Grand Rapids
Allied Waste Systems, Incorporated	Rush Creek Drain	Jenison
Dievelopment	Plaster Creek	Kentwood
Wolverine Tool & Engineering	Grand River	Belmont
Dieline Corporation	Plaster Creek	Kentwood
Dielink International	Indian Mill Creek	Grand Rapids
Superior Wood Products Incorporated	Grand River	Grand Rapids
Magic Finishing Company	Plaster Creek	Wyoming
Overnite Transportation Company	Brandywine Creek	Grand Rapids
Accuform Industries Incorporated	Grand River	Grand Rapids
HME Incorporated	Grand River	Wyoming
Bishop Distributing Company	Plaster Creek	Grand Rapids
G R Wilbert Burial Vault Company	Indian Mill Creek	Grand Rapids
Vi-Chem Corporation	Grand River	Grand Rapids
Equity Transportation Company Incorporated	Indian Mill Creek	Grand Rapids
MacDonalds Industrial Products, Incorporated	Indian Mill Creek	Grand Rapids
Mol Belting Company	Indian Mill Creek	Grand Rapids
Eerdmans Printing Company	Plaster Creek	Grand Rapids
Consumers Concrete Corporation	Grand River	Wyoming
Allied Waste Systems, Incorporated	Rush Creek	Jenison
Robinson Cartage Company	Luvis Lake	Grand Rapids
Wright Plastic Products	Prairie Creek	Sheridan
Baker Auto	Grand River	Grand Rapids
Baker Auto	Grand River	Grand Rapids
Baker Auto	Grand River	Grand Rapids
Ada Auto Salvage	Egypt Creek	Ada
Steeltech Limited	Silver Creek Drain	Grand Rapids
Davidson Plyforms Incorporated	Plaster Creek	Grand Rapids

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Zeichman Manufacturing Incorporated	Buck Creek	Wyoming
Couturier Iron Craft Incorporated	Grand River	Comstock Park
Kuperus Trucking Company	Grand River	Jenison
Rapid Engineering Incorporated	Strawberry Creek	Comstock Park
Towne Air Freight	Plaster Creek	Grand Rapids
Cascade Engineering	Little Plaster Creek	Grand Rapids
Model Die & Mold Incorporated	Buck Creek	Grand Rapids
Meridian Automotive Systems	Grand River	Ionia
RTS	Grand River	Grand Rapids
Enterprise Tool & Die, Incorporated	Grand River	Grandville
Michigan Wheel Corporation	Plaster Creek	Grand Rapids
Roman Manufacturing, Incorporated	Buck Creek	Wyoming
Future Tool & Die	Grand River	Grandville
V. L. Watkins Transport	Rush Creek	Jenison
Jackson Products, Incorporated	Grand River	Belmont
Lacks Enterprises Incorporated	Plaster Creek	Kentwood
Lacks Enterprises, Incorporated	Plaster Creek	Kentwood
Lacks Enterprises, Incorporated	Plaster Creek	Kentwood
Lacks Enterprises Incorporated	Plaster Creek	Kentwood
Kenona Industries, Incorporated	Sand Creek	Grand Rapids
VEC Incorporated-The Transportation Group	Buck Creek	Byron Center
Center Manufacturing Incorporated	Buck Creek	Byron Center
Steelcase Wood Furniture	Plaster Creek	Caledonia
Aggregate Industries	Plaster Creek	Grand Rapids
Wil-Kast Incorporated	Sharps Creek	Grand Rapids
Center Manufacturing Incorporated	Buck Creek	Wayland
Benteler Automotive Corporation	Buck Creek	Wyoming
Cascade Engineering	Little Plaster Creek	Grand Rapids
FedEx Freight East Incorporated	Cole Drain	Wyoming
Roman Manufacturing, Incorporated	Buck Creek	Grand Rapids
Meridian Automotive Systems Incorporated	Plaster Creek	Kentwood
Kentwood Manufacturing Company	Plaster Creek	Kentwood

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Ottawa Aggregates Incorporated	unnamed tributary of the Grand River	Lowell
Karona	Plaster Creek	Caledonia
Lacks Trim Systems	Plaster Creek	Kentwood
Plastech Engineered Products Incorporated	Plaster Creek	Kentwood
Lacks Wheel Division	Grand River	Grand Rapids
Rolling Frito-Lay Sales LP	Buck Creek	Byron Center
Sara Lee Bakery Group, Incorporated	Plaster Creek	Grand Rapids
Louis Padnos Iron & Metal Company	Indian Mill Creek	Grand Rapids
Grand Valley Auto Parts	Grand River	Jenison
Conjack Ready Mix Concrete	Tibbets Creek	Ionia
Steelcase Incorporated	Heyboer Drain	Grand Rapids
Wikoff Color Corporation	Buck Creek	Grand Rapids
Kent County Board of Public Works	Buck Creek	Byron Center
Pitsch Sanitary Landfill Incorporated	Dickerson Creek	Belding
Spectrum Belding Incorporated	Flat River	Belding
Markson Tool & Manufacturing	Rogue River	Sparta
RailAmerica	Flat River	Greenville
Clarion Technologies Incorporated	Flat River	Greenville
Cascade Die Casting Group, Incorporated	Rogue River	Sparta
Greenville Tool & Die Company	Flat River	Greenville
Tesa Tape Incorporated	Rogue River	Sparta
Trussway-Central	Rogue River	Sparta
General Formulations, Incorporated	Rogue River	Sparta
Byrne Electrical Specialists, Incorporated	Rouge River	Rockford
Extruded Aluminum Corporation	Flat River	Belding
R J Tower Corporation	Flat River	Greenville
Greenville Wire Products	Flat River	Greenville
Vertis, Incorporated	Flat River	Greenville
Harrison Packing Company Incorporated	Stoney Creek	Edmore
ITW AIM Components	Rogue River	Rockford
Grand Rapids Controls Company LLC	Rogue River	Rockford
Federal Mogul Piston Rings Incorporated	unnamed creek	Sparta

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Wolverine World Wide Leathers	Rogue River	Rockford
Robroy Industries	Flat River	Belding
Murray Lake Marina	Murray Lake	Lowell
Sparta Foundry, Incorporated	Nash Creek	Sparta
City of Ionia	Grand River	Ionia
Grand Haven-Spring Lake Sewer Authority	Grand River	Grand Haven
Organic Chemicals, Incorporated Steering Committee		Grandville
ChemCentral/Grand Rapids Corporation		Wyoming
Dykema Excavators Incorporated	Grand River	Belmont
Standard Aggregates Incorporated	Colony Lake and Stevens Drain	Saint Johns
DMB LLC	Dieter Drain	Saint Johns
COG Marketers, Limited	Perrin County Drain	Saint Johns
Omni Technical Services, Incorporated	Haworth Creek	Saint Johns
Lear Corporation	Maple River	Elsie
Ovid Farmers Elevator	Maple River	Ovid
Dana Corporation	Doty Brook	Saint Johns
Travers Auto	Saint Johns Big Ditch Drain	Saint Johns
Nero Plastics, Incorporated	Strohl Drain	Owosso
Sparks Pickle Company	Pine Creek	Ithaca
Federal Mogul Corporation	Hayworth Creek	Saint Johns
Transmac Carson LLC	Fish Creek	Carson City
Worthington Ag Parts	Spaulding Drain	Saint Johns
Barnard Manufacturing Company	Maple River	Saint Johns
Bay View Condominiums	Gun Lake	unknown
Quality Air Heating & Cooling	Plaster Creek	Grand Rapids
Magna International	Tyler Creek	Alto
Lacks Enterprise Incorporated	Little Plaster Creek	Kentwood
Automated Process Equipment Corporation	Jordan Lake	Lake Odessa
Paragon Die & Engineering Company	Plaster Creek	Grand Rapids
Citation Grand Rapids	Thornapple River	Grand Rapids
Voorhorst, Incorporated	Carman Drain	Charlotte
Quality Hardwoods, Incorporated	Thornapple Creek	Sunfield

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Lower–continued		
Northern Concrete Pipe, Incorporated	Carman Drain	Charlotte
St. Regis Culvert, Incorporated	Duffy Drain	Charlotte
City of Charlotte	Thornapple River	Charlotte
R. E. Davis Motor Sales Incorporated	Butternut Creek	Charlotte
Hastings Manufacturing Company	Butler Creek	Hastings
Flexfab	Thornapple River	Hastings
Freeport Sawmill, Incorporated	Coldwater River	Freeport
Louis Padnos Iron & Metal Company	Thornapple River	Hastings
TNR Machine Incorporated	Mill Pond	Dowling
Hastings Fiberglass Products, Incorporated	Thornapple River	Hastings
Twin City Foods	Jordan Lake	Lake Odessa
Best Metal Products	Thornapple River	Grand Rapids
Franklin Metal Trading Corporation	Jordan Lake	Lake Odessa
Cherry Valley Development	Thornapple River	Caledonia
Viking Corporation	Thornapple River	Hastings
Concept Industries, Incorporated	Thornapple River	Grand Rapids
Metaldyne Corporation	Thornapple River	Middleville
Bliss Clearing Niagara, Incorporated	Thornapple River	Hastings
L.L. Johnson Lumber Manufacturing Company	Duffy Drain	Charlotte
Con-Way Transportation Services, c/o CNF Incorporated	unnamed tributary to Thornapple River	Grand Rapids
Rolling Frito-Lay Sales LP	Thornapple River	Lansing
Charlotte Anodizing Products	Butternut Creek	Charlotte
C & D Hughes Aggregate LLC	Church and McClintic Drain	Charlotte
Michigan Pallet Recycling	Thornapple Drain	Charlotte
Mouth		
Grand Haven Municipal Airport	Spring Lake	Grand Haven
Ottawa County Road Commission	Cedar Drain, Bliss Creek, Macatawa River, Rose Drain, Bass Creek, Pine Creek	Grand Haven
Fruitport Charter Township	Black Creek, Stevens Creek, Cress Creek, unnamed creek tributary to Spring Lake, unnamed creek tributary to Cress Creek, Willow Hill Creek	Fruitport

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Mouth–continued		
Ottawa County Road Commission		Grand Haven
Citgo Petroleum Corporation		Ferrysburg
Buckeye Terminals, LCC	Grand River	Ferrysburg
V & S Partners	Alward Drain	unknown
KVW Venture	Low-Com County Drain	unknown
Eastbrook Development Company	unnamed creek tributary to Millhouse Bayou	Grand Haven
Zeeland Farm Services Incorporated	various receiving waters	Zeeland
Robinson Township	Stearns Bayou, Grand River	Grand Haven
Shape Corporation	Grand River	Grand Haven
Shape Corporation	Grand River	Grand Haven
Medallion Instrumentation Systems	Spring Lake	Spring Lake
Heath Manufacturing Company	Deer Creek	Coopersville
Supreme Machined Products	Spring Lake	Spring Lake
Magna Donnelly Corporation	Pottawattomie Bayou	Grand Haven
JSJ Plastics Incorporated	Grand River	Grand Haven
Atcoflex, Incorporated	Vincent Drain	Grand Haven
Herman Miller, Incorporated	Spring Lake	Spring Lake
JSJ Corporation	unnamed tributary to the Grand River	Grand Haven
Metal Technologies International	Crockery Creek	Ravenna
Herman Miller, Incorporated	Spring Lake	Spring Lake
V & V Incorporated	Grand River	Grand Haven
Barrett Boat Works	Spring Lake	Spring Lake
Gyro Powder Coating Incorporated	Grand River	Grand Haven
Engine Power Components Incorporated	Grand River	Grand Haven
Shape Corporation	Grand River	Grand Haven
North Shore Marina, Incorporated	Spring Lake	Spring Lake
JSJ Corporation	Grand River	Spring Lake
Swanson Pickle Company Incorporated	Crockery Creek	Ravenna
Great Lakes Contracting Incorporated	Grand River	Grand Haven
Grand Isle Marina	Grand River	Grand Haven
Joes Auto & Truck Parts Incorporated	Grand River	Spring Lake
Tri-Cast Incorporated	Grand River	Spring Lake

Table 17b.–Continued.

Permittee	Receiving water(s)	Location
Mouth–continued		
Seaver Industrial Finishing	Grand River	Grand Haven
Light Corporation	Grand River	Grand Haven
Harbor Industries	Grand River	Grand Haven
Ottawa County FarmsLandfill		Coopersville
Solar of Michigan Incorporated	Deer Creek	Coopersville
Grand Haven Board of Light & Power	Grand River	Grand Haven
Buckeye Terminals, LLC	Grand River	Ferrysburg
Bauer Truck Parts	Bass River	Hudsonville
Haldex Grand Haven Operations	Spring Lake	Grand Haven
Alcoa Automotive Castings	Spring Lake	Fruitport

Table 18.–Contamination sites in the Grand River watershed, by valley segment, 2005. Data from Michigan Department of Environmental Quality, Environmental Response Division. Acronyms: BTEX=benzene, toluene, ethylbenzene, and xylene; DCA=dichloroethane; DCE=dichloroethylene; DDE=dichlorodiphenyldichloroethylene; MTBE=methyl tertiary butyl ether; DDT=dichlorodiphenyltrichloroethane; PCB=polychlorinated biphenyl; PCE or PERC=perchloroethylene; PAHs=polynuclear aromatic hydrocarbons; TCA=trichloroethane; TCE=trichloroethylene; TPH=total petroleum hydrocarbons; LF=landfill. (Web: http://www.deq.state.mi.us/erd1/sites/index.jsp).

Segment and site	Location	Pollutant
Headwaters		
Clark Equipment	Jackson	Cyanide, PCBs, Heavy Metals
Conrail Jackson Yard	Jackson	Arsenic, Lead, BTEX
Franklin Street	Jackson	Cyanide
General Products Corp	Jackson	Phenol, BTEX, Heavy Metals
Henrietta Twp Dump	Henrietta Twp.	Heavy Metals, DDT
ITT Hancock Industries	Jackson	Methylene chloride, Lead, BTEX
Jackson Co LF No 1	Jackson	Zinc, Benzene, TCE
Jackson Co Rd Commission	Rives Junction	Salt
State Prison of Southern Michigan	Jackson	Heavy Metals, TCE
Jackson Wells	Jackson	Cis-1,2-DCE
Lansing Avenue Dump	Rives Junction	Heavy Metals
Libra Industries	Jackson	PERC, BTEX
MacCready Realty	Jackson	Cyanide, Heavy Metals
Mechanical Products	Jackson	PCE, TCE, Benzene, Lead
Napoleon Twp Sanitary LF	Napoleon	Domestic waste
Northeast Land Development	Jackson	Domestic waste
Page Ave Dump	Michigan Center	Heavy Metals
CDM International	Jackson	Waste Oils
Factory Sales	Napoleon	Light Industrial
Metcalf Dumpsite	Jackson	Fuel Oil
Central Michigan Plating	Jackson	Heavy Metals
Howards Radiator Service	Jackson	Lead Benzene
Ryerson Haynes Inc	Jackson	Heavy Metals
Young Rd Jackson	Jackson	Waste oil
Jackson Co Rd Comm Brills Lk Rd	Jackson	Domestic waste, Brine
Folk Oil Lansing Avenue	Jackson	Gasoline
Junction Manufacturing	Rives Junction	Lead, Barium, Cutting oil
Harvard Ind./Hayes-Albion	Jackson	TCE DCE BTEX
Dawn Donuts-Cooper St Gas Loss	Jackson	Gasoline
Cedar Knoll Rest Home LF		Solid Waste
Falcon St Area GW Contamination	Falcon	Carbon Tetrachloride, MTBE
Sam's Iron & Metal	Jackson	PCE, Heavy Metals
West Jackson GW Contamination	Jackson	DCE Vinyl Chloride
Motorpool Enterprises	Michigan Center	Diesel Fuel Gasoline
Simpson Industries-Jackson	Jackson	Dichloropropane
Jackson Drop Forge	Jackson	BTEX
Upper		
Airport Sanitary LF	Jackson	Chlorobenzene, Phenol
Jackson Flexible Products	Jackson	Organics, Heavy Metals
Spring Arbor College Maint Garage	Spring Arbor	BTEX
Spring Arbor College	Spring Arbor	PCE, TCE
Engel Corporation	Jackson	Waste Oils

Table 18.–Continued.

Segment and site	Location	Pollutant
Upper–continued		
BWL Coal Pile Area-Eckert Stn	Lansing	Light Industrial
Gunn Rd LF	Holt	Arsenic, Lead
OB and B Plating	Lansing	Lead, Chromium, Copper, Zinc
Abandoned Tank Storage Facility	Dimondale	Chem Prod Mfg
Dimondale City of	Dimondale	Sodium Chloride
Eaton Rapids Municipal LF	Eaton Rapids	Benzene,Chloroethane, DCA
Res Wells Arch Rd	Eaton Rapids	Nitrates
Res Wells Hamlin Twp	Eaton Rapids	Nitrates, Sodium Chloride
Huckaba Junkyard	Lansing	Lead, BTEX
Lockes Recycling Center		Domestic waste
Middle		
TRW Michigan Division	Portland	Vinyl Chloride, PCB, 1,2-DCE
Adams Plating	Lansing	Chromium 1,1, DCE, 1,1,1-TCA
Ashland Chemical	Lansing	Methylene Chloride
Baker St Contamination Area	Lansing	BTEX, TCE
Barrels Inc	Lansing	Phthalate 1,2 DCA, TCE
BWL Coal Pile Ottawa St	Lansing	Light Industrial
City LF Paulson St	Lansing	Benzene, Lead, TCE, 1,1-DCE
Conrail	Lansing	Heavy Metals
Crego Park	Lansing	Heavy Metals, PCBs, Toxaphene
Dart Container	Mason	Sodium Chloride, BTEX
Eastlund Concrete	Holt	Heavy Metals
Former Serv Sta Holmes and Logan	Lansing	BTEX
Foster St Aband Plating Area	Lansing	Heavy Metals
Gas Contamination Kzoo Clippert	Lansing	Gasoline
Granger LF Paulson St	Lansing	Chloroethane
Keller Rd Area	Holt	Fuel Oil
L and L Construction	Holt	Heavy Metals
Lake Lansing Sediments	Haslett	Arsenic
Lansing, Aurelius Road Landfill	Lansing	Phthalate, PERC, Heavy Metals
Macs All Car Service	Lansing	Heavy Metals
Mallard St	Meridian Twp.	Oil, PCBs, Lead
MDMB Federal Surplus	Lansing	Lead, Manganese, Zinc
Motor Wheel Disposal Area	Lansing Twp	Lead, Copper, Dibenzofuran
MSU Jolly Rd Site	East Lansing	Chloroform, Benzene, 1,2-DCA
MSU Power Plant Dump Site	East Lansing	Chlorinated organics
Municipal Well Lansing No 10 12	Lansing	Chlorinated organics
Municipal Well Lansing No 10 15	Lansing	Chlorinated organics
Municipal Well Lansing No 25 2	Lansing	Chlorinated organics
Municipal Well Lansing No 25 13	Lansing	Dichloroethylene
Municipal Well Lansing No 25 19	Lansing	1,1 Dichloroethane
Municipal Well Lansing No 25 20	Lansing	1,2 Trichloroethene, DCE, Toluene
Municipal Well Lansing No 30 07	Lansing	Trichloroethylene, Dichloroethylene
Municipal Well Lansing No 50 20	Lansing	TCE
Municipal Well Lansing No 60 10	Lansing	Perchloroethylene
Res Well Former	East Lansing	Lead, Zinc, Arsenic
Service Station 127 and Holt	Holt	BTEX
Service Station Saginaw St	Lansing	BTEX
Spartan Asphalt	Holt	Fuel oil, sulfate
Spartan Sign Co	Holt	Light Industrial

Table 18.–Continued.

Segment and site	Location	Pollutant
Middle–continued		
Sunoco Station	Lansing	Gasoline
Wood as New Refinishing	Okemos	Methylene Chloride
Allied Herrguth/Richards LF	Leslie	Benzene, Toluene
W R Grace Company	Lansing	DDD, DDT, PAHs
Frmr Ever-Clean 1478 Grand River	Okemos	Waste Solvents
Wohlert Corp.	Lansing	Chlorinated organics
Lansing Center	Lansing	Chlorinated organics
Motor Wheel Facility-Saginaw St	Lansing	Chlorinated organics
205 W. Grand River, Williamston	Williamston	BTEX
Frmr Bulk Storage Trmnl-W Willow	Lansing	BTEX, PAHs
Henry's Carb & Elec Service	Lansing	Benzene, Lead
BOC Plant#3-Frmr Plating Area	Lansing	Cyanide, Heavy Metals
Ashland Chemical-Turner St	Lansing	Chlorinated organics
City of Lansing/O&M Div Complex	Lansing	Chlorinated organics
MDPH Mdcl Wst Dsp/Cptl Airport	Lansing	Biological Products
MAACO Auto	Grand Ledge	Toluene, Lead, solvents
Parsons Chemical	Grand Ledge	1,2,7,8-TCDF, DDT
Bob's Marathon	Grand Ledge	Benzene, Toluene
Grand Ledge Tire	Grand Ledge	Benzene
Perfection Fabricating	Mulliken	DCA, TCA, xylene,ethylbenzene
Grand Ledge Clay Products Pit	Grand Ledge	Waste Thinners
Granger LF Area	Lansing	Dichloroethane
Hoffman Furniture Stripping	Dewitt	Pennesolve 814
PCA Farm	DeWitt	Chlorinated organics
Brown Brothers/Total Contracting	Lansing	Petroleum Products
Sexton Property	Laingsburg	BTEX, NAPTHALENE,
Kesler Prop/Chandler Rd Tank Dum	Bath	BTEX
CRAA Heating Oil UST	Lansing	Benzene
Ballard Residence Center Rd.	Bath Township	Lead
DNR Rose Lake Warehouse	Haslett	BTEX
Boltec Industries Inc	Fowlerville	Heavy Metals
Rooto Corp	Howell	Acids
Stanley Tools	Fowlerville	Zinc, Chromium
Lower		
Able Finishing Company	Grand Rapids	Heavy mfg
Aero Liquid Transit	Lowell	Ammonia, Oil, Grease
Approved Industrial Removal	Wyoming	Cyanide, Benzene
Attwood Corp	Lowell	Heavy Metals
Belfer Drum and Barrel	Wyoming	PCB
Butterworth LF	Grand Rapids	Heavy Metals, DDT, PCBs
Caledonia Village of	Caledonia	Nitrate, Nitrite, Chloride
Cedar Springs WWTP	Cedar Springs	Manganese, Arsenic, Lead, Selenium
ChemCentral Grand Rapids	Grand Rapids	PCE
CSX Transportation Grand Rapids	Grand Rapids	Chlorinated Solvents, BTEX, PAHs
Conrail Yards Area	Grand Rapids	BTEX, PCE, TCA, Chromium
MC Donald Ind Plastic/FCM/P Tech	Grand Rapids	Heavy Metals, MEK, Toluene
Folkertsma Refuse	Grand Rapids	Benzopyrene, Lead
Former Dexter Lock	Grand Rapids	Chromium
GRM Industries (G. R. Brass Co.)	Grand Rapids	Chromium, Cyanide
Grandville Dump	Grand Rapids	Chlorobenzene

Table 18.–Continued.

Segment and site	Location	Pollutant
Lower–continued		
Guardsman Chemicals	Grand Rapids	Xylene, Butanol
H Brown Area	Grand Rapids	Lead, Benzo(a)pyrene, PCBs, DDD
Ha Marque Wood Preserving	Grand Rapids	Copper, Arsenic, Chromium
Hard Chrome Plating	Grand Rapids	Lead, Chromium
Hekman Furniture Co		PAHs, Oil, Grease
Keeler Brass Co	Kentwood	Heavy Metals
Kentwood LF	Kentwood	Benzene, Cyanide, Heavy Metals
Knape Industries Inc	Rockford	Heavy Metals, TCE
Lacks Industries Cascade	Grand Rapids	Heavy Metals, Cyanide
Mayfield St GW Contam Plainfield	Plainfield Heights	1,2 DCA
Mich Con Market and Godfrey	Grand Rapids	Arsenic, Chlorinated Organics
Mich Con Wealthy St	Grand Rapids	Cyanide, Barium, Lead, BTEX
North Kent LF	Grand Rapids	Chlorinated Organics
Northeast Gravel Co	Belmont	Chromium, Copper, PCE
Organic Chemicals Inc	Grandvillle	PCBs, BTEX, Methylene Chloride
Plainfield Twp Wells	Grand Rapids	Chlorinated Organics
Reliable Equipment Corp	Grand Rapids	Heavy Metals, Cyanide
Res Well 4 Mile Rd Douthett Dump	Grand Rapids	Chlorinated Organics
Res Wells Sand Lake	Sand Lake	BTEX, PCE, TCA, TCE
Rockford Paper Mills	Rockford	Aluminum, Manganese, Sodium
Sparta LF	Sparta Twp	Benzene, Lead, Chromium
State Disposal Corp LF	Grand Rapids	Benzene, TCE, PCE
West Gr Rapids Area Walker	Grand Rapids	Petroleum Products
Wickes Manufacturing	Grand Rapids	Chromium, Nickel
Masselink Electroplating	Grand Rapids	Heavy Metals, Cyanide
Croff Salvage Yard	Greenville	Benzo(a)anthracene
Ranger Tool and Die Co	Walker	Cutting Oils
Consumers Power Wealthy Sub Sta	Grand Rapids	Transformer Oil
Blandford Farms	Grand Rapids	TCE, 1,2-DCA, TCA
Detrex Corp (Gold Shield Solvent)	Grand Rapids	Trichloroethylene
Dura Plating Corp Former	Wyoming	Heavy Metals
General Motors – CPC Metals	Wyoming	TCE, Oil
Yamaha Music Corp USA	Grand Rapids	TCE, 1,2-DCE
Spartan Chemical Company	Wyoming	Chlorinated Organics
Snow Ave Area Contamination	Caledonia	Xylene, Toluene
Alto Elementary School	Alto	PAHs
Berkey Street Area	Grand Rapids	Chromium
Continental Can Company-Form PET	Kentwood	Chlorinated Solvents, waste oil
RER Enterprises	Wyoming	Chlorinated Organics
Rowe International Inc	Grand Rapids	PCE, TCE
Rapids Pattern & Plastics Inc	Grand Rapids	PCE, Methanol
Root Lowell Manufacturing	Lowell	Heavy Metals, Chlorinated Organics
Davis Residence	Cascade	Heating Oil
Sparta Village of	Sparta	TCE
American Laundry (Former)	Grand Rapids	BTEX
Sparta Laundry Basket	Sparta	Chlorinated Organics
Cities Service LPG Storage		Brine, Chloride
Blair, S #1 88-12-16		Brine, Chloride
Bissel	Walker	Trichloroethene
Walker Area GW Contamination	Walker	PCE TCE TCA

Table 18.–Continued.

Segment and site	Location	Pollutant
Lower–continued		
Paulstra CRC	Grand Rapids	TCE DCE
Alloytek	Grandville	Toluene Benzene
Walker (Sunset Hills WMU Area D)	Walker	Brine, Chloride
Walker (Maynard Ave WMU Area C)	Walker	Brine, Chloride
Pine Island Auto & Supply	Sparta	BTEX
Mt. Vernon Foundry	Grand Rapids	Heavy Metals, PAHs
Bright Metals	Grand Rapids	Heavy Metals
Midwest Bumper Company	Grand Rapids	Chromium, Nickel
Liquid Haulers Maintenance	Grand Rapids	PCE, Lead, PNAs, HCB
ERB Lumber	Grand Rapids	Benzene, TCE, Cadmium
5060 Whitneyville Rd SE	Ada	PAHs
Cascade/Patterson Area Contam.	Grand Rapids	Chlorinated Organics
Lincoln Lake Ave.- Vergennes Twp	Lowell	Cadmium
68th. St. & Division Area	Grand Rapids	Tetrachloroethylene
3021 44th Street (Wyn Property)	Grandville	Tetrachlorethene
American Anodco Inc	Ionia	Heavy Metals
Brown Corp	Ionia	Heavy Metals
Ionia City Landfill	Ionia	Heavy Metals, DDT, DDE
Clyde Rd LF	Ionia	Chlorinated Organics
Graff and Meade Rds Orleans Twp	Orleans	Benzene, Xylene
Ionia Reformatory Property	Ionia	Phthalates, PAHs
Lacks Ind Saranac	Saranac	Heavy Metals, organics
Lowell City LF	Lowell	Lead, Chlorinated Organics
Michigan Consolidated Belding	Belding	Lead, Arsenic, Benzene
Pitsch LF	Belding	Heavy Metals
Saranac LF	Saranac	Chlorinated Organics
Universal Gerwin Saranac Wells	Saranac	Chlorinated Organics
Summit Steel Processing Corp	Ionia	PAHs, Phthalates
Whites Bridge Rd Area	Lowell	Heavy Metals, Cyanide
Haynor Road/M-21 Area – Ionia	Ionia	Gasoline
Haynor Road/Res Well	Ionia	Benzene
Spectrum Industries	Belding	TCE, Vinyl Chloride
Belding Products	Belding	Trichloroethene (TCE)
Charlotte Disposal Inc	Charolotte	Domestic wastes
Charlotte Municipal Airport	Charlotte	BTEX
Res Wells Shaytown Rd	Vermontville	Nitrates
Woodbury Vlg of	Woodbury	Nitrate
Vermontville Landfill	Vermontville	Lead
Owens-Brockway Glass Container	Charlotte	Arsenic, Chlorinated Organics
1490 South Royston Dump Site	Eaton Rapids	Liquid Ind. Waste
Eugene Welding Aurora Refinery	Elsie	Lead, BTEX
Industrial Phosphating	St Johns	Heavy Metals
ITT Hancock	Elsie	Paint sludges
Private Residence Moore	Ovid	Fuel Oil
St Johns LF City of	ST Johns	Lead
Central Michigan Railway	St Johns	Chromium, Arsenic, Chlorinated Organics
Residence, 3017 North US-27	St. John	BTEX
Robert's Auto Body	Elsie	BTEX, Heavy Metals
Sunshine Dry Cleaners	St. Johns	TCE cis-1,2 DCE
Bradford White Corp	Middleville	TCE

Table 18.–Continued.

Segment and site	Location	Pollutant
Lower–continued		
Farm Bureau Coop	Middleville	BTEX
Gun Lake Rd Heath Rd	Hastings	Chlorinated Organics
Hastings Sanitary Service	Hastings	Domestic wastes
Res Well Martin Rd	Lake Odessa	Gasoline
Newton Lumber Co	Hastings	Heavy Mfg
Res Wells Cloverdale	Cloverdale	Chlorinated Organics
Res Wells Woodland	Woodland	Chlorinated Organics
Green & Boltwood	Hastings	BTEX
Hastings Manufacturing	Hastings	MEK Hexanes
E W Bliss	Hastings	Chlorinated Organics
Ovid Area Gas Contamination	Ovid	BTEX
Fenske LF Ottawa Co	Grandville	Copper 1,2 DCE
Rozema Waste Garage Area	Hudsonville	Chlorinated Organics
Suburban Sanitary LF	Marne	Lead
Passmore-Goosen #1		Brine, Chloride
Farrell (Quigley #1 ?) 91-02-25		Brine, Chloride
Jones #1 FL 91-04-16		Brine, Chloride, BTEX, Crude Oil
Walker (Leonard&14th) (WMU Area A)	Walker	Brine, Chloride
Crystal Refinery	Carson City	BTEX, Copper
Federal Mogul	Greenville	TCE, 1,2-DCE
Greenville LF	Eureka	BTEX 1,1,1-TCA
Greenville Products	Greenville	TCE 1,1,1 TCA
Michigan Consolidated Greenville	Greenville	Benzene Xylene
Ore Ida Plant Area	Greenville	Nitrates
Res Well Garlock Rd	Carson City	Tetrachloroethylene
Res Well Wyman	Wyman	BTEX
Blackmere #2 88-10-06		Crude Oil, Brine, Chloride
Husted #2 WH & TB 91-04-19		Condensate-BTEX, Crude Oil, Chloride
Borkholder #3-28- 86-12-16		Brine, Chloride
Flint H & G 1-A		Condensate-BTEX, Crude Oil, Chloride
Countrymark – Carson City	Carson City	Atrazine, Alachlor
Edmore Cleaners	Edmore	Tetrachloroethylene
Mouth		
Atco Rubber Products	Grand Haven	PBB, Chlorinated Organics
B and J Industrial Finishing	Nunica	TCE, cis-1,2-DCE
Integrated Metal Technology Inc	Spring Lake	Ethylbenzene, Ammonia
Neidlinger Oil	Grand Haven	Gasoline
Rozema Indus Waste Voss Farm	Hudsonville	Heavy Metals, Cyanide
Sanico North	Spring Lake	Chlorinated Organics
Anderson Bolling Mfg	Spring Lake	Chlorinated Organics
Superior Plating	Spring lake	Heavy Metals, Cyanide
Vans Refinishing	Spring lake	Chlorinated Organics
Ferrysburg Area GW Contam	Ferrysburg	Chlorinated Organics
Res Well Cleveland St	Nunica	Chlorinated Organics
Burnside Manufacturing	Spring Lake	Chlorinated Organics
Ottawa Steel Company	Grand Haven	Waste Oil
ASP & Manufacturing Co, Inc	Grand Haven	Chromium
Michigan Gas Utilities	Grand Haven	BTEX
Koch Terminal	Ferrysburg	BTEX
Adams St Facility-Grand Haven	Grand Haven	Heavy Metals
Coopersville & Marne Railway Co.	Coopersville	Chlorinated Organics

Table 18.–Continued.

Segment and site	Location	Pollutant
Mouth–continued		
Cary Marine	Grand Haven	Heavy Metals
Citgo Terminal	Ferrysburg	BTEX, PNAs, MTBE
Host #2 TB 91-04-17		BTEX, Brine, Chloride, Crude Oil
Wiersma #1 FL 91-04-04		BTEX, Crude Oil
Walker (Winans Rd)(WMU Area "E")		Brine, Chloride
Flagel 1		Brine, Chloride
Eagle Ottawa Leather Co.	Grand Haven	Metals, PAHs
Former Bomers Carpet/Upholstery	Spring Lake	Tetrachloroethylene
Mink Salvage Yard	Fruitport	Heavy Metals
Oxy/Phillips Pipelines-Verplanks	Ferrysburg	BTEX
Lake Street Res Well	Grant	PCE
Res Wells Ravenna Twp	Ravenna	Chlorides
Marathon Pipeline - Mill Iron	Muskegon	BTEX, PAHs

Table 19.–July average stream temperature (°F) for the Grand River main stem and selected tributaries.

				Temperature (°F)		
Stream	County	Site	Year	Minimum	Maximum	Mean
Headwaters						
Grand River	Jackson	Loomis Road	1999	65.7	85.6	75.8
Grand River	Jackson	High Street	2008	65.0	78.6	71.9
Grand River	Jackson	Highway M-50	1999	69.0	93.6	79.3
Portage River	Jackson	Portage Lake Road	2002	73.0	89.2	80.4
Grand River	Jackson	Maple Grove Road	2001	52.0	77.7	70.9
Grand River	Jackson	State Road	1999	65.8	79.7	73.5
Upper						
Sandstone Creek	Jackson	Sandstone Road	2005	65.2	80.3	72.8
Mackey Brook	Jackson	Parma Road	2003	52.7	78.4	62.2
Mackey Brook	Jackson	Wellman Road	2003	56.6	70.5	63.6
Sandstone Creek	Jackson	Benn Road	2005	64.4	77.2	71.4
Grand River	Jackson	Tompkins Road	1999	65.5	81.9	73.5
Grand River	Ingham	Plank Road	1999	66.2	81	73.7
Spring Brook	Jackson	Sibley Road	2005	66.0	87.5	77.7
Spring Brook	Eaton	Spicerville Road	2005	64.3	80.7	72.0
Grand River	Eaton	Columbia Road	1999	68.2	86.2	76.8
Grand River	Eaton	Dimondale Dam	1999	68.9	88.5	77.5
Middle						
Grand River	Eaton	Waverly Road	1999	70.2	86.9	79.3
Sycamore Creek	Ingham	Pine Tree Road	2011	67.1	84.3	74.5
Grand River	Eaton	Grand Ledge	2010	69.8	83.0	78.0
Grand River	Clinton	Jones Road	1999	69.8	91.2	79.4
Sebewa Creek	Eaton	Eaton Highway	2000	59.3	72.4	65.8
Sebewa Creek	Ionia	Keefer Highway	2000	58.9	70.8	65.0
Looking Glass River	Clinton	Upton Road	1999	64.6	80.3	72.8
Looking Glass River	Clinton	Lowell Road	1999	65.4	81.5	73.8
Looking Glass River	Clinton	Tallman Road	1999	66.0	83.9	74.3
Looking Glass River	Clinton	Monroe Road	2008	62.6	81.5	72.5
Grand River	Ionia	Webber Dam	2003	74.4	84.5	78.2
Grand River	Ionia	Webber Dam	2005	72.2	87.5	81.7
Lower						
Butternut Creek	Eaton	Charlotte Country Club	2011	60.1	78.5	68.5
Butternut Creek	Eaton	Interstate 69	2011	59.6	81.5	62.2
Butternut Creek	Eaton	Maple Hill	2011	56.0	76.0	61.2
Fish Creek	Montcalm	Pine Grove Road	1996	50.7	67.8	57.4
Fish Creek	Montcalm	Pakes Road	1996	53.6	67.5	60.5
West Branch Fish Creek	Montcalm	Cedar Lake Road	1996	50.7	72.9	61.8
Fish Creek	Montcalm	Tow Road	1996	56.5	71.6	63.3
Fish Creek	Montcalm	Bollinger Road	1996	57.9	72.9	64.5
Fish Creek	Montcalm	Jenks Road	1996	59.5	77.8	67.8
Fish Creek	Ionia	Hubbardston Dam	1996	60.9	77.2	68.3
Taylor Creek	Ionia	40 Acre Town Road	2004	56.1	71.4	64.2
Libhardt Creek	Ionia	Sunfield Road	2004	60.3	76.4	68.3

Table 19.–Continued.

Stream	County	Site	Year	Temperature (°F) Minimum	Maximum	Mean
Lower–continued						
Libhardt Creek	Ionia	Reeder Road	2004	61.4	74.4	68.3
Libhardt Creek	Ionia	Riverside Drive	2004	60.4	73.1	67.2
Prairie Creek	Ionia	Sessions Road	1999	56.6	75.6	65.0
Prairie Creek	Ionia	Highway M-57	1999	56.5	77.7	66.8
Prairie Creek	Ionia	VanVleck Road	1999	58.9	77.5	68.3
Prairie Creek	Ionia	Borden Road	1999	59.5	78.2	68.7
Prairie Creek	Ionia	Charles Road	1999	60.4	77.5	68.8
Prairie Creek	Ionia	Ernest Road	1999	61.7	79.3	69.9
Prairie Creek	Ionia	Welch Road	1999	61.1	81.0	70.4
Prairie Creek	Ionia	Highway M-21	1999	61.8	78.9	70.1
Inman Creek	Ionia	Dildine Road	2000	55.1	76.8	64.0
Inman Creek	Ionia	Main Street	2000	52.7	71.0	59.7
Bellamy Creek	Ionia	Dildine Road	2011	63.8	80.9	70.8
Spring Creek	Ionia	Dildine Road	2011	59.0	75.0	66.6
Bellamy Creek	Ionia	Bellamy Road	2004	58.7	73.1	66.1
Bellamy Creek	Ionia	Potters Road	2004	58.6	71.7	65.0
Sessions Creek	Ionia	Ainsworth Road	2004	59.4	72.2	65.8
Sessions Creek	Ionia	Riverside Drive	2004	62.6	79.23	71.3
Grand River	Ionia	Saranac	1999	71.6	86.7	78.8
Flat River	Montcalm	Six Lakes Road	2005	64.4	85.3	75.9
Flat River	Montcalm	Cannonsville Road	2005	60.3	77.8	70.7
Flat River tributary	Montcalm	Cannonsville Road	2005	55.6	74.6	66.2
Flat River	Montcalm	Miller Road	2005	61.3	82.8	73.0
Dickerson Creek	Montcalm	Sydney Road	2005	58.1	81.4	70.9
Flat River	Montcalm	Wise Road	2005	62.6	78.6	71.7
Dickerson Creek	Montcalm	Miller Road	2005	60.8	74.3	68.4
Dickerson Creek	Montcalm	Station Road	2005	63.8	80.0	72.0
Dickerson Creek tributary	Montcalm	Station Road	2005	55.0	73.2	65.8
Dickerson Creek	Ionia	Long Lake Road	2005	61.1	76.8	69.3
Flat River	Ionia	Long Lake Road	2005	63.1	81.9	73.8
Flat River	Ionia	Ingalls Road	2005	66.0	83.2	74.3
Flat River	Ionia	Whites Bridge Road	2008	66.7	82.1	74.2
Flat River	Kent	Fallasburg	2011	69.6	86.3	77.8
Flat River	Kent	Burroughs Drive	2005	69.8	85.2	76.7
Flat River	Kent	Burroughs Drive	2012	75.5	88.8	80.6
Flat River	Kent	King Milling	2011	70.6	88.4	79.7
Kopf Creek	Kent	Pratt Lake Road	2008	52.7	67.8	60.4
Spring Brook	Kent	36th Street	2011	51.3	69.6	55.4
Spring Brook	Kent	Gulliford Drive	2005	50.1	61.5	54.9
Thornapple River	Eaton	Mason Road	2006	62.0	76.3	67.9
Quaker Brook	Barry	Clark Road	1997	53.6	74.3	63.9
Quaker Brook	Barry	Bivens Road	1997	54.1	79.2	65.5
Thornapple River	Barry	Greggs Crossing	2006	66.1	80.0	72.8
Highbanks Creek	Barry	Lawrence Road	1997	59.5	77.7	68.4
Highbanks Creek	Barry	Thornapple Lake Road	1997	58.1	72.5	65.8

Table 19.–Continued.

Stream	County	Site	Year	Temperature (°F) Minimum	Maximum	Mean
Lower–continued						
Horn Creek	Barry	Drake Road	2000	53.6	62.1	57.3
Cedar Creek	Barry	Dowling Road	1997	59.0	74.8	66.9
Cedar Creek	Barry	Highway M-37	1997	59.5	75.6	68.9
Tamarack Creek	Barry	Highway M-37	2000	52.7	74.3	62.3
Cedar Creek	Barry	McKeown Road	1997	58.1	74.3	67.5
Thornapple River	Barry	Center Road	2008	65.2	79.7	72.3
Glass Creek	Barry	Goodwill Road	2000	59.3	76.5	67.8
Glass Creek	Barry	Oak Road	2000	59.7	72.3	66.3
Glass Creek	Barry	Highway M-37	2000	57.6	72.5	65.4
Hill Creek	Barry	Upton Road	2000	50.0	75.0	61.0
Coldwater River	Barry	Middleville	2006	64.8	78.6	71.8
Coldwater River	Barry	Rush Road	1997	58.3	76.5	67.6
Coldwater River	Barry	Highway M-43	1997	57.7	73.6	65.8
Messer Brook	Barry	Usborne Rd	1997	53.8	77.9	64.2
Duck Creek	Ionia	Bell Road	1997	55.3	70.8	63.4
Coldwater River	Barry	Fighter Road	1997	55.6	71.6	63.8
Duck Creek	Kent	Freeport Road	1997	56.1	76.3	66.0
Tyler Creek	Ionia	Hastings Road	1997	54.1	72.9	63.5
Tyler Creek	Kent	76th Street	1997	54.5	72.7	63.5
Tyler Creek	Kent	100th Street	1997	53.6	69.3	61.6
Tyler Creek	Kent	Golf Course-East	2009	55.0	66.0	60.0
Tyler Creek	Kent	Golf Course-West	2009	53.0	66.1	59.2
Tyler Creek	Kent	Coldwater confluence	2009	54.3	65.7	60.0
Cain Creek	Barry	108th Street	1997	51.4	64.0	57.2
Coldwater River	Kent	Morse Lake Avenue	1997	56.3	70.3	63.8
Thornapple River	Kent	Cascade dam	2006	59.8	81.5	75.9
Thornapple River	Kent	Ada dam	2006	74.0	84.0	78.5
Bear Creek	Kent	Townsend Park	2005	58.7	74.4	66.2
Bear Creek	Kent	Cannonsburg Road	2011	60.5	78.3	68.0
Frozen Creek	Kent	Cannonsburg Road	2012	57.2	77.4	66.5
Rogue River	Kent	20 Mile Road	1994	62.1	76.1	67.5
Rogue River	Kent	Indian Lakes Road	1994	62.8	76.3	68.0
Rogue River	Kent	Division Avenue	1994	62.8	74.3	67.7
Rogue River	Kent	Algoma Avenue	1994	62.8	74.5	67.8
Cedar Creek	Kent	Friske Drive	2009	56.1	68.7	62.2
Stegman Creek	Kent	Rector Street	2009	51.1	60.0	55.0
Becker Creek	Kent	Porter Hollow Drive	2000	49.0	59.3	53.9
Rogue River	Kent	Summit Avenue	2005	60.9	76.4	68.3
Rogue River	Kent	d/s Rockford Dam	2009	57.3	70.7	63.8
Rogue River	Kent	Packer Drive	2009	58.1	71.1	64.6
Rogue River	Kent	Jericho Avenue	1994	60.8	75.0	67.1
Grand River	Kent	Sixth Street ladder	2011	69.8	83.0	78.0
Sand Creek	Ottawa	Cleveland Street	2006	59.2	74.4	67.8
Grand River	Ottawa	Highway M-45	1999	71.4	83.1	77.6

Table 19.–Continued.

Stream	County	Site	Year	Temperature (°F) Minimum	Maximum	Mean
Mouth						
Crockery Creek	Newaygo	Moore Road	2003	55.5	68	61.5
Crockery Creek	Muskegon	Behler Road	2003	59.2	69.9	64.4
Crockery Creek	Muskegon	Slocum Road	2003	50.6	65.3	56.4
North Branch Crockery Creek	Muskegon	Newaygo Road	2003	58.8	71.6	65.0
North Branch Crockery Creek	Ottawa	24th Avenue	2003	59.3	71.8	65.5
North Branch Crockery Creek	Ottawa	40th Avenue	2003	61.0	72.2	66.0
Crockery Creek	Muskegon	Laketon Road	2003	60.0	71.4	65.2
Crockery Creek	Muskegon	Ellis Road	2003	61.4	75.0	67.7
Rio Grande Creek	Muskegon	Hoogstraat Road	2003	60.0	72.8	65.7
Rio Grande Creek	Muskegon	Patterson Avenue	2003	60.9	74.1	66.5
Crockery Creek	Muskegon	Patterson Avenue	2003	61.1	76.5	67.8
Norris Creek	Muskegon	Sullivan Road	2004	55.2	70.1	61.6
Norris Creek	Muskegon	Maple Island Road	2004	55.1	68.0	60.5
Norris Creek	Muskegon	Hilton Park Road	2004	55.1	66.9	60.9
Norris Creek	Muskegon	Pontaluna Road	2004	57.0	69.2	63.1
Norris Creek	Muskegon	Fruitport Road	2004	59.4	76.1	67.7

Table 20.–Ambient water chemistry at select locations on the Grand River main stem. Note: Dash (–) indicates analyte was not measured. ND = not detected; RB = reagent blank.

	Valley segment/Location																
	Headwaters						Upper	Middle				Lower				Mouth
Parameter (Units)	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Grand River at West Monroe Avenue	Grand River at Parnell Road	Grand River at Maple Grove Road	Grand River at Petrieville Highway	Grand River at Grand Woods Park	Grand River at Delta Mills	Grand River at State Road	Grand River at Portland State Game	Grand River at Highway M-66	Grand River at Alden-Nash Road	Grand River at Highway M-44	Grand River at Johnson Park (M-11)	Grand River at Grand Haven (US-31)
Alkalinity (mg $CaCO_3$/L)	250	245	202	197	191	–	184	154	102	147	101	239	245	225	225	
Alkalinity-Bicarbonate	250	245	202	197	191	–	184	154	102	127	69	239	245	207	209	212
Alkalinity-Carbonate	5 [a]	5 [a]	5 [a]	5 [a]	5 [a]	–	5 [a]	5 [a]	5 [a]	20	32	ND	ND	18	16	194
Ammonia (mg N/L)	0.019	0.036	0.05	0.039	0.1	0.16	0.02	0.09	0.04	0.02	0.017	ND	ND	ND	.016	18
Calcium (mg/L)	70.4	68.7	66.1	71.1	79	–	69.4	130	300	110	110	83.5	87.3	72.7	82.2	ND
Boron (µg/L)	20 [a]	20 [a]	–	–	–	–	–	61	63.3	61.3	47.8	–	–	–	–	75.9
Chloride (mg/L)	15	19	86	82	162	–	77	93	155	89	87	47	50	41	50	–
Total Chromium (µg/L)	1.0 [a]	1.0 [a]	1.0 [a]	2.6	3.6	–	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	1.5	1.8	ND	1.5	53
COD (mg/L)	10	9.8	26	18	17	21	35	20	24	31	42	40	45	40	44	1.4
Conductivity (umho/cm)	543	552	707	703	1109	–	703	790	1066	731	628	682	695	615	664	38
Hardness (mg/L)	285	282	252	272	298	–	283	248	248	245	217	308	322	275	303	664
Hexavalent Chromium (µg/L)	5 [a]	5 [a]	5 [a]	5 [a]	5 [a]	–	5 [a]	5 [a]	5 [a]	5 [a]	5 [a]	ND	ND	ND	–	288
Magnesium (mg/L)	26.6	26.8	21.2	22.9	24.4	–	26.6	23.2	21.9	22.4	23.8	24.2	25.2	22.7	23.8	–
Mercury (µg/L)	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	–	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	ND	ND	ND	ND	23.9
Nitrate + Nitrite (mg N/L)	0.36	0.24	1.34	0.75	6	4.1	0.34	3.2	23	2.5	0.74	1.56	1.18	0.891	0.869	ND
Nitrite (mg N/L)	0.004	0.006	0.098	0.034	0.037	0.045	0.014	0.062	0.018	0.031	0.019	0.014	0.014	0.013	0.018	0.842
Nitrogen-Kjeldahl (mg N/L)	0.3	0.45	1.05	0.85	1.31	1.32	1.33	1.03	1.38	1.38	1.66	1.2	1.45	1.2	1.41	0.028
Phosphorus-Ortho (mg P/L)	0.004	0.005	0.037	0.029	0.33	0.23	0.009	0.162	0.22	0.073	0.01	0.163	0.016	0.01	0.006	1.4

Table 20.–Continued.

Parameter (Units)	Headwaters: Grand River at Sutfin Road	Headwaters: Grand River at Reed Road	Headwaters: Grand River at High Street	Headwaters: Grand River at West Monroe Avenue	Headwaters: Grand River at Parnell Road	Headwaters: Grand River at Maple Grove Road	Upper: Grand River at Petrieville Highway	Middle: Grand River at Grand Woods Park	Middle: Grand River at Delta Mills	Middle: Grand River at State Road	Middle: Grand River at Portland State Game	Lower: Grand River at Highway M-66	Lower: Grand River at Alden-Nash Road	Lower: Grand River at Highway M-44	Lower: Grand River at Johnson Park (M-11)	Mouth: Grand River at Grand Haven (US-31)
pH (standard units)	7.96	8.15	7.88 [b]	8.25 [b]	7.91 [b]	–	8.56 [b]	7.68	7.18	8.71	9.25	8.3	8.52	8.61	8.68	0.006
Phosphorus-Total (mg P/L)	0.007	0.026	0.116	0.102	0.49	0.34	0.105	0.262	0.59	0.23	0.159	0.163	0.166	0.096	0.128	8.61
Selenium (µg/L)	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	–	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	1.0 [a]	ND	ND	ND	ND	0.112
Suspended Solids (mg/L)	5	13	11	9	15	15	35	7	13	26	34	31	48	26	36	ND
Dissolved Solids (mg/L)	320	400	470	480	720	660	500	550	880	490	420	480	490	400	460	18
Sulfate (mg/L)	18	23	24	36	74	–	51	80	111	67	68	46	48	38	46	440
Total Organic Carbon (mg/L)	4.1	3.6	8.6	7	6.9	8	7.8	7.7	7.9	8.8	9.9	10	10	9.2	10	47
Arsenic (µg/L)	1.0 [a]	1.6	4.8	4	3.1	–	1.7	3.2	2	2.4	2.4	2.2	2.4	1.6	2	10
Barium (µg/L)	38	50	55	53	40	–	70	51	31	54	44	66	67	57	58	1.9
Cadmium (µg/L)	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	0.2 [a]	–	0.2 [a]	0.3	0.2 [a]	0.2 [a]	0.2 [a]	ND	ND	ND	ND	55
Copper (µg/L)	1.0 [a]	1.0 [a]	1.1	2.1	2.2	–	2	5.6	5.5	5.3	3.3	3.1	3.2	2.2	2.5	ND
Lead (µg/L)	1.0 [a]	1.0 [a]	1.0 [a]	1.3	1.3	–	1.4	1.1	1.0 [a]	2	1.0 [a]	1.3	1.5	ND	1.3	9.6
Nickel (µg/L)	2.4	3.3	6.4	9.3	7.3	–	6.9	8.5	7.9	7.7	6.6	4.5	–	–	4.7	1
Silver (µg/L)	0.5 [a]	0.5 [a]	0.5 [a]	0.5 [a]	0.5 [a]	–	0.5 [a]	0.5 [a]	0.5 [a]	0.5 [a]	0.5 [a]	ND	–	–	–	8.7
Strontium (µg/L)	112	112	–	–	–	–	–	215	211	199	185	–	ND	ND	ND	–
Zinc (µg/L)	10 [a]	15 RB	17 RB	20 RB	42 RB	–	35 RB	24 RB	34 RB	25 RB	19 RB	ND	ND	ND	ND	ND

[a] Not detected at the indicated level of quantification.
[b] Sample hold time exceeded.

Table 21.–Ambient water chemistry for selected tributaries in the Grand River watershed during 1999-2003. ND indicates analyte was not detected. Dash (–) indicates analyte was not measured.

	Parameter (units)					
Collection site	Ammonia (mg N/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus-Ortho (mg P/L)	Phosphorus–Total (mg P/L)	Suspended Solids (mg/L)
Headwaters						
Portage River at Portage Lake Road	0.018	0.002 [a]	0.092	0.003	0.027	8
Portage River at Dunn Road	0.107	0.34	0.87	0.021	0.085	20
Batteese Creek at Coon Hill Road	0.029	0.171	1.1	0.032	0.092	4
Portage River at Route 106	0.159	0.24	1.21	0.049	0.145	16
Twin Lake Outlet at Cooper Road	0.55	0.145	1.58	0.056	0.105	14
Willow Creek at Wolf Lake Road	0.014	4.6	0.37	0.007	0.02	6
Grass Lake Outlet at Lee Road	0.024	1.22	0.5	0.015	0.036	6
Wildcat Creek tributary at Seymour Road	0.043	0.062	0.71	0.007	0.035	9
Wildcat Creek at Trumble Road	0.017	0.18	0.35	0.007	0.02	9
Thornapple Creek at Heeney Road	0.038	0.193	1.3	0.011	0.15	17
Pickett Drain at Heeney Road	0.179	0.41	1.16	0.67	0.134	15
Cahaogan Creek at Baseline Road	0.073	0.24	0.97	0.036	0.091	9
Orchard Creek at Kennedy Road	0.051	0.57	0.71	0.023	0.082	11
Western Creek at Easton Road	0.038	0.69	0.79	0.017	0.073	7
Huntoon Creek upsteam Leslie	0.025	1.04	0.5	0.032	0.064	9
Huntoon Creek downstream Leslie	0.033	2.1	0.56	0.09	0.143	11
Perry Creek at Baseline Road	0.019	0.4	0.24	0.01	0.026	6
Upper						
Sandstone Creek at Reynolds Road	0.042	2.1	0.42	0.003	0.014	13
Sandstone Creek at Sandstone Road	0.05	1.18	0.51	0.012	0.039	19
Sandstone Creek at Dearing Road	0.028	0.99	0.38	0.012	0.03	6
Sandstone Creek at Roth Road	0.024	0.66	0.33	0.011	0.028	8
Mackey Brook at Rodgers Road	0.031	0.52	0.32	0.007	0.027	10
Mackey Brook at Wellman Road	0.017	0.43	0.3	0.008	0.025	8
Spring Brook at Sibley Road	0.015	0.95	0.37	0.018	0.043	4
Spring Brook at Buck Road	0.028	0.82	0.38	0.027	0.048	8
Spring Brook at Spicerville Road	0.017	0.78	0.36	0.032	0.055	5
Columbia Creek at Waverly Road	0.016	0.44	0.37	0.027	0.051	4
Silver Creek at Canal Road	0.025	1.25	0.26	0.007	0.033	5
Middle						
Red Cedar River at Coon Lake Road	0.166	0.062	1.22	0.031	0.156	20
Red Cedar River at Amos Road	0.062	0.277	0.603	0.019	0.041	12
Red Cedar River at Layton Road	0.133	0.147	0.924	0.022	0.065	23
Middle Branch Red Cedar at Sargent Road	0.067	0.094	0.657	0.028	0.054	10
Iosco Drain at Coon Lake Road	0.043	0.01 [a]	1.57	0.016	0.138	28
West Branch Red Cedar at Coon Lake Road	0.09	0.523	0.536	0.02	0.035	12
West Branch Red Cedar at Grand River Ave	0.175	0.163	0.77	0.031	0.082	15
McMahon Drain at Columbia Road	1.8	0.3	3.0	0.453	0.72	18
Kalamink Creek at Iosco Road	0.47	0.69	1.28	0.057	0.18	30
Kalamink Creek at Holt Road	0.087	0.67	0.75	0.131	0.188	6
Squaw Creek at Rowley Road	0.058	1.72	0.663	0.013	0.018	3
Dietz Creek at Dietz Road	0.048	0.29	0.42	0.046	0.084	4 [a]
Wolf Creek at Bell Oak Road	0.106	1.56	1.22	0.091	0.088	5

Table 21.–Continued.

Collection site	Ammonia (mg N/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus-Ortho (mg P/L)	Phosphorus–Total (mg P/L)	Suspended Solids (mg/L)
	Parameter (units)					
Middle–continued						
Doan-Deer Creek at Williamston-Osborn	0.028	1.83	0.27	0.055	0.079	4
Doan Creek at Meech Road	0.031	0.95	0.45	0.03	0.047	5
Doan Creek at Nobel Road	0.047	0.79	0.47	0.044	0.069	4
Sloan Creek at Jolly Road	0.062	6.67	0.922	0.114	0.122	8
Mud Creek at Harper Road	0.111	0.41	0.56	0.054	0.105	11
Talmadge Drain at Rolfe Road	0.073	0.68	0.4	0.042	0.064	5
Willow Creek at Toles Road	0.043	1.86	0.50	0.007	0.041	27
Sycamore Creek at Kipp Road	0.027	0.66	0.32	0.034	0.051	4 [a]
Sycamore Creek at Pine Tree Road	0.035	2.2	0.53	0.077	0.103	4 [a]
Sebewa Creek at Dow Road	0.073	0.104	0.59	0.02	0.098	–
Sebewa Creek at Eaton Highway	0.036	0.142	0.26	0.016	0.035	–
Sebewa Creek at Keefer Road	0.013	0.91	0.19	0.023	0.032	–
Grub Creek at Britton Road	0.026	0.5	0.5	0.009	0.028	4 [a]
Vermillion Creek at Peacock Road	0.05	1.75	0.94	0.03	0.06	9
Looking Glass River at Beardslee Road	0.071	0.83	0.8	0.028	0.094	15
Looking Glass River at Upton Road	0.063	1.09	0.91	0.027	0.068	4
Looking Glass River at Dewitt Road	0.04	0.66	1.0	0.02	0.07	10
Looking Glass River at Monroe Road	0.025	1.39	0.5	0.035	0.048	4
Goose Creek at Pline Road	0.06	2.3	0.59	.153	0.26	27
Lower						
Maple River at Ruess Road	0.08	0.65	0.61	0.037	0.065	54
Maple River at Baldwin Road	0.047	0.44	0.54	0.027	0.057	8
Bear Creek at Krouse Road	0.033	1.78	0.44	0.037	0.064	8
Maple River at Warren Road	0.023	0.61	0.47	0.015	0.02	4 [a]
Alder Creek at Woodworth Road	0.068	0.10	1.17	0.03	0.22	250
Maple River at Front Street	0.038	0.75	0.47	0.016	0.038	4
Maple River at Shephardsville Road	0.04	0.62	0.47	0.036	0.039	4 [a]
Little Maple River at Shephardsville Road	0.062	0.46	0.57	0.046	0.077	10
Maple River at South County Line Road	0.018	0.33	0.47	0.031	0.059	24
Maple River at State Road	0.013	0.125	1.11	0.061	0.24	67
Hayworth Creek u/s Peet Creek confluence	0.066	2.25	0.79	0.018 [b]	0.056	4 [a]
Cox Drain at Wacousta Road	0.10 [a]	6.8	0.46	0.016	0.027	5
Maple River at Hubbardston Road	0.012	0.005 [a]	1.4	0.041	0.195	53
Fish Creek at Colby Road	0.009 [a]	1.68	0.21	0.009	0.018	5
West Branch Fish Creek at Town Hall Road	0.023	0.37	0.48	0.023	0.047	11
Butternut Creek at Miner Road	0.035	0.63	0.37	0.011	0.026	7
Stoughton Creek at Cowman Road	0.045	0.767	0.16	0.069	0.10	6
Fish Creek at Stoudt Road	0.038	0.81	0.41	0.017	0.035	9
Spaulding Creek at Grove Road	0.023	1.52	0.63	0.009	0.037	4 [a]
Bad Creek at Centerline Road	0.017	1.43	0.51	0.009	0.03	8
Muskrat Creek at Dexter Road	0.05 [a]	2.5	0.55	0.012	0.036	6
Lost Creek at Townsend Road	0.168	0.51	0.75	0.036	0.068	–
Stony Creek at Highway M21	0.05 [a]	2.3	0.59	0.01	0.053	12
Little Libhardt Creek at David Highway	0.062	6.84	1.2	0.068	0.156	25

Table 21.–Continued.

Collection site	Parameter (units)					
	Ammonia (mg N/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus-Ortho (mg P/L)	Phosphorus–Total (mg P/L)	Suspended Solids (mg/L)
Lower–continued						
Libhardt Creek at David Highway	0.11	5.48	1.58	0.118	0.33	110
Libhardt Creek at Riverside Drive	0.115	2.87	1.66	0.34	0.078	150
Prairie Creek at Cedar Lake Road	0.041	0.59	0.45	0.027	0.049	5
Prairie Creek at Charles Road	0.010	1.94	0.30	0.013	0.024	4 [a]
Prairie Creek at Nickel Plate Road	0.007 [a]	1.86	0.30	0.002	4 [a]	4 [a]
Tibbets Creek at Riverside Drive	0.005	2.85	1.09	0.8	1.28	0.26
Sessions Creek at Riverside Drive	0.021	3.77	0.8	0.005	0.05	11
Timberland Creek at Highway M-21	0.036	3.52	0.26	0.019	0.031	ND
Red Creek at Highway M-21	0.031	2.55	1.4	0.189	0.39	100
Crooked Creek at Riverside Drive	0.068	1.67	1.28	0.103	0.4	190
Lake Creek at Division Street	0.024	0.71	0.19	0.032	0.051	ND
Toles Creek at Highway M-21	0.015	0.962	0.83	0.91	0.18	31
Black Creek at 1 Mile Road	0.043	0.134	1.21	0.006	0.91	ND
Townline Creek at Fleck Road	0.014	0.65	0.55	0.007	0.055	7
Flat River at Six Lakes Road	0.063	0.22	0.69	0.009	0.047	8
Brimmer Creek at Ferris Road	0.04	3	0.42	0.012	0.034	ND
Flat River at Miller Road	0.045	0.9	0.67	0.021	0.064	9
West Branch Creek at Stanton Road	0.031	0.99	0.38	0.003	0.031	10
Flat River at Stanton Road	0.029	1.27	0.51	0.016	0.047	4
Flat River at Sidney Road	0.044	1.28	0.78	0.013	0.05	12
Butternut Creek at Podunk Avenue	0.02	3.2	0.25	0.012	0.025	5
Coopers Creek at Podunk Avenue	0.046	0.31	0.68	0.01	0.045	17
Clear Creek at Larsen Avenue	0.038	0.79	0.6	0.003	0.015	ND
Flat River at Wise Road	0.057	1.09	0.71	0.009	0.042	11
Dickerson Creek at Peck Road	0.108	0.74	1.07	0.048	0.094	4
Dickerson Creek at Miller Road	0.055	0.84	0.71	0.03	0.084	13
Seeley Creek at Bartonville Road	0.033	0.68	0.4	0.038	0.071	ND
Wabasis Creek at Youngman Road	0.02	0.02	0.4	0.004	0.029	4 [a]
Flat River downstream of Lowell	0.046	0.35	0.61	0.003	0.047	12
Lee Creek at Forman Road	0.056	0.57	0.52	0.004	0.043	15
Thornapple River at Hartel Road	0.081	0.76	0.78	0.111	0.041	24
Thornapple Drain at Pinch Highway	0.074	0.57	0.6	0.061	0.106	ND
Thornapple River at Cochran Road	0.062	0.67	0.65	0.03	0.072	14
Church Creek at Lansing Road	0.056	0.75	0.58	0.023	0.061	23
Butternut Creek at Packard Highway	0.056	0.36	0.64	0.009	0.074	ND
Little Thornapple River at Gresham Road	0.086	1.16	0.56	0.07	0.123	10
Thornapple River at Gresham Hwy-West	0.047	0.81	0.5	0.058	0.097	6.2
Lacey Creek at Valley Highway	0.073	1.24	0.59	0.024	0.058	22
Shanty Brook at Valley Highway	0.054	0.23	0.34	0.023	0.052	4
Thornapple River at Nashville	0.132	0.31	0.56	0.058	0.11	ND
Quaker Brook at Clark Road	0.018	0.66	0.31	0.021	0.039	8
Thornapple River at Greggs Crossing Road	0.069	0.42	0.43	0.05	0.088	ND
Mud Creek at Coats Grove Road	0.042	2.1	0.43	0.03	0.063	4
Butler Creek at State Road	0.011	0.71	0.34	0.033	0.053	7
Thornapple River at Hastings	0.032	0.4	0.54	0.011	0.06	8

Table 21.–Continued.

Collection site	Ammonia (mg N/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus-Ortho (mg P/L)	Phosphorus–Total (mg P/L)	Suspended Solids (mg/L)
	Parameter (units)					
Lower–continued						
Thornapple River at Irving Impoundment	0.064	0.73	0.51	0.031	0.067	7
Glass Creek at Oak Road	0.018	0.098	0.44	0.014	0.05	14
Little Thornapple River at Rush Road	0.08	1.89	0.59	0.024	0.063	5
Coldwater River at Brown Road	0.034	1.27	0.36	0.036	0.073	7
Duck Creek at Montcalm Road	0.018	0.7	0.22	0.034	0.058	<4
Bear Creek at Hastings Road	0.12	1.75	0.47	0.081	0.12	6
Tyler Creek at 100th Avenue	0.01	3.1	0.27	0.028	0.047	ND
Pratt Lake Creek at Highway M-50	0.048	0.83	0.9	0.26	0.33	10
Clark and Bunker Drain at 92nd Street	0.34	0.83	1.23	0.082	0.17	7
Coldwater River at Morse Lake Road	0.03	2.4	0.42	0.035	0.42	11
Duncan Creek at 108th Street	0.46	3.4	1.76	0.35	0.46	4
Duncan Creek at Stimpson Road	0.05	2.5	0.66	0.038	0.09	13
Thornapple River at Labarge Impoundment	0.06	1.22	0.5	0.021	0.068	10
McCords Creek at Buttrick Avenue	0.023	0.8	0.24	0.02	0.041	4
Thornapple River at Cascade Impoundment	0.012	0.92	0.6	0.003	0.049	6
Thornapple River at Ada Impoundment	0.015	0.64	0.64	0.006	0.053	10
Honey Creek at Honey Creek Avenue	ND	0.553	0.28	0.01	0.03	4
Egypt Creek at Pettis Avenue	ND	0.367	0.52	0.02	0.048	7
Sunny Creek at Grand River Drive	ND	0.251	0.28	0.011	0.021	ND
Bear Creek at Giles Avenue	ND	0.349	0.97	0.035	0.082	14
Armstrong Creek at Egypt Valley Road	ND	0.42	0.49	0.042	0.077	5
Bear Creek at Cannonsburg Road	ND	0.387	0.68	0.096	0.142	10
Ransom Creek at 104th Avenue	0.024	0.153	0.35	0.02	0.038	7
Rogue River at 20 Mile Road	0.127	0.57	0.62	0.018	0.079	20
Walter Creek at Tyrone Avenue	0.045	0.067	0.47	0.036	0.064	ND
Spring Creek at Red Pine Drive	0.092	0.37	0.43	0.008	0.031	4
Frost Creek at 19 Mile Road	0.022 [b]	0.63 [b]	0.29 [b]	0.021 [b]	0.025 [b]	7
Duke Creek at Division Avenue	0.032	0.95	0.28	0.014	0.036	5
Ball Creek at Rusco Avenue	0.08	2.4	0.49	0.053	0.119	9
Rogue River at Indian Lakes Road	0.037	0.62	0.53	0.021	0.073	12
Nash Creek at Phelps Avenue	0.04	2.9	0.39	0.087	0.114	ND
Rogue River at Sparta	0.038	0.95	0.5	0.043	0.079	18
Cedar Creek at Algoma Avenue	0.02	3.6	0.26	0.011	0.03	6
Little Cedar Creek at Edgerton Avenue	0.042	1.19	0.26	0.026	0.049	6
Cedar Creek at Friske Road	0.03	2.9	0.32	0.015	0.037	6
Rogue River at Grange Road	0.041	0.98	0.41	0.032	0.061	7
Becker Creek at Russell Street	0.012	1.62	0.13	0.004	0.014	ND
Stegman Creek at Summit Avenue	0.01	2.2	0.16	0.003	0.019	ND
Shaw Creek at Northland Avenue	0.01	3.8	0.21	0.003	0.018	ND
Rum Creek at 10 Mile Road	0.015	1.59	0.17	0.002	0.016	ND
Barkley Creek at Northland Avenue	0.011 [b]	0.36 [b]	0.33 [b]	0.007	0.016 [b]	6
Rogue River at Packer Driver	0.023	1.25	0.38	0.018	0.053	5
Lamberton Creek at Monroe Avenue	0.042	0.71	0.44	0.009	0.035	5
Mill Creek at 8 Mile Road	0.033 [b]	1.16 [b]	0.33 [b]	0.052 [b]	0.074 [b]	5
Indian Mill Creek at Richmond Park	ND	1.79	0.26	0.019	0.031	ND

Table 21.–Continued.

Collection site	Parameter (units)					
	Ammonia (mg N/L)	Nitrate + Nitrite (mg N/L)	Nitrogen–Kjeldahl (mg N/L)	Phosphorus-Ortho (mg P/L)	Phosphorus–Total (mg P/L)	Suspended Solids (mg/L)
Lower–continued						
Plaster Creek at 68th Avenue	ND	0.2	0.56	0.038	0.066	7
Plaster Creek at Eastern Avenue	0.008	0.903	0.75	0.054	0.096	15
Buck Creek at 68th Street	0.035	0.617	0.53	0.014	0.049	14
Buck Creek at Wilson Avenue	0.044	1.01	0.5	0.012	0.047	13
East Branch Rush Creek at Barry Street	ND	1.24	0.43	0.03	0.063	7
Rush Creek at 12th Avenue	0.074	1.54	0.76	0.023	0.079	11
Ottawa Creek at Bliss Street	ND	4.72	0.72	0.028	0.046	5
Beaver Creek at Taft Street	0.09	1.38	0.79	0.23	0.33	33
Deer Creek at Roosevelt Street	0.05	4.7	0.65	0.084	0.118	4 [a]
Beaver Creek at 56th Avenue	0.16	3.6	1.07	0.23	0.38	44
Deer Creek at Cleveland Street	0.07	3.6	0.89	0.2	0.27	10
Little Deer Creek at 48th Avenue	0.05	0.69	0.81	0.079	0.143	10
Deer Creek at Leonard Avenue	0.2	2.3	1.08	0.22	0.32	26
Bass Creek at 96th Avenue	0.051	2.1	0.76	0.062	0.098	4 [a]
Little Bass Creek at 96th Avenue	0.034	9.2	0.76	0.024	0.05	8 [b]
Bear Creek at 104th Avenue	0.099	1.77	0.99	0.009	0.071	17
Bass River at Buchanan Road	0.029	5.0	0.69	0.034	0.069	10
Crockery Creek at Shaw Road	0.035	1.36	0.6	0.047	0.064	–
Crockery Creek at Behler Road	0.014	1.58	0.44	0.041	0.064	–
Crockery Creek at Laketon Road	0.014	1.48	0.47	0.044	0.07	–
North Branch Crockery Creek at 40th Avenue	0.028	1.66	0.59	0.07	0.114	–
Crockery Creek at Schramm Road	0.016	1.77	0.43	0.045	0.077	–
Rio Grande Creek at 40th Avenue	0.045	1.99	0.53	0.047	0.083	–
Rio Grande Creek at Mt. Garfield Road	0.046	6	1.17	0.136	0.21	–
Rio Grande Creek at Patterson Park	0.022	1.9	0.69	0.079	0.118	–
Crockery Creek at Patterson Road	0.028	1.62	0.5	0.043	0.073	–
Crockery Creek at Rollenhagen Road	0.039	1.58	0.5	0.047	0.082	–
Crockery Creek at Ensley Road	0.041	1.49	0.51	0.053	0.1	–
Black Creek at Apple Avenue	0.052	0.59	0.58	0.02	0.05	–
Black Creek at Cleveland Road	0.039	0.61	0.43	0.021	0.048	–
Black Creek at Leonard Avenue	0.04	0.53	0.35	0.018	0.044	–
Unnamed Tributary to Stearns Bayou	0.015	0.107	0.26	0.011	0.030	4
Norris Creek at Pontaluna Road	ND	0.738	0.56	0.022	0.056	8
Vincent Creek at 130th Avenue	0.072	0.327	0.53	0.034	0.06	ND
Stevens Creek at Pontaluna Road	0.012	0.636	0.38	0.016	0.036	ND

[a] The analyte was reported at less than the level of quantification
[b] Sample hold time exceeded.

Table 22.–Trigger levels for nine chemicals used by the Michigan Department of Community Health in the establishment of fish consumption advisories (ppm = parts per million = mg/kg; ppt = parts per trillion).

Chemical	Advisory triggers
Total chlordane	0.3 ppm
Total DDT	5.0 ppm
Dieldrin	0.3 ppm
Toxic dioxin equivalents	10.0 ppt
Heptachlor	0.3 ppm
Mercury	0.5 ppm
Mirex	0.1 ppm
Total PCB	2.0 ppm
Toxaphene	5.0 ppm

Table 23a.–State of Michigan statutes pertaining to aquatic resource protection and administered by the Michigan Department of Environmental Quality. NREPA = Natural Resources and Environmental Protection Act (1994 PA 451).

State of Michigan Acts	Description of Acts
Public Health Code (1978 PA 368, as amended)	Aquatic Nuisance Control: regulates the use of any substances for the treatment of swimmer's itch and excessive aquatic plants and algae.
Part 31 N.R.E.P. Act	Water Resource Protection: regulates discharge to surface waters according to set water quality standards.
Part 41 N.R.E.P. Act	Sewerage Systems: regulates wastewater or sewer system facilities.
Part 91 N.R.E.P. Act	Soil Erosion and Sedimentation Control: regulates any earth change that disturbs one or more acres, or is within 500 feet of a lake or stream.
Part 301 N.R.E.P. Act	Inland Lakes and Streams: this part regulates structure placement or removal, dredging, filling below the ordinary high water mark, and operating or constructing a marina in lakes and streams.
Part 303 N.R.E.P. Act	Wetland Protection: regulates dredging, filling, and structure placement within wetlands.
Part 307 N.R.E.P. Act	Inland Lake Level: regulates the establishment of legal lake levels and lake level control structures.
Part 309 N.R.E.P. Act	Inland Improvement: regulates the establishment of lake boards and revolving funds to protect and improve lakes.
Part 315 N.R.E.P. Act	Dam Safety: establishes a program to maintain a statewide inventory of dams, and provides staff to inspect dams to evaluate the integrity of the structures.

Table 23b.–Federal statutes pertaining to aquatic resource protection and administered by the Michigan Department of Environmental Quality.

Federal Water Pollution Control Act, Section 314 (as amended 2002, PL 107-303)
Federal Water Pollution Control Act, Section 402 (as amended 2002, PL 107-303)
Federal Water Pollution Control Act, Section 404 (as amended 2002, PL 107-303)
Coastal Zone Management Act (as amended 1996, PL 104-150)
River and Harbor Act, Section 10 (1899)

Table 24.–Designated drain names, length (miles), and establishment date (Est.) in the Grand River watershed by valley segment. Information provided by each county drain office. Blanks = lack of information.

Drain	Length (mi)	Est.
<u>Headwaters</u>		
Hillsdale County		
• *Somerset Township*		
Vicary	0.32	1977
Ingham County		
• *Stockbridge Township*		
Brogan	3.26	1910
Douglas	2.31	1903
Grandy	0.67	1918
Havens Intercounty		1902
Jacobs Lake	3.31	1949
Polliwog	1.13	1898
Pickett	4.53	1909
Rose, M.M.	1.35	
Salow	1.19	1961
Standish	1.53	
Upper Jacobs Lake	4.45	
Wild Intercounty		1960
Waltz	0.60	1942
• *Onondaga Township*		
Darling	0.57	1914
Darling and Christie Intercounty 1	0.65	1915
Darling and Christie Intercounty 2	1.09	1917
East Onondaga	2.6	1899
Haines	0.8	1904
Perry Creek	0.6	1919
Perry Creek Extension	1.8	1917
Perry Creek Tile	0.11	1919
• *Bunkerhill Township*		
Batdorff	1.0	
Batteese Creek	4.0	
Brogan	4.0	
Brogran, Ward Branch	2.0	
Clark and Potter	2.0	
Clinton	5.0	
Clinton, Hynes Branch	3.0	
Clinton, DeCamp Branch	1.0	
Douglas	3.0	
DuBois and Mitchell	3.0	
Fry	2.0	
Grow	2.0	
Heeney	2.0	
Morrissey	1.0	
Ingham County		
• *Bunkerhill Township–continued*		
Mud Creek and Branches	0.08	
McCluskey	1.0	
McCreery	2.0	
Neu	1.0	
Pheeny	2.0	
Quinn and Hickey	1.0	
Rossman and Gould	2.0	
Ruthig	0.05	
Shearer	2.0	
Ulrey	2.0	
Vicary	2.0	
• *Leslie Township*		
Barnard	4.0	
Campbell	3.0	
Craddock	3.0	
East Onondaga	2.2	
Haines	2.3	
Hampton	1.0	
Hampton and Owen	2.0	
Harmon	2.0	
Harkness	3.0	
Harris	1.0	
Jenks	2.0	
Kelley	1.0	
Leslie No. 1	2.0	
Mud Creek and Branches	0.3	
North Onondaga	0.1	
Perry Creek	1.4	
Perry Creek extension	0.16	
Royston	4.0	
Royston Branch No. 1	1.0	
Ruthig	2.95	
Talmadge	1.41	
Jackson County		
• *Blackman Township*		
Acme	1.18	1961
Allen Branch	0.5	1902
Barrett lateral		1954
Beebe Taylor	0.78	1911
Blackman No. 2		1942

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
<u>Headwaters–continued</u>					
Jackson County–continued			*Jackson County–continued*		
• *Blackman Township–continued*			• *Blackman Township–continued*		
Bliss	0.43	1922	Portage River		1918
Boland		1980	Reul	1.72	1906
Campbell	2.2	1972	Rives-Blackman		1869
Chanter	0.29	1893	Russell and Mead		1890
Charmin Highlands	2.94	1969	Sandstone and Blackman	2.37	1884
Chestnut	0.24	1942	Smith and Bachelder		1884
Christie	0.4	1966	Thompson Lake		1859
Clinton	0.22	1956	Thompson Lake Drain Extension		1873
Concord Blvd. Spur		1942	Tobin and Snyder	2.2	1898
Condad		1930	Todd Klee	0.61	1916
Cooper Street		1896	Wheeler		1897
Erie Street		1962	• *Columbia Township*		
Evans		1926	Meridian	0.65	1903
Fern Avenue		1953	Sanford	0.73	1917
Goodall		1897	• *Grass Lake Township*		
Grand River		1888	Cassidy Lake	5.12	1905
Gregory		1904	Corwin		1910
Hendee	2	1891	Fry		1907
Hunter's Ridge		1980	Grass Lake	5.3	1874
Hurd Marvin		1888	McGees		1883
John Saines	1.46	1971	Miles Kirkby	2.81	1949
Kent	0.47	1930	O'Leary		1951
Lorretta Branch	0.66	1973	Platt	0.3	1918
Luella-Cunningham laterals		1973	• *Henrietta Township*		
Mantleville	0.53	1916	Adams-Disbrow		1885
Mayett	1.3	1873	Farrand and McCain	0.88	1887
Maynard Branch	0.61	1954	Forner		1892
McConnell	1.4	1978	Har Drain and Katz Branch		1950
Miller	0.93	1892	Henrietta	1.42	1884
Moe lateral		1979	Jewel	2.3	1904
Murray Branch	1.13	1892	Lusk Lake	1.35	1916
Neil	0.1	1933	Munith	1.26	1961
North Valley Fams		1978	Olney	1	1890
North,Chesaning and Dover		1954	Portage River		1918
Northwest Hills		1978	Stanfield	0.62	1893
Paka Plaza	0.19	1963	Twin Lakes	4.73	1889
Park Forest Branch	0.57	1977	Wild		1942
Patty lateral		1954	• *Leoni Township*		
Perry Branch		1903	Bliss	0.43	1922
Piper	0.22	1897	Decker	3.88	1917
Poole		1912	Dietz Branch of Kennedy	0.05	1959

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Headwaters–continued</u>		
Jackson County–continued		
• *Leoni Township–continued*		
Donnelly Road	0.23	1961
Gregory		1904
H.H. Crittenden		1888
Huttenlocker	1.6	1903
Kennedy	1.4	1917
Page Avenue Lateral		1984
Plumb Van Antwerp		1916
Portage River		1918
Reul	1.72	1906
Smith	0.57	1968
Stillwell	0.3	1947
• *Liberty Township*		
McCready		1919
Meridian	0.65	1903
Sanford	0.73	1917
• *Napolean Township*		
Ackerson Lake		1919
Austin No. 1	0.28	1975
Country Estates		
Cranberry and Ackerson Lake		1879
Doty	0.87	1951
East Cranberry Lake	1.7	1904
Hatt		1906
Meadow Lark Acres		1976
Oak Hill Estates		1978
T T Townsend		1890
Winchell and Townsend		1899
• *Rives Township*		
Fisher		1909
Freeman Marsh		1892
Grand River		1888
Huntoon Lake Extension		1919
Leslie Drain	2.39	1914
Parks	0.78	1894
Rives-Blackman		1869
Shaw	2.42	1900
Tobin and Snyder	2.2	1898
Twin Lakes	4.73	1889
W B Miner		
Whitney		1898

Drain	Length (mi)	Est.
Jackson County–continued		
• *Summit Township*		
Area Career Center Branch–Argus	0.3	1961
Beverly Hills	1.09	1930
Booth and Branches	1.47	1917
Branch No. 1		
Brookside	0.41	1967
Carson	0.24	1925
Cascades Manor		1955
Cascades Vista		1980
Community College		1976
Conger Branch		1983
Cortland Blvd.		1942
Dolan lateral		
Fisk		1929
Foote Grove		1960
Golfside Terrace	0.57	1968
High Street Branch		1961
Hollis	0.35	1942
Kibby		1970
Lee Willa and Laterals	0.95	1971
Livonia Lateral	0.45	1971
Lowe Ridgeway		1969
Meadow Lane Branch		1965
Oak Street and laterals	0.88	1962
Page Avenue		1948
Pierce	0.57	1914
Ranch Park	0.09	1960
Ricks	1.11	1972
Robinson		1954
Seventeenth Street	0.6	1941
Sharp	0.94	1903
Southview lateral		
Stonewall		1970
Summit (Monkey run)	1.6	1924
Three Forty Farms		1971
Timber Meadows		1980
Todd Klee	0.61	1916
Twentieth Street	0.12	1942
Twenty first Street	0.3	1930
Twenty Second Street	0.3	1930

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Headwaters–continued					
Jackson County–continued			*Jackson County–continued*		
• *Summit Township–continued*			• *Waterloo Township–continued*		
Watts Tile		1911	Lusk Lake	1.35	1916
Woodbine lateral	0.08	1976	Lyndon and Waterloo		1884
• *Waterloo Township*			Plum Orchard Creek	2.94	1900
Fry		1907	SE Branch Waterloo and Portage		1884
Harr and Katz Branch		1950	Waterloo and Portage		1879
Havens		1892	Wild		1942
Hawley Klein		1900			
Upper			Upper–continued		
Eaton County			*Eaton County–continued*		
• *Hamlin Township*			• *Hamlin Township–continued*		
Ayres	0.52	1881	Prescott	1.06	1882
Bastedo	0.63	1909	Sherwood	1.53	1884
Boatman	0.33	1886	Sidwell	3.12	1880
Booth	1.90	1882	Smith	0.75	1883
Bly	7.82	1879	Spring Brook	1.50	1882
Buchanan	1.45	1879	Spring Brook Intercounty	3.56	1959
Carter, East	2.01	1893	Van Allen	0.50	1885
Carter, West	2.00	1893	Wilson	0.45	1883
Charlesworth	0.33	1950	Wood	1.14	1916
Clarke Intercounty	0.57	1929	• *Brookfield Township*		
Dane's Lake Ditch	0.20	1879	Carter	0.63	1913
Darling	1.78	1902	Holbrook	1.08	1904
Farnum Ditch	0.28	1880	Numbers Favorite	0.28	1882
Gale	2.13	1945	Otter Creek and East Br. Intercounty	1.54	1907
Gurley Lake Intercounty	2.13	1952	Post	1.90	1894
Gurley Lake Branch	1.35	1959	Post No. 2	0.48	1914
Hamlin Section 16	1.07	1948	Reese	0.57	1916
Hobart and Branch	6.63	1898	Sederlund	1.19	1957
Kettler	1.26	1867	Shiner	0.84	1894
Kikendall	3.74	1908	• *Eaton Township*		
Lincoln (and Heiser)	2.29	1868	Baldwin	0.48	1885
Loomis (Willow Brook)	1.93	1867	Dow	0.82	1897
McGilvra	2.56	1898	Prichard	1.79	1896
Mills	5.40	1878	• *Eaton Rapids Township*		
Norris	2.23	1894	Arnold	1.03	1913
Peacock Intercounty	3.94	1867	Barrett	1.45	1882
Phillips	0.96	1902	Bentley	1.84	1883
Phillips No. 2	1.14	1914	Benton	1.85	1882
Phillips Township	1.53	1893	Bray (vacated and abandoned)	0.28	1899

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Upper–continued</u>		
Eaton County–continued		
• *Eaton Rapids Township–continued*		
Brooks	0.93	1950
Bryan	0.42	1912
Chapman	0.58	1910
County Line Intercounty	4.71	1897
Covey (Owen)	1.54	1883
DePue	2.41	1882
Hallifax	0.19	1889
Harris	0.32	1872
Haun	0.55	1937
Kint	1.88	1891
Jackson	0.36	1915
Klotz	0.20	1892
Manning	1.31	1907
Mason Road	0.30	1930
Nelson (Bentley South Branch)	1.48	1882
Odell	1.34	1878
Olmstead	0.50	1890
Phillips	0.70	1883
Pickworth	1.45	1912
Raymer	0.25	1892
Rorabeck	0.62	1908
Seelye	0.36	1894
Slocum	1.73	1882
Spicer	0.33	1893
Spicer Creek (Long Drain)	3.40	1878
Vaughan	0.19	1883
White	0.41	1886
White and Carpenter Intercounty	1.31	1926
Whittum	0.31	1921
Zentmyer	0.23	2003
• *Windsor Township*		
Bailey	0.83	1910
Barnes Intercounty	1.78	1912
Bellows	0.44	1900
Bronson	3.54	1883
Brooks River Landing	0.33	1994
Concord Branch	0.48	1988
Corwin	0.99	1884
Daft Intercounty		
Darling	0.98	1882
Dimondale	0.00	1956
Eaton County–continued		
• *Windsor Township–continued*		
Dimondale Estates	1.39	1982
Dimondale Farms	0.58	1997
Fawn Creek	0.11	1990
Figg	0.74	1915
Fulton	1.54	1913
Gentner	1.19	1886
Gilbert and West Town Intercounty	1.05	
Graham	2.31	1882
Harris	1.67	1889
Hetrick	2.48	1917
Hill and Hollow (Orphan)		
Hilliard Branch	0.30	1968
Hull	1.68	1915
Huntington	1.29	1883
Ingham and Eaton Intercounty	1.25	1948
Lemon	1.12	1917
Martin	1.25	1891
McCabe	0.28	2003
Murray	1.66	1916
Nelson	1.11	1913
Norris	0.47	1890
Old Maid Relaid	3.58	1882
River Rock		
Section 4 Windsor	1.30	1907
Sections 27 & 34 Windsor	0.68	1901
Silver Creek	5.42	1884
South and Burnett Branch	0.70	1884
South Windsor	6.50	1882
Stiefel		
Strobel	0.60	1916
Whaley	2.16	1883
White	1.84	1886
Williams	1.72	1884
Willis Shaw	3.02	1882
Windsor	1.14	1892
Windsor Glens	0.54	1972
Winslow	0.96	1936
• *Delta Township*		
Clements	2.05	1894
Daharsh	0.61	1894
Delta Glens	0.08	1964

Table 24.–Continued.

Drain	Length (mi)	Est.
Upper–continued		
Eaton County–continued		
• *Delta Township–continued*		
Graham	0.60	1964
Hunter	4.96	1878
Jenne	0.64	1888
Keller	2.97	1882
Lantern Green	0.14	1972
Libbie	0.28	1931
Maplewood	0.61	1955
Paddletown Sewer	0.56	1889
River Cove	0.21	1995
Rouse	0.64	1888
Saier	0.90	1889
Smith and Evans Intercounty	2.31	1907
Thomas	0.67	1894
Underhill	2.39	1920
Underhill Extension	0.11	1920
Calhoun County		
• *Clarence Township*		
C.E. Walker	1.55	1893
Gurley Lake	1.43	1887
Jackson County		
• *Sandstone Township*		
Bradford Hicks		1896
Chapel and Benn	0.15	1886
Chapel and Finch		1888
Conner and Bennett		1898
Hendee	2	1891
King and Harrington		1894
Moe Brewer	3.03	1890
Murray Branch	1.13	1892
Sandstone and Blackman	2.37	1884
Stepladder	1	1954
Towsey Fellows		1886
Tucker and Foster Branch	1.04	1894
• *Spring Arbor Township*		
Bateman		1892
McCain		1917
• *Springport Township*		
C E Walker	2.05	1893
Gurley Lake		1887
Gurley Lake Branch No. 1		
Moore	1.54	1908
Jackson County–continued		
• *Springport Township–continued*		
Rhodes	1.04	1893
Springbrook	3.56	1964
Tompkins and Springport		1885
Wilcox Wooster		1886
• *Summit Township*		
McCain		1917
• *Tompkins Township*		
Baldwin	2.25	1916
Bromley tile		1912
Conner and Bennett		1898
Darling and Christie	0.65	1885
Harris and Pomeroy		1886
Minard		1905
Parks	0.78	1894
Stepladder	1	1954
Tompkins and Springport		1885
Torrey Whitney Brand		1971
Wilcox Wooster		1886
Ingham County		
• *Aurelius Township*		
Aurelius Center	0.60	
Aurelius –Delhi	1.82	
Bateman	0.75	
Clark	0.10	
East Branch Oaks	1.42	
Eckhart	1.15	
Elliot	0.30	
Fanson and Potter	0.50	
Gretton	1.06	
Hopkins	1.03	
Kenfield	1.05	
Kingman	1.44	
Marshall and Haynes	1.28	
Osborne	0.95	
Oaks	2.45	
Oaks extension	2.47	
Scutt	0.69	
Simpson	1.22	
Topliff	2.08	
Townsend	0.47	
West Aurelius	5.23	

Table 24.–Continued.

Drain	Length (mi)	Est.
Upper–continued		
Ingham County–continued		
• *Aurelius Township–continued*		
Wright and Potter	1.36	
Wright and Potter, North Branch	1.54	
Zimmerman	0.09	
• *Delhi Township*		
Abbott	1.77	
Allen No. 1	2.09	
Aurelius-Delhi	3.09	
Aurelius-Decamp	0.41	
Allen	0.95	
Binkley	1.03	
Blakeslee	2.23	
Barnes	1.30	
Barnes-Waverly Commerce Branch	1.06	
Bishop Lake	0.21	
Clark	1.91	
Drum and Heck	0.43	
Erter	0.32	
Gilbert	0.75	
Gilbert and extensions	8.20	
Gillett	1.56	
Gillet Branch No. 1	0.53	
Grovenburg and Menger	3.17	
Grovenburg and Menger Branch No. 1	1.43	
Grovenburg Branches	3.25	
Keeler	0.12	
Ingham County–continued		
• *Delhi Township–continued*		
Keller	0.50	
Mack and Swagler	0.62	
Melkvik	0.33	
Melkvik, Grovenburg Farms Branch	1.16	
Menger	1.26	
Menger-Meadow Ridge	0.53	
West Town-Bishop Lake	0.12	
Woodland	0.23	
• *Lansing Township*		
Cadillac Avenue	1.00	
Clippert	0.44	
Lansing Township No. 1	1.59	
Lansing Township No. 2	1.05	
Waverly	0.25	
• *Onondaga Township*		
Barnes and Carpenter Intercounty	1.09	
Baldwin Intercounty		
Clarke Intercounty	0.57	
Conklin	1.08	
Eldred	0.62	
Ghere	0.26	
Grand River Intercounty		
Puffenberger and Extension	2.94	
Rossman	1.16	
Stone	1.00	
Terry	0.97	
Middle		
Ingham County		
• *Aurelius Township*		
Aurelius-Vevay	1.85	
Bell	1.65	
Collins	0.32	
Cook and Thorburn	0.51	
Duck Pond	2.55	
Edgar	1.16	
Fowler	2.55	
Hancock	0.85	
Holley and Day	0.924	
Hemans	0.39	
Markley	0.88	
Middle–continued		
Ingham County–continued		
• *Aurelius Township–continued*		
Plains Road	0.24	
Sweet	0.98	
Stid	0.40	
Willow Creek and Branches	10.27	
• *Alaiedon Township*		
Alaiedon No. 2	0.25	
Alaiedon No. 3	0.31	
Alaiedon No. 4	0.64	
Aurelius-Vevay	0.08	
Angel Acres	0.60	
Bates	0.17	

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Middle–continued					
Ingham County–continued			*Ingham County–continued*		
• *Alaidon Township–continued*			• *Delhi Township–continued*		
Button	0.09		Bolter-Willoughby Road Branch	0.70	
Button Branch No. 3	0.54		Buford	0.11	
Canaan	3.18		Burgess	2.77	
Collar	0.72		Cluckey	2.76	
Cook and Thorburn	0.24		Cook and Thornburn and Branches	9.48	
County Farm	1.91		College Heights	0.80	
County Farm No. 1	0.17		Delhi No. 1	2.88	
County Farm No. 2	0.22		Diehl and Branches	3.45	
County Farm Extension	1.06		Elm Street	0.20	
Deer Creek	0.07		Exner	1.06	
Dingman	1.00		Felton	0.17	
Dell	0.43		Ferley and Branches	4.06	
Eifert	1.60		Five Oaks	0.75	
Felton	2.49		Gillett and Branches	2.09	
Force	2.98		Green and Branches	5.30	
Hawkins	0.09		Hancock and Branches	5.94	
Herron Creek	2.94		Heather Haven	1.05	
Lamb	1.48		Holley and Day	4.08	
Lounsbury	0.73		Holt Farms	0.53	
Mud Creek and Branches	4.76		Ivywood	1.12	
Mutual	0.94		Jackson	0.29	
North Branch Mud Creek	1.83		Lamoreaux	1.17	
Primeau	0.36		Matthews	0.91	
Reeves	0.80		North Cedar Park	0.45	
Rossiter	0.31		Oakwood	0.41	
Shafer and Extension	0.19		Pitt	0.45	
Slater	20.5		Pine Tree and Branches	0.46	
Sloan Creek	2.26		Pawlowski and Branches	1.98	
Smith	0.59		Pine Dell	0.10	
Totte-Chase Springfield Branch	0.93		Root	0.25	
Taylor and Laycock	0.86		Ripley	0.69	
Taylor and Laycock Extension	0.59		River Pointe	0.68	
Townline	1.49		Schoolcraft	0.60	
Vanderhoof	0.12		Schoolcraft Extension	1.00	
Waubanikin	1.98		Spahr Avenue	0.81	
Weber	0.21		Stimson and Branches	1.77	
Wise	1.55		Summitt Street and Branches	1.50	
• *Delhi Township*			Totte-Chase and Branches	0.63	
Alton	1.37		Timberland	0.15	
Banta and Branches	2.36		West Delhi and Branches	1.50	
Bolter-Gardenia Branch	0.22				

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Ingham County–continued		
• *Lansing Township*		
Banta	1.13	
Bogus Swamp and Branches	3.42	
Bowers	0.66	
Edgemont	1.69	
Farmington	0.24	
Farmington No. 2	0.04	
Farmington No. 3	0.08	
Goritz	1.17	
Homer	0.25	
Jessop	0.82	
Montgomery-Covington Branch	0.96	
Pratt	0.93	
Ravenswood	2.06	
Smedley-Coolidge and Branches	2.25	
Tollgate and Extensions	6.01	
Urbandale	1.26	
Van Buren	0.25	
• *Leslie Township*		
Barnard	3.40	
North Onondaga	0.06	
Perry Creek	1.39	
Perry Creek Extension	0.16	
Talmadge	1.41	
• *Onondaga Township*		
Battley	0.94	1921
Byrum	1.89	
Fowler	0.71	
Goodnoe	1.35	1949
Hemans	1.04	1927
North Onondaga	6.02	1912
Plains Road	0.24	1946
Sweet	0.53	1914
Stimer	0.77	1916
• *Leroy Township*		
Alchin	0.91	
Auctioneer	1.85	
Bunker	1.06	
Crandall	0.61	
Cool	0.51	
Chula-Vista	0.30	
Dana-Stark	1.03	
Ingham County–continued		
• *Leroy Township–continued*		
Dietz Creek	3.90	
Doan Creek	4.23	
Doan Creek-Culver Hills Branch	1.25	
Doan Creek-O'Hanlon Court Branch	0.74	
Donal	0.62	
Fear	0.50	
Gould	0.49	
Glen Dor	0.08	
Herrick	0.53	
Hummel	1.23	
Huske	0.42	
Kalamink Creek	3.84	
Lawrence	0.72	
Leroy No. 2	0.54	
Lewis	1.92	
Marshall and Wilcox	0.26	
Mead	1.20	
McMahon	0.31	
Putman	0.40	
Searls	2.16	
Seymour	2.29	
Shepard	2.52	
Smith and Oesterle	1.31	
• *Locke Township*		
Botsford	1.41	
Bullet Lake	5.34	1910
Chamberlain	0.49	1919
Coburn	1.87	1901
Conway and Locke No. 1 Intercounty	3.0	1907
Conway and Locke No. 2 Intercounty	0.25	1908
Conway and Locke No. 3 Intercounty	2.53	1928
Doan Creek		1901
Frederick	0.63	1908
Glen Dor	0.02	
Hart No. 2 Intercounty		1927
Hartwell	2.78	1953
Harlacher		

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Middle–continued</u>		
Ingham County–continued		
• *Locke Township–continued*		
Locke Branch No. 1	1.82	
Locke No. 4	4.09	1893
Locke No. 5	0.8	1893
Locke No. 5, Bell Oak Branch	0.32	
Locke Center	1.58	1913
Lyon	0.51	1921
Locke Ditch No. 1	5.35	1887
Locke Ditch No. 2	5.26	
Locke Ditch No. 3	0.43	1893
Locke Ditch No. 6	0.61	1893
Livingston & Ingham No. 15 I.C.		
McCrea Intercounty		
Rowley	2.55	1919
Red Cedar River Intercounty		
Silsby	0.34	1916
South Looking Glass R. Intercounty		1896
Spaulding Intercounty		1916
Sullivan Creek		1903
Squaw Creek	3.01	1898
Tuttle	1.57	1919
Wolf Creek Intercounty		1945
Williamston, Locke & Perry I.C.		
West and Tiedman	1.23	1907
Wainwright	0.39	1917
• *Stockbridge Township*		
Bauer	1.69	1946
Doan Creek		1901
Mud Creek and Branches	3.52	
Usher	1.66	1903
• *White Oak Township*		
Anderson		
Bauer	1.13	1911
Bunker		1946
Carl		1910
Clements	1.12	1927
Coulson	1.69	1908
Crandall	0.89	1919
Dietz Creek		1916
Doan Creek		
Giddings		1901
Gillam	0.45	1903
Ingham County–continued		
• *White Oak Township–continued*		
Hayner	2.12	1918
Haywood	0.84	1919
Hudson	1.23	1894
Howell and Gillam	0.43	1953
Johnson No. 1	0.66	1903
Kalamink	1.52	1950
Kalamink Creek, Ashley Acres		1883
Kalamink, Industrial Park		
Lantis		
Marshall and Wilcox	0.45	1904
Marshall and Wilcox, Oesterle Br.	1.82	
Millville	1.72	1916
Meadville	3.16	1881
McMahon		1895
Nims	0.94	1951
Oakley	2.04	1898
Patrick	2.73	1900
Proestal	0.23	1919
Patrick No. 2	0.89	
Patrick No. 2 Extension	0.65	
Reinhart	2.05	1919
Render Intercounty		1927
Smith and Conklin	0.49	1916
Wilson	4.41	1905
West Cedar Intercounty	4.26	
Wigle	0.83	1920
• *Williamston Township*		
Bullett Lake		
Bullett Lake-Clover Meadows Br.		
Burkley	0.4	
Cherry Ridge No. 2		
Deer Creek		
Foster		
Foster-Damon Road Branch		
Hideaway Woods		
Hill		
Jefferies-Shoesmith Road Branch		
Maple Shade and Branches		
McKeon		
Meadowdale		
Oak Leaf Hills		

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Ingham County–continued		
• *Williamston Township–continued*		
Oak Leaf Hills No. 2		
Oak Leaf Hills No. 3		
Partridge Intercounty		
Pebblebrook		
Powell		
Primeau	0.2	
Randall		
Randall-Pierson Road Branch		
Red Cedar Manor	0.3	
Rykert		
Shaw Extension		
Shaw Extension Branch No. 1		
Sherwood		
South Branch Looking Glass I.C.		
Spaulding Intercounty		
Suttell		
Suttell Branch No. 6		
Williamston		
Williamston, Locke, and Perry		
• *Ingham Township*		
Bates	1.24	
Bates-Scarlett Branch	1.23	
Bray	0.51	
Brown	1.51	
Brown Extension	0.66	
Brashford	1.41	
Cullen	0.47	
Deer Creek	6.60	
Deer Creek-Branch No. 2	0.22	
Doan Creek	3.09	
Doan and Deer Creek	4.88	
Dexter Ponds	0.76	
Hayhoe	2.18	
Hayhoe Extension	0.94	
Marshall and Wilcox	0.25	
Miller	2.95	
Mud Creek and Branches	0.12	
Mullen	2.20	
Reinhart	0.15	
Sweeney	3.56	
Ingham County–continued		
• *Ingham Township–continued*		
Vanderhoof and Robinson	2.86	
Vanderhoof and Robinson Extension	0.36	
• *Meridian Township*		
Addison	0.10	
Ardmore	0.10	
Banta	0.23	
Bennett	1.07	
Biebesheimer	2.18	
Brackenwoods	1.00	
Briarcliff	4.72	
Briarwood and Branches	4.72	
Briarwood-Hidden Valley Branch	0.64	
Briarwood-Spring Lake Branch	4.04	
Button	2.91	
Button-Hiawatha Park Branch	0.44	
Button-Ponderosa Branch	1.00	
Button-Spring Lakes Branch	0.26	
Chippewa Hills and Branches	0.84	
Chippewa Hills No. 4 and 5	0.38	
Ciba Geigy	0.05	
Clawson-Trails at Lake Lansing	0.49	
Costigan	1.36	
Country Place	1.25	
Daniels	0.46	
Daniels Extension	0.10	
Daniels-Cornell Woods	0.62	
Daniels-Goff Branch	0.21	
Daniels-Paddock Branch No. 2	0.33	
Daniels-Whispering Woods Branch	1.00	
Dawn Avenue	0.77	
Dobie Heights	0.65	
Dobie Heights-Indian Woods Branch	0.11	
East Gate	0.16	
East Point	0.61	
Eberly	1.88	
Eberly Branch No. 1 and 2	0.51	
Eberly-Keystone Branch	1.34	
Felton	0.34	
Forest Hills	0.88	

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Ingham County–continued		
• Meridian Township–continued		
Forest Hills Branch No. 6	0.15	
Foster and Branches	8.24	
Goritz	0.83	
Greencrest	2.08	
Greencrest Relief	0.25	
Greencrest-Heritage Hills Branch	0.39	
Greenwood	0.51	
Grettenburger	0.29	
Grettenburger Relief	0.53	
Hannah Farms	1.05	
Hannah Farms-Marriot Branch	0.12	
Hathaway	0.85	
Hathaway Branch No. 1	0.09	
Hathaway Relief	1.00	
Hathaway Relief-Whispering Oaks	1.00	
Heritage Hills	1.35	
Heritage Hills Branch No. 4	1.01	
Heritage Hills-Merritt Branch	0.10	
Herron Creek	2.06	
Hill Haven	0.17	
Hillbrook Park	1.36	
Hoskins	1.04	
Hoskins-Sundance Branch	0.72	
Hoskins-Herron Creek Branch	0.37	
Indian Hills	0.50	
Indian Hills No. 1	0.14	
Indian Lakes	0.35	
Indian Lakes and Levees	0.08	
Indian Lakes No. 2	0.18	
Indian Lakes No. 3	0.15	
Indian Lakes No. 3 Country Estates	1.11	
Jeffries and Branches	7.38	
Kent	0.21	
Kierstead	0.72	
Kierstead-Breckenridge	0.29	
Kinawa	1.6	
Kinawa View	0.51	
Lakeview	4.68	
Lake-of-the-Hills	0.84	
Lake-of-the-Hills, North Branch	0.70	

Drain	Length (mi)	Est.
Ingham County–continued		
• Meridian Township–continued		
Lakeside Village	0.57	
Meridian	1.18	
Meridian-Chimney Oaks Branch	0.99	
Meridian Hills	0.65	
Mud Lake Outlet	3.38	
Meijer	0.78	
Marshall Park	0.04	
Navaho	0.35	
Nemoka	1.26	
Nilson	0.34	
Northwind	0.26	
Okemos and Branches	0.93	
Pebblebrook	0.22	
Pike Street	0.26	
Pine Hollow	0.17	
Pine Lake Outlet and Branches	4.95	
Pine Ridge	1.07	
Ponderosa	1.13	
Povey and Branches	4.61	
Primeau and Branches	2.09	
Proctor	1.84	
Raby and Branches	6.32	
Red Cedar-Braemoor Branch	0.91	
Red Cedar Manor	0.73	
Remy Chandler and Branches	3.27	
River Downs	0.75	
Riverwood	0.60	
Shaker Heights	0.81	
Shoals and Branches	3.24	
Skyline	1.0	
Sloan Creek	0.37	
Smith and Branches	8.26	
Spross and Branches	2.03	
Tacoma Hills	1.54	
Timberlane	0.36	
Trails at Lake Lansing	0.59	
Unruh and Branches	2.53	
Wellington Estates	0.81	
Wilkshire and Branches	2.19	
Whitehills Woods	0.34	

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Middle–continued</u>		
Ingham County–continued		
• *Wheatfield Township*		
Atzinger		1903
Bates		1898
Bird	4.73	1927
Bray	1.07	1930
Burkley		1915
Cole	4.12	1900
Cole, East Branch	2.41	1929
Cole, West Branch		
Collar	0.83	1961
Deer Creek		1884
Deer Creek, Holt Rd. Br.		
Deer Creek, Plymouth Landing		
Dennis	1.48	1915
Dennis, Erin Knoll Br.		
Doan Creek		1901
Dell	0.59	1897
Eifert	2.09	1928
Frost	3.52	1947
Gould		1904
Linn	1.81	
Mutual	1.28	1910
Primeau		1946
Reeves	2.7	1921
Shepard	2.25	1919
Sloan Creek	4.14	1920
Sloan Creek, Jamestown Branch	0.27	
Swan and Beatty		1911
Sweeney		1904
Tobias		1901
Tobias, Linn Rd. Br.		
Vanderhoof and Robinson	3.12	
Vickers and Kent	0.38	1904
Van Horn Wheatfield		
Waubanikin	3.95	1902
Waubanikin, South Branch	2.03	1902
Wheatfield # 1	0.98	1922
Wheatfield # 2	0.48	1922
Wilcox	0.63	1910
West and Butler	0.3	1900

Drain	Length (mi)	Est.
Ingham County–continued		
• *Vevay Township*		
Aurelius and Vevay	2.89	1907
Bates		1898
Bergeon	0.63	1952
Bergeon, Branch No. 1		
Bergeon, Columbia Est. Br.	0.18	
Bush	0.48	1915
Bobolink	0.05	
Campbell		1916
Collins	1.31	1960
Columbia St.	1.17	1913
Columbia St., Foxcroft Br.	1.36	1978
Chapin	1.10	1917
Darrow and McRoberts	1.11	1947
Deer Creek		
Franklin	0.74	1946
Havens	1.34	1916
Havens, Lone Oak Br.		
Hawkins	1.10	1903
Hazelton	1.00	
Hawley	1.95	
Hawley, Shawnee Est. Br.	0.59	
Clinton County		
• *Eagle Township*		
Acre "B"	0.72	1902
Beashore & Maier Intercounty	0.55	1920
Brokaw Intercounty	0.73	1884
Capital Crossings		2002
Eagle Village Tile	0.33	1880
Erin's Way	0.21	1990
Graves and DeWitt		1889
Groger &Jennison Br. #1,2,3	3.15	1882
Husted & Landenberger Inter	4.94	1879
I-96/Juenker	0.73	1997
Ira Howe	0.98	1919
Ladd	0.63	1945
Moyer	1.87	1922
Mud Creek Intercounty	0.48	1919
Partlow and Reed Intercounty	1.18	1889
Pingle Intercounty	0.50	1881
Reed Intercounty	1.59	1890
River Ridge #4 (Eden Trail #4)		

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Middle–continued</u>		
Clinton County–continued		
• *Eagle Township–continued*		
Shadduck Creek	1.24	1884
Smalley	1.31	1913
Snyder (Eagle)	1.14	1880
Star Tile Intercounty	0.04	1922
Stinson		1871
Whispering Winds #1	0.14	1970
Whispering Winds #2	0.27	1970
Whispering Winds #3	0.11	1970
• *Victor Township*	0.00	0000
Case	0.32	1889
Clise		1882
Gardner (Brindle Lake)		1901
Holden, Parker Branch		2003
Jones and Branches 1 and 2	1.66	1910
Holden or Holden Extension		1881
Ives and Branches		1881
Koonter Joint Intercounty		1939
Laingsburg Branch #1 Intercounty		
Law	0.52	1890
Looking Glass River Intercounty	7.86	1944
Miller	0.31	1882
Morgan and Beuhler	1.33	1891
Mud Creek and Branches	10.01	1882
See		1882
Sleight		1880
S. Looking Glass (Vermillion Crk)		
• *Bath Township*		
Albert A. White (Meadow Subdiv)	1.54	1995
Bath Highway	1.05	1915
Baughman	1.39	1913
Baughman "A"	1.05	1913
Baughman "B"	0.86	1913
Bonnie Meadows	1.43	1990
Brundige Intercounty	0.71	1912
Butterfield Intercounty		
Chateau in the Pines	1.79	1994
Clawson Intercounty	0.12	1912
Clemons	0.71	1891
Clise	3.55	1882
Clise-Hall Branch	2.40	1902
Corcoran Intercounty		1960
Clinton County–continued		
• *Bath Township–continued*		
Corey	0.85	1892
Cushman	0.77	1915
Cushman Branch	0.19	1915
Dryer	0.88	1908
Gardner (Bindle Lake)	4.23	1901
Harper	0.53	1920
Harvest Lane Branch	0.61	2001
Hawk Hollow	6.10	2000
Hawkl Hollow East		2000
Hidden Valley		2004
Horton	0.31	1920
Hunters Crossing Branch of Clise	0.20	
Kitson	1.66	1897
Klinger Branch #1	0.63	1995
Klinger Intercounty	0.69	1991
McKibben		1870
Mead--Branch 101	0.82	1971
Mead--Mill Branch	0.05	1892
Mead and Branches	1.48	1893
Mead Creek Village Branch	0.33	1994
Meadow Ridge	0.40	1996
Meadow Brook (Tech. Center)	1.84	2000
Melrose Apartments	0.04	2001
Mud Creek—2nd West Branch	2.42	1912
O'Connor	0.20	1912
Park Isle and Branch	0.61	1993
Peacock	1.14	1921
Peacock Hills		2003
Peterson	0.64	1948
Pine Lake Intercounty		1921
Porter Smith	0.97	1917
R. Kimball	0.28	2001
Reasoner and Branch	0.19	1948
Remy (Remey) Chandler Branch #2	0.89	1915
Remy Chandler Inter Br. 2,3,4, Moore	9.66	1914
Remy Chandler Intercounty Br. #3	0.86	1915
Remy Chandler Intercounty Br. #4	0.88	1915
Roosevelt	0.62	1904
Sleight	2.90	1880
Somerset Park		2003

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Clinton County–continued		
• *Bath Township–continued*		
S. Looking Glass (Vermillion Crk)		
Sunrise Commons	0.36	1999
Timber Ridge	0.38	
Timber Ridge Branch #1		
Tyler Subdivision	0.13	1993
Whitehills Lakes North and Branches	1.53	1990
Whitehills Woods North	0.68	1997
• *DeWitt Township*		
Arbor Meadows	1.56	2001
Atlantis Campus and Branches		2001
Balduf and Lietzke	1.43	1919
Big Horn and Branches	5.30	1871
Blue Spruce	0.35	1988
Bopps and Branches #1,2,3	0.87	1940
Burke	0.58	1929
Carter and Burke	0.58	1988
Clark Tile	0.68	1954
Cooper and Branches	4.62	1930
Cortright	1.10	1920
Creekside	0.75	1997
Creeping Brook Estate	0.56	1992
Creyts Dr., Br. of Reynolds Inter	1.21	1871
Crossing Place Coleman Road	0.26	2000
Cushman and Zeeb	0.97	1990
Clemons		1891
DeWitt Four Seasons	0.54	2000
DeWitt Village Drain	0.14	1925
Downer and Branches #1 and 2	1.86	1922
Dunham	1.71	1917
Duxbury Br. of Br. 2 of Reynolds	0.46	1991
Edwards Intercounty and Branch		1907
Edward Fill	1.96	1919
Eichele	0.38	1918
Faiver and Branch	2.26	1948
Florence Street	0.43	1940
Foreback Intercounty	0.49	1921
Hannah Avenue	0.31	1957
Hawthorne Woods, East	0.46	1998
Haze (transferred to City of Lansing)		1895
Herbison Road	0.64	1975
Clinton County–continued		
• *DeWitt Township–continued*		
Heritage Glen	1.30	1998
John Voltz		1917
Jones Br. of Reynolds Intercounty	2.77	1973
Jones Br. of Reynolds, Br. #1	1.11	1988
Jones Lake Intercounty	0.11	1942
Keilen Branch, Dunham		1905
Looking Glass Pines	0.28	1988
Loesch	2.21	1914
Loesch Sanitary Sewer		2003
Long and Branches	0.70	1975
Maktech and Branches		2003
Melvin	4.13	1871
Melvin Branch #1		1905
Moore Br. of Remy Chandler	1.37	1921
Moots	0.68	1945
Nelson Br. of Wieland Rd. Br.	0.11	1999
Northdale	0.43	1926
Northway Partnership and Branches		2001
Northway Pines Apt.	0.31	1997
Norway Pine and Branch	0.26	1996
Oakland Hills No. 3 and 4	0.79	1995
Old Hickory	0.50	1975
Olive, Bath, Dewitt		1882
Parkwood and Branches	0.57	1975
Prairie Cr. & G. L., Business Pkwy	0.13	1991
Prairie Cr. & Gunderman Lk. (Lower)	2.11	1915
Prairie Cr. & Gunderman Lk. (Upper)	3.95	1880
Prairie Cr., Northway Dr. Branch	1.32	1991
Prairie View		1976
Quail Run	0.26	1988
Remy Chandler Inter Br. 2,3,4, Moore		1914
Reynolds Intercounty	4.03	1871
Reynolds, Jones Branch		1871
Ridge Rock and Branches		2004
Rouse		1888
Saffron Hills and Branches	1.87	1997
Sanderson Br. of Remy	0.85	1914
Schultz and Branches	1.08	1975

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Clinton County–continued		
• *De Witt Township–continued*		
Sheridan Rd. Intercounty	0.34	1959
Springbook East	1.66	1998
Springbook Hills	1.53	1994
Sycamore and Branch	0.36	1975
Turkey Creek		1866
Twinbrook	1.14	
Valley Road	4.00	1945
Wimple		1870
Windy Ridge	1.03	2000
• *Olive Township*		
Alpine	0.83	1901
Ambrus Smith and Branches	0.82	1914
Ives and Branches	5.05	1881
John Voltz	1.73	1917
Looking Glass River Intercounty		1944
Olive, Bath, DeWitt	0.98	1882
Rouse	1.59	1888
Schoals	0.95	1912
See	2.31	1882
Turkey Creek (Neuman)	3.52	1866
• *Watertown Township*		
Adams	0.39	1881
Aldrich	2.07	1887
Andrus (Brooks)	0.92	1914
Boylan	0.52	1887
Branch of Derham		1877
Brooks (Andrus)		1883
Buehler	0.26	1903
Carter and Burke		1988
Cutler and Extension	1.59	1880
Demmer and Branches		2002
Derham Extension	1.62	1877
Derham, Frank J. Noble Br.	0.30	1877
Edwards Extension	0.49	1992
Edwards Intercounty and Branch	3.27	1907
Faiver and Branch		1948
Felton	1.02	1882
Flyjing		2003
Foster	0.17	
Garlock	1.28	1880
Hill	0.20	1878

Drain	Length (mi)	Est.
Clinton County–continued		
• *Watertown Township–continued*		
Hill Branch of Creyts	0.39	1878
Hogle	0.95	1874
Husted and Landenberger Intercounty		1879
Industrial Parkway	0.56	
Ingersol	2.13	1878
Lakeside Preserve		2002
Maier and Garlock	1.34	1888
McRoberts	1.17	1878
Moon		1882
National Parkway	0.31	1998
Newton	0.75	1890
Openlander and Branches	1.21	1918
Pierce Ditch	1.99	1880
Rall and Watson	0.76	1883
Reeve	0.68	1884
Rhine	1.04	1901
Rosewood Hills-North		2001
Shattuck		1884
Somerset Hills		2003
Stace	1.44	1881
Summers	5.49	1899
Summers Tile	0.58	1922
T&R Investments	0.03	2001
Tate	0.43	1880
Waldo #2 & Branches Intercounty	0.79	1888
Waterfront Farms	0.12	1996
Watson and Summes	1.78	1893
Wilcox	1.31	1903
William M. Smith	1.35	1919
Wood (Shattuck)	0.83	1879
• *Westphalia Township*		
Colby and Browning Intecounty		1945
Fedewa Intercounty	0.70	1947
Kramer	7.67	1877
Leik	0.90	1880
McCausey Inter and Branches	0.95	1921
Pasche Intercounty	0.38	1877
Purcell Intercounty		1945
Stinson	2.11	1871

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Ionia County		
• *Danby Township*		
Alleman	1.21	
Alleman and Hartz	0.30	
Big Swamp	2.00	
Brokow	0.80	
Carroll and Branches	1.80	
Codding	0.22	
Cornell Branch of the Halladay	0.36	
Cryderman Lake	1.50	
Doolittle	1.40	
Doolittle and Davids	3.20	
Doxie and Wells	1.10	
Gardner and Hiar	2.50	
Geer and Culver and Branch	2.90	
Ginnebaugh	2.00	
Guilford	0.50	
Hale and Post	0.10	
Halladay	1.10	
Hart and Branch	0.87	
Horner and Pryor	2.30	
Hughs and Taylor and Branches	0.40	
Lunn	0.68	
Mud Creek	0.60	
Parker and Extension	0.66	
Potter and Mulliken	0.20	
Pryer and Gore	1.60	
Sebewa Creek	2.00	
Stambaugh	0.70	
Stiffler	2.00	
Thornberry	0.20	
Way and Weld and Branches	1.70	
Wood and Monroe		
• *Sebewa Township*		
A. M. Ralston	1.40	
Aves and Olry and Branch	2.30	
Bliss and Cooper	1.00	
Bliss and McClelland	3.80	
Gunn and Kenyon	0.45	
Gunn and Luscher	1.70	
Gunn and Ramsey	4.30	
Gunn and Ramsey Branch 1	1.00	
Jolly Carbaugh	0.80	
Ionia County–continued		
• *Sebewa Township–continued*		
King and Wolcott and Branch	1.50	
Lippincott		
Miller and Campbell	0.40	
Ramsey and Ingalls	1.30	
Relief		
Rogers and Troub	1.90	
Sweet and Samaine	2.60	
Sweet and Samaine Branches	1.70	
Wilson and Pumfrey	1.60	
Webber and Love and Branches	1.00	
• *Portland Township*		
Balderson and Extension	2.31	
Balderson Branch No. 1	1.81	
Barnes and Barber	1.50	
Colby and Browning	5.06	
Fedewa	0.20	
Horner	1.00	
Knox and Dilley	1.30	
Leik and Knox	1.01	
Pasche	2.30	
Purcel and Branch	0.63	
Rogers and Arms	2.50	
• *Orange Township*		
Rogers and Arms		
• *Lyons Township*		
Pline and Toan	0.80	
Shiawassee County		
• *Antrim Township*		
Alling	2.4	1947
Arnold & Hill	2.4	1941
Atherton	2.9	1919
Beard	3.8	1908
Beard & Fuller	1.2	
Bristol	0.6	1909
Colburn & Keeder Joint	5.4	1940
Cox	2.3	1914
Griffeth & Morgan	1.8	1919
Jordan	0.9	1894
Lake & Antrim	1.9	1920
Lewis	1.4	1914
Morgan Lake	1.3	

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle –continued		
Shiawassee County–continued		
• *Antrim Township–continued*		
Peck & Clay	1.4	1943
Proudfoot	2.2	1942
Reed (Antrim Township)	1.9	
Skinner	1.7	
Stone & Main	0.6	1908
Tucker	1.8	1908
Whaley	0.2	1910
• *Perry Township*		
Bennett	1.7	1906
Blanchard #2	0.8	1942
Blanchard & Extension	1.7	1899
Brandt & Hallock	0.7	1936
Britton	1.6	1931
Bucher	2.0	
Buck Branch (Tile)	2.9	1903
Buck Extension #2	1.5	1903
Bush	1.0	
Devore	1.1	1912
Grubb & Extension	3.6	1937
Hart #2 Joint	0.7	1926
Hasford	0.8	1920
Hasford #2	1.0	1914
Jackson	2.6	1946
Locke	1.0	1915
Looking Glass River Joint, South Branch		
McCrea Joint	1.0	1927
Millet	1.2	1929
Perry	0.5	1887
Perry #2	6.0	1915
Pickerel Lake	2.9	1928
Piper	0.6	1898
Polhemus		
Rothney	1.0	1912
Smith #3	1.6	1888
Spaulding	2.3	1903
Williamston, Locke & Perry Joint	2.3	1907
Wolfe Creek Joint	7.3	1894
• *Shiawassee Township*		
Bowles & Obert	7.0	1937
Derr	0.9	1942
Shiawassee County–continued		
• *Shiawassee Township–continued*		
Hunt & Ackley	2.3	1919
Jennings #2	2.7	1901
Josenhans	1.2	1909
Looking Glass River	10.2	1938
Obert	2.6	1893
Perry Township	0.8	1887
Warren Case (Case No.2)	0.5	
• *Woodhull Township*		
Brundidge Joint	1.5	1911
Corcoran	2.1	1903
Daft	1.5	1918
Dunham	0.7	1922
Jones & Dunn	4.3	1939
Partridge Joint	0.8	
Randall Joint	2.0	1940
Shaftsburg	0.4	1912
Shaw Extension Joint	4.2	1908
Spaulding Joint	0.8	1916
Woodhull Highway	0.3	1908
Eaton County		
• *Delta Township*		
Allison Heights	1.49	1988
Arden and Maycroft		
Armstrong Hills	1.34	1998
Ashford Manor	0.52	2001
Bank Intercounty	2.72	1907
Benjamin	1.52	1892
Bollman and Daman		1919
Bretton Woods and Branches	1.30	1944
Briggs Intercounty	3.80	1883
Brookside (Orphan Drain)		
Burrell Intercounty	0.17	1962
Burt Road	0.30	1985
Cambridge	1.07	1988
Carrier Creek	7.47	1878
Carrier Creek Condos (Orphan Drain)		
Century Commerce Branch	1.27	1989
Colt Meadows (Orphan)		
Countryside Estates Branch	0.87	1987
Dann	2.51	1888

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Eaton County–continued		
• *Delta Township–continued*		
Decke	1.50	1888
Delta Center Drain (Orphan Drain)		
Delta Mills (Ingersoll)	0.36	1888
Delta Mills and Willow Highway Br.	0.60	1972
Delta Section 17 and Branches	2.35	1907
Dornet Branches	0.98	1970
Dutch Hill Farms Branches	0.29	1980
Earlington	0.54	2000
Edwards Intercounty	2.89	1906
Evergreen Heights/Broadbent Woods	1.49	1995
Forest Glen	0.61	1992
French Creek	0.21	1993
Garfield Avenue	0.59	1949
Garfield Avenue and Branches	1.28	1963
Garlock and Foster	2.00	1917
Garlock and Foster Branch 1 (Arden)	0.58	1917
Gettysburg Branches (Orphan Drain)		
Gettysburg Estates (Orphan Drain)		
Gettysburg Farms (Orphan Drain)		
Grand River	0.84	1876
Grand Woods	0.88	1991
Greenfield Acres	1.45	1950
Halloway (Orphan Drain)		
Haner	0.14	1888
Harriett Avenue	1.04	1950
Haze Intercounty	3.34	1894
Hazel	0.94	1927
Henderson	0.69	1909
Holly	2.12	1889
Homestead Acres (Orphan Drain)		
Irvingdale Acres	0.21	1956
Lantern Green Branches	0.57	1972
Laurelwood	0.44	1996
Lazell	7.19	1908
Lee	1.80	1894
Lora Intercounty	0.93	2000
Maycroft Road	0.02	1956
McCalpin	0.53	1893
Eaton County–continued		
• *Delta Township–continued*		
Michigan Ave. and Branches 1-6	4.15	1965
Michigan Ave. and Branch 7	0.33	1989
Michigan Avenue Branch 8	1.88	1990
Michigan Avenue Branch 9	1.50	1990
Miller	2.10	1912
Miller Branch (Orphan)	0.11	1972
Miller Crk. (Myers and Henderson)	2.73	1987
Moon and Hamilton	0.64	1895
Morgan Creek Drain	0.57	1997
Myers and Extension	2.69	1890
Myers and Henderson Overflow	0.45	1987
Neller Intercounty	0.33	1894
Nixonburg Hills Branch	0.49	1987
Oak Park	1.08	1946
Oak Ridge	0.61	1992
Old River Trail (Orphan)		
Player's Club Drain	1.11	1997
Price	0.08	1974
Relocated Watson Branch 1	1.15	1963
Renker Road	0.61	1938
Riverbend Estates (Orphan)		
River Ridge	0.30	1967
Saratoga	0.40	1964
Shenandoah	0.75	1993
Sherwood Downs (Partial Orphan)		1964
Sherwood Forest	1.21	1972
Shreve	0.46	1979
Silver Ridge	0.42	1988
South Branch Carrier Crk and Relief	4.29	1999
Stony Brook Farms Branch	0.78	1987
Sunshine Gardens	0.32	1942
Teckwood	0.21	1993
Theo Avenue	0.32	1956
Towar Drain and Branches	2.60	1893
Upton (Sections 16 and 17 Delta)	1.68	1913
Vanderwalker	0.43	1883
Verndale Branch	0.41	1974
Waldo No. 2 Intercounty & Branches	2.48	1888
Wal-Mar	1.12	1990
Warren	0.17	1894

Table 24.–Continued.

Drain	Length (mi)	Est.
Middle–continued		
Eaton County–continued		
•*Delta Township–continued*		
Watson and Relocated Watson	3.05	1888
Watson Branch No. 1	1.72	1915
Wellington Fields	0.51	1998
Westland Park and Branches	1.92	1989
Weston and Branches	1.82	1994
Westridge (Orphan Drain)		
Williams	1.45	1892
Williamsburg	1.09	1983
Willow Cove	0.50	1996
Winans Intercounty	0.27	
Windcharme Branches	1.18	1990
• *Oneida Township*		
Allen Rice	0.90	1897
Bellaire Hills (Orphan)		
Big Tree Branch	0.09	1988
Bigelow	0.60	1884
Blasier	0.69	1914
Bond	1.71	1873
Brunger	1.53	1883
Deer	1.38	1921
Disbrow	0.40	1882
Fieldstone Farms	0.33	1995
Fleming	2.55	1883
Fred Feess	1.29	1889
Glenn	2.44	1884
Grand Ledge	0.17	1934
Grand Willow (Orphan)		
Guilford	0.37	1885
Hiesrodt	0.63	1909
Holmes	2.34	1870
John Earl and Extension	5.32	1882
Johnson	3.02	1883
Lumbert	0.55	1948
Maywood	0.56	1954
McMullen and Branches	3.39	1883
Miles Earl	0.32	1885
Mitchell	0.55	1885
Moon	0.78	1911
Patterson and Dubois	3.14	1870
Porter and Extension	3.98	1869
Reed	1.16	1882
Eaton County–continued		
• *Oneida Township–continued*		
Reed (Original Tile)	0.93	1882
Russell	0.45	1922
Saginaw Street	0.41	1951
Sattler	0.32	1889
Southerland	0.93	1913
Star Tile (Astley) Intercounty	1.40	1890
Sweetwater Pines	0.23	1988
Tanner	0.30	1885
Upright	0.25	1885
Waldo and Branch		1912
Watson No. One	1.08	1883
Whitney	1.00	1883
Willow Hills Branch of Waldo	0.88	1989
Woodview Estates	1.42	1994
• *Roxand Township*		
Baird	0.39	1877
Bell and Allen	0.85	1912
Big Swamp Intercounty	2.02	1902
Carroll Intercounty	1.80	1917
Cook	0.94	1870
Cross	1.76	1891
Cryderman Lake Intercounty	1.62	1902
Fisher	0.79	1919
Fults (and Relief)	1.47	1912
Guinan and Extension	2.82	1884
Hale and Post Intercounty	0.63	1917
Hart Intercounty	1.80	1951
Hilliker	1.83	1870
Horton	0.64	1891
Hoytville Extension (Center Drain)	0.99	1876
Hoytville Tile	0.81	1894
Mead	1.70	1869
Merryfield	1.36	1914
Mud Intercounty	3.19	1917
Mulliken and Extension	0.69	1894
Murphy	1.70	1912
Nickle	2.09	1870
Parker	4.47	1869
Parker Tile	0.57	1892
Parker Intercounty Extension	1.16	1945
Peabody	0.64	1919

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Middle–continued					
Eaton County–continued			*Eaton County–continued*		
• *Roxand Township–continued*			• *Sunfield Township–continued*		
Potter	0.60	1892	Clark	0.20	1883
Potter and Mulliken	0.39	1902	Dellwood	2.34	1883
Potter and Mulliken Intercounty	0.47	1916	Downing	1.10	1892
Pratt	1.40	1875	Doxie and Extension	3.44	1883
Randall	0.65	1911	Freemire	1.70	1916
Roxand Section 10	0.23		Gragg	1.51	1926
Savage	1.80	1872	Pratt (Bismark)	2.06	1880
Sebewa Intercounty	9.48	1902	Pratt Branch and Cheal	1.14	1920
Snyder and Walker Intercounty	1.17	1914	Reeder	2.21	1884
Spore (Crane)	1.90	1877	Shaytown	4.76	1910
Taylor	1.50	1898	Sunfield Section 27	2.54	1908
Thomas	1.21	1878	Thomas	3.02	1922
Wonser			Thorp	0.61	1917
• *Sunfield Township*			Thorp (Doxie Branch 1)	0.34	1893
Chamblin	0.86	1903	Winchell and Union	9.57	1871
Chatfield	0.70	1917			
Lower			Lower–continued		
Eaton County			*Eaton County–continued*		
• *Eaton Rapids Township*			• *Eaton Township*		
Bennett	0.33	1891	Ackley	1.13	1919
Broughton	0.93	1890	Allen	1.60	1886
Clark	0.60	1888	Autumn Woods	0.56	1998
Crandall	1.47	1894	Beaver	1.28	1880
Gruesbeck	2.87	1883	Butternut Creek	3.43	1870
King	3.52	1869	Byron	0.93	1875
Milbourn	2.18	1881	Byron Relief	0.37	1972
Youngs	1.73	1914	City Line and Branch		1871
• *Windsor Township*			Crane	2.30	1870
Almond	0.41	1892	Cummings and Branch	2.48	1883
Carlton	1.14	1897	Dale	0.21	1887
Divine	0.60	1893	Davis	0.41	1887
Fox	0.34	1924	Duffy and Extension	3.06	1882
Getter (Little) and Branch	1.16	1909	East Byron	1.26	1894
McPhee	0.25	1915	Eddy	0.60	1899
Robinson	0.16	1891	Flynn	0.86	1879
Treat	0.50	1892	Garber	0.79	1900
Zimmerman	1.08	1906	Garvey	2.12	1883
• *Delta Township*			Groak	0.98	1891
Barnes		1898	Hall	0.75	1886

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Eaton County–continued		
• *Eaton Township–continued*		
Hart	0.10	1878
Higby	1.93	1886
Howard	0.35	1889
Lamont	0.74	1876
Lamont Branch No. 1	0.13	1990
McClintic	3.44	1891
Medicare Storm	0.62	1964
Milbourne East Ext. and Branches	3.30	1881
Milbourne West Ext./Southworth	2.94	1876
Mott	0.24	1995
Munson	3.23	1903
Robinson	1.93	1885
Sanstone Branch (Wilcox)	1.05	1909
Section 7 Eaton	0.40	1901
Tillson Branch	1.08	1870
Township Claflin	1.63	1906
Wilcox	0.90	1909
• *Benton Township*		
Abel	1.99	1888
Brubaker	0.80	1890
Burked (Burkhead) and Branch	2.60	1878
Carman	2.64	1904
Cemetery	0.92	1890
Church	2.29	1891
Churchill	1.40	1913
Claflin	4.02	1890
Fast	2.48	1907
Hamill and Extension	2.33	1875
Hayes	4.36	1886
Holmes	0.24	1886
Horace	2.32	1891
Horner	0.52	1934
Hulett	0.22	1894
Huston	0.32	1934
Kinnie	1.00	1900
Leisher	1.74	1899
Lett	0.42	1893
Lock and Extension	1.70	1891
Lock Branch No. 1	0.76	1912
Loehr	0.76	1894
Merrill	0.42	1912

Drain	Length (mi)	Est.
Eaton County–continued		
• *Benton Township–continued*		
Mitchell	2.01	1892
Newell	0.68	1888
Old Maid	2.09	1877
Palmiter	1.06	1886
Phelps	1.67	1887
Phelps and Horner	0.25	1874
Potter and Extension	2.61	1909
Potterville	1.85	1926
Quantrell	1.09	1886
Sharp	4.33	1890
Shrontz and Extension	2.64	1868
Swan	0.97	1918
Thomas	2.43	1909
Thornapple and Extension	6.83	1874
Thornapple and Old Maid	1.29	1925
Walsh	2.19	1891
• *Oneida Township*		
Austin	1.07	1950
Clay Branch of Maxson	0.38	1882
Edwards and Smith	2.56	1916
Gear Branch of Maxson	0.51	1882
Glen No. 2	1.85	1888
Lunor Branch	0.32	1882
Munton	2.64	1897
Oneida Section 29	0.50	1908
Pardee	0.66	1892
Skinner	1.60	1882
Watson No. 2	1.60	1873
Wright	1.61	1869
• *Chester Township*		
Barhyte	1.65	1908
Beaver	1.71	1887
Big Thornapple	18.90	1901
Blair	0.99	1867
Bradley	0.84	1919
Brightly (Mitchell)	2.20	1878
Bursley	1.81	1912
Conklin (Densmore) Branch	0.30	1964
Darken	4.82	1902
Fergerson	0.75	1916
Grooms	2.03	1921

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Eaton County–continued		
• *Chester Township–continued*		
Harmon (Moon)	2.33	1871
Harrington	1.78	1911
Helms	4.93	1867
Jennie Marsh	0.79	1883
Lamie	1.31	1912
Little Thornapple	4.72	1894
Maxson and Extension	4.40	1868
Needmore and Branch	1.05	1914
Perkins (Davis)	2.24	1886
Santee	1.76	1951
Shaw	0.49	1916
Walker	0.43	1941
Wells	0.48	1901
Wheaton	0.90	1889
Youngblood	0.33	1917
• *Carmel Township*		
Ash	1.03	1919
Baker	5.60	1887
County Farm	1.05	1900
Davis and Extension	1.11	1917
Densmore	2.58	1867
Fish Creek	2.10	1902
Grier and Extension	1.49	1893
Harmon	1.03	1899
Holden	4.44	1888
Hutchings	0.62	1957
King	3.75	1885
Pollard	0.94	1867
Roberts	0.82	1868
Tice	1.43	1884
Trumbull	2.53	1869
Wile	0.22	1893
Wonser	0.59	1917
• *Roxand Township*		
Bobier	0.71	1899
Borton	0.85	1922
Bosworth	1.08	1946
Boyer	3.19	1869
Boyer and Branches	2.14	1912
Codding	1.41	1876
Cole	0.41	1890

Drain	Length (mi)	Est.
Eaton County–continued		
• *Roxand Township–continued*		
Davis (Austin)	0.95	1872
Doxtater	1.90	1870
Figg	0.83	1908
Fowler	3.48	1880
Green	0.78	1911
Haddix	0.39	1892
Hoag		1905
Hosey	1.33	1910
Litchfield	0.66	1910
Miller		1878
Moyer	0.84	1910
Rimmel and Overflow	2.21	1905
Root	0.60	1877
Spitser	0.70	1896
Vickery (and Hoag)	2.61	1870
Wheaton	0.91	1878
Wheeler	1.23	1907
Wright	0.38	1869
• *Vermontville Township*		
Aldrich	1.25	1944
Andrews	0.34	1928
Barrett	2.93	1916
Big Thornapple Intercounty Ext.	5.58	1903
Grant	4.02	1901
McLaughlin and Extension	1.25	1945
Powers and Extension (Lacey Creek)	6.79	1916
Shanty Brook	4.58	1880
Thompson	2.97	1870
Vermontville Section2	1.70	1907
Ward	4.00	1914
• *Bellevue Township*		
Branch One of Gayton Drain	1.90	1901
Harpster	0.74	1920
Palmer	2.17	1876
Seitler	2.41	1885
• *Kalamo Township*		
Babcock	0.48	1886
Barnhart	1.45	1886
Bradley and Extension	1.19	1884
Bowen	0.40	1887
Brown	0.81	1887

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Eaton County–continued		
• Kalamo Township–continued		
Brundige (Mason)	3.01	1877
Colton	2.45	1886
Corsett	0.41	1888
Dean		1877
Eaton		1894
Fairfax	2.29	1877
Fowler	3.18	1892
Gage	2.72	1867
Gayton and Extension	3.63	1876
Gridley	2.84	1899
Hill and Branch	3.43	1893
Horr	1.08	1890
Hurd	0.33	1890
Kalamo	0.28	1876
Kelly	0.38	1898
Kenyon	0.77	1885
Lacey Lake		1886
Lenic and Branches	0.85	1961
Mast	1.55	1891
Masten	0.55	1915
Mead	0.58	1886
Merriam	1.35	1884
Merritt	0.16	1884
Miles	0.45	1926
Miller	1.68	1884
Mix	1.91	1890
Nelson and Gould	0.30	1872
Nye	4.00	1884
Pinnock	0.79	1884
Powers (and Link)	1.32	1884
Quaker Brook Intercounty	5.72	1948
Reuben	0.30	1886
Roach	0.59	1892
Rouse	0.15	1891
Scott	0.44	1884
Shanty Brook (Hayon Creek)	3.19	1904
Shepard	2.01	1887
Swift	0.72	1886
Tarbell	0.21	1892
Wilcox	0.28	1891
William Mason	0.52	1892
Eaton County–continued		
• Kalamo Township–continued		
Wilson	1.90	1885
• Sunfield Township		
Barry and Eaton Intercounty	7.29	1891
Burns	2.55	1905
Burns Branch	0.36	1881
Burns Village Extension	1.01	1915
Childs	2.95	1890
Collier and Mud Creek Intercounty	17.51	1878
Day	0.35	1896
Dell Intercounty	2.02	1892
Dolan Branch	0.43	1918
Dooling (Hager Creek)		1890
Edwins	0.75	1882
Frantz	0.41	1918
Fryfogle	0.73	1894
Haddix	2.50	1882
Hunter	1.53	1883
Kinnie Brook	2.28	1915
Lundquist	1.08	1914
Magden	1.91	1905
Mud Creek Intercounty	1.38	1899
Ramsey	0.44	1892
Riley Intercounty		1882
Second Lake Intercounty	2.14	1915
Shellhorn and Reahm Intercounty	0.28	1914
Stemler	0.77	1892
Sunfield Section 9	2.06	1907
Swick	1.08	1915
Tomlinson	1.53	1883
Willis J. Torpy Intercounty	2.09	1903
Woodbury Village Intercounty	0.45	1945
Ionia County		
• Lyons Township		
Clinton and Ionia	1.60	
Cook	1.90	
Kings	0.50	
• North Plains Township		
Bonnie Moor and Branches	2.30	
Clark and Welch	2.60	
Conner	1.00	
Couzzens Br. of Clark and Welch		

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Ionia County		
• *North Plains Township–continued*		
Dalton	1.82	
Fahey Extension	1.00	
Hack and Keary and Branch	2.20	
Hogan	1.00	
McClennon and Decker and Branches	2.96	
O'Brien Branch of Clark and Welch		
Ross and Branch	2.10	
• *Ionia Township*		
Bentley	0.50	
Burbank and Cheeney	1.40	
Chamberlain	1.20	
Ellis	2.00	
Glostrick and Janes	3.80	
Glostrick and Raymore	0.80	
Kelsey	1.50	
Libhart Creek	0.64	
Sturtevant	0.30	
Townsend and Adgate	1.40	
Townsend and Loveland	0.56	
Tuttle and Whitmore	0.80	
Vanfunk		
Whiting	0.50	
• *Sebewa Township*		
Ames	0.70	
Bainbridge and Figg	1.00	
Castle and Branches	0.90	
Coe	0.70	
Collier and Mud Creek	3.50	
Combination	1.40	
Daniels Branch	1.20	
Downing	0.80	
Earl Rogers	1.40	
Fishell and Lunger	1.10	
Fletcher and Warring	1.10	
Gibbs & Matthews Br. of Carbaugh		
Guy Branch	0.60	
Hall and First	0.60	
Hall and Ingalls and Branches	4.40	
Hastings Extension		
Heintzleman Extension and Branches	5.70	

Drain	Length (mi)	Est.
Ionia County–continued		
• *Sebewa Township–continued*		
Hugh and Baird	1.80	
Johnson Extension		
Knoll and Kneale	2.80	
Koutz	3.50	
Leak Branch No. 9	0.30	
Leon Haddix	0.56	
McNeil Branch		
O. N. Stout	1.80	
Oatley Extension	2.40	
Smith	0.50	
Snyder and Walker	1.20	
Sunfield Br. of Bliss & McClelland	0.13	
Treece No. 2	0.66	
Webber		
West Branch of Knoll and Kneale	1.40	
Willis J. Torpy	0.80	
• *Orange Township*		
Carbaugh and E. Libhart Creek	10.60	
Churchill	0.70	
Darling Br. of Smith and Jordan	1.60	
Fishell and Lunger		
Green	0.57	
Hall and Lawless	0.60	
Hausserman Branch		
Knoll and Kneale		
McCoy	2.12	
Milstead	0.50	
Orange Combination		
Prosser	0.70	
Rowe and Hall	1.80	
Shook and Rowe	6.10	
Smith and Jordan	1.60	
Townline and Libhart Creek	5.00	
Townsend and Peckins	1.30	
Wright		
Wright and Dunsmore	0.90	
• *Ronald Township*		
Curtis and Trowbridge	2.10	
Ionia, Boston Ronald & Orleans		
Prairie Creek	0.53	
Pray and Smith	2.00	

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Ionia County–continued		
• *Ronald Township–continued*		
Spectacle Lake	0.40	
• *Easton Township*		
Andres	1.30	
Bowen	1.20	
Bradford Tile	0.33	
Branch No. 2		
Bricker and Branches	6.00	
Calkins Tile	0.20	
Conner and Bush	1.00	
Dake and North	0.10	
Easton Highway		
Edlin	2.60	
Hile and McPherson	0.60	
Holmes and Spears and Extension	2.70	
Hull, Snell, McKendry and Branches	7.40	
Hunt	0.20	
Ionia, Easton Ronald & Orleans	3.70	
Jackson Branch of Holmes and Spears		
Parmenter	0.20	
Peterson and Meyers	0.60	
Sanford A. Yeomans	0.40	
Slaybaugh	0.90	
Tingley	0.30	
Werner and Branches	2.65	
Wormsley	2.63	
Yeomans and Inman		
• *Orleans Township*		
Brenneman Br. Of Holmes and Spears	0.83	
Chickering Branch	1.54	
Green Lake	0.70	
Holmes and Spears		
Houghton and Hoppough	1.20	
Hurd and Kneeland	1.90	
Hurd and Wheeler		
Jackson	3.70	
Palmer		
Parmeter Br. Houghton & Hoppough	1.10	
Smith and Clifford	1.30	
Ionia County–continued		
• *Berlin Township*		
Ainsworth and Slownski	2.36	
Allen and Grimwood	1.30	
Amon Otis	2.00	
Badgley	1.50	
Bennett and Branches	2.30	
Chapple and Rudd	1.60	
Crane Branch		
Four Town	1.10	
Houserman and Seiler	0.22	
Loomis and Branch	1.00	
Lowrey and Sherwood	2.50	
Lowrey and Hubbard and Branches	5.60	
Lowrey and Hubbard Branch No. 1	1.12	
Magee and Hunter	0.70	
Morrison and Hartwell		
O'Bierne	0.44	
Peacock	4.80	
Peacock Branch No. 14	1.00	
Potter Branch of Lowrey	0.60	
Powers	1.00	
Sherwood and Branches	1.50	
State and Fisher	1.20	
State Rd.		
Topp		
Young		
• *Boston Township*		
Barber	0.40	
Boston and Campbell	3.08	
Burr	0.60	
Fahrni	1.20	
Gould	2.20	
Morrison Lake	1.00	
Sargent	0.30	
• *Keene Township*		
Campbell and Ayers	0.77	
Carr	0.50	
Covert and Lee	0.40	
Fisher and Campbell	0.92	
Gibson Branch of Bricker	2.30	
Hull, Snell, McKendry & Br. No. 2	0.33	

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Ionia County–continued		
• *Keene Township–continued*		
Jacoby	1.80	
Kennedy and Converse	0.80	
Kohn	1.00	
Lampkin and Branches	3.10	
Lucas and Irwin	3.60	
Vanderlip	0.20	
Welch		
• *Otisco Township*		
Belding and Branches	0.80	
Benedict and Kohn	1.80	
Benton	1.10	
Blassen and White	1.10	
Davis and Purdy	0.80	
Ranney Village		
Ruh	0.80	
Snow and Branches	2.20	
West Branch of Bricker	1.80	
Zahm Rd. Br. of Bricker		
• *Odessa Township*		
Anway	0.65	
Baker	1.10	
Barkdull and Davidson	2.61	
Beach and Olmstead	1.00	
Bippley and Moe	2.60	
Black Creek	4.00	
Bliss	0.80	
Branch No. 29	0.60	
Brisbin and Village	0.66	
Buche	1.00	
Cooley and McMullen	1.30	
Counter	1.50	
Crane and Doxie	3.54	
Curtis	2.60	
Eldridge	0.60	
Fox	0.80	
George Catt	0.90	
Getz	3.80	
Johnson	2.00	
Kingman	11.00	
Klingman and Jarstfer	2.20	
Koutz		
Ionia County–continued		
• *Odessa Township–continued*		
Lepard	0.70	
Majinski and Koutz	1.29	
Mallison and Branches	1.00	
McClelland Branch		
Merrell	2.60	
Mud Lake	2.40	
New Bippley and Moe		
Nye and Stairs	2.00	
O'Mara	1.19	
Pan American	2.50	
Patrick	1.20	
Peacock		
Reahm and Lepard	1.00	
Root and Culp	2.30	
Shellenberger	3.62	
Shellhorn and Reahms and Branches	6.90	
Shilton	0.75	
Strickland Branch of Shellenberger	0.64	
Stuart and Olmstead	1.80	
Tupper Creek	3.00	
• *Campbell Township*		
Allarding	1.80	
Black Creek		
Bond	2.40	
Brake and Preston	1.00	
Burt and Norcutt	1.10	
Clarksville	0.40	
Clum	2.00	
Dewey and Branch	0.50	
Fehely and Extension	0.30	
G. Richardson		
George Long	0.60	
Griffith and Minard		
Jackson and Mote		
Kart and Winey	2.42	
Klahn-Scoville and Branches	4.00	
Levi Braendle	1.10	
Lovewell and Winey	3.80	
Mallison and Branches		
Peddler Lake	1.33	
Post	0.70	

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Ionia County–continued		
• *Campbell Township–continued*		
Robbins-Tasker	0.40	
Rolloff	0.10	
Rosenberger	0.80	
Smith and Bachelder	0.50	
Stadel and Mote	0.60	
Strong and Snobble	1.00	
Strong, Blough and Brundage	1.80	
Stuart and Green	2.20	
Studt and Clemens		
Tyler Creek	6.02	
Vetter and Wise	0.60	
White	2.20	
William and Livingston	1.50	
Williams and Grey	0.50	
Wolford and Moore	0.40	
Clinton County		
• *Victor Township*		
Alder Creek Intercounty		1880
Ashley	2.21	1894
Arthur		1898
Bixby	0.78	1895
Black and Green	1.97	1896
Cutler and Walker		1906
Lake Victoria Branches		2001
Manley Hunt		2001
Montague	1.10	1906
South Maple, East Branch	2.79	1906
South Maple and Branches		1882
Throop	0.34	1882
Underhill (Sec. 15,16)	0.38	1910
Underhill (Sec.8,17)	1.56	1927
Victor Highway	0.85	1911
Wolfrom Branch of the Throop		2001
William D. Hall		1919
• *Ovid Township*		
Acre	1.04	1884
Alder Creek Inter Ext. (N of lake)	9.27	1921
Alder Creek Inter Ext. (S of lake)		1880
Arthur	1.30	1898
Baker	1.14	1892
Beaver Dam	1.61	1899
Clinton County–continued		
• *Ovid Township–continued*		
Beeman Intercounty	0.51	1916
Carnes	0.98	1892
Clark Ellis	0.96	1884
Cutler and Walker	3.84	1906
Dean and Dean Extension	2.26	1885
Duncan Levee Dike		1887
Faragher	1.02	1884
Gibbs	0.21	1883
Gill	0.63	1897
Gleason	0.39	1884
Gutshall and Norris	0.44	
Hazel		1883
Henderson	0.69	1909
Hicock (Nicholas)	4.30	1881
Hunter	0.60	1893
Janes	0.43	1884
John Gill		1909
Jury #99 and Branch	2.37	1942
Kidd	1.74	1903
Kosht	1.08	1884
Lester	2.10	1885
Lewis Kisby (Kesby)	0.26	1886
Maple River Intercounty	16.14	1905
Munsil and Jackson Intercounty	1.66	1884
Munson (Ovid)	0.17	1884
Oliver Fish and Branches 1 and 2	2.00	1919
Ovid and Duplain		1891
Ovid Village Intercounty	0.96	1910
Potter	0.57	1950
Putman	1.07	1883
Reed	0.82	1883
Shepard and Extension	6.63	1870
Simpson	1.33	1889
Smith	1.68	1883
South Maple and Branches	13.34	1882
Spaulding and Extension		1876
St. Clair (Ovid)	0.40	1884
Sturgis		1890
Taylor and Bailey		1876
Thompson and Branch	1.82	1871
Vanderbeck	0.91	1894

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Clinton County–continued		
• *Ovid Township –continued*		
Warren Intercounty	0.52	1916
William Gibbs	1.40	1872
Winfield	0.88	1917
Winfield Extension	1.31	1919
Wm. D. Hall	1.05	1884
Woodworth Intercounty	0.78	1878
Worden Cronk	1.20	1904
Wyrick and Extension		
• *Duplain Township*		
236 or Morse Intercounty	2.14	1943
85A Intercounty	1.23	1896
Bailey		1881
Bensinger (Hart Intercounty)		
Beryo	3.13	1882
Beryo Branch	0.59	1918
Bigford	2.04	1890
Brown and Beryo	0.65	1887
Clinton & Shiawassee #1 Intercounty	3.16	1909
Colony Lake	1.70	2000
Cooper	0.28	1884
Devereaux	2.75	1919
Dunlap		
Eaton Intercounty		1989
Fairfield, Elba, Duplain & Branches	2.65	1910
Faragher		1884
Faxon	0.92	1883
Goodhue	1.62	1884
Goodrich	0.95	1907
Greenbush & Duplain North Branch	1.04	1887
Hall	1.91	1885
Hart Intercounty	2.43	1881
Hause (Hawes)	0.37	1887
Heinze	0.44	1883
Love	0.73	1887
Lyverne Intercounty		1893
Maple River Intercounty		1905
Marshall and Marshall Extension	3.13	1887
Mogg	1.99	1893
Morse	0.52	1893
Olson (Dunlap)	1.48	1921
Ovid and Duplain	4.08	1891
Clinton County–continued		
• *Duplain Township–continued*		
Page	1.79	1879
Page #2	0.17	1882
Peck	0.70	1919
Perkins	2.26	1882
Setterington Intercounty (200)	0.64	1881
Sherman (and Love)		1881
Sherman Extension		1883
Sherman Extension #2	2.93	1895
Shiawassee & Clinton #2 Intercounty	1.52	1930
Smith	1.59	1882
Smith (Smith and Seeley)	0.60	1915
Squires	0.44	1884
Stanton Blind	0.08	1882
Stevens	2.86	1885
Sturgis	4.30	1890
Swarthout Intercounty	0.76	1914
Tabor	0.60	1892
Thomas Joint Intercounty	1.84	1925
Tucker	1.28	1876
Wait Intercounty	0.73	1914
Waterbury Tile	0.20	1914
Watkins Br. of Dutch Gap		1871
Watson	0.70	1894
Wright	1.86	1882
• *Olive Township*		
Alward Lake	2.13	1901
Baldwin and Muskrat	3.94	
Barrus and Branch	1.15	1914
Blizzard	2.05	1888
Boron	1.10	1910
Botroff	1.03	1880
Bradner	0.28	1882
Bray	2.08	1893
Browns South Fork	1.26	1900
Burbank	1.34	1869
Clavey	1.71	1905
Culp	0.62	1916
Dead Slough	1.36	1901
Gage	0.36	1878
Glendale	1.55	1900
Hamilton (Olive and Victor)	2.14	1888

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Clinton County–continued		
• *Olive Township–continued*		
Hammond	0.56	1922
Harris	0.83	1882
Holden or Holden Extension	8.01	1881
Hugulet		1882
Hyde	0.30	1913
Kimble	0.45	1901
Lapham	0.37	1905
Locher	1.58	1893
Marsh	0.71	1893
Mead (Olive)	0.37	1896
Merrihew (Monnett)	0.23	1883
Muskrat Lake		1892
Orkney-Knapp	0.71	1893
Passmore	2.25	1894
Peck and Brya Br. of Stony Creek		1993
Pecktil	3.46	1894
Ridenour	1.43	1913
Russell and Van Consant	1.10	1908
Scott and Brya	2.50	1883
Shafley (Case)	1.14	1907
Smith and Merchant		1882
Sperry, Irish & Stevens & Brs		1886
St. Clair	0.27	1922
Taylor (Olive)	0.75	1882
Waltz	0.37	1892
White and Hewitt	0.38	1890
White	0.23	1885
Wickerham		1996
Wilkins	0.09	1894
Youngs		1887
• *Bingham Township*		
Armstrong (Nassau Slough)		1882
Avery	1.03	1907
Avery Road Estates and Branch	0.25	1974
Bailey (Shulters & Stubbs)		1881
Baughn and Gatcher	1.20	1880
Becker		1965
Bingham #1 (Williams and Waldron)	1.16	1878
Bingham Commerce and Branches	0.96	2001
Bingham Farms		2002
Bond and Hansen	0.84	1933
Clinton County–continued		
• *Bingham Township–continued*		
Bond and Palmer	0.85	1978
Bowen (Br. of Shulters & Stubbs)	0.96	1908
Brown and Bailey	1.87	1882
Burbank		1869
Case Tile	0.12	1908
Cassler	0.14	1912
Creamer		1876
Cressman & Armstrong	0.35	1878
Crosby	0.25	1922
Culp and Lewis	1.55	1919
Dieter	1.39	1911
Diller		
Emmons and Gage	0.79	1897
Fehr	0.65	1910
Foote Br. of Brown and Bailey		1984
Gillison (Harris and Walker)	1.31	1886
Henning	0.94	1942
Hill		1893
Hitler		1876
Ice Pond	1.79	1926
Jury #99 and Branch		1942
Kelley	2.17	1873
Kipp and Fowler	0.38	1878
Kissane	1.65	1921
Kneeland Branch		1880
Kniffin	1.80	1906
Krepps Extension	3.16	1889
Lamb	0.81	1908
Lancaster		1884
Lapham		1885
Luther	0.33	1902
Moore and Perrin	4.43	1877
Moore (Bingham and Olive)	2.15	1878
Munson	0.58	1892
Nassau Slough	1.62	1900
Pearl River	1.21	1901
Rall (Bross)	0.78	1885
Rice	0.44	1886
Road Fork (Nassau Slough Br.)		1990
Schemer	1.11	1916
Shulters and Stubbs	4.50	1886

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Clinton County–continued		
• *Bingham Township–continued*		
Smith and Gillison	0.84	1912
South Branch	1.11	1900
South Shore Big Marsh	1.80	1886
Sowle (Salsbury)	0.70	1902
Spaulding and Extension	7.46	1876
Sperry, Irish & Stevens & Branches	4.65	1886
St. Johns Big Ditch and Town Ext.	2.83	1881
St. Johns-Prince	0.77	1950
Steel and Wallbridge	1.68	1877
Swain		1878
Taylor and Bailey		1876
Teed	0.84	1911
Upton	4.46	1876
Win Mil Farms	1.08	1997
• *Greenbush Township*		
121 Intercounty		1928
Bennett	3.89	1867
Beryo		1882
Bond and Branches	1.13	1896
Boots Intercounty	0.14	1917
Brenner and Branch		1921
Carrus (Rosekrans)	0.56	1918
Chilson Br. of Bennett and Branches	0.91	1878
Church Drain Intercounty	0.62	1915
Cleveland and Branch	0.63	1894
Colony Lake		2000
Cordray Intercounty	1.82	1882
Cordray Intercounty-Henry Branch	0.85	1882
County Line	1.00	1883
Diller		
Dutch Gap	0.82	1889
Eibach and Branches	1.99	1916
Ellis		1912
Ellis Br. of Euyden		1882
Erie Ingersoll		1913
Extension to Hayworth Extension	12.17	1916
Ferdon County	4.17	2006
Ferdon Intercounty	5.81	1873
Frink Tile	1.30	1919
Golden Gate	1.95	1900
Greenbush and Duplain	0.97	1881
Clinton County–continued		
• *Greenbush Township–continued*		
Greenbush and Duplain North Br.		1887
Greenbush and Washington Inter.	1.50	1882
Grubaugh #2 Extension	1.05	1912
Grubaugh Intercounty #25	0.01	1911
Halderman Creek Intercounty	2.10	1884
Hart Br. of Willard Cahoon		1919
Hayworth Extension	5.26	1868
Henderson	2.72	1890
Krepps	0.42	1989
Lapham	2.82	1885
Moore and Perrin		1877
Morris Intercounty		1918
Nye Branch of Willard Cahoon		1919
Page		1879
Perkins		1882
Quarterline		1882
Riddle Branch of Bennett	2.24	1894
Silver Fork	0.24	1900
Silver Nail #2	1.74	1895
Silver Nail (Bond and Upton)	1.07	1895
Silvers and Branches	1.89	1893
St. Johns Big Ditch and Town Ext.		1881
Steadman	0.63	1885
Stevens		1885
Stoddard and Connell		
Taber Br. of Henderson	0.43	1921
Tripp (Watkins Br. Dutch Gap)	1.92	1914
Upton		1876
Vaughn	0.76	1914
Watkins Br. of Dutch Gap		1871
Weatherby	0.59	1890
Willard Cahoon & Branches	3.84	1919
• *Watertown Township*		
Miller and Foster	0.34	1878
Tibbetts Extension		1869
Townsend	0.62	1880
Wilson and Branch		1894
• *Riley Township*		
Bad Creek		1898
Barnhart	0.43	1890
Bliss	0.94	1916

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Clinton County–continued		
• *Riley Township–continued*		
Botroff		1880
Boughton	2.16	1876
Bullard	0.98	1917
Burnes		1881
Coffman	1.71	1905
Cole	2.40	1893
Cornell	0.95	1890
Craun	1.37	1881
Culp		1916
Farrier	1.75	1895
Feazel and Extension	1.43	1874
Fisher	1.20	1882
Forwick	0.31	1876
Halstead	3.80	1876
Hamilton	1.11	1883
Hamilton, Chant Branch		
Hildreth	0.47	1896
Hopp	0.76	1920
Ingram	0.98	1887
Jacobs	1.16	1905
Jacobs	0.65	1882
Jacobs	0.38	1890
Jones	0.75	1877
Keeney and Peabody	0.55	1886
Kent	0.15	1893
Mankey		1915
Muskrat		1874
Oding	0.19	1878
Otto	0.51	1881
Owen	0.40	1883
Pecktil		1894
Pingel		1881
Pingle	0.50	1891
Pratt	0.26	1906
Ridenour		1913
Rose	1.02	1918
Rossow	0.90	1917
Schroeder	1.97	1877
Sheldon		1902
Shirts	0.38	1890
Sias	0.92	1876

Drain	Length (mi)	Est.
Clinton County–continued		
• *Riley Township–continued*		
Silm	2.21	1914
Smith and Merchant	2.81	1882
Stansell	1.07	1892
Taylor	0.33	1889
Taylor	1.12	1921
Theis	2.06	1947
Tibbetts Extension	7.56	1869
Van Dyke	0.19	1890
VanVleet	0.47	1891
Wandell Extension		1882
Wandell, Dean Branch	0.17	1997
Ware	0.25	1894
Watson	2.65	1877
Welton	0.26	1916
Westphalia, Riley and Br., Jones Br.	4.64	1880
Wickerham	0.72	1996
Wilcox	0.59	1880
Wilson and Branch	2.94	1894
Yanz	1.19	1906
• *Bengal Township*		
Amspoker	2.13	1892
Atkinson and Hunt	0.05	1887
Bad Creek	7.98	1898
Becker	1.95	1965
Brown and Travis	1.72	1884
Dallas and Bengal		1882
Dallas and Bengal Extension	3.03	1917
Doty and Cook	1.80	1883
Errer (Mankey)		1878
Evart and Stewart	1.42	1883
Fay and Williams	0.58	1887
Feightling	2.05	1913
Gallagher		1921
Granger	1.74	1904
Kneeland	4.95	1905
Kneeland Branch	2.36	1880
Lancaster	3.52	1884
Lyon and Dean	4.37	1883
Mankey (Vander Lee, Davis Br.)	1.87	1915
McGuire and Welter	0.52	1884
Murrett Ridenour	1.33	1918

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Clinton County–continued		
• *Bengal Township–continued*		
Muskrat Creek	5.69	1874
Nichols	1.16	1894
North Swagart	7.17	1878
Nuffer and Sturgis	1.94	1892
Parks and Cook	1.46	1883
Parks and Martin	0.49	1883
Sheldon	1.35	1902
Silm		1914
Smith and Sutton	4.01	1884
Snow		1910
South Swagart	2.12	1892
State Highway #1	2.18	
State Highway #2	0.85	
State Highway #3	0.36	
Stony Creek (Muskrat Creek)		1877
Sturgis	0.10	1878
Wandell Extension	4.78	1882
• *Essex Township*		
Bentley	1.33	1880
Biddinger Intercounty	1.35	1912
Brenner and Branch	2.19	1921
Carr Tile	0.60	1906
Cox	6.44	1879
Dallas and Bengal Extension		1917
Dunning	0.79	1881
Ellis	0.82	1912
Ellis and Young	1.28	1884
Extension to Hayworth Extension		1916
Fox and Burt	0.57	1886
Hayworth Extension		1868
Henderson		1890
Hulbert		1879
Jones	0.57	1880
Lowe	1.56	1936
Moss	0.30	1884
Mundell	1.21	1894
North Swagart		1878
Orchard Estates	0.63	2000
Peck	1.78	1879
Pine Creek		1881
Snow	1.55	1910

Drain	Length (mi)	Est.
Clinton County–continued		
• *Essex Township–continued*		
Sowle	0.77	1881
Travis	0.39	1913
Vanhoesen	0.25	1879
Weaver and Redfern	1.22	1893
West Br. of Hayworth	2.88	1869
Whitacre	0.63	1881
• *Eagle Township*		
Avery		1878
Brown Br. of Derbyshire	1.09	1891
Derbyshire	3.84	1894
Howe Br. of Derbyshire	0.47	1909
Howe Rd.		
Howe Tile and Branch	0.51	1909
Lee Br. of Derbyshire	1.82	1878
• *Westphalia Township*		
Bauer Rd. Br. of Stony Creek		1993
Boughton (Rose)		1876
Burnes		1881
Clinton and Ionia Intercounty		1913
Derbyshire		1894
Esch	0.81	1891
Feneis	1.44	1877
Fernholtz and Branch	1.69	1880
Gross and Taylor	3.68	1879
Heil Br. of Kloeckner		1877
Kelly (Westphalia and Eagle)	3.05	1878
Kloeckner and Fuller Creek		1891
Kreckler	0.31	1877
Lehman	2.57	1875
Morris	8.89	1872
Pohl (Gruber)	0.76	1947
Rochol Extension		1879
Schroeder		1877
Snyder	1.04	1902
Stump and Hengesbach	3.21	1909
Thelen	1.76	1912
Thome and Wieber		1886
Treat	3.29	1877
Westphalia, Riley, Jones, & Branches		1880
Williams	1.04	1879
Zimmer		1880

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Clinton County–continued		
• *Dallas Township*		
Bauer Rd. Br. of Stony Creek	1.13	1993
Bissell	1.82	1880
Clinton and Ionia Intercounty	6.05	1913
Cole	0.66	1887
Cook Intercounty	0.47	1914
Dallas and Bengal	3.87	1882
Eske		1879
Fowler Extension #2	3.37	1883
Gillman	1.65	1881
Glosser	0.76	1886
Green	0.51	1890
Higgins	0.23	1895
Kloeckner and Fuller Creek	7.95	1891
Long and Pierce	2.62	1883
Lost Creek	2.88	1880
Rochol Extension	3.76	1879
Sage and Hafner	1.65	1883
Schwartz	0.38	1891
Sears	0.23	1890
Sharps	3.27	1879
Simon Branch		2001
Smith and Sutton		1884
Stony Creek	3.29	1877
Thelen		1912
Thome and Wieber	3.92	1886
Ulrich	0.36	1921
Valleau	0.44	1881
Waltz and Sturgis	3.50	1883
Wayne Street	0.13	1886
Wieber and Branch	3.60	1941
• *Lebanon Township*		
134 Intercounty	0.66	1930
57 Grille and Cone Ext. Intercounty		1953
Bibby and Vincent	0.90	1886
Catlin and Waters	4.37	1887
Connor & Sessions Intercounty	2.11	1893
Fisher	1.30	1906
Fowler Extension #2		1883
Nichols	1.44	1892
Piggot	0.68	1887
Price	0.24	1894
Clinton County–continued		
• *Lebanon Township–continued*		
Reynolds and Sessions	4.07	1897
Smith Br. of Nichols	0.52	1917
Stoddard and Connell		
Studtt & Kinley	2.60	1886
Sullivan & Henley	0.55	1887
Tait	0.60	1893
Waters and Nash	1.58	1887
Williams and Coon	0.85	1882
Wood	1.15	1887
Gratiot County		
• *Elba Township*		
035-0 Ashley	2.84	1890
038-0 Mattison & Ball	4.69	1907
083-0 Newsome	4.96	1897
085-0 Wooley	1.49	1902
085-1 Br. 1 & 2		1954
085-2 Br. 5		1942
085-4 Br. 4		1942
085-5 Wilson Rd. Tile		1993
142-0		1899
181-0 Wolf and Bear		1897
183-0 Maple River		
183-2 Maple River		1902
191-0 Shellbarger		1902
192-0 Hines	3.69	1902
200-0 Setterington	0.63	1903
211-0 Davidson	0.84	1905
214-0 Kerr		1902
215-0 Shaw	1.97	1907
227-0 Maple Swamp	2.42	1908
236-0 Morse	3.68	1909
301-0	0.99	1902
306-0 Relief Channel	0.58	1912
308-0	2.30	1913
336-0	1.90	1915
349-0		1916
354-0	1.48	1916
375-0	0.93	1916
455-0	0.23	1928
466-0	0.2	1933

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Gratiot County–continued		
• *Hamilton Township*		
087-0 Alleghany	1.29	1904
142-0	9.42	1899
222-0 Kennett	0.7	1908
449-0	1.14	1928
• *Washington Township*		
013-0	0.95	1882
014-0 Coon and Duncan	3.20	1882
025-0 Grubaugh		1889
026-0 Greenbush or County Line	1.93	1889
027-0 & 27 Extension	3.31	1890
028-0 Bradley	5.05	1890
028-1 Branch 1		1951
032-0 Bovee	4.86	1892
035-0 Ashley		1890
044-0 Collier Creek	4.88	1888
044-1 Branch 1		1968
050-0 Bowen and Brown	3.39	1902
065-0	2.22	1902
065-1 Patterson		1902
075-0 Foster and Henson	8.26	1904
076-0 Douglass and Daggett	0.71	1908
083-0 Newsome		1897
121-0	3.21	1899
121-1 Tile Branch		1935
122-0	1.65	1898
135-0 Bear Creek	10.61	1890
153-0		1882
181-0 Wolf and Bear	12.70	1897
183-0 Maple River	7.58	
183-1 Maple River West		1948
183-2 Maple River		1902
197-0 Nile	3.72	1904
206-0 Zigler	1.1	1905
209-0 Bovee and Heinlien	2.76	1906
223-0 DeMott		1908
230-0 Halterman		
237-0 Post	0.92	1906
249-0 Davis	4.54	1888
274-0	1.30	1911
281-0	0.70	1911
308-0		1913

Drain	Length (mi)	Est.
Gratiot County–continued		
• *Washington Township–continued*		
327-0 Church	1.20	1915
340-0		1915
347-0 Open and Open	2.06	1915
362-0 Dean	0.83	1916
389-0 Hoffer	1.05	1916
422-0	1.32	1920
425-0		1922
467-0 J. B. Smith		
473-0	3.87	1937
493-0 Passenger		1949
540-0 Cordray	2.33	1933
579-0 South County Line Jt.		1911
• *North Star Township*		
027-0 & 27 Extension		1890
068-0 and Stockwell	1.87	1902
135-0 Bear Creek		1890
139-0	2.31	1899
154-0	2.38	1900
156-0 Hull and Barstow	6.08	1898
181-0 Wolf and Bear		1897
197-0 Nile		1904
217-0 Ringle and Ackles	4.13	1906
249-0 Davis		1888
353-0	0.38	1916
410-0	0.30	1918
459-0	1.03	1929
• *Fulton Township*		
001-3		1894
025-0 Grubaugh	2.49	1889
027-0 & 27 Extension		1890
028-0 Bradley		1890
028-2 Extension	5.05	1987
028-1 Branch 1		1951
028-3 Branch 2		1966
034-0		1899
049-2 and Extension		1961
055-0 Casteel		1902
063-0 McAlvey and Herald	2.06	1902
066-0 Sidell and Leddick	1.42	1903
120-0 and Branches	14.81	1873
120-1 Railroad		1987

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Gratiot County–continued		
• *Fulton Township–continued*		
120-3 Elm St.	0.09	1987
135-0 Bear Creek		1890
136-0		1899
153-0	1.78	1882
163-0	6.22	1900
173-0		1901
183-1 Maple River West	1.13	1948
183-2 Maple River	6.36	1902
186-0 Crismore		1903
248-0	2.57	1910
261-0		1910
275-0 Payne	0.65	1911
276-0 Biddinger	2.86	1912
282-0 Tile		1911
300-0	8.35	1912
302-0	0.96	1912
302-1 North Branch	1.75	1912
312-0	1.43	1912
379-0	0.78	1916
399-0	1.89	1918
400-0 and Branches	4.61	1920
400-1 Baker and Brown	0.47	1920
400-2 Carolina	0.17	1920
417-0		1921
444-0	0.16	1928
468-0	0.94	1935
473-0		1937
475-0 Otto and Valance		1882
484-0		1942
493-0 Passenger	0.85	1949
529-0 Fitzpatrick		1977
552-0 Highland Tile and Branches		1969
700-0 Rainbow Lake Dam		1986
• *Arcada Township*		
001-0 South	1.00	1894
106-0 Tile and Open	2.07	1898
106-1 Tile Extension		1989
109-0 Sykes		1894
423-0	1.03	1919
• *Newark Township*		
001-0 South		1894

Drain	Length (mi)	Est.
Gratiot County–continued		
• *Newark Township–continued*		
001-3	4.31	1894
007-0 North Shade	8.87	1884
034-0	2.68	1899
047-0 Strouse	1.46	1902
063-0 McAlvey and Herald		1902
072-0 Clark Tile	0.9	1965
103-0 and Branches	4.44	1902
109-0 Sykes	1.82	1894
130-0 and Branches		1891
133-0	6.90	1894
136-0		1899
143-0	5.08	1896
157-0 Greer and Downs	1.92	1902
168-0 River Styx		1888
171-0	3.09	1899
205-0 Wabash	1.16	1905
242-0	1.27	1908
245-0	2.17	1909
250-0	2.29	1909
261-0	1.39	1910
262-0	0.79	1910
266-0 Tile	0.59	1910
268-0	0.70	1911
272-0 Martin	0.63	1910
361-0 Tile and Open	0.53	1916
397-0 and Branches	1.64	1917
402-0	0.67	1917
403-0	0.63	1917
423-0		1919
430-0	0.39	1919
434-0	0.56	1923
442-0	0.59	1928
468-0		1935
471-0	0.43	1937
481-0	0.67	1903
503-0	1.06	1953
529-0 Fitzpatrick	1.44	1977
535-0 Carter and Beck		1893
• *New Haven Township*		
007-0		1884
015-0 Willis and Holiday		1881

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Lower–continued					
Gratiot County–continued			*Gratiot County–continued*		
• *New Haven Township–continued*			• *North Shade Township*		
016-0 Woodbury	1.48	1884	007-0		1884
019-0 Waggoner		1881	017-0 Isham and Hunter	0.69	1903
030-0 White and Blain		1890	017-1 Fraser	0.89	1903
030-1 Noll	0.86	1900	017-2 Moench	1.78	1929
048-0 Myra and Culy	2.85	1902	019-0 Waggoner	0.98	1881
048-1 Dan		1908	030-0 White and Blain	4.39	1890
048-2 McLaren	1.13	1904	034-0		1899
048-3 Cross		1908	049-0 Clark & Roberts & Todd		1905
061-0 Knowles		1890	049-1 Inninger		1957
071-0 Collins	0.91	1907	049-2 and Extensions		1961
130-0 and Branches	3.26	1891	055-0 Casteteel		1902
131-0	5.19	1899	057-0 Tile		1907
131-1 Branch	0.33	1916	057-1 Grille and Cone	7.94	1950
133-0		1894	058-0 Helwig	1.47	1903
133-1 Extension	1.06	1962	061-0 Knowles	2.79	1890
135-0 Bear Creek		1890	067-0 Smith and Hartman	1.38	1902
141-0 Wolf		1894	069-0 Todd	1.22	1902
143-0		1896	079-0 McQuaig	4.58	1906
168-0 River Styx	7.53	1888	079-1 Straight	1.60	1893
171-0		1899	080-0 Fraser and Smith	0.60	1908
175-0		1905	120-1 Railroad		1987
204-0 Wells	1.54	1905	120-2 Rich Rd.		1987
234-0 Platt		1908	134-0	3.76	1898
250-0		1909	163-0		1900
256-0	0.86	1909	163-1 Havens Branch	2.34	1900
257-0 Horton and Branches		1891	163-2 Branch 1 of Havens Branch	1.34	1900
269-0 Richards Branch of Culy	2.70	1915	172-0	1.42	1901
284-0 Tile off 168-0	1.46	1912	186-0 Crismore	1.22	1903
317-0	1.32	1913	219-0 Smith and Helwig	2.47	1907
324-0	0.5	1915	221-0 Ranger	1.08	1908
345-0	1.18	1882	240-0 Tabor	2.06	1908
346-0	0.24	1896	271-0 Hull		1883
356-0		1889	279-0 and Branch	0.93	1911
368-0	1.38	1902	280-0	2.03	1911
392-0 and Branch	0.82	1917	314-0	0.54	1913
394-0	0.51	1919	333-0 Isham	0.77	1917
433-0 Tile and Branch	0.9	1926	334-0 Barrett	0.48	1915
538-0 Champer		1954	341-0	1.57	1916
543-0 Cross		1951	342-0 and Branch	0.49	1915
556-0 Kepp	0.81	1928	368-0		1902
584-0 Waggoner		1881	386-0	1.11	1917

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Gratiot County–continued		
• *North Shade Township–continued*		
387-0	0.62	1917
391-0	1.07	1918
396-0	0.75	1917
421-0	0.36	1919
462-0	0.54	
480-0	0.39	1939
484-0	0.39	1942
584-0 Waggoner		1881
Montcalm County		
• *Ferris Township*		
No. 131 Extension	2.50	<1914
Fish Creek	4.56	1938
Fish Creek Branch No. 1	0.34	1938
Fish Creek Branch No. 2	0.09	1938
Woodard and Hyde Main Line	1.06	<1951
Woodard and Hyde Branch No. 1	0.08	<1951
Woodard and Hyde Branch No. 2	0.07	<1951
• *Day Township*		
No. 114	1.53	1935
No. 114 North Branch	2.42	
Church	0.94	1916
Hemmingway Lake	2.6	
Hemmingway Lake Branch No. 1	0.07	
Hemmingway Lake Branch No. 2	0.47	
Hemmingway Lake Branch No. 3	0.25	
Hemmingway Lake Branch No. 3A	0.15	
Hemmingway Lake Branch No. 4	0.06	
Hemmingway Lake Branch No. 5	0.32	
Hemmingway Lake Branch No. 6	0.42	
Hemmingway Lake Branch No. 7	0.11	
Neff Bros.	1.20	<1902
• *Evergreen Township*		
No. 105	1.76	1902
No. 113	0.87	1902
No. 106	2.5	1902
Hotchkiss	0.58	1912
Bryde	0.5	1911
Mud Lake Main Line	1.95	1899
Mud Lake Branch No. 1	0.51	
Mud Lake Daniel Branch	0.34	
Baker Lake	2.49	1913
Montcalm County–continued		
• *Evergreen Township–continued*		
Stanton	0.78	1912
Stanton Sewer	2.26	1925
Stanton Sewer Branch	0.15	
• *Crystal Township*		
Allen and Tissue	3.73	1898
Allen and Tissue West Branch	1.51	
Allen and Tissue South Branch	1.33	
Allen and Tissue Huych Branch	0.31	
Blackrick	0.71	1919
Bryde		1911
Butternut Creek		1899
Butternut Creek DeHart Branch	0.49	1925
Butternut Creek Donovan & Arntz Br.	1.50	
Butternut Creek North Branch		
Crystal- New Haven		
Crystal Sewer	0.37	1928
Crystal Lake	0.14	1942
Drake Bros.		
Durbin	0.26	1936
Frisbie and Branches	1.31	<1944
Frisbie Extension	0.30	<1945
Frost	0.81	1947
Fuller Extension	4.29	<1902
Grinnell	0.92	1949
Kipp	1.17	1928
LaBarr	0.55	1927
Loon Lake	2.12	1912
Manzer and Branch no. 1	2.42	1901
Manzer-Old		
Noll Branch		
North Grove		1949
No. 50 and Extension	1.77	1901
No. 103	2.76	1901
No. 111	1.43	1902
No. 131	5.29	1916
No. 234		
Rice and Branches	0.87	<1951
Ruedger	0.36	1928
Shinabarger and Branches	6.40	1904
Sigourney	1.09	1916

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Montcalm County–continued		
• *Crystal Township–continued*		
Sigsby and Branches	0.58	1937
Smith	1.53	1901
Stillwater and Branch	1.89	1912
Teed	2.85	1902
Terwilliger	0.48	1917
Tow	0.32	1928
Town Hall and Branches	0.07	1955
Weidbrauk and Branches	2.92	1922
Weidbrauk-Old	1.41	1914
Whetstone and Branches	4.61	
• *Bloomer Township*		
Allen and Tissue		1898
Allen and Tissue West Branches		
Blackmer		
Bloomer and Branch No. 2	2.01	1925
Bollinger	0.61	1937
Boyer		
Butternut Creek and Branches	16.55	1901
Carroll	0.67	1937
Dakin-Old		
Dalton	2.35	1938
Evans and Hubbard	4.58	1943
Fahey	1.55	1905
Fahey Extension and Branch No. 1	1.03	1943
Gage	0.68	1949
Greenhoe and Branches	0.86	1949
Huyck		1925
Knapp and Branches	6.86	<1940
Kohn		1946
Luscombe	1.61	<1947
Luscombe West Branch	0.42	
No. 131		1916
No. 172	2.20	1901
No. 387	0.10	1917
Maloney No. 2 and Extension	2.37	1949
McClennen and Decker	5.95	1940
Pinery Lake	2.98	1898
Sayles	1.14	<1916
Warren and Branches	1.37	1917
Wilson Creek	3.43	1941
Wilson Creek North Branch		

Drain	Length (mi)	Est.
Montcalm County–continued		
• *Bloomer Township–continued*		
Wright and Evans and Branches	6.26	1927
• *Bushnell Township*		
Bacon		1930
Bailey	1.33	1948
Barkham and Summers and Branches	8.08	1898
Butternut Creek West Branch		
Butternut Creek Donovan Branch		
Butternut Creek South Branch		
Butternut Creek Ralph Branch		
Butternut Creek Wellwood Branch		
Dean Creek and Branches	3.82	<1902
Hopkins	2.92	1918
Kohn		1938
Merithew	1.25	1925
Middleton	1.12	1952
Montcalm-Ionia		1914
Mud Lake		1899
No. 106		1902
Pinery Lake		1898
Prairie Creek and Branches	1.52	1903
Stevens	1.06	1933
Vickeryville	0.31	1941
Wright and Evans		1927
• *Home Township*		
Dallavo	0.64	1898
Edmore Sewer	0.12	1938
Edmore Sewer Extension	0.41	1946
Lorenz		
No. 6		
No. 114 and Penny Creek		
No. 115	1.10	1904
Parmeter (Palmeter)		1897
Penny Creek		1897
Stoney Creek		
Wilson		1898
• *Belvidere Township*		
No. 114 and Penny Creek	7.10	
No. 115		1904
No. 116	1.20	1904
Penny Creek	0.86	1897
Penny Creek Channel	0.46	

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Montcalm County–continued		
• *Belvidere Township–continued*		
Outman	0.23	1946
Wood	0.85	1902
Wood No. 2		
Wood No. 3		<1943
• *Cato Township*		
Blanchard Branch No. 1	0.42	1957
Blanchard Branch No. 2	0.18	1957
Bushley (Edgar?)		
Culver		
Edgar	1.73	<1906
Fresh	0.91	<1899
Gibson and Culver	3.98	1912
Macomber	0.80	
Pickerel Lake	3.36	1899
Sanborn		1915
Suckerbrook and Branches	11.41	1904
VandeWater	1.30	1903
VandeWater Extension		
Wood		1902
Wood No. 3		
• *Douglass Township*		
Crawford	0.64	1916
Lee	3.40	1962
No. 112	3.64	1902
Penny Creek		1897
Pine and Douglass		1911
Suckerbrook		1904
West Stanton-City of Stanton		1913
• *Pine Township*		
Blanchard		1897
Crawford		1916
Jorgensen Branch		
Pine and Douglass		1911
Suckerbrook		1904
• *Montcalm Township*		
Sorsen		1897
Thompson No. 2	3.28	1944
Twin Lake	0.84	1915
• *Maple Valley Township*		
Black Creek		1927
Coral	0.68	<1947

Drain	Length (mi)	Est.
Montcalm County–continued		
• *Maple Valley Township–continued*		
Durst	1.20	1906
Ehgotz		
Freeman (aka Freeman No. 1)		<1903
Lovett and Cody	2.69	1900
Maloney		1913
No. 1	0.14	<1903
No. 1 Freeman		<1903
No. 5	0.88	<1913
No 5 Extension	0.2	1913
No. 51 and Branch	2.11	<1901
No. 107	1.8	1902
No. 107 Branch No. 2	0.55	1902
Pinther and Foss-Durst	0.99	<1900
Sink Hole	0.28	1928
Ward Lake		<1938
• *Eureka Township*		
Eureka		
Greenville Sewer and Branches	1.66	1940
Houle and Green	1.88	1912
Snow		
Sorsen		1897
• *Sidney Township*		
Denmark	14.7	1944
Derby Lake		1938
Fairplains	2.55	<1913
Grandy Barlow	0.55	1897
Hansen	1.78	1940
Hatfield	0.41	1942
Huckleberry Lake	0.80	1910
Jackson		
Jensen	0.58	1942
Jerry	0.95	1946
Madison	0.37	
Pearson and Branches	2.44	1945
Petersen	1.24	<1902
Sheridan Extension	0.81	1899
Sidney and Branches	7.52	1935
Siple	0.08	1914
Thomsen	0.60	1940
Twin Lake		1915
West Stanton		1913

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Montcalm County–continued		
• *Fairplain Township*		
Bacon		1930
Barclay	0.96	1909
Dean Creek		<1902
Fairplains		<1913
Loper	0.38	1931
Morris	1.06	1925
Siple		1914
Twin Lake		1915
• *Pierson Township*		
Black Creek		1927
Grimes	0.37	1931
Herren (aka Heron No. 1)	2.73	<1904
No. 101	0.09	1901
No. 102	0.13	1901
No. 109	2.98	1902
Petrie		
Kent County		
• *Lowell Township*		
Bundy	0.71	1934
Cherry Creek	1.04	1968
Coldwater River	4.23	1917
Cumberland	0.19	1970
Easterby	1.61	1883
Howard	1.16	1986
Kilgus		1967
Kinyon	0.19	1883
Miller and Steward	0.19	1882
Pratt Lake	1.44	1882
Rittenger	0.31	1894
Stoneridge	0.33	2000
Tyler Creek	4.73	1918
Whispering Hills Central	1.42	2002
Whispering Hills Northwest	0.05	2003
Whispering Hills West Lower	0.09	203
Whispering Hills West Upper	0.06	2003
Winslow	0.33	1881
• *Spencer Township*		
Black Creek	6.34	1899
Bradshaw	0.71	1906
Cooley	3.65	1904
Five Lakes	0.16	1965
Montcalm County–continued		
• *Spencer Township–continued*		
Lincoln Lake	0.16	1962
Lincoln Lake	1.14	1924
• *Oakfield Township*		
Beaver Dam	0.57	1883
Crinnion Creek	0.31	1903
Five Lakes	0.16	1965
Harvard	0.85	1923
Wabasis Lake	0.15	1996
Wittenbach	0.40	1937
Ziegenfuss Lake	0.15	1966
• *Grattan Township*		
Big Crooked Lake	0.16	1963
Bookey	0.83	1915
Church	2.08	1939
Davis	0.47	1882
Davis and Purdy		1903
Flanagan	0.47	1882
Howard, Doyle and Howard	0.28	1903
Jones	1.42	1883
Lally	0.43	1902
Mason and Slayton	0.66	1983
McArthur	1.59	1937
Mosely	2.20	1913
Parnell	1.42	1898
Rattigan Lake	0.56	1907
Wittenbach	2.18	1937
• *Vergennes Township*		
Cherry Creek		1968
Church		1939
Down	0.19	1906
Fairchilds	0.78	1903
Hennessey	0.19	1917
Howard, Doyle and Howard	2.51	1903
Lally		1902
McGee	0.52	1909
Parker	1.28	1906
Parker Branches No. 1 and 2		1939
Parnell		1898
Rattigan Lake		1907
Scenic View		1991
Vergennes Plat No. 5	0.40	2004

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Kent County–continued		
• *Bowne Township*		
Barnes	0.24	1899
Bear Swamp (a.k.a. Hamilton)	0.38	1887
Boulard and Thompson	1.94	1871
Bowler	0.80	1908
Bowne and Irving Intercounty	0.47	1898
Brookshire Estates	0.19	1991
Camel Lake	0.43	1881
Clark and Bunker	3.41	1902
Cobb and Miller	1.99	1872
Colby and Livingston	1.44	1888
Coldwater River		1917
Geiger	0.69	1874
Hamilton (a.k.a. Bear Swamp)	1.73	1872
Hamlin and Riley	0.43	1881
Heir and Thomas	0.24	1890
Hoffman and Goder	0.52	1880
Hoplin and Riley		
Howard		1986
Johnson and Godfrey	2.23	1871
Johnson Branch	0.50	1903
Kilgus (a.k.a. Pratt Lake)		
Layer	0.45	1906
Little Thornapple River	0.30	1913
Miller and Steward	0.38	1882
Miller and Wright	0.57	1902
Pratt Lake	8.07	1882
Rittenger	0.28	1894
Scott and Lowe	0.28	1912
Timpson Estates No. 2	0.12	1993
Tyler Creek	4.73	1918
Walton	1.52	1938
Winslow	1.80	1881
Wood	0.85	1903
• *Cascade Township*		
Abbeydale Estates	0.28	1993
Ada Impoundment	0.12	1968
Alco	0.05	1970
Anderson	1.73	1899
Apple Hills	0.19	1983
Apple Hills East	0.25	1988
Arbor Shores		1994
Kent County–continued		
• *Cascade Township–continued*		
Arbor Woods	0.13	1999
Ashton Ridge	0.96	2000
Beard Farms No. 2	0.05	1984
Candlewick	0.09	1997
Cascade Highlands	0.14	1983
Cascade Impoundment	0.13	1971
Cascade Lakes Pointe	0.04	1999
Centennial Park	0.09	1975
Eastmont Meadows	0.28	1993
Esbaugh	0.62	1938
Fisk	0.83	1908
Foremost	1.35	1973
Forest Creek	0.09	2000
48th St. Bayou	0.49	2000
Heintzelman	0.64	1909
Hidden Hills	0.42	1987
Humphrey	0.19	1883
Jonathan Woods Estates	0.13	1997
Martin and Beak	2.46	1898
McKnight	1.52	1882
Meadowbrooke - North	0.42	1990
Meadowbrooke - South	1.48	1990
Oatman	0.47	1906
Patterson	3.31	1985
Shuman		1900
Spaulding	0.76	1912
Tall Pines	0.20	2003
Thornapple Hills	0.40	1974
Tobias and Walden	0.73	1882
Walden Lake	0.62	1910
Wenger and Nulty	0.92	1899
Wildwood Estates	0.18	1992
• *Ada Township*		
Ada Impoundment	0.12	1968
Adacroft	0.19	1969
Ada Woods No. 8	0.57	1994
Ada Woods No. 11	0.11	2000
Carmon Knolls	0.02	1988
Chase Lake		1882
Clark	0.40	1884
The Conservancy	0.56	1996

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Kent County–continued		
• Ada Township–continued		
Cook	1.01	1945
Downs	0.83	1884
Fase Street	0.26	1980
Forest Glen	0.38	1988
Grand Valley Estates	0.05	1992
Hill	0.69	1902
Martin and Beak	0.62	1898
Martin and Beak No. 2		
Martin and Beak No. 3		
Pettis	0.88	1884
Rattigan Lake		1907
Tobias and Walden		1882
Walden Lake		1910
• Caledonia Township		
Anderson		1899
Beesing	0.33	1910
Blackstone	0.24	1999
Caledonia (Emmons Lake)		1874
Caledonia Station	0.24	1880
Camel Lake	0.92	1881
Clark (Urban and Clark)	0.66	1936
Duncan Lake	1.25	1879
Dygert	0.12	1938
Emmons	3.13	1902
Enchantment Acres		1988
Fitch	1.42	1954
Glen Valley	0.99	1994
Jasonville Farms No. 8 – No. 11	1.01	2004
Jasonville Farms (subdivision No. 6)	0.25	2003
Keisers Park	0.45	1995
Kraft	0.57	1899
Listening Valley No. 2	0.05	1984
Maloney	0.71	1882
Maloney and Wade	0.33	1912
Riverland Ranch	0.23	1989
Schooley		1902
Sewell	0.71	1882
Southbelt Industrial	0.40	2003
Spring Valley	0.10	1997
Troy with Mosher and Farnham	3.17	1879
Wenger and Nulty	0.85	1899

Drain	Length (mi)	Est.
Kent County–continued		
• Cannon Township		
Bowen	0.33	1938
Cannon Farms	0.70	1998
Cannonsburg	0.14	1907
East Bella Vista Shores	0.07	1989
Grass Lake (Lake Bella Vista)	0.16	1970
Hunter's Ridge	0.11	1995
Hunter's Ridge No. 3	0.25	1999
Hunter's Ridge West	0.05	1997
Lake View	0.03	1996
Northport	0.05	1975
Rattigan Lake		1907
Silver Lake	0.16	1974
Woodview Estates	0.01	1992
• Grand Rapids Township		
Aberdeen Hills No. 3		1985
Apple Valley No. 14	0.04	1992
Belmont S. S.	0.19	1947
Belmont-Mayfield	0.31	1976
Beverly Hills	0.25	1995
Carlton Avenue	0.09	1980
Carmody		
Cascadia	0.57	1926
Coldbrook Creek and branches	5.40	1986
Coldbrook-Carrier	1.34	1986
Coldbrook-Highland		1978
Coldbrook-Monroe		1974
Coldbrook-North No. 2	0.95	1975
Coldbrook-South	0.14	1978
Cook		1945
Corduroy Creek	0.09	1951
Dean Lake	0.13	1965
Eastmont	0.14	1962
Echo Lake	0.15	1968
Elmridge Meadow Estates No. 3.	0.18	2004
Forest Hills Office Park	0.25	1999
Four Mile	0.07	1905
Gillett		1921
Heukels	0.57	1937
Hillside Estates No. 2	0.39	1993
Houseman Avenue	0.10	2003
Knapp's Corner	0.33	2000

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Grand Rapids Township–continued*		
Lamberton Creek	1.89	1924
Leffingwell		1970
Lenwood Hills	0.11	1990
Lenwood West	0.06	1999
Leonard Heights S. S.	0.57	1949
Leonard-Leffingwell	1.24	2000
Louis Street-Lyon Street		1978
Martin and Beak	0.14	1898
Martin and Beak No. 4	0.17	2000
Mylar and Medema		
Northbend	0.54	2003
Old Orchard East	0.23	2003
Old Orchard Estates		
The Orchards	0.85	1995
Palmer Separation	1.54	1978
Palmer-Woodmere	0.38	1974
Perkins Park	0.07	2002
Plainfield	0.76	1910
Remington	0.47	1905
Richard Fairplains	0.36	1950
Robinhood	2.23	1928
Saddlebag and branches	5.49	1884
Silver Creek		
Silver Creek-Hall Street	0.09	1979
Stonebridge	0.22	1992
Vineyard	0.50	1999
Waring	0.69	1884
Waters	0.95	1902
Wells	1.23	1908
Woodside Court	0.14	2002
York Creek		2001
• *Plainfield Township*		
Bel-West-Rogue		1905
Belmont Estates		1991
Belmont Farms	0.13	1997
Belmont Farms Condominiums	1.13	2002
Belmont Village Green	0.08	2004
Coit and Plainfield	0.24	1980
Country Club Village	1.40	1901
Country Hills	0.34	1995
Dean Lake	0.13	1965

Drain	Length (mi)	Est.
Kent County–continued		
• *Plainfield Township–continued*		
Diamond Estates	0.02	1996
English Meadows	0.21	1995
Evergreen Meadows	0.28	1995
Evergreen Meadows No. 2	0.08	1996
Evergreen Meadows No. 3	0.13	2000
Four Mile		1905
Grand Oaks	0.45	1999
Grand River Drive	1.09	1969
Hills and Dales	2.56	1956
Huntington	0.09	1978
Jupiter	0.44	2001
Jupiter Estates	0.69	2003
Lamberton Creek		1924
Little Pine Island	0.14	1963
Northbrook	1.05	1999
Northbrook No. 5	0.02	2004
Northdale Estates	0.23	1998
Northern Reflections Estates	0.65	1997
Northland Drive	0.61	1985
Northview Hills	0.06	1988
Northville No. 10	0.05	1982
Northway	0.15	2003
Paramount Estates	0.25	1995
Pebbleplane	0.78	1943
Petersen Valley	0.16	1992
Pickerel Lake	0.09	1894
Pine Island and Scotch Lake	1.70	1899
Plainfield	0.85	1910
Pleasant Creek Estates	0.06	2003
River Road Farms	0.08	1994
River Road Farms No. 2	0.22	1997
River Road Farms No. 3	0.54	1999
Rogue River	0.76	1893
Scott Creek No. 5	0.02	1991
Sub-Plain-North	0.95	1968
Summer Meadows	0.16	1995
Summit Park		1997
Veenstra	0.43	1916
Warwick Glen	0.11	1996
Waterford	0.44	2003
Waterford East	0.02	2003

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Plainfield Township–continued*		
Webber-Beltline	0.79	1991
Wells	0.43	1908
West River Drive	0.50	1970
Western Plains	0.04	1991
White Pine	1.09	2000
Whitney Creek	0.99	1938
York Creek		2001
• *Tyrone Township*		
Ball Creek	4.43	1937
Ball Creek Ext. with Branches 1 and 2		
Ball Creek Branch No. 3		
Ball Creek Branch No. 4		
Ball Creek Branch No. 5		
Casnovia	0.62	1930
Chary Ridge	0.22	2003
Clear Lake	0.15	1967
Crockery Creek	1.14	1940
Geers	1.23	1932
Gorby	1.54	1901
Greiner	1.23	1928
Hilbrand	0.33	1923
Muskegon-Kent	0.47	1944
Osborn	1.23	1905
Rogue River	2.01	1916
Walter Creek	5.78	1938
Wynwood Estates	0.13	1988
• *Solon Township*		
16 Mile-Northland Drive	0.42	1988
Cedar Creek Meadows	0.26	1995
Cedar Springs	0.33	1940
Cedarfield	1.21	1989
Clear Lake	0.15	1967
Finch	1.18	1909
Grimes	0.52	1932
Lockwood	0.38	1900
Morley	0.31	1939
Potter	1.09	1914
Road Commission	0.69	1924
Wildwood Valley		1996
Zimmerman	0.83	1923
Kent County–continued		
• *Sparta Township*		
Ball Creek	4.43	1937
Ball Creek Ext. with Branches 1 and 2		
Ball Creek Branch No. 5		
Carpenter	1.37	1942
DeBoer	3.31	1911
Farmers		1887
Mengs	0.66	1920
Mill Pond	0.52	1894
Nash	0.33	1883
Nash Creek	2.5	1905
Olson	0.24	1923
Phelps	1.99	1913
Rexford Lake	1.70	1908
Ridgefield	0.72	2001
Rogers	0.73	1948
Schindler Swamp		1887
Thorson	0.47	1918
• *Nelson Township*		
16 Mile-Northland Drive		
Alder Creek	5.02	1899
Beaver Dam	0.02	1883
Black Creek	0.97	1899
Cedar Highlands	0.26	1992
Cedar Springs	0.33	1940
County Line	1.49	1900
Crinnion Creek	0.76	1903
Durfy	0.59	1905
Lockwood	2.25	1900
Morley		1939
Overlie	2.23	1900
Pine Lake	0.17	1978
Road Commission	0.17	1924
Sand Lake	2.23	1905
Sand Lake	0.17	1966
Sceese	0.66	1908
Wagar and Bayless	0.19	1897
Williams	0.66	1915
Wolf	1.02	1938

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
<u>Lower–continued</u>					
Kent County–continued			*Kent County–continued*		
• *Courtland Township*			• *Walker Township*		
Beaver Dam	6.44	1883	Alpine Estates	0.26	1973
Bennett	0.26	1900	Alpine-Walker	1.31	1965
Big Brower Lake	0.17	1964	Arbor Estates	0.09	2000
Creek View	0.22	2001	Arbor Estates No. 2	0.51	2001
Crinnion Creek	0.76	1903	Auden View	0.08	1996
Foxtail Meadows	0.11	1995	Barber Terrace	0.19	1957
Harvard		1923	Blanch	0.12	1999
Lake Shore Estates	0.24	1992	Bristol Ridge	0.25	2004
Myers Lake	0.17	1975	Brownwood	0.33	1958
Richardson and Beatty	1.07	1913	Cogswell	0.80	1936
• *Algoma Township*			Coldbrook Creek and Branches		1986
16 Mile-Northland		1988	Coldbrook-Monroe	0.33	1974
Basin	0.36	1891	Crown View Estates		1991
Black Lake	0.57	1891	Deerfield	0.40	1996
Crystal Pines	0.42	1997	Driscoll	0.19	1905
Dutch	0.38	1898	Elmridge Estates		1986
Finch	0.40	1909	Elmridge Estates East	0.03	1997
Pickerel Lake	0.71	1894	Friar and Kimball		1896
Vandermeer	0.43	1922	Fruit Ridge Industrial Park	0.15	1989
• *Alpine Township*			Geigle	0.62	1910
Alpine-Walker	1.07	1965	Goodale Estates	0.21	1994
Baronoski	0.28	1893	Graham and Worden	0.95	1913
Baumhoff	0.14	1970	Green Ridge Br. of Alpine-Walker		1988
Blanchard	1.04	1903	Harding Estates		1992
Bradley	0.76	1920	Hibma	0.11	2001
Chase and Brown	2.56	1895	Indian Mill Creek	0.19	1886
Coffee and Wilson	0.66	1891	Jason Ridge	0.11	1999
Eldean Plat		2001	Lincoln Lawn	0.43	1965
Fables	0.28	1983	Louis Street-Lyon Street	1.14	1978
Farmers	4.55	1887	Maritime Estates No. 1	0.09	1996
Fresheter	2.23	1890	Maynard Acres	0.25	2003
Hopkins Lake	1.14	1886	Maynard Estates		1995
Indian Mill Creek	4.19	1886	Mount Mercy Estates	0.04	2000
Laubach	2.18	1897	Mullins		1908
McQueen	0.45	1941	Mullins Meadows		1991
Mill Pond	0.26	1894	Mullins Meadows South	0.10	1994
Mud Lake		1902	Nason	1.18	1894
Schindler Swamp	2.49	1887	Nolan	1.09	1881
Vitality	0.66	2001	North Wilson	0.30	1996
Westgate	0.22	1990	Oakwood	0.21	1988

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Walker Township–continued*		
O'Neil	0.66	1878
Orchard Ridge	1.20	2001
Palmer Separation	0.17	1978
Reeds-Barlow	0.88	1900
Richmond Highlands	0.11	1996
Richview Estates West	0.25	1999
Richview Park		1992
Riplow	0.47	1922
Riverside	0.50	1895
Roys Creek		1904
Sexton	1.56	1883
Sexton Ext.	0.85	1905
Shawmut Hills	2.72	1957
Silver Creek		
Sunset	0.63	2001
Sunset Hill Estates	0.66	1999
Sunshine Estates	0.06	1990
Tallman Creek	1.75	1972
Tallman Creek Plat	0.39	1995
Three Mile-Fruit Ridge	2.08	1977
Vista View	0.13	1989
Walker Industrial Park	0.05	1987
Walker No. 4	1.80	1976
West Leonard	2.18	1930
West Leonard (Worden)		1927
West Way Woods	0.25	1992
Worden	1.70	1908
Worden-7th	0.47	1978
York Creek		2001
• *Kentwood Township*		
28th St. Br. of Whiskey Creek	0.38	1973
40th St. Branch		
Allen Road	0.22	1929
Anderson		
Broadmoor	0.52	1973
Brook Trails	0.24	1985
Buck Creek		1884
Burton-Breton	1.23	1972
Churchill Downs		1989
Clafor	0.23	1992
Coldbrook Creek		
Kent County–continued		
• *Kentwood Township–continued*		
Crippen	5.02	1906
Decker (South Lawn)		
Division Avenue	2.37	1928
Eastbrook Lake	0.14	1966
Eastern Avenue	0.66	1929
Eastmont	0.45	1962
Eastmont Meadows		1993
Esbaugh	2.15	1938
Fisk	1.44	1908
Gillett	1.09	1921
Greenbrooke	0.28	1988
Hawthorne Hills Estates	0.11	1995
Heintzelman	1.09	1909
Heyboer	4.92	1898
Home Acres	1.18	1929
Indian Village	0.02	1996
Kentwood Ponds:		1995
36th and East Paris, SE		
52nd and East Paris, SW		
60th and East Paris, NW		
60th and Wing, NW		
Breton East		
Broadmoor East		
East Paris and 52nd, NE		
East Paris West		
Kreiser		
Shaffer West-between 32nd and 44th		
Laraway-Brooklyn	0.43	1976
Laraway-Plymouth	0.33	1978
Lyle Street	2.18	1959
Martin and Beak	0.09	1898
Oakwood/Beechwood	0.14	1992
Paris	1.14	1943
Patterson		1985
Pine Creek Plat	1.70	1965
Shuman (Patterson)		1900
Silver Creek	2.37	1992
Silver Creek-Hall Street	0.33	1979
Slobey	0.33	1963
Sophia Branch of Paris		
South Branch of Lyle		

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Kentwood Township–continued*		
Southlawn	0.97	1928
Southlawn No. 2	2.01	1929
Southlawn No. 3		1929
Whiskey Creek	2.65	1968
• *Gaines Township*		
Anderson		1899
Avalon Pointe	1.61	2001
Beesing	1.80	1910
Bisbee		1910
Brewer	1.21	1914
Brookshire Meadows East Phase 7	0.26	1999
Buck Creek		1884
Buck Creek Ext.		1968
Byron and Gaines	1.33	1956
Carlisle		1932
Cornerstone	1.41	2002
Cornerstone South	0.39	2003
Cranberry Lake		1912
Crippen		1906
The Crossings		1991
Crystal Creek	0.32	1994
Crystal Downes	0.05	1990
Crystal View Estates		1994
Cutlerville	3.15	1921
Denbraber	0.21	1984
Driftwood Acres	0.80	2001
Duncan Lake	2.18	1897
Dutton	1.14	1920
Ewing		1942
The Fairways	0.49	2001
Fennema	0.38	1965
Fisk	0.83	1908
Glen Hollow	0.30	1993
Hammond Estates East	0.15	2003
Hammond Estates West	0.29	2003
Hanna Lake	0.25	1994
Harmony Cove	0.71	2001
Hartman Estates		2002
The Homes of Summerwind	0.11	1996
King	0.33	1938
Klopfenstein	2.37	1882
Kent County–continued		
• *Gaines Township–continued*		
Matt		1969
McDowell	0.52	1908
McIntosh	0.33	1915
Mink Creek		1899
Rosecrest	0.31	1995
Schooley	3.15	1902
Sharps Creek	1.33	1938
Sienna Pointe	0.21	1999
Smith Farms	0.29	2003
South Creek	1.0	2004
Southpointe	0.42	2004
S.P.	0.95	2003
Stevens Pointe	1.55	2000
Stevens Pointe Phase 3	0.07	2003
Stevens Pointe Townhomes	0.12	2003
Summer Shores	0.98	1999
Sunbrook	0.73	1997
The Heathers	0.83	2003
Troy with Mosher and Farnham		1879
Van Oosten	1.06	1989
Vanschill	0.43	1983
Vantage Point	0.53	1990
Vantage Point West	0.74	1996
Voss Parker with Roth	3.15	1883
Waterman	0.17	1986
Wenger and Nulty	0.99	1899
Winter	0.28	1883
• *Wyoming Township*		
Alexandria		1991
Bayou	0.40	1891
Behan and Foley	2.69	1903
Bliss Creek	0.26	1969
Bremer		
Buck Creek	0.38	1884
Byron Lake		1998
Century Business Center		1994
Cora Office Complex	0.11	2003
Crippen	0.42	1906
Division Avenue	1.23	1928
Golfview Estates	0.09	1996
Goose Creek		

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Wyoming Township–continued*		
Heyboer	0.80	1898
Huizenga	4.95	1905
Knight		1900
M. Story Pines	0.15	1996
McKee	0.09	1974
Meadowview Estates	0.34	1996
Potomac Place	0.38	2003
Riplow	0.47	1922
Riverside	0.64	1895
Roys Creek	3.82	1904
Silver Creek	1.23	1922
VanMannen	0.66	1913
Walker No. 4	0.80	1976
Wimbledon Park	0.45	1985
• *Byron Township*		
76th St. Industrial Center	0.69	1997
76th St. Industrial Park	0.57	1990
Behan and Foley		1903
Bisbee		1910
Black Creek (Wagner)		1915
Bliss Creek		1969
Brink	0.47	1951
Brown	1.02	1947
Buck Creek	5.71	1884
Buck Creek Extension	0.78	1968
Buck Creek-Project 10	0.31	1973
Bunn	0.21	1881
Burlingame-84th	0.19	1973
Byron and Gaines		1956
Byron Center	0.21	1926
Byron Commerce Center	1.35	2000
Byron Commerce Center South	0.12	2003
Byron Country Estates	0.26	1995
Byron Country Estates No. 2	0.05	1999
Byron Country Estates No. 3	0.14	2000
Byron Estates No. 2	0.05	1987
Byron Lake	0.36	1998
Byron Oaks	0.27	1999
Byron Plaza	0.25	1988
Carlisle	4.36	1932
Carlisle Shores	0.84	2003
Kent County–continued		
• *Byron Township–continued*		
Carlisle Branch No 1		2001
Cutlerville	0.38	1821
Cutlerville Orchard	0.68	1970
Cutlerville Orchard West	0.59	2001
Dan Koster Memorial Industrial Cntr	0.12	1999
D. Koster Memorial Industrial Cntr 2	0.77	2001
Ewing	1.04	1942
Faber	0.92	1965
Goorhouse	0.97	1916
Goose Creek	1.54	1885
Grundy	1.85	1904
Haras Plat	0.31	2001
Hollie Estates	0.40	1998
Homrich	3.13	1915
Hudson	1.33	1904
Irwin (Knight)		1877
Kenowa-92nd Street	0.38	1969
Knight		1900
Knight No. 1 and 2	6.96	1900
Koster	0.66	1939
Lanting	1.66	1939
Mary Louise	0.21	2003
Matt	0.38	1969
Meadows North	0.47	1999
Meadows North Estates No. 2	1.18	2003
Meadows West	0.68	1994
Miller	3.36	1899
Mink Creek	0.78	1899
Misty Ridge	1.71	1998
Moorman	0.28	1914
Nichols	0.19	1916
Pfeiffer	1.16	1999
Piedmont Industrial Park East	0.09	1992
Planters Row	1.83	2003
Pleasant Glen	0.59	1989
Railside	0.47	1991
Railside West	0.21	2000
Railside West No. 2	0.27	2004
Rush Creek	0.93	1988
Sadler	0.47	1947
Sedroc	0.08	1997

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Kent County–continued		
• *Byron Township–continued*		
Sierrafield	0.29	2003
Sixty-eighth Street	0.38	1966
Smith-Byron		1999
South Ridge Estates	0.06	1998
Springfield No. 2		1992
Springfield Estates		1991
VanOosten		1989
VanSingel Farms	1.36	2003
Warner	2.17	1877
Waters Edge	1.34	2002
Weaver (Buck Creek)		1909
West Lake Byron	0.19	2003
Whistle Ridge	0.10	1996
Whistle Ridge No. 2	0.28	1998
Whistle Ridge No. 3	1.08	2002
Whistle Ridge No. 4	0.19	2004
Willard	0.85	1938
Winchester	1.18	1914
Winchester Estates	0.26	1989
Barry County		
• *Maple Grove Township*		
Bullis/Hawk	1.30	1913
Culp		1887
Dean	1.32	1954
Dillin	0.56	1899
Harding	1.27	1899
Hyde/Marshall	1.53	1905
Morganthaler	1.08	1905
• *Woodland Township*		
Collier Intercounty	4.43	1883
Early/Curtis	5.04	1945
Enz/Reiser	3.21	1919
Gardner	1.35	1937
Hill/Dove	0.47	1927
Kahler and extensions	3.26	1900
McArthur	0.46	1894
Miller/Hynes	1.19	1918
Nash/Rising	1.49	1915
Riley/Dell Intercounty	0.40	1915
Schaibley	0.28	1900
Second Lake		1916
Barry County–continued		
• *Woodland Township–continued*		
Spindler	0.58	1901
Stairs/Parrott	6.0	1913
Winters and extensions	3.22	1916
Wolcott	1.92	1924
Woodbury Village	0.40	1948
Woodland Center		
• *Castleton Township*		
Baine	1.81	1892
Barry/Eaton Intercounty	4.74	1892
Cole/Crouch	0.23	1889
Hart	0.51	1902
Hilton	1.21	1894
Lake One	0.63	1887
Morgan		1887
Nashville	0.36	1918
Northrup	0.19	
Ostroth and branches	0.68	1886
Quaker Brook Intercounty	5.83	1951
State Road and extensions	4.36	1918
Stockdale	0.78	1916
Strong	0.35	1892
Thornapple River #1	5.0	1888
Varney	0.25	1887
Wittie	0.71	1889
• *Johnstown Township*		
Lee	1.77	1882
Mill Lake		1900
• *Baltimore Township*		
Baltimore Corners/Dowling	1.20	1905
Baltimore/Maple Grove	0.65	1882
Burroughs	0.70	1916
Bush	0.66	1900
Castleton/Woodland	2.37	1914
Clear Lake	0.64	1900
Clem	0.55	
Eaton	0.89	1883
Erb/Pilgrim	0.62	1887
Gaskill	0.95	1918
Green	0.36	1899
Ickes	0.60	1920
Latham/Edmonds	1.04	1898

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Barry County–continued		
• *Baltimore Township–continued*		
Lower Bristol Lake	6.38	1903
Mack/Manning	1.36	1891
Mud/Brown/Jewell	9.68	1883
Paustle	0.26	1903
Sanford Brook	0.74	1884
White and extensions	1.23	1884
• *Carlton Township*		
Allerding Intercounty	1.81	1895
Barnum	1.07	1893
Bull/Edwards	6.76	1908
Bullhead	3.43	1889
Burd	3.41	1891
Coats Grove	11.0	1918
Cole/Crawford	0.67	1900
Fighter	0.93	1889
Friend	0.81	1900
Helmer	1.29	1899
Henney/Williams	3.03	1925
Hill	0.81	1894
Leach	0.67	1903
Little Thornapple River Intercounty	13.7	1912
Lower Lake	1.28	1917
Mallison Intercounty	33.3	1905
Olmstead/Stairs	0.45	1902
Parker and branches	2.18	1899
Raymond/Erb	1.11	1899
Richardson	1.52	1923
Spencer	0.90	1892
Stecklee	0.15	1899
Woolford/Moore Intercounty	2.04	1891
Wortley	0.35	1916
• *Hastings Township*		
Carlton/Irving	0.69	1894
Clary/Whitney	1.20	1881
Colwell/Stender	0.85	1882
Crouch/Benham	0.50	1882
Hastings Charter Townships	0.30	1992
Holmes	0.72	1882
Kinnie/Summers	2.76	1899
Lily Pad Lake	0.85	1913
Long Lake	0.34	1900
Barry County–continued		
• *Hastings Township–continued*		
McPharlin Lake	0.66	1915
Ragla	0.79	
Shea	0.56	1916
Thornapple Lake		1901
• *Barry Township*		
Delton	1.72	1893
Delton Village	0.36	1954
• *Hope Township*		
Bowker	1.34	1893
Cloverdale	0.13	0000
Collins	1.03	1897
Harrison	0.75	1888
Hine	1.00	1895
Howe	0.31	1893
Phillips	0.34	1901
Pierce	1.16	1897
Schultz	0.35	1895
Shallow Lake	0.91	1899
Wall Lake		1901
Zerbal	0.67	1901
• *Rutland Township*		
Colgrove	2.08	1901
Kelley	2.55	1890
Rogers	0.52	1902
Waters	0.84	1903
• *Irving Township*		
Bowne/Irving Intercounty	0.47	1899
Freeport	1.11	1892
Geiger Intercounty	0.67	
Graves	0.81	1898
Hammond	0.64	1902
Kidder		
Mitchell	1.24	1905
Moulton and extensions	0.52	1926
Price	0.36	1900
Ryan	1.50	1899
Smelker	0.42	1901
Willow Marsh	1.31	1903
• *Yankee Springs Township*		
Big Marsh	2.33	1929
Springer/Stafford	0.92	1903

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Barry County–continued		
• *Thornapple Township*		
Adams/Pike	0.98	1891
Duncan Lake Intercounty	2.11	1897
Finkbeiner	0.80	1898
Moffit	0.23	1892
Parmalee	0.71	1892
Thomas	0.81	1892
Newaygo County		
• *Ensley Township*		
Daniels Creek		
Daniels Creek Br. 1		
Daniels Creek Br. 2		
Kosten Branch 1		
Mud Lake		
Osborn		
Ransom Creek	3.3	1924
Spring Valley		
Tibbe		
Tibbe Branch 1		
• *Grant Township*		
Brummel	1.0	1908
Centerline Branch 1	5.08	1939
Centerline Branch 3		
Centerline Branch 4		
Centerline Branch 5		
Daniels Creek	2.93	1899
Geers	2.95	1929
Hilbrand	2.52	1923
Kosten Branch 1	3.97	1899
Kosten Bypass		
Osborn	3.04	1904
Plaisier	1.27	1943
Ransom Creek		
Rogue River	2.9	1898
Rogue River Intercounty	4.26	1902
Tibbe	1.61	1938
Tibbe Branch 1		
Timmer	0.46	1912
Veenboer	2.82	1895
Veenboer Br. 1		
Veenboer Br. 2		
Walter		
Newaygo County–continued		
• *Grant Township–continued*		
West Br. of Centerline	3.21	1924
Ottawa County		
• *Chester Township*		
Sand Creek		1893
Schoenborn		1942
Wilson		
• *Jamestown Township*		
Blacklock		
East Br. of Rush Creek		
Keffer		
McDuffee		
Miller Intercounty		1914
Minderhout		1909
Moorman Intercounty		1914
Rush Creek Phase II (dam)		
Rush Creek Phase III (dam)		
Shoemaker		1919
• *Blendon Township*		
64th Avenue		
Blacklock		1903
Blendon Cemetary Road		
Northwest Br. of Rush Creek		
Payne		1869
Snider		1882
Vinke		1882
• *Georgetown Township*		
8th Avenue		
12th Avenue		
40th Avenue		
Baldwin Street		
Bayou Intercounty		1891
Berger		1947
Blacklock		
Bliss Creek Intercounty		
Bluebird		
Bremer Branch to Huizenga		
Brewer Extension		
Briarwood		
Buttermilk Creek		
Chicago Drive		
Cory and Bishop		1902

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Ottawa County–continued		
• *Georgetown Township–continued*		
Cottonwood		
Cranford		
DeWeerd		1906
DeWindt		
Dood		
Edgeworth Snyder		1957
Edson Drive		
Ellen Kaysi		
Evergreen Arm		
Georgetown Forest		
Henshaw		1884
Houseman		1905
Huizenga Intercounty		1904
Jenison Heights		
LA		
Lanning		
Lawndale		
Low Com		
Mary Mark		
McClelland Street		
Meadowbrook		
Nancy		
North Drive		
Northwest Br. of Rush Creek		
Port Sheldon Branch		
Ridgewood		
Rosewood		
Rosewood Industrial		
Rosewood Street		
Rush Creek		
Rush Creek Phase I (dam)		
Sandy Hill		
Rush Creek Phase I (dam)		
Sandy Hill		
Suburban Retention		
Sunny Bliss		
Sunny View		
Terrace Gardens and Pump		
Totten		1908
Trout		1922
Tyler St. Branch to Rush Creek		
Ottawa County–continued		
• *Georgetown Township–continued*		
VanderMolen		1910
VanHaitsma		1940
VanLaar		
Waterfront		
Watson		1914
Woodsrest		
• *Wright Township*		
Barnoski		1883
Collar		1902
Dayton		1913
Farmers Intercounty		1874
Hanrahan		1869
Hellgate		
Host and Fritz		1921
Knauf and Terwilliger		1883
Laubach Intercounty		1902
Marne		1960
Mud Lake		1880
Reister		
Sand Creek		
Schoenborn		
Stephens		1915
Wright and Alpine		
• *Tallmadge Township*		
Aman		1909
Belle Cook		1902
Country Acres		
Friar and Kimble		1896
Hellgate		1912
Lake		1903
Maynard		1914
McKnight		
Remembrance		
Tallman Intercounty		
Windemere		
Shiawassee County		
• *Bennington Township*		
Bambi Lake		
Bear Creek	4.2	1894
Bennington & Perry	4.6	1908
Broughan	0.8	1919

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Lower–continued</u>		
Shiawassee County–continued		
• *Bennington Township–continued*		
Burgess	3.2	1910
Cooper	0.4	1920
Cord	1.1	1916
Doyle	2.0	1919
Drury	2.3	1911
Fauth & Extension	4.5	
Fuller & Flynn	1.2	1900
Gladden	1.6	
Hardy	1.6	1908
Hardy & Jennings		1912
Hinspeter	1.1	1912
Howard	4.6	1922
Howard Branch #1	0.9	
Kellog	2.2	1940
Morrice #2	0.5	1903
Osborn Creek	3.4	1943
Perkins	0.8	1920
Pitts	1.2	1934
Powers	0.3	1895
Powers & Evans	0.5	1911
Rood	1.8	
Rood #2	1.4	1893
Ruess #2	1.8	1910
Thompson #2	2.7	1914
Willow Brook	3.2	1902
Wright	2.1	1904
Yerkes	0.7	
• *Fairfield Township*		
Austin	1.5	1912
Brainard	1.4	1903
Carland	0.4	1908
Clinton & Shiawssee #1 Joint	5.4	1908
Colby	1.4	1908
Darling & Bennett	0.7	1916
Eaton Joint	1.9	
Fairfield & Rush	1.9	
Fairfield, Elba & Duplain Joint	3.2	1926
Gates	2.3	1923
Hart #1 Extension Joint	1.5	
Leavitt	1.7	1903
Longstaff		
Shiawassee County–continued		
• *Fairfield Township–continued*		
Loynes & Williams	1.4	
Lyvere Joint	1.0	1892
Nethaway	3.2	1906
Shiawassee & Clinton #2	6.0	1929
Thomas Joint	5.1	
Travis	1.9	1891
VanDusen & Branch	2.2	1912
Wait Joint	1.1	1889
Woodard	0.9	1929
• *Middlebury Township*		
Alder Creek Joint	6.6	
Beeman Joint	1.0	1916
Bradley	1.0	1943
Cravens	2.4	1940
Cripps	0.6	1887
Hipp	0.2	
Hyde	1.5	1912
Jorae	1.1	1933
Leland	2.5	1907
Lowe	0.7	1916
Maple River	16.1	1940
Middlebury	3.5	1916
Munsil & Jackson Joint	2.2	1910
Ockerman	0.9	1916
Ovid Joint	1.8	1910
Patrick	3.0	1948
Sprinkle	2.1	1906
Swarthout Joint	1.4	1914
Tubbs & Hanford	0.4	1910
Warren Joint	1.1	1916
West	0.5	1887
Woodworth Joint	1.5	1908
• *Owosso Township*		
Coakes	0.4	1906
Coakes #2	0.3	1906
Copes	1.0	
Cripps & Nelson	0.9	1934
Gute	0.6	1892
Hartshorn	0.8	1913
Hopkins Lake	1.1	1892
McKenzie-Dwyer E Branch & Main	2.7	

Table 24.–Continued.

Drain	Length (mi)	Est.
Lower–continued		
Shiawassee County–continued		
• *Owosso Township–continued*		
Mckenzie-Dwyer West Branch	3.4	1919
Owosso	3.6	
Owosso & Extension		
Shepard	1.2	1888
Strehl	1.1	1912
Wait #2 Extension	2.2	1904
Wilkinson	2.2	1887
• *Rush Township*		
Bignal	3.6	1938
Clark	0.5	1888
Dumond	2.6	1943
Peddington & Branch	2.5	1924
State Road	4.3	1916
• *Sciota Township*		
Alder Creek Branch	0.8	
Brendhal-Parker	2.5	1911
Shiawassee County–continued		
• *Sciota Township–continued*		
Chant	0.9	1913
Cook & Rome	1.7	1951
Laingsburg	0.7	1908
Laingsburg Br. #1 Intercounty	1.2	
Looking Glass River #2	7.8	1899
Putnam	4.7	1905
Sciota Township	3.6	
Sherman & Leveck	3.6	1898
Stark	4.6	1906
• Shiawassee Township		
Case	2.0	1893
Case #2 (Warren Case)	2.0	1918
Maple Swamp & Branches		1938
Section 16	4.6	1932
Section 16 Branch	1.5	
Mouth		
Kent County		
• *Tyrone Township*		
Chase	0.43	1881
Rexford Lake	2.18	1908
• *Sparta Township*		
Chase	20.8	1881
Rexford Lake	1.70	1908
Ottawa County		
• *Georgetown Township*		
20th Avenue		
42nd Avenue		
44th Street		
Alward		
Baldwin Street East		
Bass Creek		
Bass Creek Arm		
Lamplight Estates		
Lampwin		
Lowing Comstock		
Meyers		
• *Tallmadge Township*		
Bridge Street		1930
Jacobs		
Mouth–continued		
Ottawa County–continued		
• *Tallmadge Township–continued*		
Ottawa Creek		1902
Scanlon		1907
White		1909
• *Allendale Township*		
Allendale No. 1		1941
Bass Creek		1913
Beaverdam		1899
Bosch and VanHuizen		1896
Breen		1899
Brown		1899
Chessman		
Cole		1887
Curry		1908
DeGlopper		1877
Draght		1899
Edgewater		
Fellows		1898
Horling		
Jenkins		1886
Latham		1899
Lemmen		1898

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Mouth–continued</u>		
Ottawa County–continued		
• *Allendale Township–continued*		
Little Bass Creek		1893
Locke		1883
Lockhart		1899
Meyers		1893
Miner		
Ottawa Creek		1902
Parish		
Parker		1887
Perry		1899
Peters		
Piso		
Potgetter		1886
Quick		
Rogers		
Rogers North		
Sevey		1899
Sheffield		1945
Sheridan		1899
Stevens Underground		
Thurkettle		1902
Wilson		
• *Chester Township*		
Averill		1908
Boozer		
Chase Intercounty		1908
Chester		1885
Chester Shores		
Conklin		1907
Crockery Lake		1883
DeBoer Intercounty		1911
Dry Intercounty		1950
Finkler		
Fryer and Dinkle		1908
Highland		
Jackson and Gilbert		1887
Johnson		1914
Knowlton Intercounty		1895
Lange		1908
Lawrence		
Lewis and Gates		1908
Miller		1885

Drain	Length (mi)	Est.
Ottawa County–continued		
• *Chester Township–continued*		
Morley		1885
Schambers		1915
Scott and Tanner		1881
Seelman		1909
Smoker		
• *Wright Township*		
Dyke		
Knowlton Intercounty		
Pratt		1899
Scott and Tanner		
Sevey of Wright		
Walz		1902
• *Polkton Township*		
Barnett		
Burgemeister		1885
Busman		
Carney		
Fox		1884
Griswold		1887
Harris		1886
Knowlton Intercounty		
Laug		1890
McClellan		1884
McEwan		
Nipe		1888
Olson		1918
Parkins		1884
Perry Carr		
Porter		1890
Ruster		
Sadler and Terpstra		1886
Seamor		1887
Sietsema		1910
Sweet		1885
Truman Intercounty		1887
• *Blendon Township*		
Annema		1888
Bass Creek		
Bass Creek Arm		1962
Dys		1896
Huizenga Dunshee		1903

Table 24.–Continued.

Drain	Length (mi)	Est.
<u>Mouth –continued</u>		
Ottawa County–continued		
• *Blendon Township–continued*		
Lamer		1914
Little Bass Creek		
Meyers		
Seydell		1896
Standard		1897
• *Robinson Township*		
Allen		
Bass Creek		
Bear Creek		1907
Berg		
Bethke		1905
Bosch and VanHuizen		
Foster		
Graham		
Graper		
Little Bass Creek		
North Beeline		1895
Pipple		1894
Rork		
Scott		1897
Smith		1890
Stearns		1922
Wolf Creek		
Worley		1909
Worley Dam		
• *Crockery Township*		
Andrew Johnson		1892
Bowen Intercounty		1919
Carney		1886
Chittenden		1888
Christ and Smith		
Craven		1939
Crockery #1		1887
Crockery #2		1893
DeVries		
Garfield		
Grand Trunk		1904
Hayward and Spencer		
Hecksel		1949
Hickory Spring		

Drain	Length (mi)	Est.
Ottawa County–continued		
• *Crockery Township–continued*		
Merkins		
Nunica		1924
Parkhurst		1891
Pollie		1888
Porter		
Rosema		
TerHaar		
VanderWall		1907
Yonker		1893
• *Grand Haven Township*		
Beechtree		1884
Berg		
Blair		1886
Herry		1887
Kieft		1892
Kolberg		1886
Rork		1901
Ross		1886
Schroeder		1910
VanDoorne		1893
Vincent		1905
• *Spring Lake Township*		
Blair		
Castle		
Coles Park		
Hale		1903
Hickory Spring		
Hickory Street Industrial		
Kieft		
Lovell Park		
Rosema		
Schultz		
Spring Lake		1910
VanderKolk		1904
VanderSys		1950
VanderWall		
Vincent		
Warber		
Warners		
West Savidge		

Table 24.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
<u>Mouth –continued</u>					
Newaygo County			*Newaygo County–continued*		
• *Grant Township*			• *Ashland Township–continued*		
Crockery Creek	5.8	1939	Klever Branch 1		
Manning	0.98	1908	Klever Branch 2		
• *Ashland Township*			Klever Branch 3		
Fellows			Klever Branch 4		
Frantzen			Lewis		
Front St.			Morrison		
Front St. Extension			Morrison Branch 2		
Indian Creek			Nason		
Indian Creek Branch 1			Pollington		
Indian Creek Branch 2			Rasmussen		
Indian Creek Branch 3			Wheat		
Klever					

Table 25.–State, federal, local, and private conservation and recreational lands in the Grand River watershed organized by valley segment. Data from the Conservation and Recreational Lands database February 28, 2008 update http://glaro.ducks.org/CARL/index.htm.

Valley segment Property name	Ownership	Size (acres)	Management description
Headwaters			
Jackson County Fairgrounds	County	37.78	Recreation
Vandercook Lake Park	County	21.66	Recreation
Little Wolf Lake Park	County	6.19	Recreation
Cascade Falls Park	County	146.10	Recreation
Gilletts Lake Park	County	2.33	Recreation
Grass Lake Park	County	5.32	Recreation
Clear Lake Park	County	4.69	Recreation
Portage Lake Park	County	5.98	Recreation
Pleasant Lake Park	County	20.87	Recreation
Schlee Federal Waterfowl Production Area	Federal	159.51	Conservation
4-H Camp McGregor	Local	86.03	Recreation
Dahlem Nature Center	Local	218.02	Conservation
Sharp Park Golf Course	Local	96.60	Recreation
Park	Local	1.11	Recreation
Stetler Park	Local	2.63	Recreation
Betsy Butterfield Memorial Park	Local	0.61	Recreation
Sharp Park	Local	410.84	Recreation
Leekes Park	Local	0.40	Recreation
Exchange Park	Local	4.01	Recreation
Park	Local	2.58	Recreation
Park	Local	5.17	Recreation
Martin Luther King Center Park	Local	12.33	Recreation
Best Field	Local	6.28	Recreation
Park	Local	4.80	Recreation
Governor Austin Blair Memorial Park	Local	0.70	Recreation
Partnership Park	Local	0.49	Recreation
Bloomfield Park	Local	2.39	Recreation
Withington Park	Local	0.24	Recreation
Blackman Park	Local	0.54	Recreation
Bucky Harris Park	Local	0.40	Recreation
Rotary Park	Local	2.11	Recreation
Beech Tree Park	Local	1.27	Recreation
Loomis Park	Local	15.97	Recreation
Optimist Park	Local	5.19	Recreation
William Nixon Memorial Park	Local	16.96	Recreation
Kiwanis Park	Local	1.45	Recreation
Lions Park	Local	7.95	Recreation
R.A. Green Park	Local	16.60	Recreation
Washburn Street Baseball Diamond	Local	1.41	Recreation
Tuttle Park	Local	3.23	Recreation
Church Street Ballfield	Local	5.92	Recreation
Russell Park	Local	6.00	Recreation
Township Hall and Park	Local	0.56	Recreation
Camp Storer	NGO	796.70	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Headwaters–continued			
Camp Teetonkah	NGO	238.48	Recreation
Phyllis Haehnle Sanctuary	NGO	950.72	Conservation
Grand River/Liberty Fen-NEIDLINGER	NGO	88.47	Conservation
Grand River/Liberty Fen-PETRIE	NGO	128.49	Conservation
Grand River/Liberty Fen-LOWE	NGO	76.77	Conservation
Grand River/Liberty Fen-NEIDLINGER 2	NGO	53.05	Conservation
Grand River/Liberty Fen-BARTO	NGO	24.05	Conservation
Lefglen	NGO	188.04	Conservation
Four Seasons Campground	Private	79.69	Recreation
Fa-Ho-Lo Park/Assemblies of God Camp	Private	127.53	Recreation
G.W. Carver Camp	Private	265.31	Recreation
Lighthouse Harbor Camp	Private	52.24	Recreation
Jackson Country Club	Private	306.43	Recreation
Deer Run Golf Course	Private	81.50	Recreation
Clark Lake Golf Club	Private	213.01	Recreation
Grande Golf Course	Private	12.69	Recreation
Green Valley Golf Club	Private	105.37	Recreation
Swanee's Twin Knolls Golf Course	Private	44.34	Recreation
Lakeland Hills Golf Club	Private	111.12	Recreation
Gracewil Pines Golf Course	Private	104.52	Recreation
Sparrow Hawk Golf Course	Private	118.31	Recreation
Waterloo Golf Course	Private	67.38	Recreation
Hankerd Hills Golf Course	Private	191.99	Recreation
Willow Creek Golf Course	Private	124.92	Recreation
Lake Leann Golf Course	Private	50.57	Recreation
Jackson Outdoor Club	Private	156.29	Recreation
Waterloo State Recreation Area	State	20,147.49	Recreation
Meridian-Baseline Historic State Park	State	87.49	Conservation
Grass Lake State Game Area	State	132.12	Conservation
Dansville State Game Area	State	4,758.85	Conservation
Sharonville State Game Area	State	4,366.80	Conservation
Upper			
Cascades Golf Course	County	228.00	Recreation
Cascade Falls Park	County	146.10	Recreation
Minard Mills Park	County	5.06	Recreation
Lime Lake Park	County	183.95	Recreation
Bunker Rd Canoe Landing	Local	5.79	Recreation
Boat Launch	Local	335.75	Recreation
Woldumar Nature Center	Local	155.38	Recreation
Hamlin Township Owned Land	Local	23.74	Conservation
Groner Park	Local	3.78	Recreation
North Jackson Lions Park	Local	19.91	Recreation
Baldwin Park	Local	24.48	Recreation
Biggs Park	Local	1.42	Recreation
McArthur River Park	Local	3.73	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Upper–continued			
Memorial Park	Local	0.26	Recreation
Hall Street Park	Local	0.50	Recreation
Scott Munn Riverwalk	Local	0.87	Recreation
Island Park	Local	1.28	Recreation
Howe Memorial Field	Local	25.92	Recreation
J.B. Bradley Park	Local	2.60	Recreation
Glenna Droscha Park	Local	105.64	Recreation
Columbia Creek Park	Local	2.97	Recreation
Burchfield Park and Nature Area	Local	565.03	Conservation
Village of Dimondale Recreation Area	Local	0.55	Recreation
Lions Park	Local	8.04	Recreation
Fine Park	Local	37.06	Recreation
Risdale Park	Local	15.79	Recreation
Hillborn Park	Local	7.96	Recreation
Wainwright	Local	4.60	Recreation
Woodcreek Park	Local	4.82	Recreation
Anderson Nature Park	Local	150.86	Recreation
Fulton Park	Local	23.10	Recreation
Averill Park	Local	8.00	Recreation
Ingham Park	Local	13.34	Recreation
Lewton Park	Local	1.66	Recreation
Moores Park	Local	24.04	Recreation
Quentin Park	Local	14.18	Recreation
Frances Park	Local	74.09	Recreation
Riverside Park	Local	9.66	Recreation
Grand River Park	Local	46.29	Recreation
Cooley Gardens	Local	5.81	Recreation
Hillsdale Park	Local	1.41	Recreation
St. Joseph Park	Local	23.79	Recreation
Kate Palmer Sanctuary	NGO	34.84	Conservation
Arbor Hills Country Club	Private	148.51	Recreation
Lansing Country Club	Private	150.42	Recreation
Hickory Hills Golf Course	Private	339.35	Recreation
Burr Oak Golf Club	Private	121.48	Recreation
Foxwood Golf Course	Private	35.32	Recreation
Bonnieview Golf Course	Private	80.12	Recreation
Branson Bay Golf Course	Private	113.82	Recreation
Iron Links Golf Course	Private	155.62	Recreation
Chisolm Hills Golf Course	Private	72.12	Recreation
State Secondary Complex-State Wildlife Property	State	371.61	Conservation
Lake Interstate State Game Area	State	113.26	Conservation
McNamara Canoe Landing	Unknown	9.71	Recreation
River Frontage	Unknown	3.37	Recreation
Private Park	Unknown	1.17	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle			
Ingham County Fairgrounds	County	78.16	Recreation
Forest Reserve	County	25.82	Conservation
Forest Reserve	County	39.33	Conservation
Fenton Livingston Soil Conservation District	County	132.61	Conservation
St. Francis Retreat	Local	116.97	Recreation
Fenner Nature Center	Local	130.60	Conservation
Eagle Park Fairgrounds	Local	28.33	Recreation
Delhi Township Land	Local	22.31	Conservation
Hartrick Natural Area	Local	62.10	Conservation
Riverdowns Natural Area	Local	64.72	Conservation
Sander Property	Local	26.89	Recreation
Forest Hills Natural Area	Local	3.84	Conservation
Sanford Natural Area	Local	82.80	Conservation
Keegan Nature Area	Local	6.89	Conservation
Richard A. Padgett Natural Area	Local	64.39	Conservation
Lake Lansing Marsh	Local	11.21	Conservation
Spengler Marsh	Local	2.73	Conservation
Michigan Wildlife Habitat Foundation	Local	139.43	Conservation
Millbrook Meadows Open Space	Local	11.40	Recreation
Vevay Township Hall and Park	Local	11.08	Recreation
Dansville Community Park	Local	1.62	Recreation
Griffen Park	Local	1.98	Recreation
Bicentennial Park	Local	1.58	Recreation
Rayner Park	Local	54.05	Recreation
Lee Austin Park	Local	1.63	Recreation
Hayes Park	Local	10.57	Recreation
Laylin Park	Local	9.93	Recreation
Bond Park	Local	6.81	Recreation
Maple Grove Park	Local	9.43	Recreation
Kiwanis Park	Local	13.56	Recreation
Sycamore Park	Local	1.79	Recreation
Senior Citizens Park	Local	4.24	Recreation
Delhi Community Service Center and Park	Local	3.11	Recreation
Jaycee Park	Local	5.94	Recreation
Willoughby Park	Local	41.50	Recreation
Valhalla Park	Local	42.97	Recreation
Parcel B	Local	13.45	Other
Georgetown Park	Local	9.72	Recreation
Marscot Park	Local	9.72	Recreation
Miller Road Community Center	Local	1.65	Recreation
Graves Park	Local	13.16	Recreation
Parcel D	Local	30.59	Other
Attwood Park	Local	34.16	Recreation
Unnamed Park	Local	31.50	Conservation
Beck Park	Local	8.90	Recreation
Kenneth A Hope Soccer Complex	Local	123.11	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Davis Park	Local	48.23	Recreation
Kaynorth Park	Local	6.31	Recreation
Bluebell Park	Local	5.62	Recreation
Tot Lot	Local	0.41	Recreation
Lake Delta	Local	61.81	Conservation
Unknown Park	Local	0.57	Recreation
Erickson Park	Local	26.17	Recreation
Risdale Park	Local	15.79	Recreation
Munn Park	Local	18.20	Recreation
Pleasant View Park	Local	7.11	Recreation
Cavanaugh Park	Local	25.16	Recreation
Kendon Park	Local	5.62	Recreation
Waldo Park	Local	0.67	Recreation
Everett Park	Local	4.34	Recreation
Poxson Park	Local	19.22	Recreation
Westend Park	Local	8.51	Recreation
Hawk Island County Park	Local	85.86	Recreation
Holly Park	Local	4.99	Recreation
Deer Creek Park	Local	15.34	Recreation
Ingham Park	Local	13.34	Recreation
Lyons Park	Local	5.47	Recreation
Thurby Park	Local	0.51	Recreation
Tammany Park	Local	2.07	Recreation
Glen Eden Park	Local	6.97	Recreation
McCormick Park	Local	12.71	Recreation
Reola Park	Local	2.77	Recreation
Forest View Park	Local	12.42	Recreation
Washington Park	Local	47.64	Recreation
Elmhurst Park	Local	6.21	Recreation
Greencroft Park	Local	4.17	Recreation
Clifford Park	Local	7.54	Recreation
Meridian Riverfront Park	Local	197.84	Recreation
Barb Dean Tot Lot	Local	2.64	Other
Caesar Donora Park	Local	3.38	Recreation
Moores Park	Local	24.04	Recreation
Sycamore Park	Local	10.10	Recreation
Irving Park	Local	0.35	Recreation
MDOT Roadside Park	Local	8.64	Recreation
Trager Park	Local	1.33	Recreation
Potter Park	Local	79.56	Recreation
Ferguson Park	Local	2.94	Recreation
Wonch Park	Local	17.59	Recreation
Tacoma Hills Park	Local	24.91	Recreation
Walsh Park	Local	5.02	Recreation
Crego Park	Local	200.90	Recreation
Leland Park	Local	2.16	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Riverpoint Park	Local	5.36	Recreation
New Community Park	Local	136.99	Recreation
Cooley Gardens	Local	5.81	Recreation
Scott Park	Local	3.46	Recreation
Emerson Park	Local	9.43	Recreation
Van Atta Woods Park	Local	42.71	Recreation
Stabler Park	Local	1.51	Recreation
Colonial Park	Local	21.08	Recreation
Regent Park	Local	8.78	Recreation
Cherry Hill	Local	5.98	Conservation
Elizabeth Park	Local	2.70	Recreation
Reutter Park	Local	4.43	Recreation
Kalamazoo Plaza	Local	1.30	Recreation
Letts Community Center/Kingsley Park	Local	7.04	Recreation
St. Joseph Park	Local	23.79	Recreation
Hunter Park	Local	19.28	Recreation
Foster Park	Local	4.93	Recreation
Schreiner Park	Local	1.82	Recreation
Kircher Park	Local	6.98	Recreation
Wentworth Park	Local	1.74	Recreation
Foster Community Center	Local	3.03	Recreation
Osborn Park	Local	1.00	Recreation
Ferris Park	Local	8.01	Recreation
Ehinger Park	Local	1.08	Recreation
119th Armory	Local	4.34	Other
Stoddard Park	Local	1.76	Recreation
Orchard Street Park	Local	0.89	Recreation
Valley Court Park	Local	5.74	Recreation
Adado Riverfront Park	Local	21.06	Recreation
Mulliken Ballfield	Local	4.87	Recreation
Oak Park	Local	18.82	Recreation
Durant Park	Local	4.54	Recreation
Windmere Park	Local	8.67	Recreation
Meridian Road Park	Local	65.41	Recreation
Ranney Park	Local	20.94	Recreation
Harrison Park	Local	0.78	Recreation
Jaycees Park	Local	5.50	Recreation
Westside Park	Local	15.64	Recreation
Hull Court Park	Local	1.62	Recreation
Forest Park	Local	0.27	Recreation
Gould Park	Local	0.96	Recreation
Dunneback Park	Local	4.97	Recreation
Comstock Park	Local	11.55	Recreation
Glencairn Park	Local	1.69	Recreation
Burcham Road Park	Local	22.18	Recreation
Larch Park	Local	1.83	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Central Park	Local	250.65	Recreation
Island Park	Local	2.00	Recreation
Shaw Park	Local	0.68	Recreation
Tollgate Wetlands	Local	7.74	Conservation
Turner Mini Park	Local	0.49	Recreation
Sharp Park	Local	61.55	Recreation
Lootens Park	Local	93.77	Recreation
Ormond Park	Local	10.90	Recreation
Edmore Park	Local	0.40	Recreation
Oak Park	Local	8.04	Recreation
Patriarche Park	Local	34.18	Recreation
Dietrich Park	Local	2.95	Recreation
Boynton Riverfront Park	Local	3.39	Recreation
Turner Dodge Park	Local	8.26	Recreation
Bassett Park	Local	3.94	Recreation
Wolf Court Park	Local	0.27	Recreation
Slater Park	Local	9.11	Recreation
Glenhaven Park	Local	0.42	Recreation
Fitzgerald Park	Local	132.12	Recreation
Reasoner Park	Local	7.33	Recreation
Sunset Hills Park	Local	0.90	Recreation
Porter Park	Local	10.73	Recreation
Delta Mills Park	Local	34.78	Recreation
Bancroft Park	Local	63.12	Recreation
Kimberly Park	Local	21.22	Recreation
Brattin Woods	Local	18.50	Conservation
Harrison Meadows Park	Local	52.36	Recreation
Whitehills Park	Local	25.93	Recreation
Grand Woods Park	Local	150.08	Recreation
Seventh Park	Local	2.39	Recreation
Tecumseh Park	Local	68.57	Recreation
Tamarisk Park	Local	2.61	Recreation
Hillbrook Park	Local	18.67	Recreation
Filley Park	Local	2.99	Recreation
Henry Fine Park	Local	28.80	Recreation
Gier Community Center and Park	Local	38.78	Recreation
Hunter's Orchard Park	Local	39.27	Recreation
Wilson Park	Local	5.15	Recreation
Lake Lansing Park South	Local	32.13	Recreation
Horsebrook Park	Local	6.98	Recreation
Hawk Meadows	Local	73.04	Conservation
Lincoln Brick Park	Local	89.75	Recreation
Jones Lake Park	Local	2.41	Recreation
Abbott Park	Local	154.93	Recreation
Softball and Aquatic Park	Local	64.70	Recreation
Coleman Road Playlot	Local	1.20	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Soccer Park	Local	37.84	Recreation
Valley Turner Playlot	Local	2.38	Other
Lake Lansing Park North	Local	431.50	Recreation
Valley Farms Park	Local	12.47	Recreation
Watertown Township Land	Local	56.34	Conservation
Park Lake	Local	28.69	Recreation
Park Lake Beach	Local	1.16	Recreation
Bath Soccer Field	Local	3.82	Recreation
Rickard Park	Local	0.77	Recreation
Wiswasser Park	Local	5.12	Recreation
Looking Glass Valley Park	Local	5.54	Recreation
Fletcher Robson Nature Park	Local	2.54	Recreation
James Couzen Memorial Park	Local	4.02	Recreation
Township Park	Local	14.83	Recreation
Looking Glass Riverfront Park	Local	8.92	Recreation
Heritage Park	Local	16.64	Recreation
Sleieght Road Park	Local	4.99	Recreation
City of Dewitt Sports Park	Local	6.91	Recreation
Webster Road Park	Local	18.42	Recreation
City Park	Local	0.61	Recreation
Percy Carris Park	Local	4.70	Recreation
Memorial Park	Local	1.24	Recreation
Elmwood Park	Local	1.70	Recreation
Riverside Park	Local	6.26	Recreation
River Trail Park	Local	7.04	Recreation
McGuire Park	Local	9.35	Recreation
Perry Jubilee Park	Local	9.06	Recreation
Millbrook Meadows Park	Local	2.42	Recreation
Wilson Street Park	Local	1.56	Recreation
Athletic Field	Local	7.57	Recreation
Brush Street Park	Local	1.81	Recreation
Community Lake Park	Local	24.31	Recreation
Thompson Park	Local	7.61	Recreation
Tolan Park	Local	1.09	Recreation
Flohe Field	Local	5.89	Recreation
Alton Park	Local	2.59	Recreation
Powers Park	Local	2.27	Recreation
Joe Tichvon Park	Local	1.43	Recreation
Bogue Flats Park	Local	36.38	Recreation
Athletic Field	Local	38.55	Recreation
McClintock Mini Park	Local	4.78	Recreation
Bates Scout Park	Local	9.08	Recreation
Boat Launch	Local	1.75	Recreation
Devore Park	Local	7.60	Recreation
Shubel Park	Local	66.85	Recreation
Michigan Avenue Park	Local	46.09	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Elm Park	Local	7.45	Recreation
Elm Park	Local	7.45	Recreation
Well Field Park	Local	20.13	Recreation
Towar Park	Local	30.51	Recreation
Scott Woods Park	Local	87.84	Recreation
Stroud Park	Local	2.98	Recreation
Bon Air Park	Local	3.54	Recreation
Burchard Park	Local	7.56	Recreation
Marshall Park	Local	18.61	Recreation
McKinch Park	Local	34.53	Recreation
Orlando Park	Local	3.14	Recreation
Ottawa Hills Park	Local	6.88	Recreation
Fowlerville Community Park	Local	31.72	Recreation
Centennial Park	Local	3.82	Recreation
Marion Township Park	Local	56.47	Recreation
Michigan Steam Engines	Local	32.04	Other
Deadman's Hill	Local	30.33	Recreation
The Commons	Local	1.39	Recreation
Kramer Ruthruff Area	Local	121.19	Conservation
Fowlerville	Local	37.73	
Unknown	Local	25.80	
Howell Nature Center	NGO	219.35	Recreation
Forest Reserve	NGO	33.58	Conservation
Northumberland Nature Preserve	NGO	90.56	Conservation
Hawk Valley Farms	NGO	51.66	Conservation
Red Cedar River Floodplain	NGO	10.88	Conservation
Girl Scout Camp	Private	10.07	Recreation
Kovacs Family Conservation Easement	Private	111.07	Conservation
Grand Ledge Country Club	Private	141.55	Recreation
Walnut Hills Country Club	Private	187.11	Recreation
Portland Country Club	Private	79.96	Recreation
Designated Utility Corridors	Private	1,688.47	Conservation
El Dorado Golf Course	Private	167.99	Recreation
Iron Links Golf Course	Private	155.62	Recreation
Chisholm Hills Golf Course	Private	72.12	Recreation
Oak Lane Golf Course	Private	102.52	Recreation
Brookshire Golf Course	Private	44.56	Recreation
Forest Akers Golf Course	Private	356.95	Recreation
Players Club Golf Courses	Private	93.92	Recreation
Indian Hills Golf Course	Private	51.39	Recreation
Centennial Acres Golf Course	Private	154.20	Recreation
Red Cedar Golf Course	Private	69.27	Recreation
Ledge Meadows Golf Course	Private	146.11	Recreation
Grosebeck Golf Course	Private	99.05	Recreation
Four Winds Golf Course	Private	37.61	Recreation
Lake-O-the-Hills Golf Course	Private	27.76	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Middle–continued			
Pine Lake Golf Course	Private	107.51	Recreation
Royal Scott Golf Course	Private	127.22	Recreation
Chardell Golf Course	Private	160.65	Recreation
Hawk Hollow Golf Course	Private	199.21	Recreation
Willow Wood Golf Course	Private	156.01	Recreation
Glenbrier Golf Course	Private	147.72	Recreation
Prairie Creek Golf Course	Private	149.46	Recreation
Dewitt Golf Center	Private	21.07	Recreation
Timber Ridge Golf Course	Private	75.51	Recreation
Pine Hills Golf Course	Private	63.90	Recreation
Sycamore Golf Course	Private	52.41	Recreation
Waverly Golf Course	Private	96.99	Recreation
Eagleview Golf Course	Private	198.63	Recreation
Wheatfield Valley Golf Course	Private	186.67	Recreation
Secluded Acres	Private	152.21	Recreation
Looking Glass Sports Club	Private	77.70	Recreation
Michigan Trap Shoot	Private	425.36	Recreation
Howell Gun Club	Private	42.48	Recreation
Fowlerville Meadows	Private	2.61	
Solitude Meadows	Private	9.83	
Unknown	Private	998.29	
Babcock Landing	State	6.43	Recreation
Forest Reserve	State	13.28	Conservation
Forest Reserve	State	485.14	Conservation
Forest Reserve	State	25.42	Conservation
Forest Reserve	State	91.69	Conservation
Forest Reserve	State	17.98	Conservation
Forest Reserve	State	63.79	Conservation
Forest Reserve	State	62.79	Conservation
Ingham Conservation District	State	282.30	Conservation
Portland Extension State Game Area	State	77.80	Conservation
State Secondary Complex-State Wildlife Property	State	371.61	Conservation
Hillcrest State Game Area	State	262.90	Conservation
Dansville State Game Area	State	4,758.85	Conservation
Gregory State Game Area	State	2,690.92	Conservation
Portland State Game Area	State	2,297.52	Conservation
Rose Lake State Wildlife Area	State	4,007.98	Conservation
Lake Lansing Boat Launch	Unknown	6.38	Recreation
Candy Cane Park	Unknown	4.53	Recreation
Lake Geneva West	Unknown	1.72	Recreation
Lake Geneva Park East	Unknown	3.52	Recreation
Springbrook Meadows Subdivision	Unknown	4.34	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower			
Barry County Fairgrounds	County	158.52	Recreation
Ionia Free Fairgrounds	County	145.14	Recreation
Knapp Valley Forest Park	County	92.04	Recreation
Forest Reserve	County	97.87	Conservation
Forest Reserve	County	79.36	Conservation
Forest Reserve	County	3.24	Conservation
Forest Reserve	County	52.92	Conservation
Forest Reserve	County	95.55	Conservation
Forest Reserve	County	34.26	Conservation
Forest Reserve	County	1.00	Conservation
Charlton Park	County	287.73	Recreation
Coldwater River Park	County	3.90	Recreation
Caledonia Lakeside Park	County	45.41	Recreation
Douglas Walker Park	County	55.84	Recreation
Earle Brewer Park	County	96.37	Recreation
Spring Grove Park	County	19.01	Recreation
Dutton Park	County	17.40	Recreation
Thornapple Riverbend Park (unofficial name)	County	153.10	Recreation
Ruehs Park	County	3.60	Recreation
Creekside Park	County	32.15	Recreation
Paris Park	County	74.64	Recreation
Palmer Park	County	164.11	Recreation
Palmer Park Field	County	3.12	Recreation
Lowell Regional Park	County	702.34	Recreation
John Ball Park and Zoo	County	110.50	Recreation
Chief Hazy Cloud Park	County	34.35	Recreation
Bertha Brock Park	County	192.38	Recreation
Seidman Park	County	421.03	Recreation
Fallasberg Park	County	409.39	Recreation
Provin Trails Park	County	46.64	Recreation
Dwight Lydell Park	County	18.47	Recreation
Donald J. Lamoreaux Park	County	268.69	Recreation
Townsend Park	County	144.23	Recreation
Rogue River Park	County	56.08	Recreation
Pickerel Lake Fred Meijer Nature Preserve	County	292.76	Conservation
Wahlfield Park	County	48.62	Recreation
Luton Park	County	186.18	Recreation
Myers Lake Park	County	7.38	Recreation
Wabasis Park	County	98.77	Recreation
Bettes Park	County	8.51	Recreation
Long Lake Park	County	152.70	Recreation
White Pine Park	County	70.17	Recreation
Cooper Creek Park	County	60.28	Recreation
Gordon Park	County	26.99	Recreation
Fisk Knob Park	County	5.38	Recreation
William McCarthy County Park	County	25.78	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Ford Lincoln County Park	County	4.61	Recreation
Schmied County Park	County	44.12	Recreation
Spencer Forest	County	432.44	Recreation
Millenium Park	County	1,683.12	Recreation
Shiawassee County Agri. Society	County	114.21	Recreation
Montcalm Soil Cons District	County	65.77	Recreation
Manistee National Forest	Federal	537,329.25	Conservation
Frederik Meijers Gardens	Local	117.53	Recreation
Camp Roger	Local	101.92	Recreation
Camp Concordia	Local	50.23	Recreation
Camp Calvary	Local	213.79	Recreation
Blandford Nature Center	Local	145.25	Conservation
Ionia Schools Nature Study Area	Local	118.09	Conservation
Christiansen Nature Center	Local	76.75	Conservation
Lake Odessa Fairgrounds	Local	29.98	Recreation
Hudsonville Community Fairgrounds	Local	35.22	Recreation
Recreation Park and Youth Fairgrounds	Local	36.98	Recreation
Berlin Fairgrounds	Local	38.02	Recreation
4H Fairgrounds	Local	71.41	Recreation
Fellowship Greens	Local	89.59	Conservation
Gravel Pit	Local	38.70	Other
Gravel Pit	Local	13.96	Other
George P. Tilma Nature Preserve	Local	39.80	Conservation
Cloverdale Park	Local	3.35	Recreation
Gateway Memorial Park	Local	0.65	Recreation
Old Town Field	Local	29.12	Recreation
Putnam Park	Local	6.41	Recreation
Water Tower Park	Local	2.51	Recreation
City Ballfield	Local	2.88	Recreation
Vermontville City Park	Local	1.09	Recreation
Second Ward Park	Local	0.56	Recreation
Lake Alliance Park	Local	104.67	Recreation
Fish Hatchery Park	Local	39.53	Recreation
First Ward Park	Local	2.00	Recreation
Tyden Park	Local	11.67	Recreation
Veteran Memorial Park	Local	2.45	Recreation
Potterville City Park	Local	11.54	Recreation
Bob King Park	Local	3.81	Recreation
Fox Park	Local	85.58	Recreation
Spring Park	Local	22.11	Recreation
Athletic Field	Local	13.24	Recreation
Sesquicentennial Park	Local	0.43	Recreation
Calvin Hill Park	Local	1.88	Recreation
Classic Memorial Park	Local	6.71	Recreation
Moore Park	Local	9.59	Recreation
Floyd Van Buren Park	Local	5.57	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Village Beach Park	Local	2.09	Recreation
Village Park	Local	6.55	Recreation
Athletic Field	Local	4.21	Recreation
Athletic Field	Local	3.75	Recreation
Bicentennial Park	Local	39.53	Recreation
WhistleStop Park	Local	50.87	Recreation
Cutler Park	Local	9.83	Recreation
Park	Local	4.99	Recreation
Park	Local	10.57	Recreation
Ideal Park	Local	27.74	Recreation
Hughes Park	Local	25.24	Recreation
Jaycee Park	Local	18.83	Recreation
Jamestown Park (Proposed)	Local	8.31	Recreation
Park	Local	3.47	Recreation
Kelloggwoods Park	Local	46.58	Recreation
Pinewood Park	Local	15.48	Recreation
Kelloggsville Park	Local	15.76	Recreation
Sunrise Park	Local	12.48	Recreation
Old Farm Park	Local	9.97	Recreation
Veterans Park	Local	15.83	Recreation
Home Acres Park	Local	3.59	Recreation
Rush Creek Park	Local	39.82	Recreation
Heritage Park	Local	22.70	Recreation
Lamberts Park	Local	15.93	Recreation
Oriole Park	Local	12.06	Recreation
40th Street Park	Local	5.58	Recreation
Charles Lemery Park	Local	99.78	Recreation
Calvinrest Park	Local	9.79	Recreation
Lions Park	Local	8.02	Recreation
Pioneer Park	Local	5.63	Recreation
Stanaback Park	Local	13.50	Recreation
Wedgewood Park	Local	4.54	Recreation
Park	Local	34.94	Recreation
Cascade Township Park	Local	60.95	Recreation
Woodcrest Park	Local	13.38	Recreation
Hillcroft Park	Local	25.04	Recreation
Prairie Park	Local	10.31	Recreation
Ken-O-Sha Park	Local	91.47	Recreation
Leslie E. Tassell Park	Local	3.48	Recreation
Museums Garden Park	Local	0.41	Recreation
Southern Little League Park	Local	43.41	Recreation
Lamar Park	Local	62.11	Recreation
Pinery Park	Local	63.29	Recreation
Garfield Park	Local	29.72	Recreation
Battjes Park	Local	52.26	Recreation
Northeast Park	Local	12.78	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Mulick Park	Local	8.13	Recreation
Marquette Park	Local	38.16	Recreation
Stoney Lakeside Park	Local	68.28	Recreation
Kensington Park	Local	20.81	Recreation
Park	Local	24.59	Recreation
Rogers Field	Local	4.40	Recreation
Athletic Field	Local	35.22	Recreation
New Park	Local	35.79	Recreation
Campau Park	Local	4.39	Recreation
Richards Park	Local	1.42	Recreation
Richards Park	Local	5.31	Recreation
Martin Luther King Park	Local	18.28	Recreation
Clemente Park	Local	13.01	Recreation
Creekside Park	Local	22.01	Recreation
Boat and Canoe Launch Ramp	Local	2.36	Recreation
Michael McGraw Park	Local	68.88	Recreation
Veterans Park	Local	1.29	Recreation
Park	Local	40.39	Conservation
Scheid Park	Local	9.07	Recreation
Ada Park and Arboretum	Local	46.33	Recreation
A. Collins Park	Local	2.43	Recreation
Bates Scout Park	Local	9.08	Recreation
Bates Scout Park	Local	9.08	Recreation
Forest Hill Park	Local	11.67	Recreation
McMahon Park	Local	12.42	Recreation
Manhattan Recreation Area	Local	43.01	Recreation
Westtown Commons Park	Local	1.22	Recreation
Harmon Field	Local	6.94	Conservation
Wilcox Park	Local	13.35	Recreation
Hodenpyl Woods/Remington Park	Local	76.76	Recreation
Droste Memorial Park	Local	10.14	Recreation
Sliding Hill Park	Local	20.20	Recreation
Douglas Park	Local	0.94	Recreation
Crescent Park	Local	1.00	Recreation
Lincoln Park	Local	13.02	Recreation
Ah-Nab-Awen Park	Local	14.48	Recreation
Lincoln Lawns Park	Local	5.15	Conservation
Shawmut Hills Park	Local	4.77	Recreation
Fish Ladder Park	Local	1.21	Conservation
Walker Community Park	Local	16.74	Recreation
Sixth Street Bridge Park	Local	4.21	Recreation
Coit Park	Local	4.56	Recreation
Highland Park	Local	28.80	Recreation
Look-Out Park	Local	1.86	Recreation
Canal Street Park	Local	3.83	Recreation
Lake Victoria Beach Playlots	Local	3.75	Conservation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Aman Park	Local	347.52	Recreation
Harwood Softball Complex	Local	44.39	Recreation
Belknap Park	Local	35.73	Recreation
Harrison Park	Local	4.74	Recreation
Richmond Park	Local	60.15	Recreation
Briggs Park	Local	11.53	Recreation
Harper Park	Local	3.72	Recreation
Aberdeen Park	Local	6.89	Recreation
Shattuck Park	Local	0.68	Recreation
Balice Park	Local	0.83	Recreation
Huff Park	Local	87.82	Recreation
Boat Launch	Local	1.75	Recreation
McCann Park	Local	0.34	Recreation
McConnell Park	Local	4.90	Recreation
Athletic Field	Local	2.09	Recreation
Alpine Estates Park	Local	8.43	Recreation
Hale Park	Local	2.36	Recreation
Robinson Park	Local	1.27	Recreation
Devore Park	Local	7.60	Recreation
Jaycee Fitness Trail	Local	7.48	Recreation
English Hills Park	Local	4.71	Recreation
Riverside Park	Local	185.02	Recreation
Village Park	Local	0.82	Recreation
Athletic Field	Local	4.44	Recreation
Baseball Park	Local	15.93	Recreation
Field of Dreams	Local	5.17	Recreation
Village Park	Local	7.27	Recreation
Oak Street Park	Local	1.15	Recreation
Dean Lake Park	Local	6.21	Recreation
Holtman Park	Local	12.77	Recreation
Fells Park Property Addition	Local	62.17	Conservation
Victor Street Park	Local	0.35	Recreation
Ambrose Park	Local	9.51	Recreation
Comstock Park	Local	3.46	Recreation
Water Tower Park	Local	1.78	Recreation
Kibbee Street Park	Local	0.79	Recreation
St. Johns City Park	Local	19.45	Recreation
Fink Park	Local	3.04	Recreation
Northgate Park	Local	4.34	Recreation
Airway Township Park	Local	3.37	Recreation
Alpine Sports Complex	Local	21.67	Recreation
Jaycee Park	Local	1.13	Recreation
D.W. Richardson Park	Local	6.77	Recreation
Senior Citizen Park	Local	5.65	Recreation
Little League Recreation Park	Local	11.61	Recreation
Versluis Park	Local	12.45	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Park	Local	16.30	Recreation
Gumaer Memorial Park	Local	10.60	Recreation
Park	Local	17.17	Recreation
Gold Dust Park	Local	6.20	Recreation
Packer Park	Local	5.78	Recreation
Cannon Township Center Property	Local	36.74	Conservation
Grattan Township Roadside Park	Local	2.37	Recreation
Friendship Park	Local	27.78	Recreation
Playground	Local	1.85	Recreation
Athletic Field	Local	6.29	Recreation
East Riverside Park	Local	2.96	Recreation
Water Street Park	Local	1.75	Recreation
Armstrong Park	Local	5.24	Recreation
Demorest Field	Local	28.76	Conservation
Rotary-Jaycee Park	Local	1.93	Recreation
Richardson-Sowerby Park	Local	14.75	Recreation
Playground	Local	4.62	Recreation
Village Park	Local	2.07	Recreation
Park	Local	0.98	Recreation
Peppler Park	Local	7.44	Recreation
Memorial Park	Local	15.21	Recreation
Playground	Local	1.86	Recreation
Hope Green Park	Local	3.56	Recreation
Maple Rapids Memorial Ballfields	Local	8.80	Recreation
Maple Rapids Village Park	Local	1.33	Recreation
Elsie Park	Local	40.95	Recreation
Buth Field	Local	5.66	Conservation
Balyeat Field	Local	9.21	Recreation
Rogers Park	Local	5.69	Recreation
Nash Field	Local	8.58	Recreation
Baldwin Lake Beach	Local	3.52	Recreation
Tower Park	Local	38.23	Recreation
Jackson's Landing Park	Local	2.29	Recreation
Veteran's Memorial Park	Local	2.16	Recreation
Park	Local	64.31	Conservation
Franklin Street Park	Local	4.91	Recreation
Alan G. Davis Park	Local	65.88	Recreation
Pearl Street Park	Local	2.74	Recreation
Park	Local	22.45	Conservation
Village Park	Local	6.14	Recreation
Morley Park	Local	14.25	Recreation
Riggle Field	Local	2.32	Recreation
Park	Local	5.61	Recreation
Park	Local	5.00	Conservation
Park	Local	33.36	Conservation
Park	Local	9.58	Conservation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Park	Local	22.47	Recreation
Park	Local	78.39	Conservation
Salisbury Park	Local	4.06	Recreation
Little League Fields	Local	4.39	Recreation
Unnamed Park	Local	38.42	Conservation
Woodland Park	Local	27.32	Recreation
Grand River Riverfront Park	Local	74.86	Recreation
Central Riverside Park	Local	5.68	Recreation
Jackson Park	Local	43.26	Recreation
Jackson Street Park	Local	2.57	Recreation
Ballfield	Local	7.58	Other
Burgis Park	Local	3.42	Recreation
Victor Township Property	Local	9.43	Other
Old School	Local	4.19	Other
Camp Algonquin	NGO	44.92	Recreation
MSU Clarksville Horticultural Experiment Station	NGO	444.46	Other
Ronald Warner Nature Sanctuary	NGO	99.10	Conservation
Nature Preserve	NGO	76.76	Conservation
Wege Natural Area for the Study of Ecology	NGO	61.28	Other
Lamberton Lake Nature Preserve	NGO	46.28	Conservation
Saul Lake Nature Preserve	NGO	120.12	Conservation
Brower Lake Nature Preserve	NGO	62.58	Conservation
Otis Sanctuary	NGO	126.70	Conservation
Carter Lake Preserve	NGO	60.70	Conservation
Gertrude McPharlin Bauer Nature Sanctuary	NGO	20.00	Conservation
Coldwater River	NGO	2.34	Conservation
George and Jessie Krum Memorial	NGO	16.87	Conservation
Wesley Woods Camp	Private	94.49	Recreation
Camp Michiwana	Private	180.43	Recreation
Charlotte Optimist Youth Camp	Private	19.18	Recreation
Camp Optomist	Private	153.25	Recreation
Pine Ridge Bible Camp	Private	76.71	Recreation
Michigan Trails Girl Scouts	Private	486.41	Recreation
Paradise Cove Resort Campground	Private	18.29	Recreation
West MI Conf. of United Methodist Church	Private	251.17	Recreation
Circle Pines Center	Private	267.31	Recreation
Washington CE	Private	265.56	Conservation
Schultz Lake Preserve CE	Private	168.49	Conservation
Perry Family CE	Private	395.93	Conservation
Jones CE	Private	160.88	Conservation
Boesch CE	Private	60.51	Conservation
Gray CE	Private	115.35	Conservation
Conservation Easement	Private	0.77	Conservation
Conservation Easement	Private	6.64	Conservation
Conservation Easement	Private	1.60	Conservation
Conservation Easement	Private	3.63	Conservation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Conservation Easement	Private	3.66	Conservation
Conservation Easement	Private	0.19	Conservation
Conservation Easement	Private	0.58	Conservation
Conservation Easement	Private	0.38	Conservation
Conservation Easement	Private	0.46	Conservation
Conservation Easement	Private	0.36	Conservation
Conservation Easement	Private	1.17	Conservation
Conservation Easement	Private	0.16	Conservation
Conservation Easement	Private	0.83	Conservation
Conservation Easement	Private	0.60	Conservation
Conservation Easement	Private	0.67	Conservation
Conservation Easement	Private	5.04	Conservation
Conservation Easement	Private	5.62	Conservation
Conservation Easement	Private	3.59	Conservation
Charlotte Country Club	Private	144.13	Recreation
Hastings Country Club	Private	154.31	Recreation
Morrison Lake Country Club	Private	100.24	Recreation
Cascade Hills Country Club	Private	239.17	Recreation
Lincoln Country Club	Private	108.52	Recreation
Kent Country Club	Private	124.00	Recreation
Western Greens Country Club	Private	126.60	Recreation
Gracewil Lawn Country Club	Private	203.19	Recreation
Blythefield Country Club	Private	161.82	Recreation
Scott Lake Country Club	Private	237.34	Recreation
Grenville Country Club	Private	55.23	Recreation
North Star Country Club	Private	152.96	Recreation
Sunnybrook Country Club	Private	150.80	Recreation
Designated Utility Corridors	Private	1,763.74	Conservation
Battle Creek Outdoor Education Center	Private	137.35	Education
Twin Brook Golf Course	Private	193.66	Recreation
Mulberry fore Golf Club	Private	139.20	Recreation
Gun Ridge Golf Club	Private	106.36	Recreation
River Bend Golf Course	Private	185.83	Recreation
Briarwood Golf Club	Private	163.49	Recreation
Saskatoon Golf Course	Private	319.52	Recreation
Tyler Creek Golf Club	Private	121.06	Recreation
Broadmoor Golf Course	Private	139.94	Recreation
Byron Hills Golf Course	Private	158.34	Recreation
Crystal Springs Golf Course	Private	200.86	Recreation
Ironwood Golf Course	Private	83.69	Recreation
Summergeen Golf Course	Private	30.64	Recreation
Maple Hill Golf Course	Private	81.38	Recreation
Pines Golf Course	Private	107.92	Recreation
Gleneagle Golf Course	Private	148.15	Recreation
Kaufman Golf Course	Private	183.56	Recreation
Meadowlane Golf Course	Private	103.99	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Rolling Hills Golf Course	Private	112.39	Recreation
Deer Run Golf Course	Private	144.63	Recreation
Meadow Wood Golf Course	Private	106.24	Recreation
Indian Trails Golf Course	Private	94.65	Recreation
Wallinwood Springs Golf Course	Private	198.42	Recreation
Highland Hills Golf Course	Private	147.98	Recreation
Forest Hills Golf Club	Private	152.92	Recreation
Pine Hills Golf Course	Private	63.90	Recreation
Grand Rapids Golf Course	Private	181.82	Recreation
Highlands Golf Course	Private	113.63	Recreation
Golf Course	Private	56.27	Recreation
Rolling Hills Golf Course	Private	72.05	Recreation
Shadow Ridge Golf Course	Private	71.10	Recreation
Sand Creek Golf Club	Private	33.42	Recreation
Arrowhead Golf Club	Private	126.98	Recreation
Egypt Valley Golf Course	Private	340.10	Recreation
English Hills Golf Course	Private	129.98	Recreation
Huckleberry Creek Golf Course	Private	50.06	Recreation
Grand Island Golf Course	Private	132.54	Recreation
St. Johns Golf Center	Private	6.47	Recreation
Ridgeview Golf Club	Private	41.40	Recreation
Boulder Creek Golf Club	Private	269.88	Recreation
Alpine Golf Course	Private	120.50	Recreation
Silver Lake Golf Course	Private	149.99	Recreation
Twin Oaks Golf Course	Private	69.75	Recreation
Candlestone Inn Golf Course	Private	179.43	Recreation
Braeside Golf Course	Private	117.95	Recreation
Emerald Golf Course	Private	146.58	Recreation
Sparta Moose Lodge Golf Course	Private	55.21	Recreation
North Kent Golf Course	Private	142.28	Recreation
Glen-Kerry Golf Course	Private	130.33	Recreation
Rogue River Golf Course	Private	98.20	Recreation
Cedar Chase Golf Club	Private	186.65	Recreation
Holland Lake Golf Course	Private	189.75	Recreation
Brookside Golf Course	Private	70.79	Recreation
Unknown	Private	115.07	Recreation
Unknown	Private	63.37	Recreation
Railside Golf Club	Private	151.46	Recreation
Athletic Field	Private	29.05	Recreation
Barry County Conservation Club	Private	71.29	Conservation
Wolverine Beagle Club	Private	46.92	Recreation
Caledonia Sportsmans Club	Private	77.84	Conservation
Qua Ke Zik Sportsman Club	Private	106.41	Recreation
Kent County Conservation Club	Private	170.71	Recreation
Fowler Conservation Club	Private	1.95	Recreation
Rockford Sportsmans Club	Private	51.07	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Sparta Hunt and Fish Club	Private	60.12	Conservation
Ashley Sportsmen Club	Private	81.24	Recreation
Western Michigan Beagle Club	Private	79.29	Recreation
Fed Mogul Gun Club	Private	65.66	Recreation
Flat River Conservation Club	Private	46.33	Recreation
Central Michigan Sportsman Club	Private	62.57	Recreation
Lansing Muzzle Load Club	Private	62.45	Recreation
Boat Launch	State	5.45	Recreation
Duncan Lake Access	State	2.86	Recreation
Jordon Lake Access	State	10.09	Recreation
Forest Reserve	State	0.34	Conservation
Forest Reserve	State	0.15	Conservation
Forest Reserve	State	92.94	Conservation
Forest Reserve	State	440.62	Conservation
Forest Reserve	State	171.44	Conservation
Forest Reserve	State	34.72	Conservation
Forest Reserve	State	85.33	Conservation
Forest Reserve	State	10.81	Conservation
Forest Reserve	State	30.69	Conservation
Forest Reserve	State	44.24	Conservation
Forest Reserve	State	13.62	Conservation
Forest Reserve	State	18.12	Conservation
Forest Reserve	State	108.12	Conservation
White Pine Trail State Park	State	6,529.04	Recreation
Sleepy Hollow State Park	State	2,680.17	Conservation
Ionia State Recreation Area	State	4,357.95	Conservation
Yankee State Parkrings State Recreation Area	State	4,613.33	Conservation
Muskrat Lake State Game Area	State	211.90	Conservation
State Secondary Complex-State Wildlife Property	State	371.61	Conservation
Lake Interstate State Game Area	State	113.26	Conservation
Barry State Game Area	State	16,790.11	Conservation
Cannonsburg State Game Area	State	1,349.15	Conservation
Edmore State Game Area	State	358.10	Conservation
Flat River State Game Area	State	11,243.50	Conservation
Grand River State Game Area	State	870.48	Conservation
Gratiot-Saginaw State Game Area	State	16,446.66	Conservation
Langston State Game Area	State	3,102.78	Conservation
Maple River State Game Area	State	9,258.26	Conservation
Maple-River / Gratiot-Saginaw Connector State Game Area	State	357.93	Conservation
Middleville State Game Area	State	4,440.29	Conservation
Portland State Game Area	State	2,297.52	Conservation
Rogue River State Game Area	State	6,138.66	Conservation
Saranac-Lowell State Game Area	State	1,864.77	Conservation
Stanton State Game Area	State	4,728.95	Conservation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Lower–continued			
Tamarack Lake State Game Area	State	262.97	Conservation
Vestaburg State Game Area	State	2,935.54	Conservation
Mouth			
Muskegon County Fairgrounds	County	162.68	Recreation
Timmer Farm	County	62.76	Recreation
Ripps Bayou Site	County	126.02	Recreation
Eastmanville Bayou Site	County	61.76	Recreation
Robinson Forest	County	76.94	Conservation
Crockery Creek Site	County	295.78	Conservation
Hager Park	County	80.99	Recreation
Grand River Park	County	166.76	Recreation
Deer Creek Park	County	2.39	Recreation
Rosy Mound Natural Area	County	156.78	Conservation
Riverside Park	County	60.52	Recreation
Patterson Park	County	22.35	Recreation
Grose Park	County	45.50	Recreation
Moore Park	County	33.89	Recreation
Moore Park	County	56.14	Recreation
Johnson Street Wildlife Management Area	County	45.00	Conservation
Ravenna School Forest	Local	9.17	Conservation
The Meadows	Local	217.29	Recreation
Kimball Wildlife Preserve	Local	51.21	Conservation
Hofma Preserve	Local	285.54	Conservation
Poel Island Nature Sancuary	Local	126.07	Conservation
Ferrysburg Nature Preserve	Local	275.45	Conservation
Wagner Park	Local	27.51	Recreation
Allendale Community Park	Local	38.05	Recreation
Hofma Park	Local	77.63	Recreation
Ottawa County Farm	Local	225.37	Recreation
Pottawattomie Park	Local	27.92	Recreation
Mercury Drive Park	Local	5.31	Recreation
Duncan Woods Park	Local	45.62	Recreation
Sluka Park	Local	4.18	Recreation
Mulligan's Hollow Park	Local	81.54	Recreation
Kelly Park	Local	0.87	Recreation
Bolt Park	Local	0.69	Recreation
East Grand River Park	Local	1.70	Recreation
Central Park	Local	2.72	Recreation
Bi-Centennial Park	Local	2.77	Recreation
Chinook Pier	Local	3.07	Other
Hatton Park	Local	3.08	Recreation
Linear Berm Park	Local	15.51	Recreation
Rotary Field	Local	7.96	Recreation
Adams Street Park	Local	7.03	Recreation
Rix Robinson Park	Local	1.20	Recreation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Mouth–continued			
Grove Street Park	Local	8.38	Recreation
Mill Point Park	Local	3.57	Recreation
William Montague Ferry Park	Local	4.27	Recreation
Central Park	Local	11.38	Recreation
Lakeside Beach Park	Local	1.28	Recreation
Ferrysburg Fire Barn Park	Local	4.28	Recreation
Coast Guard Park	Local	43.81	Recreation
Water Tower Park	Local	4.91	Recreation
Rycenga Recreation Park	Local	16.56	Recreation
Pomona Park	Local	12.79	Recreation
South Fruitport Park	Local	18.99	Recreation
South Fruitport Township Park	Local	40.84	Recreation
Thatcher Park	Local	11.54	Recreation
Conklin Park	Local	22.38	Recreation
DePersia South Highlands Nature Preserve	NGO	12.92	Conservation
Minnie Skwarek Nature Preserve	NGO	24.06	Conservation
Owashtanong Islands	NGO	61.24	Conservation
Conservation Easement	Private	6.03	Conservation
Conservation Easement	Private	0.18	Conservation
Conservation Easement	Private	1.16	Conservation
Conservation Easement	Private	0.56	Conservation
Conservation Easement	Private	2.55	Conservation
Conservation Easement	Private	1.16	Conservation
Conservation Easement	Private	1.73	Conservation
Conservation Easement	Private	2.50	Conservation
Conservation Easement	Private	29.29	Conservation
Conservation Easement	Private	0.28	Conservation
Conservation Easement	Private	0.48	Conservation
Conservation Easement	Private	0.99	Conservation
Conservation Easement	Private	0.50	Conservation
Conservation Easement	Private	3.33	Conservation
Conservation Easement	Private	0.50	Conservation
Conservation Easement	Private	3.13	Conservation
Conservation Easement	Private	0.14	Conservation
Conservation Easement	Private	0.41	Conservation
Conservation Easement	Private	0.02	Conservation
Conservation Easement	Private	0.19	Conservation
Conservation Easement	Private	1.40	Conservation
Conservation Easement	Private	0.18	Conservation
Conservation Easement	Private	0.14	Conservation
Conservation Easement	Private	0.01	Conservation
Conservation Easement	Private	0.15	Conservation
Conservation Easement	Private	14.07	Conservation
Conservation Easement	Private	0.03	Conservation
Conservation Easement	Private	5.33	Conservation
Conservation Easement	Private	0.00	Conservation

Table 25.–Continued.

Valley segment Property name	Ownership	Size (acres)	Management description
Mouth–continued			
Conservation Easement	Private	0.02	Conservation
Conservation Easement	Private	0.03	Conservation
Conservation Easement	Private	0.15	Conservation
Conservation Easement	Private	1.98	Conservation
Conservation Easement	Private	0.95	Conservation
Conservation Easement	Private	4.89	Conservation
Conservation Easement	Private	1.02	Conservation
Conservation Easement	Private	3.73	Conservation
Conservation Easement	Private	2.14	Conservation
Conservation Easement	Private	0.04	Conservation
Conservation Easement	Private	2.16	Conservation
Conservation Easement	Private	13.98	Conservation
Conservation Easement	Private	0.07	Conservation
Conservation Easement	Private	0.12	Conservation
Conservation Easement	Private	1.23	Conservation
Conservation Easement	Private	1.13	Conservation
Conservation Easement	Private	4.17	Conservation
Conservation Easement	Private	11.19	Conservation
Conservation Easement	Private	4.14	Conservation
Conservation Easement	Private	1.22	Conservation
Conservation Easement	Private	4.42	Conservation
Conservation Easement	Private	8.05	Conservation
Conservation Easement	Private	1.12	Conservation
Conservation Easement	Private	29.29	Conservation
Conservation Easement	Private	10.90	Conservation
Conservation Easement	Private	17.17	Conservation
Conservation Easement	Private	2.97	Conservation
Conservation Easement	Private	0.41	Conservation
Conservation Easement	Private	10.82	Conservation
Conservation Easement	Private	3.00	Conservation
Conservation Easement	Private	20.35	Conservation
Conservation Easement	Private	2.66	Conservation
Conservation Easement	Private	9.09	Conservation
Western Greens Country Club	Private	126.60	Recreation
Spring Lake Country Club	Private	148.74	Recreation
Fruitport Country Club	Private	109.33	Recreation
Rolling Hills Golf Course	Private	112.39	Recreation
Grand Haven Golf Club	Private	151.77	Recreation
Terra Verde Golf Course	Private	131.81	Recreation
Ravenna Golf Course	Private	125.63	Recreation
Spoonville Gun Club	Private	123.97	Recreation
Grand Haven State Park	State	29.61	Conservation
Hoffmaster State Park	State	1,164.09	Conservation
Bass River State Recreation Area	State	1,688.75	Recreation
Grand Haven State Game Area	State	1,258.64	Conservation

Table 26.–Fishes currently in the Grand River watershed. Data from University of Michigan, Museums Fisheries Library; Michigan Department of Natural Resources, Institute for Fisheries Research and Southern Lake Michigan Management Unit, and the Michigan Department of Environmental Quality. Species origin: N=native; C=colonized; and I=introduced. Grand River watershed status: P=Present and recent observation; E=extirpated; U=historic record, current status unknown. Thermal class[a] (Coker et al. 2001; Lyons et al. 2009): W=warmwater, T=transitional, C=coldwater. Feeding (Lyons 1992): Pa=parasitic, C=carnivore, In=insectivore, O=omnivore, Pl=planktivore, He=herbivore, Dash (–) indicates no feeding as adult. Spawning guilds[b] from Balon (1975, 1981), Pollution tolerance (Lyons 1992): I=intolerant, T=tolerant, Michigan Conservation status (MNFI 2010): X=extirpated, E =endangered, T=threatened, SC=species of concern, SGCN=species of greatest conservation need.

		Grand River watershed status																			
		Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
Common name *Scientific name*	Species Origin	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Lampreys																					
chestnut lamprey *Icthyomyzon castaneus*	N	P	P		P	P		P	P		P	P		P	P		W	Pa	A.2.3	I	
northern brook lamprey *Ichthoimyzon fossor*	N	P	P		P	P		P	P		P	P		P	P		T	-	A.2.3	I	
American brook lamprey *Lampetra appendix*	N	P	P		P	P		P	P		P	P		P	P		T	-	A.2.3	I	
sea lamprey *Petromyzon marinus*	I										P	P		P	P		T	Pa	A.2.3	I	
Sturgeons																					
lake sturgeon *Acipenser fulvescens*	N										P			P			T	In	A.1.2	I	T
Gars																					
spotted gar *Lepisosteus oculatus*	N			P							P	P					T	C	A.1.5		SC
longnose gar *Lepisosteus osseus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	A.1.4		
Bowfins																					
Bowfin *Amia calva*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	B.2.5	T	

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Headwaters Main stem	Headwaters Tributaries	Headwaters Lakes	Upper Main stem	Upper Tributaries	Upper Lakes	Middle Main stem	Middle Tributaries	Middle Lakes	Lower Main stem	Lower Tributaries	Lower Lakes	Mouth Main stem	Mouth Tributaries	Mouth Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Freshwater eels																					
American eel *Anguilla rostrata*	I																T	C	A.1.2		X
Herrings																					
Alewife *Alosa pseudoharengus*	I												P	P		P	T	Pl	A.1.4		
gizzard shad *Dorosoma cepedianum*	N										P	P	P	P	P	P	W	Pl	A.1.2		
Minnows																					
central stoneroller *Campostoma anomalum*	N	P	P		P	P		P	P			P			P		W	He	A.2.3		
Goldfish *Carassius auratus*	I		P		P	P		P	P		P	P					W	O	A.1.5	T	
spotfin shiner *Cyprinella spiloptera*	N	P	P		P	P		P	P		P	P		P	P		W	In	A.2.4		
common carp *Cyprinus carpio*	I	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	O	A.1.4	T	
brassy minnow *Hybognathus hankinsoni*	N											U			U		T	He	A.1.5		SGCN
striped shiner *Luxilus chrysocephalus*	N	P	P	P	P	P		P			P	P			P		T	In	A.2.3		SGCN
common shiner *Luxilus cornutus*	N	P	P		P	P		P	P		P	P			P	P	T		A.2.3		
redfin shiner *Lythrurus umbratilis*	N											P			P		T	In	A.1.3		

Table 26.–Continued.

		Grand River watershed status																			
		Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
Common name *Scientific name*	Species Origin	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Minnows–continued																					
northern pearl dace *Margariscus nachtriebi*	N											P			P		T	In	A.1.3	I	
hornyhead chub *Nocomis biguttatus*	N	P	P		P	P		P	P		P	P				P	W	In	A.2.3		
river chub *Nocomis micropogon*	N	P	P		P	P		P	P		P	P			P		T	In	A.2.3	I	SGCN
golden shiner *Notemigonus crysoleucas*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	O	A.1.5	T	
pugnose shiner *Notropis anogenus*	N												P				T	He	A.1.3	I	E
emerald shiner *Notropis atherinoides*	N													P	P		W	In	A.1.1		
bigmouth shiner *Notropis dorsalis*	N											U			U		W	In	A.1.3		SGCN
blackchin shiner *Notropis heterodon*	N	P	P	P	P	P		P	P			P	P		P		T	In	A.1.5	I	
blacknose shiner *Notropis heterolepis*	N	P	P	P	P	P		P	P			P	P		P	P	T	In	A.1.5	I	
spottail shiner *Notropis hudsonius*	N	P			P	P		P			P			P			W	In	A.1.2	I	
rosyface shiner *Notropis rubellus*	N				P	P		P	P		P	P		P	P		W	In	A.2.3	I	
sand shiner *Notropis stramineus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.6		

Table 26.–Continued.

		Grand River watershed status																			
		Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
Common name *Scientific name*	Species Origin	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Minnows–continued																					
weed shiner *Notropis texanus*	N																W	He	?	I	X
mimic shiner *Notropis volucellus*	N			P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.5		
northern redbelly dace *Chrosomus eos*	N											P			P		T	He	A.1.5		
finescale dace *Phoxinus neogaeus*	N											U			U		T	In	A.1.4		SGCN
bluntnose minnow *Pimephales notatus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	O	B.2.7	T	
fathead minnow *Pimephales promelas*	N		P			P			P			P			P		W	O	B.2.7	T	
western blacknose dace *Rhinichthys obtusus*	N		P			P			P			P			P		T	O	A.1.3	T	
creek chub *Semotilus atromaculatus*	N	P	P		P	P		P	P		P	P			P		T	O	A.2.3	T	
Suckers																					
Quillback *Carpiodes cyprinus*	N										P	P	P	P	P	P	W	O	A.1.2		
longnose sucker *Catostomus catostomus*	N										P	P		P	P		C	In	A.1.2		
white sucker *Catostomus commersonii*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	T	O	A.1.2	T	
lake chubsucker *Erimyzon sucetta*	N	P	P	P		P	P		P	P		P	P	P	P	P	W	In	A.1.4		

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Grand River watershed status: Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
		Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Suckers–continued																					
northern hog sucker *Hypentelium nigricans*	N	P	P		P	P		P	P		P	P		P	P		T	In	A.1.3	I	
black buffalo *Ictiobus niger*	I										P			P			W	In	A.1.2	I	SGCN
spotted sucker *Minytrema melanops*	N							P	P		P	P		P	P		W	In	A.1.2	I	SGCN
silver redhorse *Moxostoma anisurum*	N										P	P	P	P	P	P	W	In	A.1.3	I	
river redhorse *Moxostoma carinatum*	N										P	P	P	P	P	P	W	In	A.1.3	I	T
black redhorse *Moxostoma duquesnei*	N							P	P		P	P	P	P	P	P	W	In	A.1.3	I	SGCN
golden redhorse *Moxostoma erythrurum*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.3	I	SGCN
shorthead redhorse *Moxostoma macrolepidotum*	N				P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.3	I	
greater redhorse *Moxostoma valenciennesi*	N				P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.3	I	
Catfishes																					
black bullhead *Ameiurus melas*	N				P	P			P			P			P		W	O	B.2.3		
yellow bullhead *Ameiurus natalis*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	O	B.2.7	T	
brown bullhead *Ameiurus nebulosus*	N	P	P	P	P	P	P	P	P	P		P	P		P	P	W	O	B.2.7		SGCN

Table 26.–Continued.

		Grand River watershed status																			
		Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
Common name *Scientific name*	Species Origin	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Catfishes–continued																					
channel catfish *Ictalurus punctatus*	N	P		P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	B.2.7		
Stonecat *Noturus flavus*	N											P					W	In	B.2.7	I	SGCN
tadpole madtom *Noturus gyrinus*	N		P			P			P	P		P	P	P	P	P	W	In	B.2.7		SGCN
flathead catfish *Pylodictis olivaris*	N								P		P	P		P	P		W	C	B.2.3		
Pikes																					
grass pickerel *Esox americanus vermiculatus*	N	P	P	P	P	P	P		P			P			P		W	C	A.1.5		SGCN
northern pike *Esox lucius*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	T	C	A.1.5		
Muskellunge *Esox masquinongy*	N										P	P	P	P	P	P	T	C	A.1.5	I	
tiger muskellunge *E.lucius x E. masquinongy*	I			U			U			U			U			U	T	C	A.1.5		
Mudminnows																					
central mudminnow *Umbra limi*	N	P	P		P	P		P	P		P	P		P	P		T	In	A.1.5	T	
Trouts																					
Cisco *Coregonus artedi*	N			P									P				C	Pi	A.1.2	I	T

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Headwaters: Main stem	Headwaters: Tributaries	Headwaters: Lakes	Upper: Main stem	Upper: Tributaries	Upper: Lakes	Middle: Main stem	Middle: Tributaries	Middle: Lakes	Lower: Main stem	Lower: Tributaries	Lower: Lakes	Mouth: Main stem	Mouth: Tributaries	Mouth: Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Trouts–continued																					
lake whitefish *Coregonus clupeaformis*	N										P			P			C	In	A.1.3	I	
coho salmon *Oncorhynchus kisutch*	I							P	P		P	P		P	P		C	C	A.2.3	I	
rainbow trout *Oncorhynchus mykiss*	I										P	P	P	P	P	P	C	C	A.2.3	I	
Chinook salmon *Oncorhynchus tshawytscha*	I							P	P		P	P		P	P		C	C	A.2.3	I	
round whitefish *Prosopium cylindraceum*	N										P			P			C	In	A.1.3	I	
brown trout *Salmo trutta*	I					P					P	P	P	P	P		C	C	A.2.3	I	
brook trout *Salvelinus fontinalis*	I											P			P		C	C	A.2.3	I	
lake trout *Salvelinus namaycush*	N										P			P			C	C	A.2.3	I	
Trout-perches																					
trout-perch *Percopsis omiscomaycus*	N													P	P	P	C	In	A.1.3		
Pirate perches																					
pirate perch *Aphredoderus sayanus*	N							P	P		P	P			U		W	In	A.2.1		SGCN

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Grand River watershed status: Headwaters Main stem	Headwaters Tributaries	Headwaters Lakes	Upper Main stem	Upper Tributaries	Upper Lakes	Middle Main stem	Middle Tributaries	Middle Lakes	Lower Main stem	Lower Tributaries	Lower Lakes	Mouth Main stem	Mouth Tributaries	Mouth Lakes	Species Attributes: Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Cods																					
Burbot *Lota lota*	N										P	P			P		T	C	A.1.2		
Killifishes																					
western banded killifish *Fundulus diaphanus menona*	N	P	P	P			P			P			P	P	P	P	T	In	A.1.5		
starhead topminnow *Fundulus dispar*	N											U					T	In	A.1.5		SGCN
blackstripe topminnow *Fundulus notatus*	N	P	P			P			P								T	In	A.1.5		
Silversides																					
brook silverside *Labidesthes sicculus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	A.1.4		
Sticklebacks																					
brook stickleback *Culaea inconstans*	N	P	P			P			P			P			P		T	In	B.2.4		
threespine stickleback *Gasterosteus aculeatus*	I													P		P	T	In	B.2.4		
ninespine stickleback *Pungitius pungitius*														P		P	T	In	B.2.4		
Sculpins																					
mottled sculpin *Cottus bairdii*	N								P			P			P		C	In	B.2.7	I	
slimy sculpin *Cottus cognatus*	N													P		P	C	In	B.2.7	I	

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Headwaters Main stem	Headwaters Tributaries	Headwaters Lakes	Upper Main stem	Upper Tributaries	Upper Lakes	Middle Main stem	Middle Tributaries	Middle Lakes	Lower Main stem	Lower Tributaries	Lower Lakes	Mouth Main stem	Mouth Tributaries	Mouth Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Striped basses																					
white perch *Morone americana*	I													P		P	W	In	A.1.4		
white bass *Morone chrysops*	N										P			P		P	W	C	A.1.4		
Sunfishes																					
rock bass *Ambloplites rupestris*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	T	C	B.2.3	I	
green sunfish *Lepomis cyanellus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	B.2.3	T	
Pumpkinseed *Lepomis gibbosus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	B.2.2		
Warmouth *Lepomis gulosus*	N		P	P	P	P	P	P	P	P		P	P		P	P	W	C	B.2.5		
Bluegill *Lepomis macrochirus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	In	B.2.3		
redear sunfish *Lepomis microlophus*	I			P	P		P					P					W	In	B.2.3		
northern longear sunfish *Lepomis peltastes*	N	P	P	P	P	P	P	P	P	P	P	P	P		P		W	In	B.2.3	I	
smallmouth bass *Micropterus dolomieu*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	B.2.3	I	
largemouth bass *Micropterus salmoides*	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	B.2.5		
white crappie *Pomoxis annularis*	N										P	P	P	P	P	P	W	C	B.1.4		

Table 26.–Continued.

		Grand River watershed status: Headwaters			Upper			Middle			Lower			Mouth			Species Attributes				
Common name *Scientific name*	Species Origin	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Main stem	Tributaries	Lakes	Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Sunfishes–continued																					
black crappie *Pomoxis nigromaculatus*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	W	C	B.2.5		
Perches																					
greenside darter *Etheostoma blennioides*	N	P			P	P		P	P		P				P		W	In	A.1.5		
rainbow darter *Etheostoma caeruleum*	N	P	P		P	P		P	P		P	P			P		W	In	A.2.3	I	
Iowa darter *Etheostoma exile*	N	P	P	P					P	P		P	P			P	W	In	A.1.4	I	
barred fantail darter *Etheostoma flabellare*	N	P	P		P	P						P					W	In	B.2.7		SGCN
least darter *Etheostoma microperca*	N					U						P					W	In	A.1.5	I	SGCN
johnny darter *Etheostoma nigrum*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	T	In	B.2.7		
yellow perch *Perca flavescens*	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	T	In	A.1.4		
northern logperch *Percina caprodes semifasciata*	N	P		P				P	P	P	P	P	P	P	P		W	In	A.1.6		
blackside darter *Percina maculata*	N	P	P		P	P		P	P		P	P			P		W	In	A.2.3		
Walleye *Sander vitreus*	N	P		P	P		P	P	P	P	P	P	P	P	P	P	T	C	A.1.2		

Table 26.–Continued.

Common name *Scientific name*	Species Origin	Grand River watershed status: Headwaters Main stem	Headwaters Tributaries	Headwaters Lakes	Upper Main stem	Upper Tributaries	Upper Lakes	Middle Main stem	Middle Tributaries	Middle Lakes	Lower Main stem	Lower Tributaries	Lower Lakes	Mouth Main stem	Mouth Tributaries	Mouth Lakes	Species Attributes: Thermal class	Feeding	Spawning guild	Tolerance	Conservation status
Drums																					
freshwater drum																					
Aplodinotus grunniens	N										P			P		P	W	In	A.1.1		
Gobies																					
round goby																					
Neogobius melanostomus	I										P	P		P	P	P	T	In	B.1.3		

[a] Thermal classes:
Warmwater = species found in waters with July mean temperature typically >70ºF
Transitional = species found in waters with July mean temperatures typically >63.5 and ≤70ºF
Coldwater = species found in waters with July mean temperature typically ≤63.5ºF

[b] Spawning guilds:

A.1.1: Nonguarders: Open substratum spawners: Pelagophils- Large quantities of non-adhesive, near-neutral or buoyant eggs are scattered in open water. No parental care of eggs.

A.1.2: *Nonguarders: Open substratum spawners: Litho-pelagophils* - Eggs are deposited on rocks and gravel, but eggs, embryos or larvae become sufficiently buoyant to be carried away from the spawning substrate by water currents. No parental care of eggs.

A.1.3: Nonguarders: Open substratum spawners: Lithophils – Eggs are deposited on rock, rubble, or gravel bottom where their embryos and lavae develop. No parental care of eggs.

A.1.4: Nonguarders: Open substratum spawners: Phyto-lithophils - Deposit eggs in relatively clearwater habitats on submerged plants, if available, or on other submerged items such as rocks, logs or gravel, where their embryos and larvae develop. No parental care of eggs.

A.1.5 Nonguarders: Open substratum spawners: Phytophils - Scatter or deposit eggs with an adhesive membrane that sticks to submerged, alive or dead, aquatic plants or to recently flooded terrestrial vegetation. Sometimes logs and branches. No parental care of eggs.

A.1.6: Nonguarders: Open substratum spawners: Psammophils - Usually small eggs with an adhesive membrane that are scattered directly on sand and/or the fine roots of plants that hang over the sandy bottom. No parental care of eggs.

A.2.3: Nonguarders: Brood Hiders: Lithophils - Eggs are hidden in specially constructed places. In most cases the hiding places (e.g. redds in salmonids) are excavated in gravel by the female. No parental care of eggs.

A.2.4: Nonguarders: Brood Hiders: Speleophils - Usually few large eggs with an adhesive membrane that are hidden in crevices. No parental care of eggs.

B.1.3: *Guarders: Substratum choosers: Lithophils* - Choose rocks for attachment of their eggs. Eggs are guarded, and possibly cleaned and ventilated.

B.1.4: Guarders: Substratum choosers: Phytophils - Choose plants for attachment of their eggs. Eggs are guarded, and possibly cleaned and ventilated.

Table 26.–Continued.

B.2.2: Guarders: Nest spawners: Polyphils - No particular nest building material or substrate is chosen, however, a nest is constructed and the nest and eggs are guarded.

B.2.3: Guarders: Nest spawners: Lithophils - Eggs are deposited on cleaned areas of rocks or in pits dug in gravel. Nest is guarded.

B.2.4: *Guarders: Nest spawners: Ariadnophils* - The nest building male has the ability to spin a viscid thread from a kidney secretion, which binds the nest of different material together. The eggs are guarded and ventilated by the male, who also guards the young once they hatch.

B.2.5: *Guarders: Nest spawners: Phytophils* - Eggs are deposited in nests constructed above or on a soft muddy bottom, often amid algae or other exposed roots of vascular plants. Nest is guarded.

B.2.7: Guarders: Nest spawners: Speleophils - These fishes guard a clutch of eggs in natural holes or cavities, in specially constructed burrows, or where deposited on a cleaned area of the undersurface of flat stones.

Table 27.–Aquatic macroinvertebrates in the headwaters segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicates taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Center Lake Outlet at Falahee Road	Grand River at Parnell Road	Cahaogan Creek at Fitchburg Road	Orchard Creek at Kennedy Road	Batteese Creek at Territorial Road	Portage River at Bunker Hill	Grand River at Maple Grove	Western Creek at Easton Road	Huntoon Creek at Leslie	Perry Creek at Baseline Road
Porifera (sponges)					+								
Platyhelminthes (flatworms)													
Turbellaria		+	+	+	+							+	
Nematomorpha (roundworms)													
Bryozoa (moss animals)					+								
Annelida (segmented worms)													
Hirudinea (leeches)												+	+
Oligochaeta (worms)	+	+	+	+	+	+	+		+	+			+
Arthropoda													
Crustacea													
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)			+		+	+	+					+	+
Isopoda (sowbugs)		+	+		+	+	+			+		+	
Arachnoidea													
Hydracarina	+	+	+	+		+	+		+			+	+
Insecta													
Ephemeroptera (mayflies)													
Ametropodidae													
Baetiscidae													
Baetidae	+	+	+	+	+		+				+	+	+
Caenidae	+		+	+									
Ephemerellidae													
Ephemeridae	+												
Heptageniidae		+	+		+	+	+		+	+	+	+	+
Isonichiidae													
Leptophlebiidae													
Metretopodidae													
Oligoneuriidae													
Polymitarcyidae													
Potamanthidae													
Siphlonuridae													
Tricorythidae		+	+										

Table 27.–Continued.

Taxa	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Center Lake Outlet at Falahee Road	Grand River at Parnell Road	Cahaogan Creek at Fitchburg Road	Orchard Creek at Kennedy Road	Batteese Creek at Territorial Road	Portage River at Bunker Hill	Grand River at Maple Grove	Western Creek at Easton Road	Huntoon Creek at Leslie	Perry Creek at Baseline Road
Arthropoda–continued													
Insecta–continued													
Odonata													
Anisoptera (dragonflies)													
Aeshnidae	+	+				+	+				+		+
Cordulegastridae													
Corduliidae													
Gomphidae	+												
Libellulidae						+							
Macromiidae													
Zygoptera (damselflies)													
Calopterygidae	+		+	+	+		+	+			+	+	+
Coenagrionidae		+	+	+	+	+		+	+				
Lestidae													
Plecoptera (stoneflies)													
Capniidae													
Chloroperlidae						+							
Leuctridae													
Nemouridae													
Peltoperlidae													
Perlidae													
Perlodidae													
Pteronarcyidae													
Taeniopterygidae													
Hemiptera (true bugs)													
Belostomatidae			+	+	+	+				+	+	+	+
Corixidae	+	+	+			+	+	+		+	+		+
Gelastocoridae													
Gerridae	+	+	+	+		+	+			+	+	+	+
Mesoveliidae	+	+	+	+			+	+	+		+	+	+
Naucoridae													
Nepidae										+			+
Notonectidae							+			+	+	+	+
Pleidae						+	+					+	+
Saldidae													
Veliidae											+		
Megaloptera													
Corydalidae (Dobson flies)				+									
Sialidae (alder flies)	+	+									+		
Neuroptera (spongilla flies)													
Sisyridae													

Table 27.–Continued.

Taxa	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Center Lake Outlet at Falahee Road	Grand River at Parnell Road	Cahaogan Creek at Fitchburg Road	Orchard Creek at Kennedy Road	Batteese Creek at Territorial Road	Portage River at Bunker Hill	Grand River at Maple Grove	Western Creek at Easton Road	Huntoon Creek at Leslie	Perry Creek at Baseline Road
Arthropoda–continued													
Insecta–continued													
Trichoptera (caddisflies)													
Brachycentridae		+	+				+						
Glossosomatidae													
Helicopsychidae	+										+		
Hydropsychidae	+	+	+	+	+		+		+		+	+	+
Hydroptilidae									+				
Lepidostomatidae	+	+	+										
Leptoceridae		+	+										+
Limnephilidae	+	+	+	+	+		+		+		+	+	+
Molannidae													
Odontoceridae													
Philopotamidae													
Phryganeidae	+												
Polycentropodidae	+		+				+		+				
Psychomyiidae													
Rhyacophilidae													
Sericostomatidae													
Uenoidae			+										
Lepidoptera (moths)													
Noctuidae													
Pyralidae													
Coleoptera (beetles)													
Chrysomelidae (adults)													
Curculionidae (adults)													
Dytiscidae (total)						+		+	+				
Gyrinidae (adults)		+	+	+	+		+			+			
Haliplidae (adults)	+	+	+	+	+	+	+					+	
Heterocerodae (total)													
Hydraenidae (total)													
Hydrophilidae (total)		+			+		+	+					
Lampyridae (adults)													
Limnichidae (adults)													
Noteridae (adults)													
Psephenidae (adults)		+											
Ptilodactylidae (adults)													
Scirtidae (adults)													

Table 27.–Continued.

Taxa	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Center Lake Outlet at Falahee Road	Grand River at Parnell Road	Cahaogan Creek at Fitchburg Road	Orchard Creek at Kennedy Road	Batteese Creek at Territorial Road	Portage River at Bunker Hill	Grand River at Maple Grove	Western Creek at Easton Road	Huntoon Creek at Leslie	Perry Creek at Baseline Road
Arthropoda–continued													
Insecta–continued													
Chrysomelidae (larvae)													
Curculionidae (larvae)													
Dryopidae											+		
Elmidae	+	+	+	+	+	+	+		+			+	+
Gyrinidae (larvae)													
Haliplidae (larvae)													
Lampyridae (larvae)													
Limnichidae (larvae)													
Noteridae (larvae)													
Psephenidae (larvae)													
Ptilodactylidae (larvae)													
Scirtidae (larvae)													
Diptera (flies)													
Athericidae						+							
Ceratopogonidae				+			+						
Chaoboridae													
Chironomidae		+	+	+	+	+	+	+	+	+	+	+	+
Culicidae	+	+	+	+			+			+	+		
Dixidae		+		+			+	+				+	
Dolichopodidae													
Empididae													
Ephydridae													
Muscidae													
Psychodidae													
Ptychopteridae													
Sciomyzidae													
Simulidae		+			+		+				+	+	+
Stratiomyidae													
Syrphidae													
Tabanidae	+	+								+			
Thaumaleidae													
Tipulidae												+	
Mollusca													
Gastropoda (snails and limpets)													
Ancylidae		+	+								+		
Bithyniidae													
Hydrobiidae						+							
Lymnaeidae											+		
Physidae	+	+	+	+	+	+	+	+	+		+	+	+

Table 27.–Continued.

Taxa	Grand River at Sutfin Road	Grand River at Reed Road	Grand River at High Street	Center Lake Outlet at Falahee Road	Grand River at Parnell Road	Cahaogan Creek at Fitchburg Road	Orchard Creek at Kennedy Road	Batteese Creek at Territorial Road	Portage River at Bunker Hill	Grand River at Maple Grove	Western Creek at Easton Road	Huntoon Creek at Leslie	Perry Creek at Baseline Road
Mollusca–continued													
Gastropoda–continued													
Planorbidae													+
Pleuroceridae								+					
Valvatidae													
Pomatiopsidae													
Viviparidae													
Pelecypoda (bivalves)													
Corbicula					+								
Dreissenidae													
Pisidiidae													
Sphaeriidae	+	+	+	+	+	+							
Unionidae (mussels)		+	+	+									

Table 28.–Aquatic macroinvertebrates in the upper segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Grand River at Dixon Road	Mackey Brook at Wellman Road	Sandstone Creek at Gordon Road	Grand River at Onondaga Park	Grand River at Petrieville Road	Springbrook at Spicerville Highway	Columbia Creek at Waverly Road	Grand River at Waverly Road	Silver Creek at Canal Road
Porifera (sponges)			+						
Platyhelminthes (flatworms)									
Turbellaria			+		+	+	+	+	
Nematomorpha (roundworms)									
Bryozoa (moss animals)					+	+	+	+	
Annelida (segmented worms)									
Hirudinea (leeches)			+	+			+	+	+
Oligochaeta (worms)		+	+		+	+	+	+	+
Arthropoda									
Crustacea									
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+		+	+	+	+	+
Isopoda (sowbugs)			+		+	+	+	+	+
Arachnoidea									
Hydracarina		+	+		+	+	+		+
Insecta									
Ephemeroptera (mayflies)									
Ametropodidae									
Baetiscidae									
Baetidae	+	+	+	+	+	+	+	+	+
Caenidae			+	+	+	+		+	
Ephemerellidae									
Ephemeridae			+			+			
Heptageniidae	+	+	+	+	+	+	+	+	+
Isonichiidae			+		+	+		+	
Leptophlebiidae									
Metretopodidae									
Oligoneuriidae									
Polymitarcyidae									
Potamanthidae					+				
Siphlonuridae						+			
Tricorythidae					+			+	
Odonata									
Anisoptera (dragonflies)									
Aeshnidae		+	+	+		+	+		
Cordulegastridae									
Corduliidae									
Gomphidae			+			+	+	+	
Libellulidae									
Macromiidae			+						

Table 28.–Continued.

Taxa	Grand River at Dixon Road	Mackey Brook at Wellman Road	Sandstone Creek at Gordon Road	Grand River at Onondaga Park	Grand River at Petrieville Road	Springbrook at Spicerville Highway	Columbia Creek at Waverly Road	Grand River at Waverly Road	Silver Creek at Canal Road
Zygoptera (damselflies)									
Calopterygidae	+	+	+	+	+	+	+	+	
Coenagrionidae			+			+			
Lestidae				+					
Plecoptera (stoneflies)									
Capniidae									
Chloroperlidae									
Leuctridae									
Nemouridae									
Peltoperlidae									
Perlidae			+		+	+	+	+	
Perlodidae			+				+		
Pteronarcyidae									
Taeniopterygidae									
Hemiptera (true bugs)									
Belostomatidae				+		+	+		
Corixidae		+	+	+		+	+		
Gelastocoridae									
Gerridae	+	+	+	+	+	+	+	+	+
Mesoveliidae		+	+		+	+	+	+	
Naucoridae									
Nepidae				+		+	+		
Notonectidae					+	+	+		+
Pleidae		+	+			+	+		
Saldidae						+	+		
Veliidae		+	+			+	+		+
Megaloptera									
Corydalidae (Dobson flies)	+		+		+	+	+	+	
Sialidae (alder flies)		+	+			+	+	+	
Neuroptera (spongilla flies)									
Sisyridae									
Trichoptera (caddisflies)									
Brachycentridae			+	+	+	+	+	+	
Glossosomatidae							+		
Helicopsychidae		+	+			+	+		
Hydropsychidae	+	+	+	+	+	+	+	+	+
Hydroptilidae						+	+		
Lepidostomatidae									
Leptoceridae	+		+		+	+	+	+	
Limnephilidae	+	+	+	+	+	+	+	+	
Molannidae						+			
Odontoceridae									
Philopotamidae			+		+	+	+	+	
Phryganeidae									
Polycentropodidae			+			+			

Table 28.–Continued.

Taxa	Grand River at Dixon Road	Mackey Brook at Wellman Road	Sandstone Creek at Gordon Road	Grand River at Onondaga Park	Grand River at Petrieville Road	Springbrook at Spicerville Highway	Columbia Creek at Waverly Road	Grand River at Waverly Road	Silver Creek at Canal Road
Psychomyiidae						+			
Rhyacophilidae									
Sericostomatidae									
Uenoidae			+			+	+		
Lepidoptera (moths)									
Noctuidae									
Pyralidae									
Coleoptera (beetles)									
Chrysomelidae (adults)									
Curculionidae (adults)									
Dytiscidae (total)							+		
Gyrinidae (adults)	+			+	+	+	+	+	
Haliplidae (adults)	+		+			+	+		+
Heterocerodae (total)									
Hydraenidae (total)									
Hydrophilidae (total)		+	+	+		+	+		
Lampyridae (adults)									
Limnichidae (adults)									
Noteridae (adults)									
Psephenidae (adults)			+			+			
Ptilodactylidae (adults)									
Scirtidae (adults)						+			
Chrysomelidae (larvae)									
Curculionidae (larvae)									
Dryopidae						+	+		
Elmidae	+	+	+		+	+	+	+	
Gyrinidae (larvae)			+						
Haliplidae (larvae)							+		
Lampyridae (larvae)									
Limnichidae (larvae)									
Noteridae (larvae)									
Psephenidae (larvae)									
Ptilodactylidae (larvae)									
Scirtidae (larvae)							+		
Diptera (flies)									
Athericidae							+		
Ceratopogonidae		+	+		+	+	+		
Chaoboridae									
Chironomidae		+	+		+	+	+	+	+
Culicidae							+		
Dixidae		+	+			+	+		
Dolichopodidae									
Empididae							+		
Ephydridae									
Muscidae									
Psychodidae									

Table 28.–Continued.

Taxa	Grand River at Dixon Road	Mackey Brook at Wellman Road	Sandstone Creek at Gordon Road	Grand River at Onondaga Park	Grand River at Petrieville Road	Springbrook at Spicerville Highway	Columbia Creek at Waverly Road	Grand River at Waverly Road	Silver Creek at Canal Road
Ptychopteridae									
Sciomyzidae									
Simulidae	+	+	+	+	+	+	+	+	
Stratiomyidae			+			+	+		
Syrphidae									
Tabanidae			+				+		
Thaumaleidae									
Tipulidae		+	+			+	+		
Mollusca									
Gastropoda (snails and limpets)									
Ancylidae	+	+	+		+	+	+	+	
Bithyniidae									
Hydrobiidae			+						
Lymnaeidae			+		+	+	+	+	+
Physidae		+	+		+	+	+	+	
Planorbidae							+		
Pleuroceridae									
Pomatiopsidae									
Valvatidae			+						
Viviparidae									
Pelecypoda (bivalves)									
Corbicula									
Dreissenidae									
Pisidiidae							+		
Sphaeriidae			+		+	+	+	+	
Unionidae (mussels)					+	+		+	

Table 29a.–Aquatic macroinvertebrates in the middle segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected. (Modified from MDEQ Procedure 51 database modified accessed August 2006).

Taxa	Red Cedar River at Gregory Road	West Branch Red Cedar River at Grand River Ave	Kalamink Creek at Holt Road	Wolf Creek at Bell Oak Road	Squaw Creek at Rowley Road	Doan Creek at Iosco Road	Deer Creek at Clark Road	Red Cedar River at Zimmer Road	Sloan Creek at Jolly Road	Red Cedar River at Okemos Road	Willow Creek at Kipp Road	Sycamore Creek at Holt Road
Porifera (sponges)	+									+	+	
Platyhelminthes (flatworms)												
Turbellaria			+				+	+		+	+	+
Nematomorpha (roundworms)												
Bryozoa (moss animals)							+	+		+	+	+
Annelida (segmented worms)												
Hirudinea (leeches)	+	+	+		+	+	+	+		+	+	+
Oligochaeta (worms)	+	+	+		+	+	+	+		+	+	+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+	+	+	+	+	+	+	+
Isopoda (sowbugs)						+			+	+	+	+
Arachnoidea												
Hydracarina					+	+		+		+	+	+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae					+					+		
Baetidae	+				+	+	+	+	+	+	+	+
Caenidae					+					+	+	+
Ephemerellidae										+		+
Ephemeridae		+			+			+		+	+	+
Heptageniidae	+	+	+	+	+	+	+	+	+	+	+	+
Isonichiidae										+		
Leptophlebiidae				+	+				+	+		
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae										+		
Potamanthidae												
Siphlonuridae										+		
Tricorythidae										+	+	
Odonata												
Anisoptera (dragonflies)												
Aeshnidae			+	+	+	+	+			+	+	+
Cordulegastridae												
Corduliidae										+		
Gomphidae	+					+		+		+		+

Table 29a.–Continued.

Taxa	Red Cedar River at Gregory Road	West Branch Red Cedar River at Grand River Ave	Kalamink Creek at Holt Road	Wolf Creek at Bell Oak Road	Squaw Creek at Rowley Road	Doan Creek at Iosco Road	Deer Creek at Clark Road	Red Cedar River at Zimmer Road	Sloan Creek at Jolly Road	Red Cedar River at Okemos Road	Willow Creek at Kipp Road	Sycamore Creek at Holt Road
Libellulidae				+	+		+			+		
Macromiidae										+		
Zygoptera (damselflies)												
Calopterygidae	+		+	+	+	+	+	+	+	+	+	+
Coenagrionidae	+	+	+		+		+	+	+	+	+	+
Lestidae	+	+	+								+	
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae								+		+		+
Perlodidae										+		+
Pteronarcyidae												
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae	+				+		+	+		+	+	+
Corixidae	+	+	+	+	+	+	+	+		+	+	+
Gelastocoridae												
Gerridae	+	+	+		+	+	+	+	+	+	+	+
Mesoveliidae	+						+			+		+
Naucoridae												
Nepidae	+				+		+	+		+		+
Notonectidae			+		+	+	+	+	+	+	+	+
Pleidae	+									+		+
Saldidae				+								
Veliidae						+	+			+		+
Megaloptera												
Corydalidae (Dobson flies)									+	+		
Sialidae (alder flies)	+	+		+	+	+	+	+		+	+	+
Neuroptera (spongilla flies)												
Sisyridae										+		
Trichoptera (caddisflies)												
Brachycentridae						+	+			+		+
Glossosomatidae						+			+	+	+	
Helicopsychidae						+			+	+	+	+
Hydropsychidae	+		+		+	+	+	+	+	+	+	+
Hydroptilidae						+				+		
Lepidostomatidae							+				+	
Leptoceridae						+	+			+	+	+
Limnephilidae	+		+		+	+	+	+		+	+	+
Molannidae						+						
Odontoceridae												

Table 29a.–Continued.

Taxa	Red Cedar River at Gregory Road	West Branch Red Cedar River at Grand River Ave	Kalamink Creek at Holt Road	Wolf Creek at Bell Oak Road	Squaw Creek at Rowley Road	Doan Creek at Iosco Road	Deer Creek at Clark Road	Red Cedar River at Zimmer Road	Sloan Creek at Jolly Road	Red Cedar River at Okemos Road	Willow Creek at Kipp Road	Sycamore Creek at Holt Road
Philopotamidae									+	+		+
Phryganeidae					+						+	
Polycentropodidae						+	+			+	+	+
Psychomyiidae							+			+		
Rhyacophilidae												
Sericostomatidae												
Uenoidae						+		+		+		
Lepidoptera (moths)												
Noctuidae								+			+	
Pyralidae										+		
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)	+	+			+	+	+			+	+	+
Gyrinidae (adults)	+	+		+	+	+	+	+			+	
Haliplidae (adults)			+		+		+			+	+	+
Heterocerodae (total)												+
Hydraenidae (total)												
Hydrophilidae (total)	+					+	+			+	+	+
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)			+					+		+		
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae							+			+	+	
Elmidae	+	+	+	+	+		+	+		+	+	+
Gyrinidae (larvae)										+	+	
Haliplidae (larvae)										+		
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)										+		
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae							+	+	+			
Ceratopogonidae	+	+	+	+	+	+	+			+	+	+
Chaoboridae					+							
Chironomidae	+		+	+	+	+	+	+	+	+	+	+
Culicidae					+		+			+		+
Dixidae					+		+	+			+	+

Table 29a.–Continued.

Taxa	Red Cedar River at Gregory Road	West Branch Red Cedar River at Grand River Ave	Kalamink Creek at Holt Road	Wolf Creek at Bell Oak Road	Squaw Creek at Rowley Road	Doan Creek at Iosco Road	Deer Creek at Clark Road	Red Cedar River at Zimmer Road	Sloan Creek at Jolly Road	Red Cedar River at Okemos Road	Willow Creek at Kipp Road	Sycamore Creek at Holt Road
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae			+			+	+	+		+	+	+
Stratiomyidae												
Syrphidae												
Tabanidae	+					+	+			+	+	+
Thaumaleidae												
Tipulidae			+		+	+	+	+	+	+	+	+
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+					+	+	+		+	+	+
Bithyniidae												
Hydrobiidae										+		
Lymnaeidae						+	+			+	+	+
Physidae	+		+	+	+	+	+	+	+	+	+	+
Planorbidae	+			+		+	+	+			+	+
Pleuroceridae										+		+
Pomatiopsidae										+		
Valvatidae										+		
Viviparidae								+		+		
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae						+			+	+	+	+
Sphaeriidae	+			+		+	+	+		+	+	+
Unionidae (mussels)	+						+	+		+		

Table 29b.–Aquatic macroinvertebrates in the middle segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database modified accessed August 2006).

Taxa	Grand River at Grand Woods Park	Carrier Creek at Willow Highway	Grand River at State Road	Sebewa Creek at Keefer Highway	Grand River at Portland State Game Area	Looking Glass River at Beardslee Road	Vermillion Creek at Peacock Road	Looking Glass River at Upton Road	Looking Glass River at DeWitt Road	Looking Glass River at Monroe Road	Goose Creek at Pline Road
Porifera (sponges)		+	+	+		+		+	+		
Platyhelminthes (flatworms)											
Turbellaria	+	+	+	+	+	+	+	+	+	+	+
Nematomorpha (roundworms)											
Bryozoa (moss animals)	+		+	+	+	+		+	+		+
Annelida (segmented worms)											
Hirudinea (leeches)	+	+	+	+	+	+	+		+	+	
Oligochaeta (worms)	+	+	+	+	+				+	+	+
Arthropoda											
Crustacea											
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+		+
Decapoda (crayfish)	+	+	+	+	+	+		+	+	+	
Isopoda (sowbugs)	+	+	+	+	+		+		+	+	+
Arachnoidea											
Hydracarina			+			+	+	+	+		
Insecta											
Ephemeroptera (mayflies)											
Ametropodidae											
Baetiscidae									+	+	
Baetidae	+	+	+	+	+	+	+	+	+	+	+
Caenidae	+		+		+		+	+	+	+	
Ephemerellidae							+		+		
Ephemeridae									+	+	
Heptageniidae	+		+	+	+		+	+	+	+	+
Isonichiidae	+		+	+	+				+	+	
Leptophlebiidae											
Metretopodidae											
Oligoneuriidae											
Polymitarcyidae					+						
Potamanthidae											
Siphlonuridae											
Tricorythidae	+		+		+				+	+	
Odonata											
Anisoptera (dragonflies)											
Aeshnidae				+	+	+	+	+	+	+	+
Cordulegastridae											
Corduliidae											
Gomphidae							+		+	+	

Table 29b.–Continued.

Taxa	Grand River at Grand Woods Park	Carrier Creek at Willow Highway	Grand River at State Road	Sebewa Creek at Keefer Highway	Grand River at Portland State Game Area	Looking Glass River at Beardslee Road	Vermillion Creek at Peacock Road	Looking Glass River at Upton Road	Looking Glass River at DeWitt Road	Looking Glass River at Monroe Road	Goose Creek at Pline Road
Libellulidae											
Macromiidae											
Zygoptera (damselflies)											
Calopterygidae	+	+	+	+	+	+	+	+	+	+	
Coenagrionidae	+		+		+	+		+	+		
Lestidae					+			+	+		
Plecoptera (stoneflies)											
Capniidae											
Chloroperlidae											
Leuctridae											
Nemouridae											
Peltoperlidae											
Perlidae	+		+	+	+	+	+	+	+	+	
Perlodidae											
Pteronarcyidae										+	
Taeniopterygidae											
Hemiptera (true bugs)											
Belostomatidae				+					+	+	
Corixidae		+	+	+	+	+	+	+	+	+	
Gelastocoridae											
Gerridae	+	+	+	+	+	+	+	+	+	+	
Mesoveliidae	+		+	+	+	+	+		+	+	
Naucoridae											
Nepidae					+				+		
Notonectidae						+		+	+		
Pleidae							+		+		
Saldidae									+		
Veliidae											
Megaloptera											
Corydalidae (Dobson flies)	+		+		+				+	+	
Sialidae (alder flies)									+		
Neuroptera (spongilla flies)											
Sisyridae			+								
Trichoptera (caddisflies)											
Brachycentridae	+		+		+	+			+		
Glossosomatidae				+					+		
Helicopsychidae	+		+	+	+	+	+	+	+	+	
Hydropsychidae	+	+	+		+	+	+	+	+	+	
Hydroptilidae		+		+					+		
Lepidostomatidae					+					+	
Leptoceridae			+		+		+	+	+		
Limnephilidae	+		+	+	+	+	+	+	+	+	+
Molannidae						+					
Odontoceridae											

Table 29b.–Continued.

Taxa	Grand River at Grand Woods Park	Carrier Creek at Willow Highway	Grand River at State Road	Sebewa Creek at Keefer Highway	Grand River at Portland State Game Area	Looking Glass River at Beardslee Road	Vermillion Creek at Peacock Road	Looking Glass River at Upton Road	Looking Glass River at DeWitt Road	Looking Glass River at Monroe Road	Goose Creek at Pline Road
Philopotamidae	+		+	+					+	+	
Phryganeidae							+	+	+	+	
Polycentropodidae	+		+		+				+		
Psychomyiidae									+		
Rhyacophilidae											
Sericostomatidae											
Uenoidae			+	+	+		+		+	+	
Lepidoptera (moths)											
Noctuidae											
Pyralidae									+		
Coleoptera (beetles)											
Chrysomelidae (adults)											
Curculionidae (adults)											
Dytiscidae (total)		+				+	+	+	+		
Gyrinidae (adults)		+	+	+		+	+		+	+	+
Haliplidae (adults)	+					+	+	+	+		
Heterocerodae (total)											
Hydraenidae (total)											
Hydrophilidae (total)	+		+			+	+	+	+		
Lampyridae (adults)											
Limnichidae (adults)											
Noteridae (adults)											
Psephenidae (adults)			+		+					+	
Ptilodactylidae (adults)											
Scirtidae (adults)									+		
Chrysomelidae (larvae)											
Curculionidae (larvae)											
Dryopidae		+		+					+		
Elmidae	+	+	+	+	+	+	+	+	+	+	+
Gyrinidae (larvae)									+		
Haliplidae (larvae)											
Lampyridae (larvae)											
Limnichidae (larvae)											
Noteridae (larvae)											
Psephenidae (larvae)											
Ptilodactylidae (larvae)											
Scirtidae (larvae)											
Diptera (flies)											
Athericidae		+				+				+	
Ceratopogonidae						+	+		+		+
Chaoboridae											
Chironomidae	-+	+	+	+	+	+	+	+	+	+	+
Culicidae					+		+	+			+
Dixidae	+										

Table 29b.–Continued.

Taxa	Grand River at Grand Woods Park	Carrier Creek at Willow Highway	Grand River at State Road	Sebewa Creek at Keefer Highway	Grand River at Portland State Game Area	Looking Glass River at Beardslee Road	Vermillion Creek at Peacock Road	Looking Glass River at Upton Road	Looking Glass River at DeWitt Road	Looking Glass River at Monroe Road	Goose Creek at Pline Road
Dolichopodidae											
Empididae											
Ephydridae											
Muscidae											
Psychodidae											
Ptychopteridae											
Sciomyzidae											
Simulidae	+	+	+	+	+	+	+	+	+		
Stratiomyidae											
Syrphidae											
Tabanidae	+		+			+	+	+	+	+	+
Thaumaleidae											
Tipulidae				+					+		
Mollusca											
Gastropoda (snails and limpets)											
Ancylidae	+		+	+		+		+	+	+	
Bithyniidae											
Hydrobiidae									+		
Lymnaeidae	+				+				+		
Physidae	+	+	+	+	+	+	+	+	+	+	+
Planorbidae		+	+			+	+	+	+		
Pleuroceridae									+		
Pomatiopsidae											
Valvatidae									+		
Viviparidae	+						+	+	+	+	
Pelecypoda (bivalves)											
Corbicula											
Dreissenidae											
Pisidiidae											
Sphaeriidae	+	+	+	+	+	+	+	+	+	+	
Unionidae (mussels)			+		+					+	

Table 30a.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Maple River at Reuss Road	Bear Creek at Shaftsburg Road	Alder Creek at Woodworth Road	Little Maple River at Shepardsville Road	Maple River at Shepardsville Road	Baker Creek at Meridian Road	Maple River at South County Line Road	Pine Creek at Johnson Road	River Styx at Ely Highway	South Fork Hayworth Creek at Colony Road	Peet Creek at Wacousta Road	Hayworth Creek at Bauer Road
Porifera (sponges)		+			+							
Platyhelminthes (flatworms)												
Turbellaria		+	+	+	+							
Nematomorpha (roundworms)												
Bryozoa (moss animals)			+									
Annelida (segmented worms)												
Hirudinea (leeches)	+	+	+	+			+			+	+	
Oligochaeta (worms)	+		+		+					+		
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+			+
Decapoda (crayfish)	+	+	+	+	+	+	+	+		+		+
Isopoda (sowbugs)			+		+	+		+	+	+	+	+
Arachnoidea												
Hydracarina												
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												
Baetidae		+	+	+	+		+					+
Caenidae	+	+	+	+	+		+	+				
Ephemerellidae			+		+		+					
Ephemeridae					+							
Heptageniidae	+	+	+	+	+	+	+					+
Isonichiidae					+		+					+
Leptophlebiidae												
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae							+					
Tricorythidae			+	+			+					+
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+			+				+
Cordulegastridae												
Corduliidae												
Gomphidae	+			+	+				+	+		

Table 30a.–Continued.

Taxa	Maple River at Reuss Road	Bear Creek at Shaftsburg Road	Alder Creek at Woodworth Road	Little Maple River at Shepardsville Road	Maple River at Shepardsville Road	Baker Creek at Meridian Road	Maple River at South County Line Road	Pine Creek at Johnson Road	River Styx at Ely Highway	South Fork Hayworth Creek at Colony Road	Peet Creek at Wacousta Road	Hayworth Creek at Bauer Road
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+	+	+	+	+		+	+			
Coenagrionidae	+		+	+	+		+	+	+			
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae		+			+							
Perlodidae		+	+		+							+
Pteronarcyidae												
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae				+								
Corixidae	+	+	+	+	+	+	+	+	+	+		+
Gelastocoridae												
Gerridae	+	+	+	+	+	+	+	+	+	+	+	+
Mesoveliidae		+	+							+		
Naucoridae												
Nepidae		+	+		+							
Notonectidae			+									
Pleidae			+	+								
Saldidae						+						
Veliidae				+			+					
Megaloptera												
Corydalidae (Dobson flies)												
Sialidae (alder flies)				+	+		+					
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae					+		+					
Glossosomatidae			+	+			+					
Helicopsychidae	+	+	+	+	+							
Hydropsychidae		+	+	+	+	+	+	+				+
Hydroptilidae			+									
Lepidostomatidae					+							
Leptoceridae												
Limnephilidae	+		+	+	+	+	+	+				
Molannidae												
Odontoceridae												

Table 30a.–Continued.

Taxa	Maple River at Reuss Road	Bear Creek at Shaftsburg Road	Alder Creek at Woodworth Road	Little Maple River at Shepardsville Road	Maple River at Shepardsville Road	Baker Creek at Meridian Road	Maple River at South County Line Road	Pine Creek at Johnson Road	River Styx at Ely Highway	South Fork Hayworth Creek at Colony Road	Peet Creek at Wacousta Road	Hayworth Creek at Bauer Road
Philopotamidae			+	+	+		+					
Phryganeidae				+	+		+	+				
Polycentropodidae						+						
Psychomyiidae												
Rhyacophilidae												
Sericostomatidae												
Uenoidae		+	+	+	+		+					
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)	+	+		+		+	+					+
Gyrinidae (adults)				+	+					+		+
Haliplidae (adults)			+	+		+		+	+	+		+
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)			+		+		+	+	+	+		
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)			+									
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												
Elmidae	+	+		+	+		+	+		+		+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae		+		+								
Ceratopogonidae				+								
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+		+
Culicidae			+	+	+							
Dixidae		+					+					

Table 30a.–Continued.

Taxa	Maple River at Reuss Road	Bear Creek at Shaftsburg Road	Alder Creek at Woodworth Road	Little Maple River at Shepardsville Road	Maple River at Shepardsville Road	Baker Creek at Meridian Road	Maple River at South County Line Road	Pine Creek at Johnson Road	River Styx at Ely Highway	South Fork Hayworth Creek at Colony Road	Peet Creek at Wacousta Road	Hayworth Creek at Bauer Road
Dolichopodidae												
Empididae												
Ephydridae			+									
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae			+			+	+	+	+			
Stratiomyidae												
Syrphidae												
Tabanidae												
Thaumaleidae												
Tipulidae		+	+		+		+					
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae			+		+							
Bithyniidae												
Hydrobiidae												
Lymnaeidae			+	+								
Physidae	+	+	+		+	+	+	+	+	+		+
Planorbidae									+			+
Pleuroceridae												
Pomatiopsidae												
Valvatidae												
Viviparidae								+				
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae	+											
Sphaeriidae	+	+	+	+	+			+	+			+
Unionidae (mussels)	+	+		+				+		+		+

Table 30b.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Cox Drain at Wacousta Road	West Branch Fish Creek Stevenson Road	Fish Creek at Vickerville Road	Fish Creek at Condensery Road	Stoughton Creek at Cowman Road	Fish Creek at Stoudt Road	Spaulding Creek at Grove Road	Muskrat Creek at Dexter Trail	Stony Creek at Wright Road	Lost Creek at Townsend Road	Stony Creek Highway M-21	Little Libhart Creek at David Highway
Porifera (sponges)											+	
Platyhelminthes (flatworms)												
Turbellaria	+				+	+	+	+	+			
Nematomorpha (roundworms)												
Bryozoa (moss animals)					+						+	+
Annelida (segmented worms)												
Hirudinea (leeches)	+	+						+		+	+	
Oligochaeta (worms)	+	+			+		+	+	+			+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+		+	+	+	+	+		+	+	+
Decapoda (crayfish)	+	+	+	+	+	+	+	+		+	+	+
Isopoda (sowbugs)	+				+	+	+	+		+	+	+
Arachnoidea												
Hydracarina									+			+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+
Caenidae					+	+		+	+		+	+
Ephemerellidae						+	+	+				
Ephemeridae		+	+	+					+			
Heptageniidae	+	+	+	+	+		+	+	+	+	+	
Isonichiidae		+		+	+	+			+		+	
Leptophlebiidae												
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae									+			
Siphlonuridae												
Tricorythidae			+	+	+	+	+		+		+	+
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+	+	+		+		+	
Cordulegastridae												
Corduliidae												
Gomphidae				+		+	+	+	+		+	

Table 30b.–Continued.

Taxa	Cox Drain at Wacousta Road	West Branch Fish Creek Stevenson Road	Fish Creek at Vickerville Road	Fish Creek at Condensery Road	Stoughton Creek at Cowman Road	Fish Creek at Stoudt Road	Spaulding Creek at Grove Road	Muskrat Creek at Dexter Trail	Stony Creek at Wright Road	Lost Creek at Townsend Road	Stony Creek Highway M-21	Little Libhart Creek at David Highway
Libellulidae						+					+	
Macromiidae				+								
Zygoptera (damselflies)												
Calopterygidae	+	+	+	+	+	+	+		+		+	+
Coenagrionidae						+	+	+	+	+	+	+
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae		+	+	+	+	+	+		+		+	+
Perlodidae				+	+							
Pteronarcyidae				+		+						
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae		+				+			+			
Corixidae	+	+		+	+	+	+	+	+	+	+	+
Gelastocoridae												
Gerridae	+	+		+	+	+	+		+	+	+	+
Mesoveliidae				+	+	+			+			
Naucoridae												
Nepidae					+							
Notonectidae												
Pleidae												
Saldidae	+											
Veliidae												
Megaloptera												
Corydalidae (Dobson flies)		+		+	+						+	
Sialidae (alder flies)	+			+		+			+			
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae		+	+	+	+							
Glossosomatidae		+		+								
Helicopsychidae		+		+	+	+	+	+	+		+	+
Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	+
Hydroptilidae												
Lepidostomatidae												
Leptoceridae			+				+	+	+		+	+
Limnephilidae	+	+	+	+	+	+	+	+			+	
Molannidae	+			+								
Odontoceridae												

Table 30b.–Continued.

Taxa	Cox Drain at Wacousta Road	West Branch Fish Creek Stevenson Road	Fish Creek at Vickerville Road	Fish Creek at Condensery Road	Stoughton Creek at Cowman Road	Fish Creek at Stoudt Road	Spaulding Creek at Grove Road	Muskrat Creek at Dexter Trail	Stony Creek at Wright Road	Lost Creek at Townsend Road	Stony Creek Highway M-21	Little Libhart Creek at David Highway
Philopotamidae		+			+						+	
Phryganeidae							+					
Polycentropodidae					+							
Psychomyiidae												
Rhyacophilidae												
Sericostomatidae												
Uenoidae	+	+		+	+						+	
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)				+					+	+		
Gyrinidae (adults)						+	+	+	+			
Haliplidae (adults)	+			+	+	+	+	+	+	+	+	+
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)	+			+	+	+		+	+		+	
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)	+	+			+				+		+	
Ptilodactylidae (adults)												
Scirtidae (adults)									+			
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae									+			
Elmidae	+	+	+	+	+	+	+	+	+		+	+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae			+	+	+	+						
Ceratopogonidae							+	+			+	
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae	+						+	+	+			+
Dixidae									+			

Table 30b.–Continued.

Taxa	Cox Drain at Wacousta Road	West Branch Fish Creek Stevenson Road	Fish Creek at Vickerville Road	Fish Creek at Condensery Road	Stoughton Creek at Cowman Road	Fish Creek at Stoudt Road	Spaulding Creek at Grove Road	Muskrat Creek at Dexter Trail	Stony Creek at Wright Road	Lost Creek at Townsend Road	Stony Creek Highway M-21	Little Libhart Creek at David Highway
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae		+	+	+		+	+	+	+		+	+
Stratiomyidae									+			
Syrphidae												
Tabanidae			+	+	+			+	+		+	
Thaumaleidae												
Tipulidae				+	+	+			+			
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+	+		+	+							+
Bithyniidae												
Hydrobiidae												
Lymnaeidae				+								+
Physidae	+				+	+	+	+	+		+	+
Planorbidae	+		+		+						+	
Pleuroceridae		+		+					+			
Pomatiopsidae												
Valvatidae								+				
Viviparidae							+	+			+	
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae												
Sphaeriidae	+	+		+	+	+	+	+	+		+	+
Unionidae (mussels)								+	+			

Table 30c.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database modified accessed August 2006).

Taxa	Libhart Creek at David Highway	Prairie Creek at Westbrook Road	Prairie Creek at Nickel Plate Road	Tibbets Creek at Riverside Drive	Bellamy Creek at Potters Road	Sessions Creek at Riverside Drive	Timberland Creek at Highway M-21	Red Creek at Highway M-21	Crooked Creek at Riverside Drive	Lake Creek at Division Street	Toles Creek at Highway M-21	Black Creek at One Mile Road
Porifera (sponges)	+											
Platyhelminthes (flatworms)												
Turbellaria	+									+		+
Nematomorpha (roundworms)												
Bryozoa (moss animals)											+	
Annelida (segmented worms)												
Hirudinea (leeches)	+	+										+
Oligochaeta (worms)	+			+			+	+	+		+	
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+		+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+	+			+	+		+
Isopoda (sowbugs)	+			+	+			+	+	+	+	
Arachnoidea												
Hydracarina	+	+					+	+		+		+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												
Baetidae	+	+	+	+	+	+	+		+	+	+	+
Caenidae	+		+					+				+
Ephemerellidae												
Ephemeridae		+	+									+
Heptageniidae		+	+		+	+				+	+	+
Isonichiidae		+	+									+
Leptophlebiidae						+					+	
Metretopodidae		+										
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae												
Tricorythidae	+	+	+									
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+	+		+	+	+	+	+
Cordulegastridae												
Corduliidae												
Gomphidae		+	+									

Table 30c.–Continued.

Taxa	Libhart Creek at David Highway	Prairie Creek at Westbrook Road	Prairie Creek at Nickel Plate Road	Tibbets Creek at Riverside Drive	Bellamy Creek at Potters Road	Sessions Creek at Riverside Drive	Timberland Creek at Highway M-21	Red Creek at Highway M-21	Crooked Creek at Riverside Drive	Lake Creek at Division Street	Toles Creek at Highway M-21	Black Creek at One Mile Road
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+	+	+	+			+	+	+	+	
Coenagrionidae	+											+
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae				+			+					
Peltoperlidae												
Perlidae	+	+	+	+	+	+	+				+	
Perlodidae		+										
Pteronarcyidae		+	+									
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae			+		+			+				
Corixidae	+	+	+					+		+		+
Gelastocoridae												
Gerridae	+	+	+	+	+		+	+	+	+	+	+
Mesoveliidae		+							+			
Naucoridae												
Nepidae												
Notonectidae		+										
Pleidae			+									
Saldidae							+	+	+			
Veliidae				+		+		+				+
Megaloptera												
Corydalidae (Dobson flies)			+	+	+							
Sialidae (alder flies)		+	+									+
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae			+				+					
Glossosomatidae					+							
Helicopsychidae		+				+						
Hydropsychidae	+	+	+	+	+	+	+	+		+	+	
Hydroptilidae												
Lepidostomatidae				+								
Leptoceridae	+	+	+									
Limnephilidae		+	+		+	+	+	+		+	+	+
Molannidae												
Odontoceridae												

Table 30c.–Continued.

Taxa	Libhart Creek at David Highway	Prairie Creek at Westbrook Road	Prairie Creek at Nickel Plate Road	Tibbets Creek at Riverside Drive	Bellamy Creek at Potters Road	Sessions Creek at Riverside Drive	Timberland Creek at Highway M-21	Red Creek at Highway M-21	Crooked Creek at Riverside Drive	Lake Creek at Division Street	Toles Creek at Highway M-21	Black Creek at One Mile Road
Philopotamidae				+								
Phryganeidae												
Polycentropodidae												
Psychomyiidae					+							
Rhyacophilidae												
Sericostomatidae												
Uenoidae	+	+	+	+	+	+	+			+		
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)		+					+				+	
Gyrinidae (adults)												+
Haliplidae (adults)	+	+			+			+		+		
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)		+	+		+					+		
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)		+				+	+					
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae							+	+	+		+	
Elmidae	+	+	+	+	+	+		+	+	+	+	+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae			+	+	+	+				+		
Ceratopogonidae				+								+
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae	+		+					+	+			+
Dixidae		+						+				

Table 30c.–Continued.

Taxa	Libhart Creek at David Highway	Prairie Creek at Westbrook Road	Prairie Creek at Nickel Plate Road	Tibbets Creek at Riverside Drive	Bellamy Creek at Potters Road	Sessions Creek at Riverside Drive	Timberland Creek at Highway M-21	Red Creek at Highway M-21	Crooked Creek at Riverside Drive	Lake Creek at Division Street	Toles Creek at Highway M-21	Black Creek at One Mile Road
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+		+	+	+	+		+	+	+	
Stratiomyidae												
Syrphidae					+							
Tabanidae			+									
Thaumaleidae												
Tipulidae		+	+	+		+			+	+	+	
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae												
Bithyniidae												
Hydrobiidae												
Lymnaeidae		+			+	+					+	
Physidae	+	+	+		+	+		+	+	+	+	
Planorbidae		+	+					+			+	
Pleuroceridae												
Pomatiopsidae												
Valvatidae												
Viviparidae		+	+									+
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae	+			+								
Sphaeriidae	+	+	+			+			+	+		+
Unionidae (mussels)		+										

Table 30d.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Flat River at Six Lakes Road	Brimmer Creek at Ferris Road	Flat River at Miller Road	Flat River at Stanton Road	Flat River at Sidney Road	Clear Creek at Larsen Road	Butternut Creek at Podunk Avenue	Coopers Creek at Pinewood Street	Flat River at Wise Road	Wabasis Creek at Greenville Road	Dickerson Creek at Peck Road	Seeley Creek at Bartonville Road
Porifera (sponges)	+				+	+				+	+	
Platyhelminthes (flatworms)												
Turbellaria	+		+									
Nematomorpha (roundworms)												
Bryozoa (moss animals)												
Annelida (segmented worms)												
Hirudinea (leeches)	+		+		+	+	+	+	+		+	
Oligochaeta (worms)	+			+			+		+			
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+		+	+	+
Decapoda (crayfish)	+	+	+	+	+	+	+	+		+	+	+
Isopoda (sowbugs)					+		+			+		
Arachnoidea												
Hydracarina	+	+	+	+	+	+						
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae			+	+	+							
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+
Caenidae	+			+		+			+			
Ephemerellidae												
Ephemeridae	+	+	+	+	+	+	+	+	+	+	+	
Heptageniidae	+	+	+	+	+	+	+	+	+	+	+	+
Isonichiidae				+	+							
Leptophlebiidae												
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae												
Tricorythidae	+		+			+				+		
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+	+	+	+	+	+	+	+
Cordulegastridae												
Corduliidae												
Gomphidae	+			+	+	+		+	+	+		

Table 30d.–Continued.

Taxa	Flat River at Six Lakes Road	Brimmer Creek at Ferris Road	Flat River at Miller Road	Flat River at Stanton Road	Flat River at Sidney Road	Clear Creek at Larsen Road	Butternut Creek at Podunk Avenue	Coopers Creek at Pinewood Street	Flat River at Wise Road	Wabasis Creek at Greenville Road	Dickerson Creek at Peck Road	Seeley Creek at Bartonville Road
Libellulidae	+					+					+	
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+	+		+	+	+	+	+	+	+	+
Coenagrionidae	+					+				+		
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae				+	+	+			+			+
Perlodidae										+		
Pteronarcyidae			+	+	+	+			+			
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae	+										+	
Corixidae	+	+	+		+				+	+	+	
Gelastocoridae												
Gerridae	+	+	+	+	+	+	+	+		+	+	+
Mesoveliidae		+				+		+			+	
Naucoridae												
Nepidae		+				+						
Notonectidae												
Pleidae	+				+							
Saldidae			+	+	+							
Veliidae	+	+		+	+		+					
Megaloptera												
Corydalidae (Dobson flies)		+		+	+	+	+	+			+	
Sialidae (alder flies)	+	+	+				+	+	+			
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae		+	+	+	+	+	+	+	+	+		+
Glossosomatidae									+			
Helicopsychidae	+		+	+		+	+	+	+		+	
Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	+
Hydroptilidae					+							
Lepidostomatidae	+											
Leptoceridae	+	+	+	+	+			+	+	+	+	
Limnephilidae	+	+	+	+	+	+	+	+	+	+	+	+
Molannidae							+	+				
Odontoceridae												

Table 30d.–Continued.

Taxa	Flat River at Six Lakes Road	Brimmer Creek at Ferris Road	Flat River at Miller Road	Flat River at Stanton Road	Flat River at Sidney Road	Clear Creek at Larsen Road	Butternut Creek at Podunk Avenue	Coopers Creek at Pinewood Street	Flat River at Wise Road	Wabasis Creek at Greenville Road	Dickerson Creek at Peck Road	Seeley Creek at Bartonville Road
Philopotamidae										+		+
Phryganeidae	+	+										
Polycentropodidae	+					+	+					
Psychomyiidae					+							
Rhyacophilidae												
Sericostomatidae												
Uenoidae	+		+		+	+			+		+	
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)												
Gyrinidae (adults)	+				+					+		
Haliplidae (adults)	+											
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)	+		+		+				+	+	+	
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)	+		+		+	+			+			
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												
Elmidae	+	+	+	+	+	+	+	+	+		+	+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae												
Ceratopogonidae												
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae							+				+	
Dixidae												

Table 30d.–Continued.

Taxa	Flat River at Six Lakes Road	Brimmer Creek at Ferris Road	Flat River at Miller Road	Flat River at Stanton Road	Flat River at Sidney Road	Clear Creek at Larsen Road	Butternut Creek at Podunk Avenue	Coopers Creek at Pinewood Street	Flat River at Wise Road	Wabasis Creek at Greenville Road	Dickerson Creek at Peck Road	Seeley Creek at Bartonville Road
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+	+	+	+	+	+	+		+		
Stratiomyidae												
Syrphidae												
Tabanidae				+			+					
Thaumaleidae												
Tipulidae	+		+	+								+
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+		+	+	+	+	+	+	+		+	+
Bithyniidae												
Hydrobiidae												
Lymnaeidae	+		+	+					+			+
Physidae	+		+	+	+	+	+	+		+	+	
Planorbidae	+		+							+		
Pleuroceridae			+							+		
Pomatiopsidae												
Valvatidae												
Viviparidae				+			+			+	+	
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae						+						
Pisidiidae												
Sphaeriidae	+	+	+	+	+	+	+	+	+		+	+
Unionidae (mussels)	+		+			+				+	+	

Table 30e.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database modified accessed August 2006).

Taxa	Flat River at Ingalls Road	Page Creek at Briggs Road	Lee Creek at Foreman Road	Thornapple River at Hartel Road	Butternut Creek at Packard Highway	Little Thornapple River at Gresham Road	Thornapple River at Gresham Highway-West	Lacey Creek at Valley Highway	Shanty Brook at Valley Highway	Quaker Brook at Highway M-79	Thornapple river at Greggs Crossing Road	Mud Creek at Coats Grove Road
Porifera (sponges)	+								+			
Platyhelminthes (flatworms)												
Turbellaria	+		+	+	+						+	
Nematomorpha (roundworms)												
Bryozoa (moss animals)				+	+				+			
Annelida (segmented worms)												
Hirudinea (leeches)		+		+	+	+	+	+	+		+	
Oligochaeta (worms)	+	+	+				+		+		+	+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+	+	+	+	+	+	+	+
Isopoda (sowbugs)	+		+	+	+	+	+		+	+	+	+
Arachnoidea												
Hydracarina	+	+										
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae							+				+	
Baetidae	+	+		+	+	+	+		+	+	+	+
Caenidae	+						+		+		+	
Ephemerellidae		+					+					
Ephemeridae	+						+				+	
Heptageniidae	+	+		+		+	+	+	+	+	+	+
Isonichiidae	+	+									+	
Leptophlebiidae											+	
Metretopodidae												
Oligoneuriidae											+	
Polymitarcyidae												
Potamanthidae												
Siphlonuridae				+								
Tricorythidae											+	
Odonata												
Anisoptera (dragonflies)												
Aeshnidae		+	+		+	+	+	+	+	+	+	+
Cordulegastridae												
Corduliidae												
Gomphidae	+	+	+				+				+	

Table 30e.–Continued.

Taxa	Flat River at Ingalls Road	Page Creek at Briggs Road	Lee Creek at Foreman Road	Thornapple River at Hartel Road	Butternut Creek at Packard Highway	Little Thornapple River at Gresham Road	Thornapple River at Gresham Highway-West	Lacey Creek at Valley Highway	Shanty Brook at Valley Highway	Quaker Brook at Highway M-79	Thornapple river at Greggs Crossing Road	Mud Creek at Coats Grove Road
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+	+		+	+	+	+	+	+	+	+
Coenagrionidae											+	+
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae							+					
Peltoperlidae												
Perlidae	+	+					+	+			+	
Perlodidae							+				+	+
Pteronarcyidae											+	
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae											+	
Corixidae					+	+	+	+	+	+	+	+
Gelastocoridae												
Gerridae		+	+	+	+	+	+	+	+	+	+	+
Mesoveliidae						+	+	+	+		+	+
Naucoridae											+	
Nepidae												
Notonectidae												
Pleidae							+				+	
Saldidae												
Veliidae	+		+					+		+		
Megaloptera												
Corydalidae (Dobson flies)	+	+					+				+	+
Sialidae (alder flies)	+	+									+	+
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae	+	+		+			+				+	
Glossosomatidae												
Helicopsychidae	+	+		+			+				+	
Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	+
Hydroptilidae				+								
Lepidostomatidae												
Leptoceridae											+	
Limnephilidae		+		+	+	+	+	+	+	+	+	+
Molannidae			+									
Odontoceridae												

Table 30e.–Continued.

Taxa	Flat River at Ingalls Road	Page Creek at Briggs Road	Lee Creek at Foreman Road	Thornapple River at Hartel Road	Butternut Creek at Packard Highway	Little Thornapple River at Gresham Road	Thornapple River at Gresham Highway-West	Lacey Creek at Valley Highway	Shanty Brook at Valley Highway	Quaker Brook at Highway M-79	Thornapple river at Greggs Crossing Road	Mud Creek at Coats Grove Road
Philopotamidae	+	+									+	
Phryganeidae			+				+				+	
Polycentropodidae											+	
Psychomyiidae												
Rhyacophilidae												
Sericostomatidae												
Uenoidae	+	+					+			+	+	
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)					+						+	
Gyrinidae (adults)											+	
Haliplidae (adults)							+		+		+	+
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)			+	+			+	+		+	+	
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)												
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												
Elmidae	+	+	+		+	+	+	+	+	+	+	+
Gyrinidae (larvae)	+						+				+	
Haliplidae (larvae)					+						+	
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae							+					
Ceratopogonidae												+
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae							+					
Dixidae												

Table 30e.–Continued.

Taxa	Flat River at Ingalls Road	Page Creek at Briggs Road	Lee Creek at Foreman Road	Thornapple River at Hartel Road	Butternut Creek at Packard Highway	Little Thornapple River at Gresham Road	Thornapple River at Gresham Highway-West	Lacey Creek at Valley Highway	Shanty Brook at Valley Highway	Quaker Brook at Highway M-79	Thornapple river at Greggs Crossing Road	Mud Creek at Coats Grove Road
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+		+	+		+				+	
Stratiomyidae								+				
Syrphidae												
Tabanidae		+								+		
Thaumaleidae												
Tipulidae	+	+					+	+				
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae											+	
Bithyniidae												
Hydrobiidae												
Lymnaeidae											+	
Physidae	+				+	+	+	+	+		+	+
Planorbidae			+									
Pleuroceridae											+	
Pomatiopsidae												
Valvatidae												
Viviparidae						+	+			+	+	+
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae											+	
Sphaeriidae	+	+	+	+		+	+		+	+	+	+
Unionidae (mussels)												

Table 30f.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	High Banks Creek at Dowling Road	Cedar Creek at McKeown Road	Fall Creek at Cook Road	Thornapple River at Hastings	Glass Creek at Oak Road	Bassett Creek at Shaw Lake Road	Duncan Creek at Stimpson Road	Coldwater River at Brown Road	Duck Creek at Montcalm Rd	Pratt Lake Creek at 84th Street	Tyler Creek at 100th Avenue	Coldwater River at Morse Lake Avenue
Porifera (sponges)				+				+				+
Platyhelminthes (flatworms)												
Turbellaria				+	+	+		+	+			
Nematomorpha (roundworms)												
Bryozoa (moss animals)				+						+	+	+
Annelida (segmented worms)												
Hirudinea (leeches)	+	+	+				+	+	+	+	+	+
Oligochaeta (worms)		+					+	+		+	+	+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+	+	+	+	+	+	+	+
Isopoda (sowbugs)	+			+	+	+	+	+	+			
Arachnoidea												
Hydracarina		+										+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae	+		+									
Baetidae		+		+	+	+	+	+	+	+	+	+
Caenidae				+								
Ephemerellidae												
Ephemeridae	+	+	+	+		+						+
Heptageniidae	+	+	+	+	+	+	+	+	+	+	+	+
Isonichiidae			+		+							
Leptophlebiidae												
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae				+								
Siphlonuridae												
Tricorythidae				+								+
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+	+	+	+	+	+	+	+
Cordulegastridae												
Corduliidae												
Gomphidae	+	+	+		+	+	+					+

Table 30f.–Continued.

Taxa	High Banks Creek at Dowling Road	Cedar Creek at McKeown Road	Fall Creek at Cook Road	Thornapple River at Hastings	Glass Creek at Oak Road	Bassett Creek at Shaw Lake Road	Duncan Creek at Stimpson Road	Coldwater River at Brown Road	Duck Creek at Montcalm Rd	Pratt Lake Creek at 84th Street	Tyler Creek at 100th Avenue	Coldwater River at Morse Lake Avenue
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae		+	+		+	+	+	+	+	+	+	+
Coenagrionidae		+		+		+				+	+	
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae		+	+		+	+	+			+		+
Perlodidae			+	+	+			+	+		+	+
Pteronarcyidae												+
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae								+				
Corixidae	+	+	+	+	+	+	+	+	+	+	+	+
Gelastocoridae												
Gerridae	+	+	+	+	+	+	+		+	+	+	+
Mesoveliidae				+			+	+			+	
Naucoridae												
Nepidae												
Notonectidae	+							+				
Pleidae	+	+										
Saldidae												
Veliidae		+										
Megaloptera												
Corydalidae (Dobson flies)		+				+						+
Sialidae (alder flies)	+	+						+	+	+		
Neuroptera (spongilla flies)												
Sisyridae				+								
Trichoptera (caddisflies)												
Brachycentridae		+	+		+	+			+	+	+	+
Glossosomatidae					+	+	+	+	+	+		+
Helicopsychidae		+	+			+	+	+	+		+	+
Hydropsychidae	+	+	+	+	+	+		+	+	+	+	+
Hydroptilidae												
Lepidostomatidae						+						
Leptoceridae				+		+				+	+	+
Limnephilidae	+	+	+	+	+	+	+	+	+	+	+	+
Molannidae												
Odontoceridae												

Table 30f.–Continued.

Taxa	High Banks Creek at Dowling Road	Cedar Creek at McKeown Road	Fall Creek at Cook Road	Thornapple River at Hastings	Glass Creek at Oak Road	Bassett Creek at Shaw Lake Road	Duncan Creek at Stimpson Road	Coldwater River at Brown Road	Duck Creek at Montcalm Rd	Pratt Lake Creek at 84th Street	Tyler Creek at 100th Avenue	Coldwater River at Morse Lake Avenue
Philopotamidae		+										+
Phryganeidae		+		+		+						
Polycentropodidae				+								
Psychomyiidae						+		+	+			
Rhyacophilidae												
Sericostomatidae												
Uenoidae		+	+	+	+	+	+		+	+	+	+
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)												
Gyrinidae (adults)											+	+
Haliplidae (adults)										+	+	
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)		+	+	+	+	+		+	+			+
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)							+					
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												
Elmidae	+	+	+	+	+	+	+	+	+	+	+	+
Gyrinidae (larvae)							+					
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae							+					
Ceratopogonidae							+				+	+
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae		+					+				+	
Dixidae												

Table 30f.–Continued.

Taxa	High Banks Creek at Dowling Road	Cedar Creek at McKeown Road	Fall Creek at Cook Road	Thornapple River at Hastings	Glass Creek at Oak Road	Bassett Creek at Shaw Lake Road	Duncan Creek at Stimpson Road	Coldwater River at Brown Road	Duck Creek at Montcalm Rd	Pratt Lake Creek at 84th Street	Tyler Creek at 100th Avenue	Coldwater River at Morse Lake Avenue
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+	+	+	+	+	+	+	+	+	+	+
Stratiomyidae												
Syrphidae												
Tabanidae		+							+		+	+
Thaumaleidae												
Tipulidae		+				+	+	+				+
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+	+	+	+		+	+	+				+
Bithyniidae												
Hydrobiidae												
Lymnaeidae		+			+			+				
Physidae	+			+	+	+		+	+	+	+	+
Planorbidae				+								+
Pleuroceridae												
Pomatiopsidae												
Valvatidae												
Viviparidae				+			+		+		+	+
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae												
Sphaeriidae	+	+	+	+	+	+		+	+		+	+
Unionidae (mussels)	+	+		+							+	

Table 30g.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	McCords Creek at Buttrick Avenue	Honey Creek at Honey Creek Avenue	Egypt Creek at Pettis Avenue	Sunny Creek at Grand River Avenue	Bear Creek at Giles Avenue	Armstrong Creek at Egypt Valley Road	Bear Creek at Cannonsburg Road (East)	Ransom Creek at 104th Street	Rogue River at 20 Mile Road	Spring Creek at Red Pine Road	Frost Creek at 19 Mile Road	Duke Creek at Division Avenue
Porifera (sponges)												
Platyhelminthes (flatworms)												
Turbellaria						+	+					
Nematomorpha (roundworms)												
Bryozoa (moss animals)	+											
Annelida (segmented worms)												
Hirudinea (leeches)							+	+		+		
Oligochaeta (worms)		+	+	+	+	+	+			+		+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+		+	+	+	+		+
Isopoda (sowbugs)	+		+		+		+				+	
Arachnoidea												
Hydracarina	+	+	+			+						+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												+
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+
Caenidae							+					
Ephemerellidae			+			+						
Ephemeridae	+				+	+					+	
Heptageniidae	+	+	+		+			+	+	+	+	+
Isonichiidae						+						+
Leptophlebiidae							+					
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae												
Tricorythidae							+					
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+	+	+	+	+			+			+	+
Cordulegastridae	+	+		+	+						+	
Corduliidae										+		
Gomphidae		+			+				+			

Table 30g.–Continued.

Taxa	McCords Creek at Buttrick Avenue	Honey Creek at Honey Creek Avenue	Egypt Creek at Pettis Avenue	Sunny Creek at Grand River Avenue	Bear Creek at Giles Avenue	Armstrong Creek at Egypt Valley Road	Bear Creek at Cannonsburg Road (East)	Ransom Creek at 104th Street	Rogue River at 20 Mile Road	Spring Creek at Red Pine Road	Frost Creek at 19 Mile Road	Duke Creek at Division Avenue
Libellulidae										+		
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+		+	+		+	+	+	+	+	+
Coenagrionidae	+								+			
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae		+				+	+				+	
Peltoperlidae												
Perlidae	+	+			+							
Perlodidae												
Pteronarcyidae	+											
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae		+	+									+
Corixidae	+		+	+	+			+	+	+		
Gelastocoridae												
Gerridae	+	+	+	+	+	+	+	+	+	+	+	+
Mesoveliidae	+	+		+			+	+			+	
Naucoridae												
Nepidae												
Notonectidae									+			
Pleidae												
Saldidae									+			
Veliidae										+		+
Megaloptera												
Corydalidae (Dobson flies)	+	+	+	+	+						+	
Sialidae (alder flies)						+	+			+	+	
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae					+	+	+	+			+	+
Glossosomatidae	+	+	+				+				+	
Helicopsychidae	+				+		+					
Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	+
Hydroptilidae												
Lepidostomatidae												
Leptoceridae	+			+		+						
Limnephilidae	+	+	+	+	+		+	+	+		+	+
Molannidae												
Odontoceridae												

Table 30g.–Continued.

Taxa	McCords Creek at Buttrick Avenue	Honey Creek at Honey Creek Avenue	Egypt Creek at Pettis Avenue	Sunny Creek at Grand River Avenue	Bear Creek at Giles Avenue	Armstrong Creek at Egypt Valley Road	Bear Creek at Cannonsburg Road (East)	Ransom Creek at 104th Street	Rogue River at 20 Mile Road	Spring Creek at Red Pine Road	Frost Creek at 19 Mile Road	Duke Creek at Division Avenue
Philopotamidae	+				+			+			+	
Phryganeidae	+											
Polycentropodidae											+	
Psychomyiidae												
Rhyacophilidae						+						
Sericostomatidae												
Uenoidae	+	+	+	+	+		+	+			+	+
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)									+	+		
Gyrinidae (adults)												
Haliplidae (adults)	+		+							+		
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)									+			
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)	+											
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												+
Elmidae	+	+	+	+	+	+	+	+	+	+	+	+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae			+	+		+	+					
Ceratopogonidae		+		+		+					+	
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae			+									
Dixidae												

Table 30g.–Continued.

Taxa	McCords Creek at Buttrick Avenue	Honey Creek at Honey Creek Avenue	Egypt Creek at Pettis Avenue	Sunny Creek at Grand River Avenue	Bear Creek at Giles Avenue	Armstrong Creek at Egypt Valley Road	Bear Creek at Cannonsburg Road (East)	Ransom Creek at 104th Street	Rogue River at 20 Mile Road	Spring Creek at Red Pine Road	Frost Creek at 19 Mile Road	Duke Creek at Division Avenue
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+	+	+	+	+	+	+			+	+
Stratiomyidae												
Syrphidae												
Tabanidae												+
Thaumaleidae												
Tipulidae	+			+			+	+				
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae					+		+	+			+	
Bithyniidae												
Hydrobiidae												
Lymnaeidae										+		
Physidae	+	+	+	+		+	+	+	+			
Planorbidae				+					+	+		
Pleuroceridae												
Pomatiopsidae												
Valvatidae										+		
Viviparidae					+				+	+		
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae												
Sphaeriidae	+	+	+	+	+	+	+		+	+	+	+
Unionidae (mussels)												

Table 30h.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Ball Creek at Sparta Avenue	Rogue River at Indian Lakes Road	Nash Creek at Phelps Avenue	Cedar Creek at Algoma Avenue	Cedar Creek at Friske Road	Rogue River at Grange Avenue	Becker Creek at Russell Street	Stegeman Creek at Summit Avenue	Shaw Creek at Northland Ave	Rum Creek at 10 Mile Road	Barkely Creek at Northland Avenue	Rogue River at Packer Drive
Porifera (sponges)												+
Platyhelminthes (flatworms)												
Turbellaria				+		+						
Nematomorpha (roundworms)												
Bryozoa (moss animals)				+								+
Annelida (segmented worms)												
Hirudinea (leeches)		+										
Oligochaeta (worms)		+		+	+	+	+	+	+		+	
Arthropoda												
Crustacea												
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+	+	+						+
Isopoda (sowbugs)	+	+	+	+		+				+		+
Arachnoidea												
Hydracarina	+		+		+	+	+	+	+	+	+	+
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+
Caenidae												
Ephemerellidae				+			+	+		+		
Ephemeridae		+			+		+	+	+	+	+	
Heptageniidae		+	+	+	+	+	+	+			+	+
Isonichiidae					+							+
Leptophlebiidae							+					+
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae												
Tricorythidae												
Odonata												
Anisoptera (dragonflies)												
Aeshnidae	+		+	+	+	+						+
Cordulegastridae												
Corduliidae												
Gomphidae		+			+	+						

Table 30h.–Continued.

Taxa	Ball Creek at Sparta Avenue	Rogue River at Indian Lakes Road	Nash Creek at Phelps Avenue	Cedar Creek at Algoma Avenue	Cedar Creek at Friske Road	Rogue River at Grange Avenue	Becker Creek at Russell Street	Stegeman Creek at Summit Avenue	Shaw Creek at Northland Ave	Rum Creek at 10 Mile Road	Barkely Creek at Northland Avenue	Rogue River at Packer Drive
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae	+	+	+	+	+	+	+				+	
Coenagrionidae	+											
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae								+		+		
Peltoperlidae												
Perlidae				+	+	+	+				+	+
Perlodidae												+
Pteronarcyidae						+						+
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae												
Corixidae	+		+		+		+					+
Gelastocoridae												
Gerridae	+	+	+	+	+	+	+	+	+	+		+
Mesoveliidae			+				+					
Naucoridae												
Nepidae												
Notonectidae										+		
Pleidae												
Saldidae		+										
Veliidae		+	+	+					+	+		+
Megaloptera												
Corydalidae (Dobson flies)		+		+	+	+				+	+	
Sialidae (alder flies)			+	+	+				+	+	+	+
Neuroptera (spongilla flies)												
Sisyridae												
Trichoptera (caddisflies)												
Brachycentridae		+		+		+	+	+	+	+		
Glossosomatidae						+	+					+
Helicopsychidae				+	+							+
Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	
Hydroptilidae										+		+
Lepidostomatidae									+	+		
Leptoceridae					+	+	+				+	+
Limnephilidae	+	+	+	+	+	+	+	+		+		+
Molannidae					+							
Odontoceridae												

Table 30h.–Continued.

Taxa	Ball Creek at Sparta Avenue	Rogue River at Indian Lakes Road	Nash Creek at Phelps Avenue	Cedar Creek at Algoma Avenue	Cedar Creek at Friske Road	Rogue River at Grange Avenue	Becker Creek at Russell Street	Stegeman Creek at Summit Avenue	Shaw Creek at Northland Ave	Rum Creek at 10 Mile Road	Barkely Creek at Northland Avenue	Rogue River at Packer Drive
Philopotamidae								+			+	
Phryganeidae										+		+
Polycentropodidae												
Psychomyiidae						+						+
Rhyacophilidae												
Sericostomatidae												
Uenoidae			+	+	+	+	+	+	+	+		+
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)	+											
Gyrinidae (adults)										+		
Haliplidae (adults)							+		+			
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)									+			
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)					+	+						
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae				+				+				
Elmidae		+	+		+	+	+	+		+		+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												+
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae								+	+		+	
Ceratopogonidae		+		+			+		+	+	+	
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae			+									
Dixidae									+			

Table 30h.–Continued.

Taxa	Ball Creek at Sparta Avenue	Rogue River at Indian Lakes Road	Nash Creek at Phelps Avenue	Cedar Creek at Algoma Avenue	Cedar Creek at Friske Road	Rogue River at Grange Avenue	Becker Creek at Russell Street	Stegeman Creek at Summit Avenue	Shaw Creek at Northland Ave	Rum Creek at 10 Mile Road	Barkely Creek at Northland Avenue	Rogue River at Packer Drive
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+	+	+	+	+	+	+	+	+	+	+
Stratiomyidae												
Syrphidae												
Tabanidae			+	+	+					+		
Thaumaleidae												
Tipulidae	+				+					+		+
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+					+					+	+
Bithyniidae												
Hydrobiidae												
Lymnaeidae									+			
Physidae	+		+		+						+	+
Planorbidae			+									
Pleuroceridae						+						+
Pomatiopsidae												
Valvatidae												
Viviparidae					+	+						
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae					+							
Sphaeriidae		+	+	+	+	+	+					+
Unionidae (mussels)											+	

Table 30i.–Aquatic macroinvertebrates in the lower segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database accessed August 2006).

Taxa	Lamberton Creek at Monroe Avenue	Mill Creek at Baumhoff Avenue	Strawberry Creek at Westshire Avenue	York Creek at West River Drive	Indian Creek at Richmond Park	Little Plaster Creek at East Paris	Plaster Creek at Eastern Avenue	Buck Creek at 68th Avenue	Buck Creek at Wilson Avenue	Rush Creek at 12th Avenue	Sand Creek at Luce Street	Ottawa Creek at Bliss Avenue
Porifera (sponges)	+		+			+					+	
Platyhelminthes (flatworms)												
Turbellaria		+	+	+	+	+	+		+	+		
Nematomorpha (roundworms)												
Bryozoa (moss animals)											+	
Annelida (segmented worms)												
Hirudinea (leeches)	+	+		+		+			+	+		
Oligochaeta (worms)	+	+	+	+	+		+	+	+	+	+	+
Arthropoda												
Crustacea												
Amphipoda (scuds)	+		+			+	+	+	+	+	+	+
Decapoda (crayfish)	+	+			+	+	+	+			+	+
Isopoda (sowbugs)			+	+	+	+	+		+	+	+	+
Arachnoidea												
Hydracarina				+				+				
Insecta												
Ephemeroptera (mayflies)												
Ametropodidae												
Baetiscidae												
Baetidae	+		+	+	+	+	+	+	+			+
Caenidae								+				
Ephemerellidae												
Ephemeridae												
Heptageniidae	+		+				+		+			
Isonichiidae												
Leptophlebiidae												
Metretopodidae												
Oligoneuriidae												
Polymitarcyidae												
Potamanthidae												
Siphlonuridae												
Tricorythidae												
Odonata												
Anisoptera (dragonflies)												
Aeshnidae		+	+		+				+		+	+
Cordulegastridae												
Corduliidae												
Gomphidae				+							+	

Table 30i.–Continued.

Taxa	Lamberton Creek at Monroe Avenue	Mill Creek at Baumhoff Avenue	Strawberry Creek at Westshire Avenue	York Creek at West River Drive	Indian Creek at Richmond Park	Little Plaster Creek at East Paris	Plaster Creek at Eastern Avenue	Buck Creek at 68th Avenue	Buck Creek at Wilson Avenue	Rush Creek at 12th Avenue	Sand Creek at Luce Street	Ottawa Creek at Bliss Avenue
Libellulidae												
Macromiidae												
Zygoptera (damselflies)												
Calopterygidae		+					+			+	+	+
Coenagrionidae										+		+
Lestidae												
Plecoptera (stoneflies)												
Capniidae												
Chloroperlidae												
Leuctridae												
Nemouridae												
Peltoperlidae												
Perlidae												
Perlodidae												
Pteronarcyidae												
Taeniopterygidae												
Hemiptera (true bugs)												
Belostomatidae												
Corixidae		+							+		+	
Gelastocoridae												
Gerridae	+		+	+	+	+	+				+	+
Mesoveliidae			+	+			+			+	+	
Naucoridae												
Nepidae										+		
Notonectidae										+		
Pleidae							+		+	+		
Saldidae								+		+		+
Veliidae												
Megaloptera												
Corydalidae (Dobson flies)	+										+	
Sialidae (alder flies)												
Neuroptera (spongilla flies)												
Sisyridae						+						
Trichoptera (caddisflies)												
Brachycentridae												
Glossosomatidae												
Helicopsychidae												
Hydropsychidae	+		+	+	+	+	+	+	+	+		+
Hydroptilidae												
Lepidostomatidae												
Leptoceridae												
Limnephilidae											+	
Molannidae												
Odontoceridae												

Table 30i.–Continued.

Taxa	Lamberton Creek at Monroe Avenue	Mill Creek at Baumhoff Avenue	Strawberry Creek at Westshire Avenue	York Creek at West River Drive	Indian Creek at Richmond Park	Little Plaster Creek at East Paris	Plaster Creek at Eastern Avenue	Buck Creek at 68th Avenue	Buck Creek at Wilson Avenue	Rush Creek at 12th Avenue	Sand Creek at Luce Street	Ottawa Creek at Bliss Avenue
Philopotamidae												
Phryganeidae												
Polycentropodidae												
Psychomyiidae												
Rhyacophilidae												
Sericostomatidae												
Uenoidae												
Lepidoptera (moths)												
Noctuidae												
Pyralidae												
Coleoptera (beetles)												
Chrysomelidae (adults)												
Curculionidae (adults)												
Dytiscidae (total)												
Gyrinidae (adults)												
Haliplidae (adults)										+		
Heterocerodae (total)												
Hydraenidae (total)												
Hydrophilidae (total)								+				
Lampyridae (adults)												
Limnichidae (adults)												
Noteridae (adults)												
Psephenidae (adults)												
Ptilodactylidae (adults)												
Scirtidae (adults)												
Chrysomelidae (larvae)												
Curculionidae (larvae)												
Dryopidae												
Elmidae	+		+		+		+	+	+	+	+	+
Gyrinidae (larvae)												
Haliplidae (larvae)												
Lampyridae (larvae)												
Limnichidae (larvae)												
Noteridae (larvae)												
Psephenidae (larvae)												
Ptilodactylidae (larvae)												
Scirtidae (larvae)												
Diptera (flies)												
Athericidae			+									
Ceratopogonidae										+		
Chaoboridae												
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae		+										
Dixidae												

Table 30i.–Continued.

Taxa	Lamberton Creek at Monroe Avenue	Mill Creek at Baumhoff Avenue	Strawberry Creek at Westshire Avenue	York Creek at West River Drive	Indian Creek at Richmond Park	Little Plaster Creek at East Paris	Plaster Creek at Eastern Avenue	Buck Creek at 68th Avenue	Buck Creek at Wilson Avenue	Rush Creek at 12th Avenue	Sand Creek at Luce Street	Ottawa Creek at Bliss Avenue
Dolichopodidae												
Empididae												
Ephydridae												
Muscidae												
Psychodidae												
Ptychopteridae												
Sciomyzidae												
Simulidae	+	+	+	+	+			+	+			+
Stratiomyidae												
Syrphidae												
Tabanidae												
Thaumaleidae												
Tipulidae			+	+				+				
Mollusca												
Gastropoda (snails and limpets)												
Ancylidae	+						+		+			
Bithyniidae												
Hydrobiidae												
Lymnaeidae									+			
Physidae		+					+		+	+	+	
Planorbidae												
Pleuroceridae											+	
Pomatiopsidae												
Valvatidae												
Viviparidae	+											
Pelecypoda (bivalves)												
Corbicula												
Dreissenidae												
Pisidiidae						+						
Sphaeriidae	+					+	+				+	+
Unionidae (mussels)												

Table 31.–Aquatic macroinvertebrates in the mouth segment of the Grand River main stem and select tributaries. Data code: (+) = present, blanks indicate taxa not collected (Modified from MDEQ Procedure 51 database modified accessed August 2006).

Taxa	Beaver Creek at 56th Avenue	Deer Creek at Cleveland Street	Deer Creek at Mill Road	Bass Creek at 92nd Avenue	Bear Creek at 104th Avenue	Bass River at Buchanan Road	Crockery Creek at Behler Road	Crockery Creek at Schram Road	Rio Grande Creek at Patterson Park	Black Creek at Cleveland Street	Rhymer Creek at Sternburg Road	Norris Creek at Farr Road	Stevens Creek at Pontaluna Road
Porifera (sponges)		+	+		+			+	+				
Platyhelminthes (flatworms)													
Turbellaria	+				+		+		+				
Nematomorpha (roundworms)													
Bryozoa (moss animals)				+				+	+				
Annelida (segmented worms)													
Hirudinea (leeches)							+	+	+		+		+
Oligochaeta (worms)			+	+	+		+	+	+	+		+	
Arthropoda													
Crustacea													
Amphipoda (scuds)	+	+	+	+	+	+	+	+	+	+	+	+	+
Decapoda (crayfish)	+	+	+	+		+	+	+	+	+	+	+	
Isopoda (sowbugs)	+	+	+	+		+	+	+	+	+	+	+	+
Arachnoidea													
Hydracarina	+	+			+			+					
Insecta													
Ephemeroptera (mayflies)													
Ametropodidae													
Baetiscidae													
Baetidae	+	+		+	+	+	+	+	+		+	+	+
Caenidae				+									
Ephemerellidae													
Ephemeridae							+			+	+	+	+
Heptageniidae		+	+	+		+	+	+	+	+		+	+
Isonichiidae								+					
Leptophlebiidae													
Metretopodidae													
Oligoneuriidae													
Polymitarcyidae													
Potamanthidae													
Siphlonuridae													
Tricorythidae				+									
Odonata													
Anisoptera (dragonflies)													
Aeshnidae		+		+	+	+	+			+	+	+	+
Cordulegastridae													
Corduliidae													
Gomphidae				+		+	+	+				+	

Table 31.–Continued.

Taxa	Beaver Creek at 56th Avenue	Deer Creek at Cleveland Street	Deer Creek at Mill Road	Bass Creek at 92nd Avenue	Bear Creek at 104th Avenue	Bass River at Buchanan Road	Crockery Creek at Behler Road	Crockery Creek at Schram Road	Rio Grande Creek at Patterson Park	Black Creek at Cleveland Street	Rhymer Creek at Sternburg Road	Norris Creek at Farr Road	Stevens Creek at Pontaluna Road
Libellulidae													
Macromiidae													
Zygoptera (damselflies)													
Calopterygidae		+	+	+	+	+	+		+	+	+	+	+
Coenagrionidae													
Lestidae													
Plecoptera (stoneflies)													
Capniidae													
Chloroperlidae													
Leuctridae													
Nemouridae													
Peltoperlidae													
Perlidae							+	+					
Perlodidae												+	
Pteronarcyidae								+					
Taeniopterygidae													
Hemiptera (true bugs)													
Belostomatidae	+			+					+				
Corixidae	+	+	+	+			+	+	+	+	+	+	+
Gelastocoridae													
Gerridae	+	+	+	+	+	+	+	+	+	+	+	+	+
Mesoveliidae	+	+	+	+			+	+	+	+	+	+	+
Naucoridae													
Nepidae												+	
Notonectidae	+												
Pleidae													
Saldidae	+	+											
Veliidae			+										
Megaloptera													
Corydalidae (Dobson flies)					+		+	+					+
Sialidae (alder flies)	+					+				+			
Neuroptera (spongilla flies)													
Sisyridae													
Trichoptera (caddisflies)													
Brachycentridae						+	+	+			+	+	+
Glossosomatidae							+						
Helicopsychidae								+					
Hydropsychidae		+		+		+	+	+	+		+	+	+
Hydroptilidae									+				
Lepidostomatidae													
Leptoceridae				+									
Limnephilidae		+	+		+	+	+	+	+	+	+	+	+
Molannidae													
Odontoceridae													

Table 31.–Continued.

Taxa	Beaver Creek at 56th Avenue	Deer Creek at Cleveland Street	Deer Creek at Mill Road	Bass Creek at 92nd Avenue	Bear Creek at 104th Avenue	Bass River at Buchanan Road	Crockery Creek at Behler Road	Crockery Creek at Schram Road	Rio Grande Creek at Patterson Park	Black Creek at Cleveland Street	Rhymer Creek at Sternburg Road	Norris Creek at Farr Road	Stevens Creek at Pontaluna Road
Philopotamidae										+			
Phryganeidae													
Polycentropodidae				+					+				
Psychomyiidae													
Rhyacophilidae													
Sericostomatidae													
Uenoidae								+					
Lepidoptera (moths)													
Noctuidae													
Pyralidae													
Coleoptera (beetles)													
Chrysomelidae (adults)													
Curculionidae (adults)													
Dytiscidae (total)	+				+	+						+	+
Gyrinidae (adults)	+			+									
Haliplidae (adults)	+									+		+	+
Heterocerodae (total)					+								
Hydraenidae (total)													
Hydrophilidae (total)	+			+			+		+	+		+	+
Lampyridae (adults)													
Limnichidae (adults)													
Noteridae (adults)													
Psephenidae (adults)									+				
Ptilodactylidae (adults)													
Scirtidae (adults)				+									
Chrysomelidae (larvae)													
Curculionidae (larvae)													
Dryopidae	+	+	+								+		
Elmidae	+	+	+	+			+	+	+				
Gyrinidae (larvae)													
Haliplidae (larvae)													
Lampyridae (larvae)													
Limnichidae (larvae)													
Noteridae (larvae)													
Psephenidae (larvae)													
Ptilodactylidae (larvae)													
Scirtidae (larvae)													
Diptera (flies)													
Athericidae					+		+	+	+				
Ceratopogonidae	+												
Chaoboridae													
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+	+
Culicidae	+		+						+				
Dixidae	+	+		+									

Table 31.–Continued.

Taxa	Beaver Creek at 56th Avenue	Deer Creek at Cleveland Street	Deer Creek at Mill Road	Bass Creek at 92nd Avenue	Bear Creek at 104th Avenue	Bass River at Buchanan Road	Crockery Creek at Behler Road	Crockery Creek at Schram Road	Rio Grande Creek at Patterson Park	Black Creek at Cleveland Street	Rhymer Creek at Sternburg Road	Norris Creek at Farr Road	Stevens Creek at Pontaluna Road
Dolichopodidae													
Empididae													
Ephydridae													
Muscidae													
Psychodidae													
Ptychopteridae													
Sciomyzidae													
Simulidae	+	+			+	+			+	+	+	+	+
Stratiomyidae													
Syrphidae													
Tabanidae													
Thaumaleidae													
Tipulidae					+				+				
Mollusca													
Gastropoda (snails and limpets)													
Ancylidae			+					+					
Bithyniidae													
Hydrobiidae													
Lymnaeidae					+				+				+
Physidae	+	+		+	+	+	+		+	+	+	+	
Planorbidae						+							
Pleuroceridae													
Pomatiopsidae													
Valvatidae													
Viviparidae		+											
Pelecypoda (bivalves)													
Corbicula													
Dreissenidae													
Pisidiidae													
Sphaeriidae	+	+	+	+	+		+	+	+	+	+	+	+
Unionidae (mussels)		+											

Table 32.–Occurrence of freshwater mussels (Unionidae) present during surveys of the Grand River main stem. Data from Coker et al. 1921, van der Schalie 1948, Goforth et al. 2000, and Badra and Goforth 2002 and 2003. Main stem segment codes: H=Headwaters, U=Upper, M=Middle, L=Lower, Mo=Mouth, T=Tributaries. Data codes: X=live specimen present, Xs=shell present, dash (–) indicates not collected, blank indicates no survey data in segment. Miscellaneous data for main stem tributaries derived from museum collections and unpublished surveys. Michigan Conservation Status (in bold after species name): **X**=extirpated, **E**=endangered, **T**=threatened, **SC**=special concern, **SGCN**=species of greatest conservation need.

	Survey year/location																					
Common name	1909				1945				1999–2003				Miscellaneous									
Scientific name	H	U	M	L	H	U	M	L	H	U	M	L	H	U	M	L	Mo	T				
mucket																						
Actinonaias ligamentina	–	X	X	X				X			X	X	–	X	X	X	X	X				
elktoe **SC**																						
Alasmidonta marginata	–	X	X	X				X			Xs	X	–	X	X	X	–	X				
slippershell **T**																						
Alasmidonta viridis	X	X	X	–				–			Xs	Xs	X	X	X	X	–	X				
three–ridge																						
Amblema plicata	X	X	X	X				X			X	X	–	X	X	X	X	X				
pimpleback **SGCN**																						
Amphinaias pustulosa	–	–	–	X				X			Xs	X	–	–	X	X	X	X				
cylindrical papershell **SGCN**																						
Anodontoides ferussacianus	X	X	–	X				–			–	X	X	X	X	X	–					
purple wartyback **T**																						
Cyclonaias tuberculata	–	–	X	X				X			Xs	X	–	–	–	X	X	X				
spike																						
Elliptio dilatata	X	X	X	X				X			Xs	X	X	X	X	X	X	X				
snuffbox **E**																						
Epioblasma triquetra	–	–	–	–				–			Xs	X	–	–	–	X	–	X				
Wabash pigtoe																						
Fusconaia flava	X	X	–	X				X			X	X	X	X	X	X	X	X				
plain pocketbook																						
Lampsilis cardium	X	X	X	X				X			X	X	X	X	X	X	X	X				
fatmucket																						
Lampsilis siliquoidea	X	X	–	X				X			Xs	Xs	X	X	X	X	X	X				
white heelsplitter																						
Lasmigona complanata complanata	–	–	–	X				–			–	–	–	–	–	–	X	X				
creek heelsplitter **SGCN**																						
Lasmigona compressa	X	X	X	–				–			–	X	X	X	X	–	–	X				
flutedshell																						
Lasmigona costata	X	X	X	X				X			Xs	X	X	X	X	X	X	X				
fragile papershell																						
Leptodea fragilis	–	–	–	–				–			–	X	–	–	–	X	X	X				
black sandshell **E**																						
Ligumia recta	–	–	X	X				X			–	X	–	–	–	X	X	X				
threehorn wartyback **E**																						
Obliquaria reflexa	–	–	–	X				–			–	–	–	–	–	X	X					
hickorynut **E**																						
Obovaria olivaria	–	–	–	X				–			–	–	–	–	–	X	X	X				

Table 32.–Continued.

Common name	Survey year/location																				
	1909				1945				1999–2003				Miscellaneous								
Scientific name	H	U	M	L	H	U	M	L	H	U	M	L	H	U	M	L	Mo	T			
round pigtoe **SC** *Pleurobema sintoxia*	X	X	X	X				X			Xs	X	X	X	X	X	X	X			
pink heelsplitter *Potamilis alatus*	–	–	–	X				–			–	–	–	–	–	–	X				
pink papershell **T** *Potamilus ohiensis*																	X				
giant floater *Pyganodon grandis*	X	X	X	X				X			X	X	X	X	X	X	X	X			
Mapleleaf *Quadrula quadrula*	–	–	–	X				X			Xs	X	–	–	–	X	X	X			
creeper *Strophitus undulatus*	X	X	X	X				X			Xs	X	X	X	X	X	X	X			
lilliput **E** *Toxoplasma parvus*																		X			
fawns foot **T** *Truncilla donaciformis*	–	–	–	–				–			–	–	–	–	–	X	X				
deer toe **SC** *Truncilla truncate*	–	–	–	X				–			–	X	–	–	–	X	X	X			
paper pondshell **SC** *Utterbackia imbecilis*	–	–	–	–				–			–	–	X	–	–	–	–				
ellipse **SC** *Venustaconcha ellipsiformis*	X	X	X	X				X			Xs	X	X	X	X	X	–	X			
rainbow **SC** *Villosa iris*	X	X	X	X				X			Xs	–	X	X	X	X	–	X			

Table 33.–Snail species potentially present in the Grand River watershed based on Nature Serve Explorer (2006) and Burch (1991). Nomenclature follows Turgeon et al. (1998). Michigan Conservation Status (in bold after species name): **X**=extirpated, **E**=endangered, **T**=threatened, **SC**=special concern, **SGCN**=species of greatest conservation need.

Family/Species	
Mystery Snails (Viviparidae)	
ponderous campeloma	*Campeloma crassulum*
pointed campeloma	*Campeloma decisum*
banded mysterysnail	*Viviparus georgianus*
Valve Snails (Valvatidae)	
two-ridge valvata	*Valvata bicarinata*
fringed valvata	*Valvata lewisi*
purplecap valvata	*Valvata perdepressa*
mossy valvata	*Valvata sincera*
threeridge valvata	*Valvata tricarinata*
flanged valvata	*Valvata winnebagoensis*
Spire Snails (Hydrobiidae)	
mud amnicola	*Amnicola limosus*
globe siltsnail	*Birgella subglobosus*
campeloma spire snail	*Cincinnatia cincinnatiensis*
watercress snail **SC**	*Fontigens nickliniana*
Canadian Duskysnail	*Lyogyrus walkeri*
delta hydrobe	*Probythinella emarginata*
boreal marstonia	*Pyrgulopsis lustrica*
Looping Snails (Pomatiopsidae)	
brown walker **SC**	*Pomatiopsis cincinnatiensis*
Faucet Snails (Bithyniidae)	
mud bithynia	*Bithynia tentaculata*
Horn Snails (Pleuroceridae)	
liver elimia	*Elimia livescens*
sharp hornsnail	*Pleurocera acuta*
Pond Snails (Lymnaeidae)	
spindle lymnaea **SC**	*Acella haldemani*
mammoth lymnaea	*Bulimnaea megasoma*
bugle fossaria	*Fossaria cyclostoma*
dusky fossaria	*Fossaria dalli*
graceful fossaria	*Fossaria exigua*
boreal fossaria	*Fossaria galbana*
rock fossaria	*Fossaria modicella*
golden fossaria	*Fossaria obrussa*
pygmy fossaria	*Fossaria parva*
	Fossaria rustica
swamp lymnaea	*Lymnaea stagnalis*
mimic lymnaea	*Pseudosuccinea columella*
wrinkled marshsnail	*Stagnicola caperata*

Table 33.–Continued.

Family/Species	
Pond Snails–continued	
woodland pondsnail	*Stagnicola catascopium*
marsh pondsnail	*Stagnicola elodes*
St. Lawrence pondsnail	*Stagnicola emarginata*
flat-whorled pondsnail	*Stagnicola exilis*
coldwater pondsnail	*Stagnicola woodruffi*
Tadpole Snails (Physidae)	
lance aplexa	*Aplexa elongata*
glass physa	*Physa skinneri*
vernal physa	*Physa vernalis*
pumpkin physa	*Physella ancillaria*
tadpole physa	*Physella gyrina*
pewter physa	*Physella heterostropha*
ashy physa	*Physella integra*
broadshoulder physa	*Physella parkeri*
Ramshorn Snails (Planorbidae)	
disc gyro	*Gyraulus circumstriatus*
star gyro	*Gyraulus crista*
flexed gyro	*Gyraulus deflectus*
ash gyro	*Gyraulus parvus*
two-ridge rams-horn	*Helisoma anceps*
corpulent rams-horn	*Planorbella corpulenta*
aquatic snail (no common name) **SC**	*Planorbella smithi*
marsh rams-horn	*Planorbella trivolvis*
sharp sprite	*Promenetus exacuous*
umbilicate sprite	*Promenetus umbilicatellus*
True Freshwater Limpets (Ancylidae)	
fragile ancylid	*Ferrissia fragilis*
oblong ancylid	*Ferrissia parallelus*
creeping ancylid	*Ferrissia rivularis*
cloche ancylid	*Ferrissia walkeri*
dusky ancylid	*Laevapex fuscus*

Table 34.–Crayfish species (Cambaridae) potentially present in the Grand River watershed (Creaser 1931). Scientific nomenclature follows Taylor et al. (2007). Common names were taken from McLaughlin et al. (2005). Michigan Conservation Status (in bold after species name): **X**=extirpated, **E**=endangered, **T**=threatened, **SC**=special concern, **SGCN**=species of greatest conservation need.

Common name	Scientific name
devil crawfish **SGCN**	*Cambarus diogenes*
Paintedhand mudbug	*Cambarus polychromatus*
big river crayfish	*Cambarus robustus*
digger crayfish **SGCN**	*Fallicambarus fodiens*
calico crayfish	*Orconectes immunis*
northern clearwater crayfish	*Orconectes propinquus*
rusty crayfish	*Orconectes rusticus*
virile crayfish	*Orconectes virilis*
White River crawfish	*Procambarus acutus*

Table 35.–List of amphibians and reptiles in the Grand River watershed. Data from distributions described by Holman et al (1989); Harding and Holman (1990 and 1992). Michigan Conservation status **X**=extirpated, **E**=endangered, **T**=threatened, **SC**=species of concern, **SGCN**=species of greatest conservation need.

Common name	Scientific name
Turtles	
Blanding's turtle **SC**	*Emydiodes blandingi*
common musk turtle	*Sternotherus odoratus*
eastern box turtle **SC**	*Terrapene carolina coroliona*
map turtle	*Graptemys geograpnica*
painted turtle	*Chrysemys picta marginata*
snapping turtle	*Chelydra serpentina*
spiny softshell	*Apalone spinifera*
spotted turtle **T**	*Clemmys guttata*
wood turtle **SC**	*Clemmys insculpta*
Snakes	
black rat snake **SGCN**	*Elaphne obsoleta obsoleta*
blue racer **SGCN**	*Coluber constrictor foxi*
brown snake	*Storeria dekayi*
Butler's garter snake	*Thamnophis butleri*
copperbelly water snake **E**	*Nerodia erythrogaster neglecta*
eastern garter snake	*Thamnoshis sirtalis sirtalis*
eastern hognose snake **SGCN**	*Heterodon platyrhinos*
eastern milk snake	*Lampropeltis triangulum triangulum*
eastern massasauga **SC**	*Sistrurus catenatus*
Kirtland's snake **E**	*Clonophis kirtlandii*
northern red-bellied snake	*Storeria occipitomaculata occipitomaculata*
northern ribben snake	*Thamnophis sauritus septentrionalis*
northern ringneck snake **SGCN**	*Diadophis punctatus edwardi*
northern water snake	*Nerodia sipedon sipedon*
queen snake **SC**	*Regina septemvittata*
smooth green snake **SGCN**	*Opheodrys vernalis*
Salamanders and Lizards	
blue-spotted salamander **SGCN**	*Ambystoma laterale*
central newt	*Notophthalmus viridescens louisianensis*
eastern tiger salamander **SGCN**	*Ambustoma tigrinum tigrinum*
five-lined skink	*Eumeces fasciatus*
four-toed salamander **SGCN**	*Hemidactylium scutatum*
mudpuppy **SGCN**	*Necturus maculosus maculosus*
red-backed salamander	*Plethodon cinereus*
red-spotted newt	*Notophthalmus viridescens viridescens*
spotted salamander **SGCN**	*Ambystoma maculatum*

Table 35.–Continued.

Common name	Scientific name
Frogs and Toads	
American toad	*Bufo americanus*
Blanchard's cricket frog **T**	*Acris crepitans blanchardi*
bullfrog	*Rana catesbeiana*
Fowler's toad **SGCN**	*Bufo woodhousei fowleri*
gray treefrog	*Hyla versicolor*
green frog	*Rana clamitans melanota*
northern leopard frog **SC**	*Rana pipiens*
pickerel frog **SGCN**	*Rana palustris*
spring peeper	*Pseudacris crucifer*
western chorus frog **SGCN**	*Pseudacris triseriata triseriata*
wood frog	*Rana sylvatica*

Table 36.–Bird species found in the Grand River watershed. Data from Brewer et al. 1991. Michigan Conservation status **X**=extirpated, **E**=endangered, **T**=threatened, **SC**=species of concern, **SGCN**=species of greatest conservation need.

Common name	Scientific name
Acadian Flycatcher **SGCN**	*Empidonax virescens*
Alder Flycatcher	*Empidonax alnorum*
American Bittern **SC**	*Botaurus lentiginosus*
American Black Duck **SGCN**	*Anas rubripes*
American Coot **SGCN**	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparverius*
American Redstart	*Setophaga ruticilla*
American Woodcock **SGCN**	*Scolopax minor*
Bald eagle **SC**	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Barred Owl	*Strix varia*
Belted Kingfisher	*Ceryle alcyon*
Black Tern **SC**	*Chlidonias niger*
Black-and-white Warbler	*Mniotilta varia*
Black-billed Cuckoo **SGCN**	*Coccyzus erythropthalmus*
Blackburnian Warbler **SGCN**	*Dendroica fusca*
Black-capped chickadee	*Parus atricapillus*
Black-crowned Night-heron **SC**	*Nycticorax nycticorax*
Black-throated Blue Warbler **SGCN**	*Dendroica caerulescens*
Black-throated Green Warbler	*Dendroica virens*
Blue Jay	*Cyanocitta cristata*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Blue-winged Teal **SGCN**	*Anas discors*
Blue-winged Warbler **SGCN**	*Vermivora pinus*
Bobolink **SGCN**	*Dolichonyx oryzivorus*
Brewer’s Blackbird	*Euphagus cyanocephalus*
Broad-winged Hawk	*Buteo platypterus*
Brown Thrasher **SGCN**	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Canada Goose	*Branta canadensis*
Canada Warbler **SGCN**	*Wilsonia canadensis*
Carolina Wren	*Thryothorus ludovicianus*
Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombucilla cedrorum*
Cerulean Warbler **T**	*Dendroica cerulea*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Chimney Swift	*Chaetura pelagica*
Chipping Sparrow	*Spizella passerina*
Chuck-wills-widow **SGCN**	*Caprimulgus carolinensis*
Cliff Swallow	*Hirundo pyrrhonota*
Common Goldeneye	*Bucephala clangula*

Table 36.—Continued.

Common name	Scientific name
Common Grackle	*Quiscalus quiscula*
Common Loon **T**	*Gavia immer*
Common Merganser	*Mergus merganser*
Common Moorhen **T**	*Gallinula chloropus*
Common Nighthawk **SGCN**	*Chordeiles minor*
Common Snipe	*Gallinago gallinago*
Common Yellowthroat	*Geothlypis trichas*
Copper's Hawk **SGCN**	*Accipiter cooperii*
Dickcissel **SC**	*Spiza americana*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
Eastern Kingbird **SGCN**	*Tyrannus tyrannus*
Eastern Meadowlark **SGCN**	*Sturnella magna*
Eastern Phoebe	*Sayornis phoebe*
Eastern Screech Owl	*Otus asio*
Eastern Towhee **SGCN**	*Pipilo erythrophthalmus*
Eastern Wood-Pewee	*Contopus sordidulus*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
Golden Eagle	*Aquila chrysaetos*
Golden-crowned Kinglet	*Regulus satrapa*
Golden-winged Warbler **SGCN**	*Vermivora chrysoptera*
Grasshopper sparrow **SC**	*Ammodramus savannarum*
Great Blue Heron **SGCN**	*Ardea herodias*
Great Crested Flycatcher	*Myiarchus crinitus*
Great Egret	*Casmerodius albus*
Great Horned Owl	*Bubo virginianus*
Green Heron **SGCN**	*Butorides striatus*
Hairy Woodpecker	*Picoides villosus*
Henslow’s Sparrow **E**	*Ammodramus henslowii*
Hermit Thrush	*Catharus guttatus*
Herring Gull	*Larus argentatus*
Hooded Merganser	*Lophodytes cucullatus*
Hooded Warbler **SC**	*Wilsonia citrina*
Horned Lark	*Ermophila alpestris*
House Finch	*Carpodacus cassinii*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Indigo Bunting	*Passerina cyahea*
Kentucky Warbler **SGCN**	*Oporornis formosus*
Killdeer **SGCN**	*Charadrius vociferus*
King Rail **E**	*Rallus elagans*
Least Bittern **T**	*Ixobeychus exilis*
Least Flycatcher **SGCN**	*Empidonax minimus*

Table 36.—Continued.

Common name	Scientific name
Long-eared Owl **T**	*Asio otus*
Louisiana Waterthrush **T**	*Seiurus motacilla*
Mallard	*Anas platyrhynchos*
Marsh Wren **SC**	*Cistothorus palustris*
Merlin **T**	*Falco columbarius*
Migrant Loggerhead Shrike **E**	*Lanius ludovicianus migrans*
Mourning Dove	*Zenaida macroura*
Mourning Warbler	*Oporornis philadelphia*
Mute Swan	*Cygnus olor*
Northern Bobwhite **SGCN**	*Colinus virginianus*
Northern Cardinal	*Richmondena cardinalis*
Northern Flicker **SGCN**	*Colaptes auratus*
Northern Goshawk **SC**	*Accipiter gentilis*
Northern Harrier **SC**	*Circus cyaneus*
Northern Mockingbird **SGCN**	*Mimus polyglottos*
Northern Oriole	*Icterus galbula*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern Saw-whet Owl	*Aegolius acadicus*
Orchard Oriole	*Icterus spurius*
Osprey **SC**	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapillus*
Peregrine Falcon **E**	*Falco peregrinus*
Pied-billed grebe **SGCN**	*Podilymbus podiceps*
Pileated Woodpecker	*Dryocopus pileatus*
Pine Sisken	*Carduelis pinus*
Prairie Warbler **E**	*Dendroica discolor*
Prothonotary Warbler **SC**	*Protonotaria citea*
Purple Martin **SGCN**	*Progne subis*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-breasted Nuthatch	*Sitta canadensis*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker **SGCN**	*Melanerpes erythrocephalus*
Red-shouldered Hawk **T**	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Aselaius phoeniceus*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Pheasant	*Phasianus colcnicus*
Robin	*Turdus migratorius*
Rock Dove	*Columba livia*
Rose-breasted Grosbeak	*Pheuticus ludovicianus*
Ruby-crowned Kinglet **SGCN**	*Regulus calendula*
Ruby-throated Hummingbird	*Archilochus colubris*
Ruffed Grouse	*Bonasa umbellus*
Sandhill Crane	*Grus canadensis*

Table 36.—Continued.

Common name	Scientific name
Savannah Sparrow **SGCN**	*Passerculus sandwichensis*
Scarlet Tanger	*Piranga olivacea*
Sedge Wren **SGCN**	*Cistothorus platensis*
Sharp-shinned Hawk	*Accipiter striatus*
Short-eared Owl **E**	*Asio flammeus*
Solitary Vireo	*Vireo solitarius*
Song Sparrow	*Melospiza melodia*
Sora **SGCN**	*Porzana carolina*
Spotted Sandpiper **SGCN**	*Actitis macularia*
Swamp Sparrow	*Melospiza georgina*
Tree Swallow	*Iridoprocne bicolor*
Trumpeter Swan **T**	*Cygnus buccinator*
Tufted Titmouse	*Parus bicolor*
Turkey Vulture	*Cathartes aura*
Upland Sandpiper **SGCN**	*Bartramis longicauda*
Veery	*Catharus fuscescens*
Vesper Sparrow **SGCN**	*Pooecetes gramineus*
Virginia Rail **SGCN**	*Rallus limicola*
Warbling Vireo	*Vireo gilvus*
Western Meadowlark **SGCN**	*Sturnella neglecta*
Whip-poor-will **SGCN**	*Caprimulgus vociferus*
White-breasted Nuthatch	*Sitta carolinensis*
White-crowned Sparrow	*Zonotrichia leucopheys*
White-eyed Vireo **SGCN**	*Vireo griseus*
Wild Turkey	*Meleagris galloparo*
Willow Flycatcher	*Empidonax traillii*
Wilson’s Snipe **SGCN**	*Gallinago delicata*
Winter Wren	*Troglodytes Troglodytes*
Wood Duck	*Aix sponsa*
Wood Thrush **SGCN**	*Hylocichla mustelina*
Worm-eating Warbler **SGCN**	*Helmitheros vermivorus*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-billed Cuckoo **SGCN**	*Coccyzus americanus*
Yellow-breasted Chat **SGCN**	*Icteria virens*
Yellow-throated Vireo	*Vireo flaviforns*

Table 37.–Mammals that occur or formerly occurred in the Grand River watershed. Data from Baker, 1983 and Michigan Department of Natural Resources, Wildlife Division. Michigan Conservation status X=extirpated, E =endangered, T=threatened, SC=species of concern, SGCN=species of greatest conservation need.

Common name	Scientific name
American marten **X**	*Martes americana*
badger	*Taxidea taxus*
beaver	*Castor canadensis*
big brown bat	*Epesicus fuscus*
bison **X**	*Bison bison*
black bear	*Ursus americanus*
bobcat	*Felis rufus*
coyote	*Canis latrans*
deer mouse **SGCN**	*Peromyscus maniculatus*
eastern chipmunk	*Sylvilagus floridanus*
eastern cottontail	*Sylvilagus floridanus*
eastern mole	*Scalopus aquaticus*
elk **X**	*Cervus elaphus*
ermine	*Mustela erminea*
European hare	*Lepus capensis*
evening bat **T**	*Nycticeius humeralis*
fisher **X**	*Martes pennanti*
fox squirrel	*Sciurus niger*
gray fox	*Urocyon cinereoargenteus*
gray squirrel	*Sciurus carolinensis*
gray wolf **X**	*Canis lupus*
hoary bat **SGCN**	*Lasiurus cinereus*
house mouse	*Mus musculus*
Indiana bat **E**	*Myotis sodalis*
Keen's Bat	*Myotis keenii*
least shrew **T**	*Cryptotis parva*
least weasel **SGCN**	*Mustela nivalis*
little brown myotis	*Myotis luifugus*
longtail weasel	*Mustela frenata*
lynx **X**	*Lynx canadensis*
masked shrew	*Sorex cinereus*
meadow jumping mouse	*Zapus hudsonius*
meadow vole **SC**	*Microtus pennsylvanicus*
mink	*Mustela vison*
moose **X**	*Alces alces*
mountain lion **X**	*Felis concolor*
muskrat	*Ondatra zibethicus*
northern flying squirrel **SC**	*Glaucomys sabrinus*

Table 37.—Continued.

Common name	Scientific name
norway rat	*Rattus norvegicus*
opossum	*Didelphus marsupialis*
porcupine	*Erethizon dorsatum*
raccoon	*Procyon lotor*
red bat **SGCN**	*Lasiurus borealis*
red fox	*Vulpes fulva*
red squirrel	*Tamiasciurus hudsonicus*
river otter	*Lutra canadensis*
shorttail shrew	*Blarina brevicauda*
silver-haired bat **SGCN**	*Lasionycteris noctivagans*
snowshoe hare **SGCN**	*Lepus americanus*
southern bog lemming **SGCN**	*Synaptomys cooperi*
southern flying squirrel	*Glaucomys volans*
starnose mole	*Condylura cristata*
striped skunk	*Mephitis mephitis*
thirteen-lined ground squirrel	*Citellus tridecemineatus*
white-footed mouse	*Peromyscus leucopus*
white-tailed deer	*Odocoileus virginianus*
woodchuck	*Marmota monax*
woodland vole **SC**	*Microtus pinetorum*

Table 38a.–Status and ranking codes for Natural features occurring in the Grand River watershed. Information from Michigan State University Extension, Natural Features Inventory.

Status or ranking code	Description
State Status	
E	Endangered
T	Threatened
SC	Species of Special Concern
Federal Status	
LE	Listed endangered
LT	Listed threatened
LELT	Partly listed endangered and partly listed threatened
PDL	Proposed for delisting
E(S/A)	Endangered based on similarities in appearance
PS	Partial status (Federally listed in only part of the species range)
C	Species being considered for federal status
State ranking	
S1	Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
S2	Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state
S3	Rare or uncommon in state (on the order of 21 to 100 occurrences).
S4	Apparently secure in state, with many occurrences.
S5	Demonstrably secure in state and essentially ineradicable under present conditions.
SA	Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.
SE	An exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).
SH	Of historical occurrence in state and suspected to be still extant.
SN	Regularly occurring, usually migratory and typically nonbreeding species.
SR	Reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.
SRF	Rported falsely (in error) from state but this error persisting in the literature.
SU	SU = possibly in peril in state, but status uncertain; need more information.
SX	SX = apparently extirpated from state.
Global ranking	
G1	Critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction
G2	Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range
G3	Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

Table 38a.–Continued.

Status or ranking Code	Description
Global ranking–continued	
G4	Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5	Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GH	Historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).
GU	Possibly in peril range-wide, but status uncertain; need more information
GX	Believed to be extinct throughout its range (e.g. Passenger Pigeon with virtually no likelihood that it will be rediscovered).
G?	Incomplete data.
Q	Taxonomy uncertain
T	Subspecies
U	Unmappable through out the global geographic extent
?	Questionable data.

Table 38b.–Known natural feature element occurrences in the Grand River watershed. Data from Michigan State University Extension, Michigan Natural Features Inventory, September 2005.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Headwaters					
Vertebrate					
American Bittern	*Botaurus lentiginosus*	SC		S3S4	G4
Black Tern	*Chlidonias niger*	SC		S3	G4
Cerulean Warbler	*Dendroica cerulea*	T		S3	G4
Common Moorhen	*Gallinula chloropus*	T		S3	G5
Dickcissel	*Spiza americana*	SC		S3	G5
Henslow's Sparrow	*Ammodramus henslowii*	E		S2S3	G4
Hooded Warbler	*Wilsonia citrina*	SC		S3	G5
King Rail	*Rallus elegans*	E		S1	G4
Least Bittern	*Ixobrychus exilis*	T		S2	G5
cisco	*Coregonus artedi*	T		S3	G5
spotted gar	*Lepisosteus oculatus*	SC		S2S3	G5
Indiana Bat or Indiana Myotis	*Myotis sodalis*	E	LE	S1	G2
least shrew	*Cryptotis parva*	T		S1S2	G5
Blanchard's cricket frog	*Acris crepitans blanchardi*	T		S2S3	G5T5
Blanding's turtle	*Emys blandingii*	SC		S3	G4
eastern box turtle	*Terrapene carolina carolina*	SC		S2S3	G5T5
eastern massasauga	*Sistrurus catenatus catenatus*	SC	C	S3S4	G3G4T3T4Q
spotted turtle	*Clemmys guttata*	T		S2	G5
Invertebrate					
angular spittlebug	*Lepyronia angulifera*	SC		S1S2	G3
barrens buckmoth	*Hemileuca maia*	SC		S2S3	G5
blazing star borer	*Papaipema beeriana*	SC		S1S2	G2G3
Mitchell's satyr	*Neonympha mitchellii mitchellii*	E	LE	S1	G1G2T1T2
pinetree cricket	*Oecanthus pini*	SC		S1S2	GNR
poweshiek skipperling	*Oarisma poweshiek*	T		S1S2	G2G3
red-legged spittlebug	*Prosapia ignipectus*	SC		S2S3	G4
regal fern borer	*Papaipema speciosissima*	SC		S2S3	G4
regal fritillary	*Speyeria idalia*	E		SH	G3
silphium borer moth	*Papaipema silphii*	T		S1S2	G3G4
swamp metalmark	*Calephelis mutica*	SC		S1S2	G3
tamarack tree cricket	*Oecanthus laricis*	SC		S1S2	G1G2
Plant					
American chestnut	*Castanea dentata*	E		S1S2	G4
bog bluegrass	*Poa paludigena*	T		S2	G3
Clinton's bulrush	*Scirpus clintonii*	SC		S3	G4
cross-leaved milkwort	*Polygala cruciata*	SC		S3	G5
dwarf hackberry	*Celtis tenuifolia*	SC		S3	G5
edible valerian	*Valeriana edulis var. ciliata*	T		S2	G5T3
Engelmann's spike-rush	*Eleocharis engelmannii*	SC		S2S3	G4G5Q
false boneset	*Kuhnia eupatorioides*	SC		S2	G5
hairy angelica	*Angelica venenosa*	SC		S3	G5
horsetail spike-rush	*Eleocharis equisetoides*	SC		S3	G4
kitten-tails	*Besseya bullii*	E		S1	G3
mat muhly	*Muhlenbergia richardsonis*	T		S2	G5
orange or yellow fringed orchid	*Platanthera ciliaris*	E		S1S2	G5
prairie dropseed	*Sporobolus heterolepis*	SC		S3	G5
purple coneflower	*Echinacea purpurea*	X		SX	G4
purple milkweed	*Asclepias purpurascens*	T		S2	G5?

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Headwaters–continued					
Plant–continued					
purple twayblade	*Liparis liliifolia*	SC		S3	G5
spike-rush	*Eleocharis geniculata*	X		SX	G5
tall green milkweed	*Asclepias hirtella*	T		S2	G5
tall nut-rush	*Scleria triglomerata*	SC		S3	G5
upland boneset	*Eupatorium sessilifolium*	T		S1	G5
white lady-slipper	*Cypripedium candidum*	T		S2	G4
white or prairie false indigo	*Baptisia lactea*	SC		S3	G4Q
wild-rice	*Zizania aquatica var. aquatica*	T		S2S3	G5T5
yellow nut-grass	*Cyperus flavescens*	SC		S2S3	G5
Plant community					
prairie fen				S3	G3
rich tamarack swamp				S3	G4
dry southern forest				S3	G4
southern wet meadow				S3	G4?
southern hardwood swamp				S3	G3
bog				S4	G3G5
dry-mesic southern forest				S3	G4
Other features					
Great Blue Heron rookery				SU	GNR
Upper					
Vertebrate					
American Bittern	*Botaurus lentiginosus*	SC		S3S4	G4
King Rail	*Rallus elegans*	E		S1	G4
cisco	*Coregonus artedi*	T		S3	G5
weed shiner	*Notropis texanus*	X		S1	G5
Indiana bat or Indiana myotis	*Myotis sodalis*	E	LE	S1	G2
Blanchard's cricket frog	*Acris crepitans blanchardi*	T		S2S3	G5T5
Blanding's turtle	*Emys blandingii*	SC		S3	G4
eastern box turtle	*Terrapene carolina carolina*	SC		S2S3	G5T5
eastern massasauga	*Sistrurus catenatus catenatus*	SC	C	S3S4	G3G4T3T4Q
spotted turtle	*Clemmys guttata*	T		S2	G5
Invertebrates					
culver's root borer	*Papaipema sciata*	SC		S2S3	G3G4
Laura's snaketail	*Stylurus laurae*	SC		S1S2	G4
maritime sunflower borer	*Papaipema maritima*	SC		S1S2	G3
regal fern borer	*Papaipema speciosissima*	SC		S2S3	G4
regal fritillary	*Speyeria idalia*	E		SH	G3
riverine snaketail	*Stylurus amnicola*	SC		S1S2	G4
splendid clubtail	*Gomphus lineatifrons*	SC		S2S3	G4
Plant					
blue-eyed-grass	*Sisyrinchium strictum*	SC		S2	G2Q
downy sunflower	*Helianthus mollis*	T		S2	G4G5
false hop Sedge	*Carex lupuliformis*	T		S2	G4
ginseng	*Panax quinquefolius*	T		S2S3	G3G4
goldenseal	*Hydrastis canadensis*	T		S2	G4
Hill's thistle	*Cirsium hillii*	SC		S3	G3
kitten-tails	*Besseya bullii*	E		S1	G3
Leiberg's panic-grass	*Panicum leibergii*	T		S2	G5

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Upper–continued					
Plant–continued					
prairie dropseed	*Sporobolus heterolepis*	SC		S3	G5
purple milkweed	*Asclepias purpurascens*	T		S2	G5?
showy orchis	*Galearis spectabilis*	T		S2	G5
white or prairie false indigo	*Baptisia lactea*	SC		S3	G4Q
Plant community					
prairie fen				S3	G3
mesic southern forest				S3	G2G3
dry-mesic southern forest				S3	G4
floodplain forest				S3	G3?
Other features					
Great Blue Heron rookery				SU	GNR
Middle					
Vertebrate					
Cerulean Warbler	*Dendroica cerulea*	T		S3	G4
Dickcissel	*Spiza americana*	SC		S3	G5
King Rail	*Rallus elegans*	E		S1	G4
pugnose shiner	*Notropis anogenus*	E		S3	G3
weed shiner	*Notropis texanus*	X		S1	G5
least shrew	*Cryptotis parva*	T		S1S2	G5
woodland vole	*Microtus pinetorum*	SC		S3S4	G5
Blanchard's cricket frog	*Acris crepitans blanchardi*	T		S2S3	G5T5
Blanding's turtle	*Emys blandingii*	SC		S3	G4
eastern box turtle	*Terrapene carolina carolina*	SC		S2S3	G5T5
eastern massasauga	*Sistrurus catenatus catenatus*	SC	C	S3S4	G3G4T3T4Q
spotted turtle	*Clemmys guttata*	T		S2	G5
Invertebrate					
barrens buckmoth	*Hemileuca maia*	SC		S2S3	G5
culver’s root borer	*Papaipema sciata*	SC		S2S3	G3G4
pinetree cricket	*Oecanthus pini*	SC		S1S2	GNR
regal fern borer	*Papaipema speciosissima*	SC		S2S3	G4
regal fritillary	*Speyeria idalia*	E		SH	G3
splendid clubtail	*Gomphus lineatifrons*	SC		S2S3	G4
swamp metalmark	*Calephelis mutica*	SC		S1S2	G3
tamarack tree cricket	*Oecanthus laricis*	SC		S1S2	G1G2
elktoe	*Alasmidonta marginata*	SC		S2S3	G4
ellipse	*Venustaconcha ellipsiformis*	SC		S2S3	G4
purple wartyback	*Cyclonaias tuberculata*	T		S2S3	G5
rainbow	*Villosa iris*	SC		S2S3	G5Q
round pigtoe	*Pleurobema coccineum*	SC		S2S3	G4G5
slippershell	*Alasmidonta viridis*	T		S2S3	G4G5
Plant					
American chestnut	*Castanea dentata*	E		S1S2	G4
beak grass	*Diarrhena americana*	T		S2	G4G5
bog bluegrass	*Poa paludigena*	T		S2	G3
cattail sedge	*Carex typhina*	T		S1	G5
Clinton's bulrush	*Scirpus clintonii*	SC		S3	G4
Cooper's milk-vetch	*Astragalus neglectus*	SC		S3	G4

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Middle–continued					
Plant–continued					
cup-plant	*Silphium perfoliatum*	T		S2	G5
Davis's sedge	*Carex davisii*	SC		S3	G4
dwarf-bulrush	*Hemicarpha micrantha*	SC		S3	G5
eastern few-fruited sedge	*Carex oligocarpa*	T		S2	G4
false hop sedge	*Carex lupuliformis*	T		S2	G4
fire pink	*Silene virginica*	E		S1	G5
ginseng	*Panax quinquefolius*	T		S2S3	G3G4
goldenseal	*Hydrastis canadensis*	T		S2	G4
green violet	*Hybanthus concolor*	SC		S3	G5
hairy angelica	*Angelica venenosa*	SC		S3	G5
hairy-fruited sedge	*Carex trichocarpa*	SC		S2	G4
mullein foxglove	*Dasistoma macrophylla*	E		S1	G4
panicled hawkweed	*Hieracium paniculatum*	T		S2	G5
prairie white-fringed orchid	*Platanthera leucophaea*	E	LT	S1	G3
purple milkweed	*Asclepias purpurascens*	T		S2	G5?
raven's-foot sedge	*Carex crus-corvi*	E		S1	G5
red mulberry	*Morus rubra*	T		S2	G5
rock cress	*Arabis perstellata sensu lato*	T		S1	G5
showy orchis	*Galearis spectabilis*	T		S2	G5
small skullcap	*Scutellaria parvula*	T		S2	G4
small-fruited panic-grass	*Panicum microcarpon*	SC		S2	GNR
snow trillium	*Trillium nivale*	T		S2	G4
Torrey's bulrush	*Scirpus torreyi*	SC		S2S3	G5?
twinleaf	*Jeffersonia diphylla*	SC		S3	G5
Vasey's rush	*Juncus vaseyi*	T		S1S2	G5?
Virginia flax	*Linum virginianum*	T		S2	G4G5
Virginia spiderwort	*Tradescantia virginiana*	SC		S2	G5
Virginia water-horehound	*Lycopus virginicus*	T		S2	G5
wahoo	*Euonymus atropurpurea*	SC		S3	G5
white or prairie false indigo	*Baptisia lactea*	SC		S3	G4Q
Plant community					
mesic southern forest				S3	G2G3
sandstone cliff				S2	G4G5
Other features					
Great Blue Heron rookery				SU	GNR
Lower					
Vertebrate					
American Bittern	*Botaurus lentiginosus*	SC		S3S4	G4
Bald Eagle	*Haliaeetus leucocephalus*	SC		S4	G4
Cerulean Warbler	*Dendroica cerulea*	T		S3	G4
Common Loon	*Gavia immer*	T		S3S4	G5
Grasshopper Sparrow	*Ammodramus savannarum*	SC		S3S4	G5
Henslow's Sparrow	*Ammodramus henslowii*	E		S2S3	G4
Hooded Warbler	*Wilsonia citrina*	SC		S3	G5
King Rail	*Rallus elegans*	E		S1	G4
Louisiana Waterthrush	*Seiurus motacilla*	T		S2S3	G5
Marsh Wren	*Cistothorus palustris*	SC		S3S4	G5
Osprey	*Pandion haliaetus*	SC		S4	G5

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Lower–continued					
Vertebrate–continued					
Prothonotary Warbler	*Protonotaria citrea*	SC		S3	G5
Trumpeter Swan	*Cygnus buccinator*	T		S3	G4
bigmouth shiner	*Notropis dorsalis*	SC		S4	G5
cisco	*Coregonus artedi*	T		S3	G5
lake sturgeon	*Acipenser fulvescens*	T		S2	G3G4
pugnose shiner	*Notropis anogenus*	E		S3	G3
river redhorse	*Moxostoma carinatum*	T		S1	G4
spotted gar	*Lepisosteus oculatus*	SC		S2S3	G5
starhead topminnow	*Fundulus dispar*	SC		S2	G4
woodland vole	*Microtus pinetorum*	SC		S3S4	G5
Indiana bat or Indiana myotis	*Myotis sodalis*	E	LE	S1	G2
Blanchard's cricket frog	*Acris crepitans blanchardi*	T		S2S3	G5T5
Blanding's turtle	*Emys blandingii*	SC		S3	G4
eastern box turtle	*Terrapene carolina carolina*	SC		S2S3	G5T5
eastern massasauga	*Sistrurus catenatus catenatus*	SC	C	S3S4	G3G4T3T4Q
spotted turtle	*Clemmys guttata*	T		S2	G5
wood turtle	*Clemmys insculpta*	SC		S2S3	G4
Invertebrate					
angular spittlebug	*Lepyronia angulifera*	SC		S1S2	G3
barrens buckmoth	*Hemileuca maia*	SC		S2S3	G5
culver's root borer	*Papaipema sciata*	SC		S2S3	G3G4
dusted skipper	*Atrytonopsis hianna*	SC		S2S3	G4G5
frosted elfin	*Incisalia irus*	T		S2S3	G3
Great Plains spittlebug	*Lepyronia gibbosa*	SC		S1S2	G3G4
Henry's elfin	*Incisalia henrici*	T		S2S3	G5
karner blue	*Lycaeides melissa samuelis*	T	LE	S2	G5T2
Laura's snaketail	*Stylurus laurae*	SC		S1S2	G4
Mitchell's satyr	*Neonympha mitchellii mitchellii*	E	LE	S1	G1G2T1T2
Newman's brocade	*Meropleon ambifusca*	SC		S1S2	G3G4
ottoe skipper	*Hesperia ottoe*	T		S1S2	G3G4
persius duskywing	*Erynnis persius persius*	T		S3	G5T1T3
pinetree cricket	*Oecanthus pini*	SC		S1S2	GNR
poweshiek skipperling	*Oarisma poweshiek*	T		S1S2	G2G3
regal fritillary	*Speyeria idalia*	E		SH	G3
small heterocampa	*Heterocampa subrotata*	SC		S1S2	G4G5
spartina moth	*Spartiniphaga inops*	SC		S1S2	G3G4
Sprague's pygarctia	*Pygarctia spraguei*	SC		S2S3	G5
swamp metalmark	*Calephelis mutica*	SC		S1S2	G3
tamarack tree cricket	*Oecanthus laricis*	SC		S1S2	G1G2
three-staff underwing	*Catocala amestris*	E		S1	G4
brown walker	*Pomatiopsis cincinnatiensis*	SC		SU	G4
elktoe	*Alasmidonta marginata*	SC		S2S3	G4
ellipse	*Venustaconcha ellipsiformis*	SC		S2S3	G4
purple wartyback	*Cyclonaias tuberculata*	T		S2S3	G5
rainbow	*Villosa iris*	SC		S2S3	G5Q
round pigtoe	*Pleurobema coccineum*	SC		S2S3	G4G5
slippershell	*Alasmidonta viridis*	T		S2S3	G4G5
snuffbox	*Epioblasma triquetra*	E	C	S1	G3
spindle lymnaea	*Acella haldemani*	SC		S3	G3

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Lower–continued					
Plant					
Alleghany or sloe plum	*Prunus alleghaniensis davisii*	SC		S3	G4T3Q
American lotus	*Nelumbo lutea*	T		S2	G4
bald-rush	*Psilocarya scirpoides*	T		S2	G4
beak grass	*Diarrhena americana*	T		S2	G5
beard tongue	*Penstemon calycosus*	T		S2	G5
black-fruited spike-rush	*Eleocharis melanocarpa*	SC		S3	G4
blue-eyed-grass	*Sisyrinchium strictum*	SC		S2	G2Q
bog bluegrass	*Poa paludigena*	T		S2	G3
broad-leaved puccoon	*Lithospermum latifolium*	SC		S2	G4
Canadian milk-vetch	*Astragalus canadensis*	T		S1S2	G5
Carey's smartweed	*Polygonum careyi*	T		S1S2	G4
cattail sedge	*Carex typhina*	T		S1	G5
Clinton's bulrush	*Scirpus clintonii*	SC		S3	G4
Cooper's milk-vetch	*Astragalus neglectus*	SC		S3	G4
creeping whitlow-grass	*Draba reptans*	T		S1	G5
cut-leaved water-parsnip	*Berula erecta*	T		S2	G4G5
Davis's sedge	*Carex davisii*	SC		S3	G4
downy gentian	*Gentiana puberulenta*	E		S1	G4G5
dwarf hackberry	*Celtis tenuifolia*	SC		S3	G5
dwarf spike-rush	*Eleocharis parvula*	E		S1	G5
dwarf-bulrush	*Hemicarpha micrantha*	SC		S3	G5
Engelmann's spike-rush	*Eleocharis engelmannii*	SC		S2S3	G4G5Q
false boneset	*Kuhnia eupatorioides*	SC		S2	G5
flattened spike-rush	*Eleocharis compressa*	T		S2	G4
furrowed flax	*Linum sulcatum*	SC		S2S3	G5
ginseng	*Panax quinquefolius*	T		S2S3	G3G4
goldenseal	*Hydrastis canadensis*	T		S2	G4
goosefoot corn salad	*Valerianella chenopodiifolia*	T		S1	G5
green violet	*Hybanthus concolor*	SC		S3	G5
hairy-fruited sedge	*Carex trichocarpa*	SC		S2	G4
heart-leaved plantain	*Plantago cordata*	E		S1	G4
horsetail spike-rush	*Eleocharis equisetoides*	SC		S3	G4
kitten-tails	*Besseya bullii*	E		S1	G3
lake cress	*Armoracia lacustris*	T		S2	G4?
leadplant	*Amorpha canescens*	SC		S3	G5
Leiberg's panic-grass	*Panicum leibergii*	T		S2	G5
meadow beauty	*Rhexia virginica*	SC		S3	G5
Missouri goldenrod	*Solidago missouriensis*	T		S2	G5
Missouri rock-cress	*Arabis missouriensis deamii*	SC		S2	G5?QT3?Q
Olney's (three-square) bulrush	*Schoenoplectus americanus*	E		S1	G5
orange or yellow fringed orchid	*Platanthera ciliaris*	E		S1S2	G5
prairie buttercup	*Ranunculus rhomboideus*	T		S2	G5
prairie golden alexanders	*Zizia aptera*	T		S1S2	G5
prairie indian-plantain	*Cacalia plantaginea*	SC		S3	G4G5
prairie-smoke	*Geum triflorum*	T		S2S3	G5
purple coneflower	*Echinacea purpurea*	X		SX	G4
red mulberry	*Morus rubra*	T		S2	G5
Richardson's sedge	*Carex richardsonii*	SC		S3S4	G4
rock cress	*Arabis perstellata sensu lato*	T		S1	G5
Scirpus-like rush	*Juncus scirpoides*	T		S2	G5

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Lower–continued					
Plant–continued					
showy orchis	*Galearis spectabilis*	T		S2	G5
side-oats grama grass	*Bouteloua curtipendula*	E		S1	G5
small skullcap	*Scutellaria parvula*	T		S2	G4
small-fruited panic-grass	*Panicum microcarpon*	SC		S2	GNR
snow trillium	*Trillium nivale*	T		S2	G4
spotted pondweed	*Potamogeton pulcher*	E		S1	G5
stiff gentian	*Gentianella quinquefolia*	T		S2	G5
tall beakrush	*Rhynchospora macrostachya*	SC		S3S4	G4
three-birds orchid	*Triphora trianthophora*	T		S1	G3G4
tinted spurge	*Euphorbia commutata*	T		S1	G5
Torrey's bulrush	*Scirpus torreyi*	SC		S2S3	G5?
trailing wild bean	*Strophostyles helvula*	SC		S3	G5
twinleaf	*Jeffersonia diphylla*	SC		S3	G5
umbrella-grass	*Fuirena pumila*	T		S2	G4
Vasey's pondweed	*Potamogeton vaseyi*	T		SH	G4
Virginia bluebells	*Mertensia virginica*	E		S1	G5
Virginia flax	*Linum virginianum*	T		S2	G4G5
Virginia snakeroot	*Aristolochia serpentaria*	T		S2	G4
Virginia spiderwort	*Tradescantia virginiana*	SC		S2	G5
water-willow	*Justicia americana*	T		S2	G5
western silvery aster	*Aster sericeus*	T		S2	G5
whiskered sunflower	*Helianthus hirsutus*	SC		S3	G5
white gentian	*Gentiana flavida*	E		S1	G4
white lady-slipper	*Cypripedium candidum*	T		S2	G4
white or prairie false indigo	*Baptisia lactea*	SC		S3	G4Q
whorled pogonia	*Isotria verticillata*	T		S2	G5
wild rice	*Zizania aquatica var. aquatica*	T		S2S3	G5T5
yellow-flowered leafcup	*Polymnia uvedalia*	T		S1	G4G5
Plant community					
prairie fen				S3	G3
dry sand prairie				S2	G3
hillside prairie				S1	G3
coastal plain marsh				S2	G2
mesic southern forest				S3	G2G3
inland salt marsh				S1	G1
wet-mesic prairie				S2	G2
oak openings				S1	G1
wet prairie				S2	G3
floodplain forest				S3	G3?
dry-mesic southern forest				S3?	G4
poor conifer swamp				S4	G4
bog				S4	G3G5
hardwood-conifer swamp				S3	G4
emergent marsh				S4	GU
southern shrub-carr				S5	GU
southern hardwood swamp				S3	G3
Other features					
Great Blue Heron rookery				SU	GNR

Table 38b.–Continued.

Common name or feature	Scientific name	State status	Federal status	State rank	Global rank
Mouth					
Vertebrate					
Marsh Wren	*Cistothorus palustris*	SC		S3S4	G5
Peregrine Falcon	*Falco peregrinus*	E		S1	G4
Red-shouldered Hawk	*Buteo lineatus*	T		S3S4	G5
bigmouth shiner	*Notropis dorsalis*			S4	G5
black buffalo	*Ictiobus niger*	SC		S3	G5
cisco	*Coregonus artedi*	T		S3	G5
lake sturgeon	*Acipenser fulvescens*	T		S2	G3G4
river redhorse	*Moxostoma carinatum*	T		S1	G4
weed shiner	*Notropis texanus*	X		S1	G5
Blanchard's cricket frog	*Acris crepitans blanchardi*	SC		S2S3	G5T5
Blanding's turtle	*Emys blandingii*	SC		S3	G4
eastern box turtle	*Terrapene carolina carolina*	SC		S2S3	G5T5
spotted turtle	*Clemmys guttata*	T		S2	G5
wood turtle	*Clemmys insculpta*	SC		S2S3	G4
Invertebrate					
dune cutworm	*Euxoa aurulenta*	SC		S1S2	G5
pink papershell	*Potamilus ohiensis*	T		SNR	G5
three-horned wartyback	*Obliquaria reflexa*	E		SNR	G5
Plant					
American lotus	*Nelumbo lutea*	T		S2	G4
broad-leaved puccoon	*Lithospermum latifolium*	SC		S2	G4
climbing fumitory	*Adlumia fungosa*	SC		S3	G4
ginseng	*Panax quinquefolius*	T		S2S3	G3G4
mermaid-weed	*Proserpinaca pectinata*	E		S1	G5
northern appressed clubmoss	*Lycopodium subappressa*	SC		S2	G2
northern prostrate clubmoss	*Lycopodiella margueriteae*	T		S2	G2
pine-drops	*Pterospora andromedea*	T		S2	G5
pitcher's thistle	*Cirsium pitcheri*	T	LT	S3	G3
spearwort	*Ranunculus ambigens*	T		SH	G4
Mouth					
Plant					
three-ribbed spike-rush	*Eleocharis tricostata*	T		S2	G4
Virginia bluebells	*Mertensia virginica*	E		S1S2	G5
wild-rice	*Zizania aquatica var. aquatica*	T		S2S3	G5T5
Plant community					
interdunal wetland				S2	G2?
Great Lakes barrens				S2	G3
open dunes				S3	G3
mesic southern forest				S3	G2G3
Great Lakes marsh				S3	G2
mesic northern forest				S3	G4

Table 39.–Fish stocked in the Grand River watershed, 1873-2006. Data from Michigan Department of Natural Resources Fisheries Division records. Includes known federal, state, and private fish stockings. Years in parentheses denotes alternate year stockings for indicated period.

Segment County Water body	Species	Years	Number stocked in period
Headwater			
Hillsdale			
Braxee Lake	bluegill	1940–45	31,500
	largemouth bass	1944–45	850
Crystal Lake	northern pike	1995	50
	walleye	1993	500
Goose Lake	bluegill	1933–45	296,500
	largemouth bass	1933–36, 1938–39, 1941–45	16,050
	rainbow trout	1958, 1961, 1964	13,200
	walleye	2003–04	788
	yellow perch	1938–39	20,000
Grand River	bluegill	1937	5,000
Lake Le Ann	bluegill	1936, 1938–39, 1941–45	31,750
	fathead minnow	1988–92, 1994, 1996–97	612,788
	hybrid sunfish	1982, 1988–92	5,600
	largemouth bass	1944–45,1982, 1984, 1997	4,250
	northern pike	1982, 1997	400
	walleye	1982, 1984, 1988–92, 1994, 1996–97	19,250
	yellow perch	1984, 1994, 1996–97	7,075
Perch Lake	bluegill	1939, 1941–42	17,500
Hewes Lake	bluegill	1939	10,000
Ingham			
Huntoon Lake	American eel	1883	3,000
	bluegill	1934–38, 1941–45	43,600
	bullheads	1939	6,000
	golden shiner	1939	3,000
	largemouth bass	1933–37, 1939–45	14,900
	rock bass	1939	6,000
	sunfish	1939	15,400
	yellow perch	1933, 1935–37, 1939	17,400
Island Lake	American eel	1883	3,000
Jacobs Lake	bluegill	1933, 1935	7,000
	largemouth bass	1933–34	1,350
	yellow perch	1933, 1935	3,800
Vicory Gravel Pit	bluegill	1936	1,000
Ackerson Lake	bluegill	1933–1936, 1938–43, 1945	89,300
	largemouth bass	1933–1945	10,210
	smallmouth bass	1935, 1943	1,500
	sunfish	1939, 1941	850
	yellow perch	1933–36, 1938–39	37,800

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson			
Batteese Lake	bluegill	1934, 1936–42, 1944	81,600
	largemouth bass	1933–37, 1939, 1941–44	5,840
	smallmouth bass	1936, 1938, 1943–44	2,900
	sunfish	1941	300
	yellow perch	(1933–1939)	18,600
Berry Lake	bluegill	1934, 1939	11,000
	largemouth bass	1933, 1935	400
Braze Lake	largemouth bass	1933	100
Breeze Lake	bluegill	1934	2,000
	largemouth bass	1937–38	500
Brill Lake	bluegill	1934, 1937–42, 1944	73,800
	largemouth bass	1933, 1935–37, 1939–41, 1943–45	4,900
Brown Lake	bluegill	1933–34, 1937–45	65,500
	lake whitefish	1876	10,000
	largemouth bass	1933–34, 1936, 1938, 1940–45	7,225
	rainbow trout	1974–75	2,800
	smallmouth bass	1937–38, 1943–44	2,700
	sunfish	1941	150
	walleye	1938–40, 1942	400,000
	yellow perch	1935–39	22,600
Cascade Pond	channel catfish	1986	30
	bluegill	1976	100
Center Lake	bluegill	1938–45	179,000
	largemouth bass	1938, 1942–45	5,900
	northern pike	1981–92	453,212
	smallmouth bass	1939–40, 1943	7,400
	tiger musky	1967, 1969, 1971, 1973–74, 1976, 1978, 1981–83	44,931
	yellow perch	1939	4,500
Center Lake Pike Marsh	tiger muskellunge	1979–80	1,837
Chatfield Lake	lake trout	1877	10,000
	lake whitefish	1877	10,000
Clear Lake	bluegill	1933–34, 1936–37, 1940–42, 1944	47,700
	largemouth bass	1935–36, 1938, 1940, 1943–45	6,200
	redear sunfish	1987	13,600
	smallmouth bass	1933, 1943–44, 1946, 1957–58, 1987	14,915
	walleye	1951–52, 1954–55	6,060,000
	yellow perch	1939	700
Cove Lake	bluegill	1934	1,000
	largemouth bass	1933–35, 1938	1,165

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson–continued			
Cranberry Lake	bluegill	1934–44	103,450
	largemouth bass	1933–38, 1940–43, 1945	11,060
	smallmouth bass	1934–39, 1941–43	9,050
	sunfish	1941	100
	yellow perch	1933–34, 1936–39	30,000
Crispell Lake	bluegill	1934–35, 1937, 1939–43	44,000
	lake whitefish	1879	30,000
	largemouth bass	1933, 1935, 1937–41, 1943, 1945	6,330
	smallmouth bass	1937–39, 1942	2,300
	sunfish	1939	700
	walleye	1990	1,368
	yellow perch	1935, 1939	17,100
Dobsons Lake	smallmouth bass	1935	200
Dollar (Round) Lake	bluegill	1934	1,500
	largemouth bass	1933, 1935, 1937–41, 1943, 1945	6,330
Eagle Lake	bluegill	1941–42	15,000
East Twin Lake	bluegill	1939	2,500
Gilletts Lake	American eel	1883	4,500
	bluegill	1933–42, 1944, 1970	132,108
	channel catfish	1987–89, 1991, 1995–97, 1999–2002, 2004–06	116,349
	hybrid sunfish	1969	52,500
	largemouth bass	1933–34, 1936–37, 1939–40, 1942–45, 1969–70	85,328
	northern pike	1983–85	12,000
	redear sunfish	1986–87, 1991–92	79,872
	sunfish	1939	100
	tiger muskellunge	1970, '1980	151,000
	yellow perch	1933, 1935, 1939	15,400
Goose Lake	bluegill	1937–38, 1940–42	82,000
	largemouth bass	1933	200
Grand Lake	bluegill	1934, 1941, 1943	8,000
	largemouth bass	1933–34, 1937	1,110
Grand River	American eel	1877	20,000
	Atlantic salmon	1873	1,000
	channel catfish	1977, 1988–91, 1999	9,000
	Chinook salmon	1873, 1879	42,000
	smallmouth bass	1944	1,000
	tiger muskellunge	1979–80, 1982–84	1,580
	walleye	1982–89, 1991, 1994, 1996–97, 2001, 2004	265,368

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson–continued			
Grass Lake	American eel	1877	20,000
	bluegill	1934–42	142,900
	brook trout	1941	6,000
	lake whitefish	1876	10,000
	largemouth bass	1933–34, 1937, 1939, 1942–44	4,810
	redear sunfish	1987, 1991–92	80,820
	smallmouth bass	1938	700
	tiger muskellunge	1980	1,000
	yellow perch	1935–37	34,000
Green Lake	bluegill	1940	500
	largemouth bass	1939–40	1,700
	smallmouth bass	1935	250
Kryst Pond	smallmouth bass	1934	250
Leeke Lake	bluegill	1948	3,000
	largemouth bass	1948	600
Leoni Mill Pond	bluegill	1934	3,500
	largemouth bass	1933	300
	yellow perch	1935	1,000
Little Cranberry Lake	bluegill	1940	100
	largemouth bass	1940	100
Little Grand Lake	bluegill	1934, 1939	3,500
	largemouth bass	1933, 1937–38	1,100
	smallmouth bass	1934	410
Little Portage Lake	bluegill	1935, 1937–38, 1941–42	73,000
	hybrid sunfish	1985	2,090
	largemouth bass	1933, 1936–37, 1943	1,700
	walleye	1935, 1937–40, 1942	531,000
Little Wolf Lake	bluegill	1934, 1937–38, 1941–42	71,000
	largemouth bass	1933, 1935, 1938, 1941, 1944	1,700
	sunfish	1941	100
Markle Lake	bluegill	1941–42, 1945, 1947–48	27,100
	largemouth bass	1945, 1947–48	7,500
Michigan Center Pond	bluegill	1934–35, 1937	58,200
	largemouth bass	1933, 1936	1,100
	smallmouth bass	1937	800
	yellow perch	1935	15,000
Mirror Lake	rainbow trout	1978	305
	walleye	1988	750
Mud Lake	American eel	1878, 1883	9,500
	bluegill	1937, 1941	11,600
Olcott Lake	bluegill	1934	3,000
	largemouth bass	1933–34, 1939,1941	1,200
	sunfish	1941	500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson–continued			
Peter White Lake	largemouth bass	1936–37	300
	smallmouth bass	1935	250
Pleasant Lake	bluegill	1933–42, 1944	202,650
	lake whitefish	1876	20,000
	largemouth bass	1933–37, 1939, 1941–45	12,925
	redear sunfish	1991–93	102,900
	smallmouth bass	1933, 1943–44	3,200
	yellow perch	1933, 1935, 1939	21,600
Pond Lilly Lake	bluegill	1944	1,000
	largemouth bass	1944, 1962	20,035
	hybrid sunfish	1985	2,530
Portage Creek	brook trout	1933–34	3,966
	brown trout	1935, 1937–41	18,000
Portage Creek Pond	brook trout	1944, 1950–55, 1957–65	18,435
	brown trout	1944–48, 1950–52, 1955, 1957–64, 1966	6,458
	rainbow trout	1944–47, 1950–55, 1957–68, 1970–72, 1988	23,134
Portage Lake	bluegill	1934–42	399,600
	brown trout	1941, 1968	14,440
	largemouth bass	1933–34, 1936, 1939, 1942–44	4,650
	rainbow trout	1965–67, 1969–1971	240,553
	redear sunfish	1985, 1987, 1991	57,853
	smallmouth bass	1943–44	1,500
	tiger muskellunge	1980	1,000
	walleye	1933, 1935–40, 1942, 1982–83, 1985–86, 1988–89, 1992–95	1,959,281
	yellow perch	1934–35, 1939	20,700
Prison (Tyler) Lake	largemouth bass	1957	300
Putney Mill Pond	bluegill	1938, 1941	25,000
	largemouth bass	1937–38, 1943	1,450
	smallmouth bass	1937–38, 1941–42	2,000
	yellow perch	1938	2,000
Riley Lake	lake whitefish	1876	10,000
Rives Creek	brook trout	1933–34, 1936–40, 1943–47	37,610
	brown trout	1935–41, 1943–44	38,400
Saint John Lake	largemouth bass	1933	200
Schoolhouse Lake	bluegill	1937, 1939–41	12,700
	largemouth bass	1933, 1935–39, 1965	3,625
	smallmouth bass	1935	250
	sunfish	1939	800
Sharpes Lake	bluegill	1941	5,000
	smallmouth bass	1936–37, 1939	2,250

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson–continued			
Skiff Lake	bluegill	1934–35, 1938, 1940–43	48,000
	largemouth bass	1933–34, 1936–38, 1940–41, 1943, 1945	4,600
	smallmouth bass	1933, 1941–42	1,800
	yellow perch	1935–36, 1939	21,800
Tims Lake	bluegill	1934–42, 1944	46,400
	lake whitefish	1876	10,000
	largemouth bass	1933–39, 1942–45	5,090
	sunfish	1939	200
Trist Creek	brown trout	1957, 1983–88	23,143
Trist Mill Pond Inlet	brown trout	1952	10,000
Trumbull Lake	bluegill	1934, 1939–1942	20,500
	largemouth bass	1933, 1935–39	1,350
	yellow perch	1939	700
Twin Lake No. 1	lake whitefish	1876	10,000
Twin Lake No. 2	lake whitefish	1876	10,000
	largemouth bass	1939, 1941	726
Vandercook Lake	bluegill	1933–1945	97,000
	largemouth bass	1933–39, 1942–45	6,725
	rainbow trout	1983–84	12,800
	smallmouth bass	1937, 1939, 1942–44	3,500
	sunfish	1939	400
	walleye	1938–40, 1942	340,000
	yellow perch	1936–39	15,600
Welch Creek	brook trout	1933	1,200
Welch Lake	black crappie	1982	80
	bluegill	1934, 1941–42	16,000
	channel catfish	1982	136
	largemouth bass	1933–34, 1939	2,060
	smallmouth bass	1935	250
White Lake	bluegill	1934, 1938–42	26,800
	largemouth bass	1934, 1936–37, 1939–1941	1,960
	sunfish	1939	100
Whiting Pond	black bass	1951	25
Williams Lake	bluegill	1933–34, 1937	3,700
	lake whitefish	1876	10,000
	largemouth bass	1933–34, 1936–37	1,220
	smallmouth bass	1935	250
	yellow perch	1935	2,000
Willow Creek	brook trout	1933–34, 1936–41, 1943–64	86,045
	brown trout	1935, 1941–42, 1949–50, 1954, 1956–65	22,110
	rainbow trout	1945–64	24,625
Wilson Creek	brook trout	1942	400

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Headwater–continued			
Jackson–continued			
Wolf Creek	brook trout	1933	233
Wolf Lake	brook trout	1934	233
	bluegill	1934–39, 1941–44	128,200
	largemouth bass	1933–36, 1938–39, 1941, 1943–45	7,465
	lake whitefish	1876	10,000
	smallmouth bass	1937–38	1,750
	sunfish	1939	800
	walleye	1983, 1985, 1987–89, 1991, 1993	101,878
	yellow perch	1934–35, 1939	38,600
Washtenaw			
Lehmans Lake	largemouth bass	1938	300
Mud Lake	American eel	1878	5,000
	bluegill	1940–43	38,000
	largemouth bass	1940–41, 1945	1,340
	lake whitefish	1878	60,000
Sugarloaf Lake	bluegill	1934–35, 1937–44	87,000
	largemouth bass	1937–45	5,730
	northern pike	1952, 1963	3,422
	yellow perch	1933, 1937, 1939	15,000
Sylvan Pond	brook trout	1955, 1957	500
	northern pike	1944	70
Sylvan Pond	rainbow trout	1976–77	950
Sylvan Pond - Lower	brook trout	1950–54, 1958–65	2,974
	rainbow trout	1946–48, 1964–68, 1970–75	5,490
Sylvan Pond - Middle	brook trout	1950–54, 1958–65	938
	rainbow trout	1965–68, 1970–75, 1979–81	1,050
Sylvan Pond - Upper	brook trout	1950–54, 1958–65	1,108
	rainbow trout	1946–48, 1964–68, 1970–74, 1978, 1988	2,510
Winnewana Impoundment	bluegill	1964, 1986	1,866
	fathead minnow	1986	137,500
	largemouth bass	1964, 1986	220
Winnewana Lake	largemouth bass	1963	90,000
	northern pike	1959, 1963	200,006
Upper			
Jackson			
Cooper Lake	bluegill	1939, 1941	25,000
Crouch Creek	brook trout	1933–34, 1936	3,625
	brown trout	1935	1,000
	Chinook salmon	1874	4,000
Gurley Lake	bluegill	1939, 1941	25,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Upper–continued			
Jackson–continued			
Lime Lake	brook trout	1951–55, 1958, 1961–63	6,400
	rainbow trout	1951–56, 1958–65, 1967–68	21,490
	walleye	1936–40, 1942	405,000
Lords Lake	lake whitefish	1878	20,000
Mackey Brook	brook trout	1933–34, 1936, 1938, 1940–42, 1944–64	79,980
	brown trout	1938–39, 1941, 1943–45, 1949–50, 1952, 1954–65, 1967–68, 1983–84, (1989–2005)	48,508
	rainbow trout	1947–64	26,775
Montague Lake	bluegill	1939, 1941	25,000
	largemouth bass	1941	100
	sunfish	1941	265
North Lake	bluegill	1934	2,500
	largemouth bass	1933, 1938	1,150
	yellow perch	1935	3,000
Sandstone Creek	Artic grayling	1877	75
	brook trout	1934	359
	brown trout	1934–36, 1938, 1941, 1943–44, 1971–81	177,728
	Chinook salmon	1874	24,000
	rainbow trout	1943–44	10,800
	Lake whitefish	1876	15,000
Snyder Brook	brook trout	1933–34, 1936–50, 1952–53, 1985	88,330
	brown trout	1935, 1940–41, 1949–50, 1952, 1986–2006	28,097
	rainbow trout	1944–50, 1952–53	11,675
South Lake	bluegill	1934, 1938–39, 1941	9,100
	largemouth bass	1933, 1938	350
	yellow perch	1934	5,000
Spring Arbor Lake	American eel	1877	15,000
	lake whitefish	1876	10,000
	walleye	1933, 1935	736,000
Spring Brook	brook trout	1933–34, 1936	8,010
	brown trout	1935	3,000
Tomkins Center	smallmouth bass	1941	350
Eaton			
Blye Lake	largemouth bass	1933	1,050
Crane Lake	lake whitefish	1876	10,000
Gale Creek	brook trout	1933–34, 1936	2,090
Grand River	American eel	1883	8,000
	bluegill	1937	2,000
	largemouth bass	2005	250

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Upper–continued			
Jackson–continued			
Grand River–continued	rainbow trout	1982	15,000
	smallmouth bass	1935–44	37,400
	tiger muskellunge	1982–84	1,720
	walleye	1937–40, 1942, 1980, 1982–84, 1986, 1988, 1990, 1992, 1993	2,638,059
Spring Brook	brook trout	1933–34, 1936, 1938–1944	32,820
	brown trout	1933–35, 1937–42, 1944–45	51,580
	rainbow trout	1944–45	1,100
Ingham			
Grand River	brown trout	1988	50
	channel catfish	1988–91, 1995, 2004	55,000
	Chinook salmon	1979–81, 1983–84	1,275,947
	coho salmon	1979–85	1,380,278
	largemouth bass	1994–95	2,103
	northern pike	1991, 1993	8,389
	rainbow trout	1979–80, 1983–85	129,000
	smallmouth bass	1940, 1942–44	17,300
	tiger muskellunge	1982–84	660
	walleye	1982–84, 1986–88, 1990, 1992–93, 1996–98, 2001–02, 2004	1,580,745
Grand River Park Pond	rainbow trout	1970, 1973–76	2,500
Lane Lake	lake whitefish	1877	10,000
Laur Lake	lake whitefish	1878	40,000
Middle			
Clinton			
Burke Lake	brook trout	1942–43, 1945, 1950–55, 1957–65, 1974–75	8,301
	brown trout	1965–66, 1977, 1980	1,740
	rainbow trout	1958–64, 1966–74, 1979	8,467
Grand River	steelhead	1979–80, 1982	60,000
	walleye	1980	8,500
Looking Glass River	rainbow trout	1978	25,000
	smallmouth bass	1933	1,000
	steelhead	1979–83	290,000
	walleye	1934	600,000
Mud Lake	lake whitefish	1876	10,000
Park Lake	bluegill	1933–34, 1937–40, 1942	19,510
	channel catfish	1994, (1999–2005)	9,258
	largemouth bass	1933–34, 1937–42, 1977	16,743
	northern pike	1991	18,000
	yellow perch	1939	4,000
Rose Lake	bluegill	1933	500
	largemouth bass	1933	500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Middle–continued			
Clinton–continued			
Round Lake–Bath Twp.	bluegill	1933	2,000
	largemouth bass	1933	2,000
	lake whitefish	1876	10,000
Round Lake–Victor Twp.	bluegill	1934, 1937–42	27,310
	largemouth bass	1934, 1937–42, 1944	5,750
Eaton			
Butternut Creek (Claflin Drain)	rainbow trout	1960–64	4,650
Grand River	channel catfish	1988–91	11,500
	Chinook salmon	1980–82	850,272
	largemouth bass	1995–96	3,000
	rainbow trout	1982–83	20,048
Grand River	smallmouth bass	1939–44, 1988	14,819
	walleye	1939–40, 1942, 1982–83, 1986, 1990, 1993	333,056
Hoover Lake	bluegill	1935, 1937, 1941–43	16,200
	largemouth bass	1941, 1942, 1945	2,600
	yellow perch	1935	2,000
Lake Delta (Erickson Pond)	black crappie	1987	1,548
	bluegill	1988	20
	brown bullhead	1988	50
	channel catfish	1987, 1995–95, 1999, 2003, 2005	8,836
	largemouth bass	1987–88, 1991–92, 1994	4,912
	northern pike	1991	1,000
	pumpkinseed	1988	150
	walleye	1987, 1997–98, 2002	12,470
Sebewa Creek	brook trout	1948–1964	6,050
	brown trout	1948–49, 1951–52, 1955–64, 1969–90	34,779
	rainbow trout	1948–50, 1952–64	9,299
Sharp Park Pond	black bullhead	1979	1,050
	brown bullhead	1987	110
	bullhead	1977	100
	largemouth bass	1977	544
Ingham			
Coal Mine Pond	bluegill	1939, 1952	2,500
	largemouth bass	1952	75
Dobie Lake	bluegill	1933, 1937, 1939–45	53,200
	largemouth bass	1937–45	9,800
	yellow perch	1937, 1939	4,300

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Middle–continued			
Ingham–continued			
Grand River	American shad	1873	50,000
	bluegill	1937–39	42,000
	channel catfish	1989, 1991	9,150
	Chinook salmon	1978	150,000
	coho salmon	1986–93, 1997–2003, 2005–06	6,147,160
	largemouth bass	1993	319
	rainbow trout	1978,1987–2006	592,560
	smallmouth bass	1937, 1939–40, 1942–44	19,265
	walleye	1937–40, 1942, 1992, 2003	876,016
Lake Lansing	bluegill	1934–1943	216,200
	largemouth bass	1934–1942	19,700
	smallmouth bass	1936, 1942	2,750
	tiger muskellunge	1970, 1974–75, 1977	9,570
	yellow perch	1933, 1935–37, 1939	28,300
MSU Botanical Dept Pond	common carp	1884	unknown
Mud Lake	American eel	1883	9,000
	lake whitefish	1876	10,000
North Lake	bluegill	1933–35	11,250
	largemouth bass	1933–35	4,100
	yellow perch	1933, 1935–36	8,300
Red Cedar Lake (City of Lansing)	channel catfish	1970	1,100
	hybrid sunfish	1970	7,500
Red Cedar River	walleye	1937–40, 1942	390,000
South Lake	bluegill	1937, 1941–45	14,200
	largemouth bass	1937, 1940–45	6,100
	yellow perch	1937	2,400
Three Lakes	bluegill	1936	8,000
	largemouth bass	1936	1,000
Tihart Lake	bluegill	1939	4,000
Waverly Pond, Grand River	bluegill	1939	4,000
Ionia			
Cryderman Lake	yellow perch	1933, 1935–36	4,380
Faxon Creek	brook trout	1945	1,100
Grand River and impoundments	bluegill	1943–44	8,000
	channel catfish	1953	190
	Chinook salmon	1977, 1979, 1983, 1991–98	1,256,503
	coho salmon	1969–70, 1978–82, 1990–93, 1996–2003, 2005–06	899,760
	largemouth bass	1945	2,600

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Middle–continued			
Ionia–continued			
Grand River and impoundments–continued	rainbow trout	1978	100,000
	smallmouth bass	1933–45	43,889
	steelhead	1979–83, 1986	300,000
	walleye	1934–39, 1978–79, 1981–90, (1992–2006)	15,878,956
Looking Glass River	bluegill	1987	144
	smallmouth bass	1935	400
	steelhead	1979–80, 1982	60,000
Sebewa Creek	brown trout	1969–90	86,463
Livingston			
Cedar Lake	American eel	1879	15,000
	bluegill	1934, 1936, 1940–41, 1943, 1945	30,000
	lake trout	1879	9,500
	largemouth bass	1934, 1936, 1938–41, 1944–45	3,835
	Lake whitefish	1878–79	80,000
	northern pike	1975	16,000
	smallmouth bass	1933, 1943	1,000
	yellow perch	1937	10,000
Coon Lake	bluegill	1933, 1936–37, 1940–41, 1943, 1945	27,500
	lake trout	1878	5,000
	largemouth bass	1936–37, 1939–40, 1943–45	3,160
	lake whitefish	1876, 1978	67,500
	yellow perch	1937	10,000
Triangle Lake	American eel	1879	5,000
	bluegill	1936, 1940–41, 1943, 1945	16,200
	largemouth bass	1936, 1938–41, 1943–45	3,420
	lake whitefish	1879	30,000
	yellow perch	1937	5,000
Shiawassee			
Colby Lake	bluegill	1938, 44	7,000
	largemouth bass	1944	500
	lake whitefish	1876	10,000
Diamond Lake	American eel	1877	5,000
Looking Glass River	American eel	1877	2,500
Moon Lake	bluegill	1948	1,000
	largemouth bass	1948	775
Moon Lake	lake whitefish	1876	10,000
Stevens Lakes	lake whitefish	1876	10,000
Wolf Lake	American eel	1877	2,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower			
Barry			
Algonquin Lake	bluegill	1934–1945	121,600
	Great Lakes shiners	1936, 1939	110,000
	largemouth bass	1933, 1934, 1936, 1937–9, 1941–45, 1964	28,100
	muskellunge	1964–5	11,322
	northern pike	1958, 1960, 1979	7,630
	smallmouth bass	1933, 1936, 1939, 1941–43	11,700
	walleye	2001, 2003, 2005	4,000
	yellow perch	1934–37, 1939	29,100
Baker Lake	bluegill	1935–42	42,000
	yellow perch	1935	1,500
Bass Lake	bluegill	1945	2,000
	largemouth bass	1945	1,000
Basset Lake	lake whitefish	1876	10,000
	bluegill	1935–36, 1941–42	14,150
	largemouth bass	1937	1,000
	northern pike	1954	700
	yellow perch	1935–1937	9,600
Bates Pond	brook trout	1944–55, 1957–64	4,137
	brown trout	1944–55, 1957, 1965	2,718
	rainbow trout	1944–55, 1957–66	5,526
Bawker Lake	bluegill	1934, 1936, 1938, 1942–43	15,000
	largemouth bass	1934, 1936–8, 1942	3,350
	yellow perch	1937	2,000
Big Cedar Lake	bluegill	1935–43	76,000
	largemouth bass	1934–37	3,000
	lake whitefish	1874	5,000
	yellow perch	1934–1937, 1939	12,500
Boot Lake	bluegill	1936–1941, 1943	16,000
	yellow perch	1939	1,200
Brewster Lake	bluegill	1935	6,000
Bristol Lake	bluegill	1935–44	72,000
	largemouth bass	1934, 1937, 1939, 1941–43, 1945	8,100
	sunfish	1941	3,000
	walleye	1998–2000	25,955
	yellow perch	1933, 1935, 1939	8,300
Cain Creek	brook trout	1933–34, 1936, 1938–57, 1961–1964	53,370
	brown trout	1935, 1937–42, 1958–60, 1994–96	25,520
	rainbow trout	1940–41, 1948–49, 1952–1960, 1963–64	7,500
Carr Lake	bluegill	1935–1945	28,700
	largemouth bass	1942, 1945	700
	smallmouth bass	1937	300

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
Carter Lake	bluegill	1937–1945	33,000
	Chinook salmon	1875	6,000
	largemouth bass	1937, 1942–45	4,600
	northern pike	1984–91	135,638
Cedar Creek	brown trout	1970–71, 1973–2006	219,672
Clear Lake	bluegill	1934–39, 1941	71,400
	largemouth bass	1933–34, 1937–39, 1941–45	23,848
	lake whitefish	1878	40,000
	muskellunge	1967	2,567
	northern pike	1985	1,211
	smallmouth bass	1933, 1936–37, 1944	5,570
	sunfish	1941	4,000
	tiger muskellunge	1974, 1976, 1977–82	6,399
	yellow perch	1933–35, 1937, 1939	18,600
Cloverdale Lake	bluegill	1939, 1943–45	13,500
	largemouth bass	1942–43, 1945	1,700
Coldwater River	brook trout	1884	10,000
	rainbow trout	1974, 1987, 1997, 2005–06	126,288
Cook Pond	brook trout	1946–49, 1951–55, 1957–62	3,550
	brown trout	1947–49, 1951–1955, 1957	6,525
	rainbow trout	1946–1949, 1951–55, 1957–1962	13,450
Cox Lake	bluegill	1935–36, 1938–39, 1942	31,000
	yellow perch	1939	2,500
Culver Lake	bluegill	1935, 1936, 1938–39, 1941–44	29,500
	largemouth bass	1943, 1945	3,000
	sunfish	1941	4,000
Culver Lake	yellow perch	1935	2,500
Dagget Lake	largemouth bass	1990–91	120
	northern pike	1963	1,500
	tiger muskellunge	1978–79, 1981, 1983	475
	walleye	1973, 1975, 1985–87, 1990–93, 1995–96	12,483
Deep Lake	brook trout	1965	50
	bluegill	1935–36, 1941	14,500
	brown trout	1963–66, 1968, 1989–2003	21,344
	largemouth bass	1934	900
	rainbow trout	1942–43, 1957, 1959–63, 1966–71, 1973–88	41,230
	yellow perch	1933, 1935–36	9,400
Duncan Lake–Thornapple Twp.	bluegill	1934–35, 1937–39, 1941–43	80,500
	largemouth bass	1934, 1937, 1942–43	3,500
	lake whitefish	1876	10,000
	yellow perch	1935, 1937, 1939	10,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
Duncan Lake – Woodland Twp.	bluegill	1938–39	2,000
Ellison Lake	lake whitefish	1876	5,000
Fine Lake	bluegill	1933, 1935–39, 1941	68,000
	largemouth bass	1933–35, 1937, 1941	8,300
	lake whitefish	1876	20,000
	redear sunfish	1996, 1999–2000	78,498
	smallmouth bass	1933, 1935	2,588
	sunfish	1941	4,000
	walleye	1943–44, 1951, 1955, 1959, 1975–77, 1979, 1998–2000	1,077,993
	yellow perch	1935, 1939	8,500
Glass Creek	brook trout	1933–34, 1936–44, 1946–64	95,210
	brown trout	1933–42, 1945, 1948–53, 1955–58, 1960, 1962–68, 1971, 1973–2006	305,310
	rainbow trout	1940–50, 1952–64	63,220
Glass Creek Tributary	brook trout	1945–46	16,000
	brown trout	1945	12,000
Guernsey Lake	bluegill	1935–39, 1941–43	74,100
	largemouth bass	1933–35, 1941, 1943, 1945	13,150
	northern pike	1960	4,000
	smallmouth bass	1943	500
	yellow perch	1933, 1935	6,500
Glass Creek	brook trout	1933–34, 1936–44, 1946–64	95,210
Hardwood Lake	bluegill	1934–36, 1939, 1941	28,000
	largemouth bass	1933–34, 1937, 1942–43	2,700
	lake whitefish	1876	10,000
	yellow perch	1933, 1935, 1937	5,500
Hathaway Lake	bluegill	1944–45	3,000
Head Lake	bluegill	1935–37, 1939, 1942	20,500
	largemouth bass	1934, 1942	950
	smallmouth bass	1942	500
	yellow perch	1935	3,500
Highbanks Creek	brown trout	1974–2006	83,431
Hill Creek	brook trout	1934, 1936–1964	111,160
	brown trout	1934–35, 1940, 1956, 1965–66, 1968, 1973–79, 1981–82, 1985	21,850
	rainbow trout	1940, 1943–50, 1952–64	40,375
Hill Lake	largemouth bass	1933	1,900
Horn Creek	brook trout	1937–41, 1943, 1945–46, 1958–64	31,445
	rainbow trout	1948–50	200

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
Horseshoe Lake	bluegill	1934–35, 1939, 1942–44	18,500
	largemouth bass	1934, 1937, 1939, 1942	1,826
	smallmouth bass	1943	500
	yellow perch	1933, 1939	4,900
Johnson Creek	brook trout	1933	500
Jordan Lake	bluegill	1936–39, 1941–45	69,500
	largemouth bass	1942, 1944, 1945	4,800
Kilpatrick Lake	bluegill	1937–39, 1941–45	19,900
	largemouth bass	1942, 1945	700
Lake Twenty-One	bluegill	1938–39, 1943–45	18,700
	largemouth bass	1939, 1942	600
	yellow perch	1933, 1935,1938	5,000
Larabee Lake	bluegill	1935–36, 1942	23,500
	yellow perch	1939	3,000
Lawhead Lake	bluegill	1935–39, 1941–44	29,400
Leach Lake	bluegill	1934–39, 1941–45	102,500
	largemouth bass	1934, 1939, 1941–42, 1944–45	7,100
	smallmouth bass	1942–43	600
	yellow perch	1934–37, 1939	14,900
Little Cedar Lake	bluegill	1933–43	45,350
	largemouth bass	1933, 1935–36	1,450
	yellow perch	1934–35, 1937	4,600
Little Leap Lake	bluegill	1934–35, 1937–39, 1941–43	31,700
	largemouth bass	1933, 1942–43	1,300
	rainbow trout	1955–63	3,500
	yellow perch	1935	2,000
Little Pine Lake	bluegill	1945, 1948	2,500
	largemouth bass	1945, 1948	1,500
Little Thornapple River	brown trout	1992	10,000
Long Lake Pike Marsh	northern pike	1967–70, 1973, 1979–80	568,914
Long Lake Pond	bluegill	1938	4,000
	yellow perch	1938–39	4,600
Long Lake–Hastings Twp.	bluegill	1933–39, 1941–43	65,800
	largemouth bass	1936, 1939	1,450
	smallmouth bass	1936	150
	yellow perch	1933–35, 1939	7,700
Long Lake–Hope Twp.	bluegill	1933–39, 1941–45	124,000
	largemouth bass	1933–35, 1937–39, 1941–42, 1944–45	13,400
	northern pike	1973–78, 1981–91	87,064
	smallmouth bass	1937–38, 1942–43	7,550
	walleye	2003–04	2,000
	yellow perch	1933–35, 1937–39	19,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
Long Lake–Johnstown Twp.	bluegill	1933–39, 1941–43	29,000
	Chinook salmon	1875	2,000
	largemouth bass	1933, 1941–43, 1945	5,100
	rainbow trout	1956–58, 1960, 1962, 1964–66, 1968–69, 1971, 1973–76, 1983–88	44,360
	sunfish	1941	4,000
	yellow perch	1935, 1939	6,500
Loomis Lake	largemouth bass	1937–38, 1941, 1945, 1947, 1949	7,046
	shiners	1937	300
	suckers	1937	200
	sunfish	1937	1,000
	yellow perch	1937	500
Lower Lake	bluegill	1936, 1939, 1941, 1943	15,000
	largemouth bass	1944–45	1,400
Messer Brook	brown trout	1992	1,998
Meyers Lake	bluegill	1935–38, 1942	42,000
	yellow perch	1935	2,500
Middle Lake–Baltimore Twp.	bluegill	1933, 1935–37	24,750
Middle Lake–Carlton Twp.	bluegill	1934–39, 1941–45	113,300
	largemouth bass	1933–34, 1939, 1942, 1944–45	5,800
	smallmouth bass	1943	400
	yellow perch	1934–37, 1939	16,900
Mill Creek	brook trout	1933	1,300
Mill Lake	bluegill	1934–35, 1937–39, 1941–44	56,500
	largemouth bass	1934, 1937, 1942–43, 1945	4,700
	muskellunge	1964	9,250
	yellow perch	1933, 1935, 1939	6,300
Mill Pond	American eel	1878	5,000
Morris Lake	bluegill	1941	1,000
Mud Lake–Hope Twp.	bluegill	1933, 1935, 1936, 1939, 1941–42, 1944	15,750
Mud Lake–Johnstown Twp.	bluegill	1935–6, 1941–42, 1944	19,000
Mud Lake	sunfish	1941	4,000
Nashville Pond	bluegill	1956	10,000
	largemouth bass	1956	1,200
Newton Lake	bluegill	1935–6, 1938	15,100
	largemouth bass	1933	1,000
	yellow perch	1935, 1938–39	6,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
North Branch Cedar Creek	brook trout	1980	500
	brown trout	1933–39, 1979, 1981–97	30,584
North Twin Lake	bluegill	1942	1,000
Otis Lake	bluegill	1942	4,000
Perch Lake	smallmouth bass	1933–35, 1941	783
	yellow perch	1935	1,000
Pine Lake	bluegill	1933, 1935–9, 1942–43	72,550
	largemouth bass	1933–34, 1941–42	1,877
	smallmouth bass	1938, 1942	1,300
	yellow perch	1935	8,000
Podunk Lake	bluegill	1933–39, 1941–44	74,500
	largemouth bass	1934–37, 1939, 1941–42	10,575
	smallmouth bass	1937–39, 1941–43	9,250
	yellow perch	1934–35, 1937–38	11,400
Powers Creek	brook trout	1933	250
Quaker Brook	brown trout	1943	6,000
	brook trout	1943, 1980–81, 1984–1997	20,714
Saddlebag Lake	bluegill	1935–39, 1941–45	46,200
Shallow Lake	bluegill	1945	1,000
	largemouth bass	1945	1,000
Shaw Lake	northern pike	1963	500
Sister Lakes	bluegill	1933–35, 1937–38	19,600
	largemouth bass	1933–34	2,700
	yellow perch	1934–5, 1937	14,500
South Twin Lake	bluegill	1942	1,000
Stewart Lake	bluegill	1934–7, 1939, 1941–43	53,250
	largemouth bass	1933–34, 1942–44	4,050
	smallmouth bass	1933–34, 1936–37, 1941–43	6,325
	yellow perch	1935, 1939	8,000
Sugarbush Lake	bluegill	1935–39, 1941, 1943, 1944	45,500
	largemouth bass	1937, 1942–43	2,200
	rainbow trout	1951–1969, 1971, 1973–74, 1976–84	44,255
	smallmouth bass	1937–38	900
	splake	1969	750
	walleye	1933–39	1,190,000
	yellow perch	1935, 1937, 1939	12,100
Tamarack Creek	brook trout	1943, 1945–46, 1948–62	9,675
	brown trout	1940–53, 1955–62, 1971–78	51,590
	rainbow trout	1943–44, 1948–50, 1952–62	27,275
Tanner Lake	bluegill	1936, 1939	11,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Barry–continued			
Thornapple Lake	bluegill	1934–39, 1941–45	115,000
	Chinook salmon	1875	6,000
	largemouth bass	1933, 1935, 1939, 1944, 1945, 1991	10,825
	muskellunge	1964–65, 1967, 1969–71, 1973, 1976–81, 1983–89, 1991, 1994, (1997–2005	44,642
	northern pike	1991, 2001	21
	smallmouth bass	1933, 1939, 1941–43	12,200
	walleye	1976, 1981, 1984–94, 1996–99, (2001–03)	357,958
	yellow perch	1935–37, 1939	23,600
Thornapple River	smallmouth bass	1935–39, 1942–44	39,250
	walleye	1977,1980–81	69,570
Tillotson Lake	bluegill	1934–36, 1938	32,300
	yellow perch	1935	3,000
Twin Lakes–Hastings Twp.	bluegill	1938	200
	lake whitefish	1878	40,000
Twin Lakes–Hope Twp.	bluegill	1942	2,000
	yellow perch	1935	1,000
Unknown water body–Irving Twp.	American eel	1883	3,000
Unknown water body–Johnstown Twp.	American eel	1881	10,000
Van Syckle Lake	bluegill	1939, 1941	4,000
Wall Lake	bluegill	1933–1939, 1942–1945	117,500
	Great Lakes shiners	1936	27,000
	largemouth bass	1933–1935, 1937–1939, 1941–1945	17,900
	Lake whitefish	1874, 1876	20,000
	smallmouth bass	1933–34, 1936–1939, 1941–1943	30,995
	walleye	1933–38, 1940, 1942, 1954–55, 1974, 1994–96	3,308,835
	yellow perch	1934–35, 1937–38	18,000
Warner Lake	bluegill	1936	10,000
	yellow perch	1935	3,500
Wilkinson Lake	bluegill	1933, 1935–39, 1941–45	81,800
	largemouth bass	1934–39, 1941–42	9,700
	smallmouth bass	1933, 1935, 1941	3,200
	yellow perch	1933, 1935	10,500
Zigler Lake	bluegill	1942	1,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Clinton			
Alward Lake	bluegill	1933–34, 1937–40, 1942	25,130
	largemouth bass	1933–34, 1937–42, 1944	6,905
	walleye	1998	200
	yellow perch	1939	4,000
Blood's Lake	lake whitefish	1874	3,000
Hayworth Creek	smallmouth bass	1958	1,000
Lake Ovid/Sleepy Hollow	black crappie	1975	24
	bluegill	1976, 1978	140,662
	bullhead	1976	704
	channel catfish	1976–78, 1988–89, 1994–97, 1999, 2001, 2003–05	184,400
	fathead minnow	1976	75,000
	green sunfish	1976	15,740
	hybrid sunfish	1975	21,041
	largemouth bass	1975	804
	northern muskellunge	1999–2000, 2003, 2005	4,450
	pumpkinseed sunfish	1976	14,898
	redear sunfish	1995, 1997	91,642
	tiger muskellunge	1977–82, 1984–91	18,380
	walleye	1973	100,000
Maple River	channel catfish	1986	3,272
	Chinook salmon	1875	6,000
	northern pike	1974	125,000
	smallmouth bass	1933	1,000
	walleye	1938–40, 1942, 1988–89	2,780,440
Muskrat Lake	bluegill	1933–34, 1937–38	9,820
	largemouth bass	1933–34, 1937–42, 1944	7,055
	yellow perch	1939	4,000
Parsons Pond	bluegill	1969	521
Eaton			
Lacey Lake	American eel	1883	9,000
	black crappie	1996	1,000
	bluegill	1933, 1935–45	47,450
	channel catfish	1995	1,000
	hybrid sunfish	1995–96	2,000
	largemouth bass	1937–45	9,500
	walleye	1995, 2005	575
	yellow perch	1933, 1935, 1937–39, 1996	12,800
Lake Alliance	channel catfish	1995–96, 1998	3,488
	largemouth bass	1992, 1994	1,290
	rainbow trout	1992–2005	17,436

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Eaton–continued			
Lake Interstate	channel catfish	1991, 1995–96, 1998, 2000, 2002–03, 2005	7,420
	largemouth bass	1995–96, 1998, 2000, 2002–03, 2005	2,500
	rainbow trout	1991, 1996–2004	19,421
	redear sunfish	1995–1997	7,574
Mud Lake	bluegill	1935	10,000
	largemouth bass	1935	800
	yellow perch	1935	1,500
Nashville Pond	northern pike	1957–58	254
Saddlebag Lake	bluegill	1934–35	5,700
	largemouth bass	1934–1942	1,800
	yellow perch	1935	3,500
Saubee Lake	bluegill	1933–35, 1937–39, 1941–45	31,050
	largemouth bass	1934, 1937, 1942, 1944–45	4,400
	redear sunfish	1986	6,000
	yellow perch	1933, 1935, 1937, 1939	11,800
Tamarack Lake	bluegill	1935	10,000
	largemouth bass	1935	1,200
	yellow perch	1935	2,000
Thornapple River	Chinook salmon	1875	6,000
	northern pike	1957	24
Gratiot			
Maple River	channel catfish	1986	3,000
	walleye	1988, 1990	13,000
Rainbow Lake	rainbow trout	2004	160
	walleye	1998	21,200
Ionia			
Arnold's Creek	brook trout	1941, 1943–44	2,150
Belding Pond No. 3	fathead minnow	1971–72	12,015
	walleye	1971	758,000
Belding Pond No. 4	fathead minnow	1971	675
	walleye	1971	285,300
Belding Pond No. 5	fathead minnow	1971	405
	walleye	1971	245,000
Bellamy Creek	brown trout	1953	300
Browns Creek	brook trout	1939, 1945	3,000
Cannon Creek	brook trout	1938–64	271,415
	rainbow trout	1949–50, 1952–64	4,500
D. Brooks Lake	rainbow trout	1952	3,500
Derby Lake	American eel	1879	10,000
Duck Creek	brown trout	1971–75, 1980–89, 1992–2006	76,791
Eckley Creek	brook trout	1945	1,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Ionia–continued			
Fish Creek and impoundments	Chinook salmon	1996	276
	smallmouth bass	1933–34, 1937–41, 1943–45	9,000
	steelhead	1979–83, 1988–2006	234,018
	walleye	1942	250,000
Flat River and impoundments	American eel	1879	15,000
	brown trout	1980	6,000
	largemouth bass	1935	525
	smallmouth bass	1935	1,200
	steelhead	1979–80, 1982	75,000
	walleye	1942, 1987, (1988–94)	1,111,800
Gould Lake	largemouth bass	1933	250
Grand River	American eel	1873	80,000
	steelhead	1979–80, 1982	60,000
	walleye	1938, 1981–83, 1985–90, (1992–2006)	11,821,719
Hawns (or Hahn's) Creek	brook trout	1933–34, 1937, 1939–42, 1944–45, 1947–64	32,607
Hubbell Pond	yellow perch	1934	1,000
Ionia Club Pond	brook trout	1961–62	100
Ionia Creek	brook trout	1959	10,000
South Ionia Creek	brook trout	1933–36, 1945–50	2,246
	rainbow trout	1949	200
Ionia Pond No. 1	brook trout	1951–53	560
	brown trout	1951–53	510
	rainbow trout	1951–53	560
Ionia Pond No. 2	brook trout	1951–53	870
	brown trout	1951–53	795
	rainbow trout	1951–53	870
Ionia Pond, Lower	brook trout	1950	250
	rainbow trout	1950	250
Ionia Pond, Upper	brook trout	1950	100
	rainbow trout	1950	100
Jordan Lake	brook trout	1943	250
	bluegill	1933–44	62,915
	largemouth bass	1933–35, 1937–45	24,090
	yellow perch	1933–39	54,025
Kidville Pond	yellow perch	1938	3,250
Knapp Creek	brook trout	1939, 1941	2,200
Lake Creek and impoundment	bluegill	1935	2,000
	brook trout	1961, 1975	607
	brown trout	1942–53, 1955–64, 1974–77	30,402
Ledar Lake	American eel	1879	5,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Ionia–continued			
Libhart Creek	channel catfish	1970	10,860
	smallmouth bass	1969–70, 1976–77	15,113
Long Lake	American eel	1879	5,000
	bluegill	1933–42, 1944	67,565
	channel catfish	1988–90	34,800
	crayfish	1942	3,000
	golden shiner	1936	1,000
	Great Lakes shiner	1942	5,160
	lake trout	1878	5,000
	largemouth bass	1933–36, 1938–40, 1942–45, 1977	34,813
	lake whitefish	1876, 1978	30,000
	smallmouth bass	1941	1,040
	yellow perch	1933–35, 1937–39	40,560
Maggie Amons Creek	brook trout	1943	250
Maple River	channel catfish	1986	5,826
	smallmouth bass	1937	350
	walleye	1939–40, 1942	1,000,000
Messer Brook	brown trout	1992	999
Morrison Lake	bluegill	1933–41	55,341
	crayfish	1940	3,900
	largemouth bass	1933–36, 1938–41	22,975
	walleye	1988–94, 1996–97, 1999	1,973,577
	yellow perch	1933–36, 1938–39	44,400
Peck Lake	American eel	1878	5,000
	bluegill	1933–38, 1943	9,315
	largemouth bass	1933–35, 1938, 1941, 1943, 1945	5,440
	lake whitefish	1878	20,000
	yellow perch	1935–36, 1938–39	9,520
Pedler Lake	yellow perch	1933	1,760
Prairie Creek	American eel	1877	8,000
	brown trout	1966–69, 1975–79, 1982–87, 1989–2006	453,021
	rainbow trout	1975–77	131,334
	steelhead	1984–2006	212,748
Sessions Creek	brown trout	1985–88	1,540
Sessions Lake	black crappie	1988	980
	bluegill	1985, 1988	624
	brown trout	1985–88, 1990	27,200
	channel catfish	1986, 1988–90, 1997–2005	79,315
	fathead minnow	1985	197,200
	largemouth bass	1985	277
	rainbow trout	1985–90	30,447
	smallmouth bass	1987	131
	walleye	1985–90, 1992–98, (2000–2006)	1,893,970

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Ionia–continued			
Stoney Creek	brook trout	1938, 1940	1,210
	smallmouth bass	1933, 1935, 1937, 1940–42, 1945	4,475
Tebbel (Tubbell) Pond	yellow perch	1933, 1935, 1938	5,880
Tibbets Creek	brook trout	1933–34, 1943–45, 1947–64	27,726
Timberline Creek	brook trout	1933, 1938–39, 1943–46	950
Tupper Lake	bluegill	1933–42, 1944	34,370
	largemouth bass	1933–35, 1938–45	11,990
	walleye	2001	1,000
	yellow perch	1934, 1936, 1938–39	15,651
Tyler Creek	brown trout	1971–77, 1979–80, 1982–84, 1986–89, 1992–2006	23,053
Unknown water body	American eel	1883	9,000
Whitney Creek	brook trout	1939	2,050
Woodard (Woodward) Lake	bluegill	1933–37	19,040
	crayfish	1937	52,500
	lake whitefish	1874	5,000
	largemouth bass	1933–35, 1937–42, 1944–45	13,774
	rainbow trout	1970–71	4,000
	walleye	1964, 1987, 1990, 1994–96, 1998, 2000, 2003, 2005	74,452
	yellow perch	1933–34, 1939	10,090
Kent			
Ada Township Park Pond	black crappie	1981, 1988	606
	bluegill	1980–82, 1984	2,221
	pumpkinseed sunfish	1981	55
	rainbow trout	2004	800
	yellow bullhead	1984	88
Ambrosa Pond	hybrid sunfish	1971	11,260
	largemouth bass	1971	1,448
Angel Lake	bluegill	1933, 1937, 1940–41, 1943–44	22,820
	bullheads	1941	1,650
	crayfish	1937, 1941	31,400
	largemouth bass	1933, 1936, 1938–39, 1941–45	10,856
	yellow perch	1935, 1938–39, 1941	11,693
Armstrong Creek	brown trout	1939, 1943–49	28,550
Baird Creek	brook trout	1939	200
Bank Lake	bluegill	1937	3,000
	largemouth bass	1941	50
Barber Lake	largemouth bass	1936, 1941	1,625

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Bass Lake	bluegill	1933–35, 1937, 1940–41	41,230
	crayfish	1941	9,000
	largemouth bass	1933–38, 1940–42, 1957	19,281
	northern pike	1958, 1963	634
	smallmouth bass	1937	1,000
	tiger muskellunge	1977–78	1,600
	walleye	1987–89, 1991–92, (1994–1998)	476,754
	yellow perch	(1933–39)	17,785
Battjes Park Pond	black crappie	1988	530
	bluegill	1988	229
	brown trout	1995	400
	largemouth bass	1988, 1991	132
	rainbow trout	1968–70	12,178
Beals Creek	brook trout	1933	72
Bear Creek and tributaries	brown trout	1934–64	160,495
	rainbow trout	1949–50, 1952–61, 1963–64	3,600
Becker Creek	brook trout	1933, 1936–41, 1943–49, 1951, 1959, 1963–64	50,000
	rainbow trout	1949–50, 1952–62	2,100
Bell Lake	largemouth bass	1933	1,050
Belmont Creek	brook trout	1963	300
	rainbow trout	1959	900
Belmont Ponds	brook trout	1950–55, 1957–61	7,650
	brown trout	1950–55, 1957–61	5,600
	rainbow trout	1950–55, 1957–58, 1960–62	7,500
Big Brook	brook trout	1882	6,000
Big Brower Lake	brown trout	1968	3,000
	largemouth bass	1970, 1975	5,000
	northern pike	1976–77	3,900
	rainbow trout	1967, 1969–71	17,100
Big Crooked Lake	bluegill	1933–35, 1937–38, 1940–44	45,398
	crayfish	1937, 1940, 1942	8,100
	Great Lakes shiner	1942	350
	largemouth bass	1933–34, 1937–45, 1970	50,855
	northern pike	1971	3,000
	walleye	2000	1,025
	yellow perch	1933, 1935, 1938–39, 1941	19,050
Big Muskrat Lake	bluegill	1933–35, 1937, 1941	322,370
	crayfish	1937, 1940	7,650
	largemouth bass	1933–35, 1938–42	31,170
	yellow perch	1933, 1939	6,600

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Big Olin Lake	bluegill	1933, 1937, 1940, 1941,1943	13,890
	crayfish	1939	600
	lake trout	1878	500
	lake whitefish	1878	2,500
	largemouth bass	1933–34, 1938–42, 1944–45	14,804
	yellow perch	1935, 1939	5,045
Big Pine Island Lake	bluegill	1933–35, 1937–42, 1944	49,800
	crayfish	1940	500
	largemouth bass	1933–35, 1937–45, 1975	34,500
	smallmouth bass	1934	60,000
	tiger muskellunge	1972, 1975, 1977–78	6,700
	walleye	1985, 1987–89	21,488
	yellow perch	1933, 1935, 1938–39, 1941	16,375
Big Spring Lake	black bass	1953	2,970
	bluegill	1953	600
Black Lake	black bass	1953	10
Blue Lake	bluegill	1933–34, 1938–41	46,175
	largemouth bass	1933–34, 1935–42	19,175
	smallmouth bass	1937	624
	walleye	1985, 1987	1,600
	yellow perch	1935, 1937–39	9,975
Bostwick Lake	bluegill	1933–35, 1937–38, 1940–41, 1943–33	54,260
	crayfish	1937, 1942	46,150
	largemouth bass	1933–35, 1937–45	14,468
	smallmouth bass	(1937–41)	4,600
	yellow perch	1934, 1937, 1939	28,805
Bowen Lake	bluegill	1933–34, 1940	8,750
	largemouth bass	1933–34, 1940	5,180
	yellow perch	1939	5,625
Brower Lake	bluegill	1934, 1937–38, 1940, 1943	20,800
	largemouth bass	1933, 1939–41, 1944–45	8,900
	yellow perch	1934, 1939	2,870
Brown's Lake	lake whitefish	1874	4,940
Bryones Lake	bluegill	1937	4,940
Buck Creek	brook trout	1933	3,000
	brown trout	1969–80, 1983–2006	375,019
	rainbow trout	1969	4,000
	steelhead	1969	2,000
Buck Lake	largemouth bass	1942	2,000
	yellow perch	1935	3,420
Burk Creek	brook trout	1882	150
Burn Creek	brook trout	1882	2,310

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Byrnes Lake	bluegill	1934, 1940–41	15,150
	crayfish	1940	1,600
	largemouth bass	1934, 1937–42	10,080
	yellow perch	1935, 1939	3,295
Camp Lake	bluegill	1933–35, 1937–38, 1940–41, 1943	38,680
	largemouth bass	1933–35, 1937, 1939–42, 1944–45	14,383
	lake whitefish	1874	1,350
	smallmouth bass	1937, 1941	6,040
	sunfish	1936, 1939	725
	yellow perch	1934–35, 1938–39, 1941	23,115
Campau Lake	black crappie	1967	9,750
	bluegill	1935, 1938, 1941, 1943, 1968	311,317
	brown trout	1968	1,500
	crayfish	1935	5,130
	largemouth bass	1933–35, 1939, 1940–44, 1965–66	38,415
	muskellunge	1966, 1997, (1998–2006)	2,194
	rainbow trout	1965	4,000
	smallmouth bass	1941	1,775
	tiger muskellunge	1969–71, 1973, 1975, 1977–82, 1984–91	34,805
	yellow perch	1934–35, 1937–38	18,120
Campbell Lake	bluegill	1934, 1938	1,000
	largemouth bass	1934, 1937–38	5,750
	yellow perch	1938–39	4,626
Canfield Creek	brook trout	1941–42	10,250
Cascade Creek	brook trout	1954–56, 1958–62	11,800
Cascade Impoundment	bluegill	1937–38, 1940	5,400
	coho salmon	1984–86, 1988–89	99,851
	largemouth bass	1933	100
	smallmouth bass	1933–34, 1940	9,750
	yellow perch	1939	1,500
Cedar Creek and tributaries	brook trout	1933, 1940, 1944–48, 1956, 1958–64	39,500
	brown trout	1938, 1943	5,450
	rainbow trout	1948–55, 1980	11,670
Chapin Lake	bluegill	1943	150
	largemouth bass	1935	500
Chase Lake	"black bass"	1953	150
Cherry Creek	brook trout	1933–34, 1936, 1938, 1943, 1948–51, 1956–62	4,545
	rainbow trout	1952–55	350
Childsdale Impoundment	bluegill	1970	50
	hybrid sunfish	1970	400
Chopin Lake	largemouth bass	1941	3,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Church Lake	Chinook salmon	1876	35
	lake whitefish	1874	4,000
Clear Lake–Plainfield Twp.	crayfish	1937	3,000
Coldwater River	brown trout	1971–77, 1979–89, 1992–2006	489,740
	rainbow trout	1974, 1992, 2005–06	123,297
Comstock Park Pond	black crappie	1988	550
	bluegill	1949, 1985	12,681
	largemouth bass	1996	14
	northern pike	1996	227
Conover Lake	brook trout	1951	4,826
Cook and White (Gilbert) Lake	bluegill	1940–41	77,000
	largemouth bass	1933, 1937, 1940–41, 1945	12,360
	yellow perch	1941	275
Corduroy Cord Pond	crayfish	1935	50,000
Cowan Lake	hybrid sunfish	2000	1,000
Cranberry Lake	bluegill	1937, 1940–41	79,720
	largemouth bass	1933, 1937, 1941, 1944–45	14,181
Crawford Lake	walleye	1970–71	1,338
Crinnon Creek	brook trout	1933–34, 1938, 1941	803,600
Crystal Lake	lake trout	1878	7,800
	lake whitefish	1878	7,800
Cummings Pond	bluegill	1974	300,000
Darb Creek	brown trout	1940	6,000
Dargies Brook	brook trout	1882	20,000
Dean Lake	black bass	1953	9,120
	bluegill	1953	1,500
	largemouth bass	1949, 1966, 1979	1,900
	tiger muskellunge	1969–70, 1972, 1974, 1976–82, 1984–91, 2001	21,364
Deer Lake	bluegill	1940	400
	largemouth bass	1933, 1940	800
Dopt Creek	brook trout	1934	1,732
Duck Creek	brown trout	1943–46, 1971–75, 1980–89, 1992–2006	49,425
Duke Creek and tributaries	brown trout	1933–36, 1938–44, 1946–53, 1955–64	77,365
	rainbow trout	1949–50, 1952–64	3,225
Dwight Lydell Pond	black crappie	1985	156
	bluegill	1986, 1990	375
Egypt Creek	brook trout	1933–34, 1936–64	95,233

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Emmons Lake	bluegill	1934–35, 1938, 1941, 1943, 1956	11,220
	brown trout	1972–73	3,100
	catfish	1970	6,000
	hybrid sunfish	1970–73	34,000
	largemouth bass	1933–35, 1937–43, 1970–71	14,905
	rainbow trout	1970–71, 1974, 1976	13,860
	yellow perch	1934–35, 1937–39	56,259
Fase Pond	bluegill	1951	2,730
	rainbow trout	1951	4,550
Filkens Pond	largemouth bass	1978	5,150
Fish Lake	largemouth bass	1933, 1941	300
Fisk Lake	bluegill	1933, 1938	740
	largemouth bass	1937, 1964	8,100
	rainbow trout	1964	1,400
	yellow perch	1937	500
Flat River	American eel	1878	1,500
	Chinook salmon	1975	2,500
	largemouth bass	1945	109,758
	rainbow trout	1978	107
	smallmouth bass	1935, 1945	1,000
	steelhead	1979–2006	215,722
	walleye	1933, 1987–89, (1990–94)	3,217,000
Forest Creek	brown trout	1940, 1944–47	710,500
Frederick Creek	brook trout	1936, 1938–45	13,650
Freska Lake	bluegill	1938, 1943	3,000
	largemouth bass	1938–40, 1944	4,450
Freska Lake	yellow perch	1939	1,006
Frost Creek	brown trout	1943–47	25,550
Fullington Creek	brook trout	1933	2,000
Giddings Lake	bluegill	1945	2,500
	largemouth bass	1945	500
Grand River	American eel	1878	2,310
	bluegill	1934	140,225
	bullheads	1936, 1941	8,000
	Chinook salmon	1970–71, 1973–75, 1979–2006	7,140,052
	coho salmon	1969–72, 1974, 1976–77, 1979–84	1,881,757
	crayfish	1935, 1937, 1939–40, 1942, 1946	765,630
	largemouth bass	1996	202
	smallmouth bass	1933–35, 1937–44	99,922
	steelhead	2006	3,000
	sunfish	1936	700
	walleye	1933, 1939, 1975–83, 1985–90, 1992–94, (1996–2006)	29,813,129
	yellow perch	1936, 1942	20,488

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Green Lake	bluegill	1933–35, 1937–38, 1940–41	1,165,050
	crayfish	1937, 1940	9,000
	largemouth bass	1933–35, 1939, 1941, 1944	20,530
	smallmouth bass	1940	800
	yellow perch	1933, 1935, 1938–39	6,710
Grove Lake	yellow perch	1939	8,250
Half Mile Lake	bluegill	(1933–37), 1940	12,375
	largemouth bass	1933–35, 1939	19,070
	yellow perch	1934–35, 1939	1,975
Hanna Lake	bluegill	1934, 1938, 1956	3,510
Hansons Creek	brook trout	1938–42	14,100
Harkness Pond	hybrid sunfish	1971	1,000
Hart Lake	bluegill	1933, 1938, 1940–41, 1944	7,591
	largemouth bass	1933, 1937–40, 1944	18,259
	smallmouth bass	1938	1,750
	yellow perch	1939	1,500
Helena (Mud) Lake	bluegill	1942, 1945	701
	largemouth bass	1942, 1945	2,550
High Lake	largemouth bass	1934	220
Hilton Lake	lake trout	1878	300
	lake whitefish	1878	260
Honey Creek and tributary	brook trout	1933–51, 1954–55, 1958–65	137,667
Hopkins Lake	largemouth bass	1935	100
Horseshoe Lake	bluegill	1933, 1935, 1938, 1940	6,885
	largemouth bass	1933–35, 1939–42, 1945	7,700
	yellow perch	1935, 1939	772
House Lake	bluegill	1934, 1940, 1943	7,015
	largemouth bass	1934–35, 1940, 1942–45	5,251
Indian Lake No. 1	bluegill	1933	100
Indian Lake No. 2	bluegill	1933	1,600
Ingleright Lake	lake whitefish	1877	115
John Ball Park Ponds	black bullhead	1979	1,050
	black crappie	1975, 1990	155
	bluegill	1975, 1981, 1990	23,825
	bullheads	1975	385
	largemouth bass	1975	111
	pumpkinseed sunfish	1990	75
Kent City State Park	brown trout	1952	82
Kent League Pond	brook trout	1965	441
	brown trout	1965, 1968	450
	rainbow trout	1958, 1960–64, 1966–67, 1970	1,150
Kenyon Creek	brook trout	1936, 1938–45, 1948–57	16,650
Kopf Creek	brook trout	1938–45, 1948, 1951	13,100

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
LaBarge Impoundment	largemouth bass	1933	25
	smallmouth bass	1933–34	3,075
Lake Bell	bluegill	1933	150
Lake Forest	largemouth bass	1945	2,000
Lamar Park Pond	bluegill	1970	103
	largemouth bass	1934, 1970	1,700
	rainbow trout	1951–52	822
	yellow perch	1934, 1970	3,100
Lamberton Creek (Duck Pond)	bluegill	2004	200
	channel catfish	2004	100
	fathead minnow	2004	2,000
	largemouth bass	2004	100
	rainbow trout	2004	375
	yellow perch	2004	200
Lamberton Lake	Chinook salmon	1876	700
	largemouth bass	1939, 1941	300
	yellow perch	1941	2,000
Leach Creek	brook trout	1882	504
Lime Lake	bluegill	1933, 1937, 1941, 1943	11,400
	brown trout	1968	4,250
	lake trout	1972	600
	largemouth bass	1933, 1938, 1941–42, 1945	7,896
	rainbow trout	1951–57, 1959–67, 1969–2006	188,452
Lincoln Lake	American eel	1878	5,000
	bluegill	1933–35, 1937–38, 1940–41	70,640
	crayfish	1941	4,680
	lake trout	1878	1,625
	lake whitefish	1874, 1978	1,785
	largemouth bass	1933–35, 1937–39, 1940–42	47,761
	smallmouth bass	1939–43	39,861
	tiger muskellunge	1970–72, 1974, 1976–82, 1984	21,239
	walleye	1986–92, 1994, 1996, (1997–2003), (2004–06)	597,800
	yellow perch	(1933–39)	7,000
Little Muskrat Lake	bluegill	1933–34, 1937, 1941, 1943–44	33,770
	largemouth bass	1933–34, 1937–39, 1941–43	15,314
Little Olin Lake	bluegill	1933, 1940	4,900
	largemouth bass	1933–34, 1938, 1940	4,724
	yellow perch	1935, 1939	3,865
Little Pine Island Lake	bluegill	1937, 1940–43	27,380
	brown trout	1966, 1968	6,200
	lake trout	1878	9,750
	lake whitefish	1879	7,500

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Little Pine Island Lake–continued	largemouth bass	1933–35, 1937–40, 1944	12,528
	sunfish	1936	580
	walleye	1982	800
	yellow perch	1933–34, 1937–38, 1939, 1941	220,418
Logan Lake	bluegill	1934, 1938, 1941, 1943	9,255
	largemouth bass	1933, 1934, 1937–43	5,546
	yellow perch	1935, 1939	710
Long Lake–Oakfield Twp.	bluegill	1933, 1935	6,880
	largemouth bass	1933, 1935	8,130
	yellow perch	1935	1,200
Long Lake–Solon Twp.	bluegill	1934, 1941, 1943	7,450
	largemouth bass	1933, 1937, 1939–42, 1944–45, 1977	12,910
	walleye	1987, 1990, 1995–95, (1996–2000), (2003–05)	36,659
	yellow perch	1933, 1934, 1939	6,945
Lowell School Pond	largemouth bass	1977	3,625
	rainbow trout	1976	3,900
Lower Lake	bluegill	1941	3,900
	largemouth bass	1937, 1941–42	1,900
	yellow perch	1939	2,000
Marjella (Clear) Lake	bluegill	1974	3,250
	brown trout	1968, 1974–80, 1982–95	24,022
	lake trout	1879	3,250
	largemouth bass	1974	700
	rainbow trout	1966–67, 1969–70, 1974, 1984, 1996–2003	12,355
Marl Pit	bluegill	1951	806
	rainbow trout	1951	50
Maston Lake	bluegill	1933–35, 1937–38, 1940–41, 1944	46,235
	largemouth bass	1933–35, 1937–42, 1944	14,863
	walleye	1985	371
	yellow perch	1933, 1935, 1937–39	20,410
Maxwell Lake	lake trout	1878–79	7,700
	lake whitefish	1878	3,000
McCarthy Lake	bluegill	1943	20,000
	largemouth bass	1935, 1942, 1944	5,400
	yellow perch	1939	2,900
McEvans Lake	yellow perch	1939	3,250
McEwen Lake	bluegill	1937, 1943	4,000
	largemouth bass	1937, 1941–43	1,820
	yellow perch	1939	3,250

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
McVean Lake	bluegill	1940–41	6,250
	rainbow trout	1971	450
Mead Lake	bluegill	1938, 1941–43	6,908
	crayfish	1942	15,800
	largemouth bass	(1938–42), 1944–45	4,886
	yellow perch	1939	4,400
Middle Lake	bluegill	1934, 1941	7,040
	largemouth bass	1934–35, 1937, 1939, 1941–42, 1945	5,210
	yellow perch	1934–35, 1939	9,670
Mill Creek	brook trout	1883	3,250
	brown trout	1940, 1945, 1954–56, 1958–65, 1974, 1984–85	26,025
	bullheads	1939	500
	rainbow trout	1948, 1957, 1974, 1984–85	8,457
Morgan Lake Chain	bluegill	1934, 1938, 1940–44	51,010
	largemouth bass	1933, 1935, 1939–45	22,009
	smallmouth bass	1940	550
	yellow perch	1934–35, 1939	7,570
Murray Lake	bluegill	1933, 1937–38, 1940–43	44,425
	largemouth bass	1933, 1938–42, 1944, 1975	18,014
	muskellunge	1976, 1998, 2000, 2003, 2005–06	105,667
	northern pike	1958	430
	tiger muskellunge	1970–74, 1977–82, 1984–91	25,138
	walleye	1933–35	1,501,300
	yellow perch	1936, 1938–39, 1941	986,000
Myers (Meyers) Lake	bluegill	1933–34, 1937–38, 1940–41	21,704
	flathead catfish	1994, 1996	2,710
	largemouth bass	1933, 1938–41, 1944	5,514
	yellow perch	1939	5,440
Nagle Lake	lake whitefish	1879	380
New Boston Lake	lake trout	1878	60,000
No Name Creek	brown trout	1971	5,000
Overacre Creek	brook trout	1941	2,800
Perch Lake	American eel	1878	1,000
Pickerel Lake–Cannon Twp.	bluegill	1948	7,550
	lake whitefish	1874	900
	largemouth bass	1948	2,500
	rainbow trout	1951	500
Pickerel Lake–Plainfield Twp.	bluegill	1934	500
	crayfish	1937	2,000
	largemouth bass	1933, 1934	31,026

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Pickerel Lake (unspecified location)	Chinook salmon	1876	1,850
Pine Lake	bluegill	1969	150,000
	brown trout	1968	4,100
	largemouth bass	1933, 1939, 1941, 1944, 1969–70, 1972	7,625
	northern pike	1969–72	4,705
	rainbow trout	1968	2,000
	hybrid sunfish	1969–70	29,300
	yellow perch	1934, 1939	29,000
Pond in Ada Township	brown trout	1938	3,250
Porter Creek	brook trout	1934	30
Pratt Lake	American eel	1878	20,000
	black crappie	1981	35
	bluegill	1981	320
	lake whitefish	1878	1,500
	northern pike	1983, 1985	354,402
	pumpkinseed sunfish	1981	48
Pratt Lake Creek	brown trout	1982–89, 1992–2006	14,950
Private Ponds	Chinook salmon	1874	5,100
Quiggle (Gove) Lake	bluegill	1934–35, 1940, 1943	4,500
	brown trout	1968	3,420
	largemouth bass	1933–35, 1940–44	6,601
	rainbow trout	1953–56, 1958–67, 1969–74, 1986–87	33,350
	yellow perch	1935	3,000
Ratigan Lake	bluegill	1938, 1940–41, 1943	10,800
	crayfish	1940	2,000
	largemouth bass	1938–44	8,837
	yellow perch	1935, 1939, 1941	11,800
Rattleford Creek	brook trout	1883	150,000
Reeds Lake	black crappie	1967	4,000
	bluegill	1933–35, 1937–38, 1940, 1942, 1968	69,270
	Chinook salmon	1876	15,000
	emerald shiner	1936	145
	lake whitefish	1874	2,300
	lake trout	1878	500
	largemouth bass	1933–35, 1937–42, 1944, 1964, 1975	43,780
	northern pike	1966	3,900
	rainbow trout	1964	15,209
	smallmouth bass	1937	10,000
	walleye	1987–89, 1991–92	93,934
	yellow perch	1933–35, 1937–39	52,060

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Richmond Park Pond	black bullhead	1979	1,050
	black crappie	1975, 1988	455
	bluegill	1975, 1979, 1981, 1986	5,085
	bullheads	1975	388
	crayfish	1935	309
	largemouth bass	1977	30,400
	pumpkinseed sunfish	1976, 1983	700
Riley Lake	bluegill	1934	322
	largemouth bass	1934	3,000
Rockford Impoundment	bluegill	1938	400
	hybrid sunfish	1970	8,000
Rogue River	brook trout	1884, 1933	9,300
	brown trout	1933–34, 1936, 1943, 1955–56, 1958–72, 1974–80, 1982–2006	975,247
	crayfish	1940	35,000
	rainbow trout	1933–34, 1936–38, 1954–55, 1957, 1969–72, 1974–83, 1985–2006	733,099
	smallmouth bass	1935, 1939, 1984	8,640
	steelhead	1969–75, 1978–2006	3,559,169
Rogue River tributary	brook trout	1938	150
Round Lake–Gratten Twp.	bluegill	1933–35, 1937–38, 1940–41, 1943–44	29,610
	crayfish	1940	3,360
	largemouth bass	1933–34, 1937–45	9,072
	yellow perch	1935, 1939	15,975
Round Lake–Solon Twp.	bluegill	1934	300
	largemouth bass	1933	170
Round Lake (unspecified location)	rainbow trout	1951	5,000
Rum Creek	brook trout	1933–34, 1954–56, 1958–64	17,615
	brown trout	1933, 1940–42, 1944–56, 1958–64	49,025
	rainbow trout	1950, 1952–64	6,250
Sand Bottom Lake	yellow perch	1939	5,000
Sand Creek	brown trout	1970, 1972	3,500
Sand Creek tributary	brown trout	1971	4,527
Sand Lake	bluegill	1937	7,500
	largemouth bass	1937, 1939	1,950
	walleye	2001	450
Scalley Lake	bluegill	1933–35, 1937–38, 1940–41, 1943–44	29,110
	crayfish	1940	3,360
	largemouth bass	1933–34, 1937–45	7,797
	rainbow trout	1956, 1959–60, 1962, 1964–65	10,000
	yellow perch	1935, 1939	8,225

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Scarm Lake	yellow perch	1936	300
Schaaps Creek	brook trout	1941	1,200
Schaeffer Pond	bluegill	1951	100
	rainbow trout	1951	100
Scheltema Pond	bluegill	1951	50
	rainbow trout	1951	50
School Creek	brook trout	1933, 1938–39, 1943	6,500
Scotch Lake	lake whitefish	1879	60,000
Scram Lake	bluegill	1933, 1940–41, 1943–44	15,270
	brown trout	1968	2,000
	crayfish	1937, 1941	42,700
	largemouth bass	1933–34, 1938–39, 1941–42, 1944–45, 1965–66	9,930
	northern pike	1969	205
	rainbow trout	1965	17,000
	yellow perch	1935, 1938–39	15,663
Scum Lake	American eel	1883	6,000
Shaw Creek	brook trout	1933–34, 1936–42, 1944	12,188
Shugage Lake	bluegill	1933, 1938	4,000
	largemouth bass	1933, 1940–42, 1945	3,697
	yellow perch	1939	5,200
Silver Lake	bluegill	1934, 1937–38	14,220
	crayfish	1935, 1937	43,200
	lake whitefish	1874	5,000
	largemouth bass	1937–38	2,700
	smallmouth bass	(1935–39)	7,353
	walleye	1982–83, 1985–89, 1991	24,044
Slayton Lake	bluegill	1933–35, 1937–38, 1940–41, 1943–44	27,210
	crayfish	1940	3,360
	largemouth bass	1933–35, 1937–42, 1944–45	11,842
	smallmouth bass	1934, 1943	1,270
	yellow perch	1933, 1935, 1939	12,385
Snyder, C.H. Pond	black bass	1952	300
Soft Water Lake	Chinook salmon	1876	2,000
	crayfish	1937	21,875
	emerald shiner	1935	4,460
	lake whitefish	1874	3,000
South Branch Creek	brook trout	1884	12,000
Spring Brook	brook trout	1938–45, 1948–49, 1951	15,150
	brown trout	1943–44	19,000
Spring Creek	brook trout	1934, 1936	1,625
	brown trout	1934, 1940, 1945, 1947–48, 1974	32,627

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Spring Lake	bluegill	1974	22,285
	brook trout	1968	3,000
	brown trout	1974	1,627
	largemouth bass	1974	1,000
	rainbow trout	1969–72, 1974–77	18,364
Steam Mill Lake	bluegill	1934	880
	largemouth bass	1934–35	500
	yellow perch	1934	2,405
Steele Lake	bluegill	1933, 1935, 1938, 1940	6,960
	largemouth bass	1933, 1935, 1938, 1940, 1945	852
Stegman Creek	brook trout	1933–49, 1951, 1959	99,055
	brown trout	1933, 1935–36, 1942, 1945	7,525
	rainbow trout	1937–38, 1940–41, 1946, 1948–64	21,004
Stevenson Lake	lake whitefish	1874	5,000
Stocks Lake	lake trout	1879	3,000
Stoner Lake	walleye	1972	360,000
Stout Creek	brown trout	1946–47	7,500
Strawberry Creek	brook trout	1933–34, 1938–41, 1944–45, 1981	5,840
	brown trout	1966	300
Sugarbush Creek	brook trout	1941	100
Tek-e-nink Lake	bluegill	1938, 1940–41, 1944	15,670
	largemouth bass	1937, 1939–41, 1944–45	7,459
	smallmouth bass	1938	150
	yellow perch	1938–39	6,500
Thomas Lake	bluegill	1933, 1935, 1937–38, 1940	16,290
	bullheads	1941	1,650
	largemouth bass	1933–35, 1938, 1940–42	4,827
	yellow perch	1934–35, 1939	6,925
Thornapple River	bullheads	1940	975
	Chinook salmon	1975	101,238
	crayfish	1935, 1937, 1942	126,280
	largemouth bass	1938	2,088
	smallmouth bass	1935, 1938, 1940–44	15,284
	yellow perch	1935–36, 1942	755,175
Toohey Lake	bluegill	1945	1,500
	largemouth bass	1941, 1945	650
	rainbow trout	1954, 1959–61	2,250
Tower Lake	bluegill	1938	5,000
	largemouth bass	1939, 1941	500
Tyler Creek	brown trout	1971–75,1977, 1979–80, 1982–89, 1992–2006	62,742
	rainbow trout	2005	880
Unknown Stream	brook trout	1881–84	111,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Kent–continued			
Unnamed Pond– Oakfield Twp.	bluegill	1934	450
Upper Lake	bluegill	1941	600
	largemouth bass	1937, 1941–42, 1945	2,820
	yellow perch	1935, 1939	6,150
Versluis Lake	brown trout	1996	4,847
	rainbow trout	1980, 1982–95	71,579
	walleye	2004	600
	yellow perch	2004	600
Veteran's Facility Pond	black bass	1952	89
	black bullhead	1979	826
	largemouth bass	1979	412
Vieley Creek	brown trout	1944–45, 1947–48	21,000
Wabasis Creek	brown trout	1943	600
Wabasis Lake	bluegill	1933, 1935–38, 1940–42, 1944	64,950
	crayfish	1939–40	20,650
	emerald shiner	1938	480
	largemouth bass	1933, 1935, 1937–45	21,340
	northern pike	1972	2,500
	smallmouth bass	1934, 1938–41	10,024
	walleye	1987–90, 1992	113,736
	yellow perch	1935, 1937–39, 1941	355,000
Little Wabasis Lake	bluegill	1938, 1940–41	6,170
	crayfish	1940	2,800
	largemouth bass	1939–42	2,350
	yellow perch	1939, 1941	155,000
Walter Creek	brown trout	1974	500
Whipperwill Lake	bluegill	1940–41	5,650
	largemouth bass	1940	500
Whitneyville Creek	brook trout	1954–55	200
Woodbeck Lake	bluegill	1933, 1935, 1937–38, 1940	18,070
	largemouth bass	1933–35, 1938–42, 1945	4,941
	yellow perch	1935–35, 1939	10,475
York Creek	brook trout	1933, 1938–39, 1941	2,925
Ziegenfuss Lake	bluegill	1933–34, 1938, 1940	11,500
	largemouth bass	1933–34, 1938–42	3,107
Montcalm			
Bachman Creek	brook trout	1933, 1941	1,900
Baldwin Lake	bluegill	1934–37, 1939, 1941–42, 1944	30,485
	Lake whitefish	1874	5,000
	largemouth bass	(1933–37), 1939–42, 1944	3,945
	smallmouth bass	1940	4,200

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Baldwin Lake–continued	sunfish	1937	400
	yellow perch	1933–1935, 1939	19,795
Barnard Lake	bluegill	1938, 1940–42	9,850
	largemouth bass	1940–42	1,320
	sunfish	1939	180
	yellow perch	1936	1,750
Bass Lake - Belvidere Twp.	bluegill	1936, 1938, 1940–42	11,350
	largemouth bass	1936, 1939, 1941–42, 1945	1,565
	yellow perch	1936, 1939	4,750
Bass Lake–Cato Twp.	bluegill	1941–42	3,050
	largemouth bass	1941	500
Little Bass Lake–Belvidere Twp.	bluegill	1942, 1944	3,250
	largemouth bass	1942, 1944	450
Beardsley Lake	bluegill	1942	1,050
	largemouth bass	1942	110
Big Mud Lake–Evergreen Twp.	bluegill	1937	540
Big Penny Lake	bluegill	1934, 1937	4,850
	largemouth bass	1933–34	1,910
Burgess Lake	bluegill	1934–37, 1940–42	15,180
	bullheads	1939	360
	lake whitefish	1876	20,000
	largemouth bass	1933, 1941–42	780
	northern pike	1939	30
	yellow perch	1933	2,200
Camo Lake	bluegill	1939	7,500
Carson City Pond	black crappie	1972	33
	bluegill	1938, 1972, 1995	3,562
	channel catfish	1995	100
	fathead minnow	1995	6,000
	golden shiner	1972	41,040
	largemouth bass	1935, 1972	640
	muskellunge	1972	30,000
	pumpkinseed sunfish	1972	109
	yellow perch	1936, 1995	1,850
Carters Pond	bullheads	1937	500
Chapin Creek	brook trout	1933, 1944, 1946, 1948–56, 1958–64	8,240
Church Creek	brook trout	1971	2,000
Clear Lake	bluegill	1940–42, 1944	11,000
	lake whitefish	1874, 1976	10,000
	largemouth bass	1941–42	520

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Clifford Lake	bluegill	1933–34, 1936, 1938–42, 1944	48,542
	channel catfish	1995, 2000, 2005	9,715
	fathead minnow	1995	40,000
	largemouth bass	1933–38, 1940–42, 1944–45, 1975, 1979	21,140
	muskellunge	1976	500
	northern pike	1971–72	3,196
	sunfish	1939	102
	tiger muskellunge	1977–78	1,600
	walleye	1979–80, 1990, 1992–95, 2000–01, 2003–04, 2006	158,294
	yellow perch	1933–35, 1937, 1939	32,130
Coady Lake	bluegill	1933–38, 1940–42, 1944	21,663
	lake whitefish	1876	20,000
	largemouth bass	1933–34, 1936, 1939–40, 1942, 1944–45	6,512
	smallmouth bass	1941	400
	sunfish	1939	120
	yellow perch	1935–36, 1938–39	20,585
Colby Campground	brown trout	1977	150
Como Lake	bluegill	1941–42	5,050
	bullheads	1937	650
	largemouth bass	1941–42	310
	sunfish	1937	300
County Farm Lake	northern pike	1939	20
County Line Lake	bluegill	1937	360
Cowden Lake	bluegill	1933–38, 1940–42, 1944	26,853
	flathead catfish	1996	73
	lake whitefish	1876	10,000
	largemouth bass	1933–36, 1940–42, 1944–45, 1972	20,693
	northern pike	1972	3,500
	smallmouth bass	1942–43	1,760
	sunfish	1939	120
	yellow perch	1935–36, 1938–39	23,350
Cromo Lake	bluegill	1937	710
Crooked Lake	bluegill	1937, 1940–42, 1944	12,440
	largemouth bass	1934, 1941–42, 1944	2,150
	yellow perch	1939	5,000
Crystal Lake	American eel	1878	5,000
	bluegill	1936–41	39,060
	lake trout	1878	15,000
	lake whitefish	1876	20,000
	largemouth bass	1933–36, 1939–41	15,903
	smallmouth bass	1935, 1937–38, 1941	4,492

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Crystal Lake–continued	smelt	1970–71	22,600
	sunfish	1939	156
	walleye	1933–40,1970–71, 1978–80, 1982–83, 1985–86, 1988, 1990–92, 1994, 1998, 2000, 2003, 2005	5,500,293
	yellow perch	1934–35, 1937, 1939, 1941	550,775
Curtis Creek	brook trout	1933, 1938–41, 1946–56, 1958–1962	17,765
Derby Lake	bluegill	1936–38, 1940–42, 1944	20,120
	brown trout	1968	2,000
	bullheads	1939	600
	lake trout	1879, 1972	9,000
	lake whitefish	1876	10,000
	largemouth bass	1934–35, 1937, 1940–42, 1944	4,550
	rainbow trout	1945–48, 1950–55, 1959–60, 1969–80, 1982–95	209,001
	smallmouth bass	1941–43	2,360
	sunfish	1939	120
	yellow perch	1935, 1937, 1939	13,765
Dickerson Creek	brown trout	1968–69, 1975–77	59,200
Dickerson Lake	bluegill	1933–34, 1936–42, 1944	39,682
	largemouth bass	1933–37, 1941–42, 1944–45	12,410
	smallmouth bass	1937–38	3,860
	sunfish	1937, 1939	302
	yellow perch	1933–35, 1937, 1939	29,480
Duck Lake	bluegill	1934, 1937, 1939–41, 1945, 1959, 1962	84,522
	bullheads	1939	300
	grass pickerel	1944	100
	largemouth bass	1934–35, 1941, 1945, 1959	14,750
	northern pike	1959, 1962	103,100
	yellow perch	1934, 1939	7,000
Edwards Creek	brook trout	1937–41	5,000
Fatal Lake	bluegill	1941	3,000
	lake whitefish	1874	2,500
Ferguson Lake	bluegill	1941–42	3,050
	largemouth bass	1941	100
Fish Creek and tributaries	brook trout	1933–36, 1938, 1944–47, 1963–64, 1972	61,665
	brown trout	1933, 1950, 1952, 1955–66, 1968, 1972–80, 1983–2006	335,744
Fish Lake	bluegill	1940–42	7,800
	bullheads	1939	180
	largemouth bass	1940–42	720
	sunfish	1939	180

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Flat River	bluegill	1937	900
	bullheads	1937, 1939	7,765
	golden shiner	1937	500
	largemouth bass	1933	940
Grass Lake	bluegill	1940–42, 1944	11,650
	brown trout	1968	1,000
	bullheads	1939	180
	lake whitefish	1876	5,000
	largemouth bass	1941–42	420
	rainbow trout	1966–67	11,200
Half Moon Lake	bluegill	1937–42, 1944	19,374
	largemouth bass	1937, 1940–42, 1944	2,937
	rainbow trout	1947–48, 1950–52, 1960, 1984–89	19,500
	sunfish	1939	180
	yellow perch	1936, 1939	8,500
Hammels Lake	bluegill	1939	750
	bullheads	1939	90
	largemouth bass	1939	90
Hemmingway Lake	bluegill	1941–42, 1944	5,050
	largemouth bass	1941–42, 1944	430
Hisington lake	bluegill	1948	1,680
	largemouth bass	1948	1,000
Holland Lake	bluegill	1936–42, 1944	25,846
	lake trout	1879	3,000
	largemouth bass	1935–37, 1939–42, 1944	5,079
	sunfish	1939	120
	yellow perch	1935–39	25,530
Hooker Creek	brook trout	1941, 1944–54	23,230
	rainbow trout	1942–43	12,000
Horseshoe Lake	bluegill	1934–35, 1937, 1939–42, 1944–45	20,700
	lake whitefish	1874, 1876	10,000
	largemouth bass	1933–34, 1936, 1941–42, 1944–45	5,900
	rainbow trout	1945–48, 1950–52	14,000
	sunfish	1937, 1939	460
	walleye	1980–82	26,000
	yellow perch	1939	8,450
Hunter Lake	bluegill	1940–42	8,400
	brown trout	1968	2,000
	bullheads	1939	180
	largemouth bass	1941–42	520
	rainbow trout	1966–67	16,800
	sunfish	1939	180
	yellow perch	1939	3,000
Kirby Lake	bluegill	1937	5,100

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Lake Montcalm	bluegill	1934–37, 1940–42, 1944	27,000
	largemouth bass	1933–34, 1936, 1940–42, 1944–45	10,035
	smallmouth bass	1941–42	1,550
	sunfish	1937, 1939	460
	walleye	1934, 1935, 1937–40	2,460,000
Lake Montcalm	yellow perch	1938–39, 1941	318,850
Little Crystal Lake	bluegill	1934	2,400
Little Lake	bluegill	1977	225
	black crappie	1977	42
	largemouth bass	1977	8
Little Penny Lake	bluegill	1934, 1937	4,150
	largemouth bass	1933–34	1,440
	sunfish	1937	250
Logan Lake	bluegill	1942	1,050
	largemouth bass	1942	110
Loge Lake	bluegill	1944	1,050
	largemouth bass	1944	120
Long Lake–Pierson Twp.	bluegill	1940–42	7,050
	largemouth bass	1941–42	665
	sunfish	1939	180
	yellow perch	1939	5,000
Long Lake–Pine Twp.	bluegill	1939, 1942, 1944	6,600
	largemouth bass	1942	330
	sunfish	1939	282
Loon Lake–Evergreen Twp.	bluegill	1934, 1936, 1938, 1940–41	14,900
	largemouth bass	1936, 1941	1,840
	northern pike	1985	1,000
	yellow perch	1939	5,000
Loon Lake–Eureka Twp.	lake whitefish	1879	40,000
Manaka Lake	bluegill	1937	360
McBrides Lake	bluegill	1936, 1939–42, 1948	14,750
	bullheads	1939	600
	largemouth bass	1936, 1941, 1948	1,075
Middle Lake	bluegill	1937, 1960	2,708
	largemouth bass	1960	2,000
	rainbow trout	1960	300
Millmine Lake	bluegill	1942, 1944	2,100
	largemouth bass	1942, 1944	230
Mitchell Lake	bluegill	1936, 1941–42, 1944	6,800
	largemouth bass	1936, 1941–42	920
	yellow perch	1936	1,750

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Mud Lake–Crystal Twp.	bluegill	1940	3,000
	largemouth bass	1962	32,000
	northern pike	1962	10,000
Mud Lake–Douglas Twp.	bluegill	1935, 1941–42, 1944	6,100
	largemouth bass	1936, 1941–42, 1944	2,540
Mud Lake–Evergreen Twp.	bluegill	1939, 1940–42, 1944	12,150
	largemouth bass	1934, 1940–42, 1944	1,840
	northern pike	1962	30,000
	yellow perch	1936, 1939	8,500
Muskellunge Lake	bluegill	1933–38, 1940–42, 1944, 1969–70	105,320
	largemouth bass	1933–36, 1940–42, 1944–45, 1969–70, 1976	36,918
	northern pike	1971–72	4,375
	rainbow trout	1969–71	19,000
	sunfish	1937, 1939	1,050
	walleye	1970, 1990–93	175,485
	yellow perch	1933, 1935, 1939	24,185
Nelson Lake	bluegill	1936, 1945	3,000
	largemouth bass	1936, 1945	1,375
Nevins Lake	bluegill	1940–42, 1944	13,300
	brown trout	1968	1,000
	lake trout	1972	1,000
	largemouth bass	1937, 1941–42, 1944	3,940
	rainbow trout	1945–48, 1950–57, 1959–60, 1962–67, 1969, 1972–2006	222,692
Norton Creek	brook trout	1941–44	2,715
Norton Lake	bluegill	1941–42, 1944	8,000
	largemouth bass	1941, 1944	1,500
Little Norton Lake	bluegill	1941	2,000
	largemouth bass	1941	300
Pearl Lake	bluegill	1935, 1938, 1940–42, 1944	23,350
	largemouth bass	1935–37, 1939–42, 1944	3,145
	sunfish	1939	120
	yellow perch	1935–36, 1939	9,225
Penny Lake	bluegill	1935–36, 1940–42, 1944	16,100
	largemouth bass	1936, 1941–42, 1944–45	2,435
	sunfish	1939	120
	yellow perch	1939	3,600
Little Penny Lake	bluegill	1935, 1940–42, 1944	9,800
	largemouth bass	1941–42, 1944–45	920
	sunfish	1939	120
	yellow perch	1939	3,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Perch Lake	bluegill	1940	3,000
	largemouth bass	1933–35	1,950
Pickerel Lake	bluegill	1939, 1941–42	5,250
	bullheads	1939	90
	lake whitefish	1874	3,000
	largemouth bass	1941–42	750
Prairie Creek	brook trout	1933	500
	brown trout	1966–69, 1975–79, 1982–87, 1989–2006	113,798
	rainbow trout	1975	30,000
Race Lake	bluegill	1939, 1941–42, 1944	8,050
	bullheads	1939	186
	largemouth bass	1941–42	420
Rainbow Lake	bluegill	1933–38, 1940–41, 1959	39,338
	channel catfish	1988, 1991–92, 1996	7,600
	largemouth bass	1933–36, 1941, 1944–45, 1959, 1961–62	22,379
	northern pike	1960, 1962–63	7,730
	rainbow trout	1960	2,000
	redear sunfish	1991–93	86,910
	yellow perch	1933, 1935, 1939, 1988	19,185
Rosa Lake	bluegill	1938–42, 1944	14,800
	largemouth bass	1935, 1939, 1941–42, 1944	1,795
	yellow perch	1935–36, 1939	8,225
Round Lake–Pierson Twp.	bluegill	1934, 1938, 1941–42, 1944	11,100
	largemouth bass	1941–42, 1944–45	1,720
	yellow perch	1939	5,000
Salt Marsh Creek	brook trout	1933, 1937–38	6,400
Sand Lake	bluegill	1933–34, 1938, 1940–42, 1944	28,600
	bullheads	1941	1,200
	largemouth bass	1933, 1941–42, 1944–45	5,352
	smallmouth bass	1949	1,000
	yellow perch	1935, 1937	11,675
Sanderson Lake	bluegill	1939–42	15,500
	largemouth bass	1941–42	620
	northern pike	1939	90
Sawdust (Round) Lake	bluegill	1940–42, 1944, 1959	10,500
	largemouth bass	1941–42, 1944, 1959	2,140
	rainbow trout	1960	200
	yellow perch	1939	3,000
Six Lakes Chain	bluegill	1937–38, 1941–42, 1944	42,600
	largemouth bass	1934, 1936, 1940–42, 1944–45	15,170
	sunfish	1939	420

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
First Lake	largemouth bass	1933	940
	walleye	1980	9,000
	yellow perch	1939	3,000
Second Lake	largemouth bass	1933	940
	walleye	1980	8,000
	yellow perch	1939	4,000
Third Lake	largemouth bass	1933	940
	walleye	1980	8,000
	yellow perch	1939	5,000
Fourth Lake	bluegill	1940	3,000
	walleye	1980	8,000
	yellow perch	1939	3,000
Fifth Lake	largemouth bass	1933	940
	walleye	1980	8,000
	yellow perch	1939	3,000
Sixth Lake	largemouth bass	1933	940
	walleye	1980	9,000
	yellow perch	1939	2,000
Small (No Name) Lake	largemouth bass	1965	1,000
Smokey Run	brook trout	1933	2,000
Snaky Run	brook trout	1938–40, 1942, 1952–56, 1958–64	15,035
Snow Lake	bluegill	1937, 1939–42, 1944	19,200
	bullheads	1939	96
	largemouth bass	1935, 1939, 1941–42	1,610
	yellow perch	1936, 1938–39	11,600
Spring Lake	bluegill	1935	4,000
Spruce Lake	bluegill	1942	1,050
	largemouth bass	1934, 1936, 1942	1,210
Sucker Creek	brook trout	1933	1,500
Tacoma Lake	brown trout	1968	500
	rainbow trout	1966–67	14,700
Townline Lake	bluegill	1933–34, 1936, 1938, 1940–41, 1944	31,350
	catfish	1970	30,000
	channel catfish	1988–90, 1995	60,727
	crayfish	1943	7,650
	lake whitefish	1876	20,000
	largemouth bass	1933–34, 1936, 1940–42, 1945, 1970–71	51,161
	northern pike	1961, 1971–74, 1977, 1979–86, 1988–2006	748,402
	smallmouth bass	(1935–39), 1941–43	8,225
	walleye	1982–83	20,000
	yellow perch	1935–36, 1939, 1941	336,445

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Montcalm–continued			
Triangle Lake	brown trout	1968	800
	rainbow trout	1966–67, 1969	7,000
Turk Lake Creek	brook trout	1933	1,000
Turk Lake	brook trout	1938–41	7,600
	bluegill	1934–41	30,360
	bullheads	1939	360
	largemouth bass	1933–39, 1941–42, 1944, 1956	11,595
	northern pike	1939, 1957	180
	sunfish	1939	192
	yellow perch	1933–39	40,175
Twin Stone Lakes	bluegill	1939–41, 1944	6,884
	sunfish	1939	186
West Branch Creek	brook trout	1933, 1936, 1938–39, 1941	7,850
	brown trout	1938, 1940, 1950, 1952, 1955–60, 1962–64	10,700
	rainbow trout	1937–40, 1942–44, 1946–64	34,804
West Lake	bluegill	1933, 1935–42, 1944	33,633
	brown trout	1968	1,500
	largemouth bass	1933–34, 1936, 1941–42, 1944–45	9,695
	rainbow trout	1966	10,400
	sunfish	1939	282
	yellow perch	(1933–39)	15,550
Newaygo			
Bills Lake	bluegill	1933, 1936–39	41,475
	brook trout	1950, 1952–56	19,538
	crayfish	1937	14,550
	largemouth bass	1936, 1938, 1944	14,100
	rainbow trout	1950, 1957–58, 1960–64, 1968–75, 1981–84	324,060
	smallmouth bass	1938–43	9,460
	splake	1965–66	30,000
	walleye	1934, 1942, 1984, 1986–88, 1990–93, 1995, 1997–98, (2000–05)	452,891
	yellow perch	1936	20,000
Ransom Lake	bluegill	1987	200
	channel catfish	1987–88	1,998
	northern pike	1987–88, 1990–91	3,250
	rainbow trout	1987–88	2,400
	smallmouth bass	1948–49, 1987	4,811
Rogue River	brown trout	1974	9,742
	rainbow trout	1974	3,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Lower–continued			
Ottawa			
Cranberry Lake	bluegill	1938	12,500
	brook trout	1939	11,125
	brown trout	1939	1,950
	largemouth bass	1938	548
	yellow perch	1941	500,000
Fennessy Lake	bluegill	1933, 1937–38, 1940, 1943, 1945, 1983	12,770
	brook trout	1939	920
	brown trout	1939	1,000
	largemouth bass	1933, 1936–37, 1940–41, 1943, 1945, 1951, 1983–84	4,420
	smallmouth bass	1938, 1942	550
	walleye	1983	600,000
	yellow perch	1933, 1937	3,000
Grand River	brook trout	1939	4,250
	crayfish	1935, 1937	81,400
	largemouth bass	1938	1,200
	smallmouth bass	1934–35, 1937–38, 1940, 1943	22,106
Jackobenia Lake	hybrid sunfish	1969	4,000
	rainbow trout	1967–68	600
Nelson Pond	rainbow trout	1971	150
Sand Creek and tributaries	brook trout	1960	100
	brown trout	1970–72	34,009
	rainbow trout	1959, 1970–71, 1974	225,946
	smallmouth bass	1943	270
Lower			
Shiawassee			
Spring Brook Creek	brook trout	1948–64	4,550
	rainbow trout	1952	300
Mouth			
Muskegon			
Crockery Creek	brook trout	1933, 1982, 1991, 1995–97, 2003–05	14,652
	brown trout	1936, 1971–2006	358,355
	steelhead	1971, 1973–74, 1977–78, 1979–2006	665,961
	smallmouth bass	1984	3,000
Crockery Creek tributary	brook trout	1982	1,000
	brown trout	1979–80, 1982–2006	13,232
Half Moon Lake	bluegill	1934, 1938	6,500
	brown trout	1968	1,000
	crayfish	1937	56,000
	lake whitefish	1874	5,000

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Mouth–continued			
Muskegon–continued			
Half Moon Lake–continued	rainbow trout	1955–58, 1960–65, 1969–2006	291,835
	smallmouth bass	1937–41	8,166
	walleye	1933–35	1,074
	yellow perch	1938–39, 1941	260,400
Norris Creek	brown trout	1938–40, 1942, 1959–64, 1966, 1968, 1970–77, 1993–98	103,692
North Branch Crockery Creek	brown trout	1971, 1977–78, 1979–80, 1982–2003	12,215
Ovidhall Lake	lake whitefish	1874	3,000
Rio Grande Creek	brown trout	2004–06	2,410
Newaygo			
Crockery Creek	brook trout	1880	1,200
	brown trout	1971, 1977, 1979–1999	37,340
Ottawa			
Bass River and bayous	brown trout	1943–44	825
	yellow perch	1941–42	2,500,000
Biderman (Biederman) Creek	brook trout	1933–34	800
Bignell Creek	brook trout	1933–34, 1943–45	13,310
Bruce's Bayou	bluegill	1940	3,900
	brook trout	1939	5,000
	crayfish	1937, 1940	24,100
	smallmouth bass	1937	800
	walleye	1933, 1937	445,000
Clarks Channel	walleye	1938–40	575,000
Crockery Lake	bluegill	1936–38, 1940–41	29,475
	brook trout	1939	1,500
	brown trout	1939, 1971–74, 1977–78, 1985	46,435
	hybrid sunfish	1971–73	124,124
	largemouth bass	1933, 1936, 1940–41, 1944, 1971, 1973	43,094
	rainbow trout	1971–75	43,204
	smallmouth bass	1937–38, 1940	2,100
	walleye	1972, 1983–86, 1988, 1990–93, 1995, 1997–98, 2000, 2003, 2005	375,485
	yellow perch	1941	500,000
Crockery Lake outlet	brown trout	1979–80, 1982–84, 1986–2000	3,809
Dermo Bayou	smallmouth bass	1940	1,000
Eastmanville Bayou	yellow perch	1941–42	1,000,000
Grand River	American eel	1878	5,000
	bluegill	1934, 1992	3,500
	brook trout	1939, 1942	254,250

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Mouth–continued			
Ottawa–continued			
Grand River–continued	brown trout	1975, 1979, 1983, 2003–06	95,850
	Chinook salmon	1970, 1972–73, 1976, 1978, 1984–2006	5,574,635
	crayfish	1935, 1937	91,900
	lake trout	1981–85	315,300
	largemouth bass	1938	1,200
	rainbow trout	1984, 1989–90	33,749
	smallmouth bass	1933–35, 1937–38, 1940–41, 1943	35,831
	walleye	1935–36, 1981–82, 1985–90	7,110,222
	yellow perch	1934, 1942	255,500
Lloyd Bayou	bluegill	1938, 1940	40,850
	brook trout	1939	800
	brown trout	1939	15,000
	crayfish	1940	6,600
	rainbow trout	1939	11,000
	smallmouth bass	1934, 1938, 1940	5,800
	walleye	1933, 1937–40	1,085,000
Mastenbrook Creek	brook trout	1943–45	12,200
Mierhauser (Meyerhouser) Creek	brook trout	1943–45	4,350
Millhouse Bayou	largemouth bass	1936	2,125
	smallmouth bass	1937	325
	walleye	1933, 1935	220,000
	yellow perch	1933	2,970
North Branch Crockery Creek	brown trout	1975–80, 1982–2006	80,178
Pettys Bayou	bluegill	1940	3,900
	brook trout	1939	2,250
	brown trout	1939	20,000
	crayfish	1940	6,600
	largemouth bass	1941	400
	smallmouth bass	1934, 1941	5,800
	walleye	1938–40	675,000
	yellow perch	1933, 1941	502,970
Pottawattomie Bayou	bluegill	1940	3,900
	brown trout	1939	10,000
	crayfish	1940	4,200
	smallmouth bass	1933, 1941	1,825
	walleye	1933, 1935	530,000
	yellow perch	1933	2,970
Presley Creek	brook trout	1933, 1946	675
Richardson Creek	brook trout	1933–34, 1943–64	14,680

Table 39.–Continued.

Segment County Water body	Species	Years	Number stocked in period
Mouth–continued			
Ottawa–continued			
Smith Bayou	bluegill	1940	3,900
	crayfish	1940	6,600
	walleye	1938–40	575,000
	yellow perch	1938, 1941	500,100
Spring Lake	American eel	1883	6,000
	bluegill	1936–38	56,000
	brown trout	1939	20,000
	smallmouth bass	1933, 1935–36, 1941	8,850
	walleye	1933, 1935	510,000
	yellow perch	1933	6,050
Stearns Bayou	bluegill	1936–38, 1940–41	21,265
	brown trout	1939	15,000
	largemouth bass	1937, 1940–41	900
	muskellunge	1966	933
	smallmouth bass	1933	600
	walleye	1933, 1937	3,770
Stearns Creek	brook trout	1943–45, 1950–64	23,135
The Sag	smallmouth bass	1941	1,125
Wesley Creek	brook trout	1943–45	8,335

Table 40.–Organizations with interest in the Grand River watershed.

Organization name
Audubon Society of Michigan
American Fisheries Society-Michigan Chapter
Annis Water Resources Institute
Association of State Floodplain Managers – Region 5
Barry Conservation District
Bear Creek Watershed Council
Clinton Conservation District
Coalition for the Preservation of the Grand River
Coldwater River Watershed Council
Dahlem Environmental Education Center
Ducks Unlimited – Great Lakes/Atlantic Region
Eaton Conservation District
Friends of the Looking Glass River
Friends of the Maple River
Gratiot Conservation District
Grand River Environmental Action Team
Grand Valley State University Water Resources Institute
Great Lakes Commission
Great Lakes Fishery Commission
Greater Lansing Groundwater Management Board
Greater Lansing Regional Committee
Impression 5 Science Center
Ingham Conservation District
Ionia Conservation District
Izaak Walton League – Michigan Division
Jackson Conservation District
Jackson County Watershed
Kalamazoo Valley Chapter of Trout Unlimited
Kent Conservation District
Land Conservancy of West Michigan
Lansing "Perrin" Chapter of Trout Unlimited
Lansing Oar and Paddle Club
Livingston Conservation District
Lower Grand River Organization of Watersheds
Mecosta Conservation District
Michigan Association of Conservation District
Michigan Clean Water Action
Michigan Duck Hunters Association
Michigan Environmental Council
Michigan Lakes and Streams Association
Michigan Nature Associaton
Michigan Sea Grant – Southwest District Extension
Michigan State University Extension
Michigan State University Watershed Action Through Education and Research
Michigan Steelhead and Salmon Fisherman's Association
Michigan United Conservation Club Districts 2, 3, 5, 6, 7, 11, and 12
Mid-Michigan Land Conservancy
Middle Grand River Organization of Watersheds

Table 40.–Continued.

Organization name
Montcalm Conservation District
Muskegon Conservation District
National Wildlife Federation
Natural Areas Conservancy of Western Michigan
Newaygo Conservation District
Ottawa Conservation District
Pheasants Forever
Pierce Cedar Creek Institute
Potawatomi Resource Conservation and Development Council
Quiet Water Society
Rogue River Watershed Council
Saginaw Bay Resource Conservation and Development Council
Shiawassee Conservation District
Southeast Michigan Resource Conservation and Development Council
Southwest Michigan Land Conservancy
Student Stream Teams of Kent County
The Wildlife Society – Michigan Chapter
Thornapple River Watershed Council
Timberland Resource Conservation and Development Council
Trout Unlimited
Upper Grand River Watershed Alliance
Verlen Kruger Memorial
Washtenaw Conservation District
West Michigan "Schremms" Chapter of Trout Unlimited
West Michigan Environmental Action Council
West Michigan Walleye Club
Woldumar Nature Center

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