Michigan Department of Environmental Quality

Water Division

August 2003

Total Maximum Daily Load for Biota for Black Creek Muskegon County, Michigan

INTRODUCTION

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

PROBLEM STATEMENT

The TMDL reach of Black Creek, a coldwater designated water body, is located in Muskegon County and extends from Mona Lake upstream to its headwaters in the vicinity of the Muskegon County Wastewater Management System Metro Wastewater Treatment Facility (Muskegon County WWMS) (Figure 1). The impaired designated uses (Michigan's WQS Rule 100) include the lack (absence of trout) of support of coldwater fish. This condition served as the basis for placing Black Creek on Michigan's Section 303(d) list of impaired water bodies requiring the development of a TMDL. The TMDL reach is about 13 miles in length and is identified in the Section 303(d) report (Creal and Wuycheck, 2002) as follows:

BLACK CREEK WBID# **082701J**

County: MUSKEGON HUC: 04060101 Size: 13 M

Location: Tributary to Mona Lake.

Problem: **FCA-PCBs; Fish community rated poor.**

TMDL YEAR(s): 2010 2003 RF3RchID: 4060101 14

This document represents the basis for the development of a biota TMDL that focuses on the restoration of the coldwater designated fish communities of the 13-mile impaired reach to meet Michigan's WQS. The presence of a poor rated fish community (absence of trout) and insufficient numbers of individual fish in the TMDL reach was the basis for including Black Creek on Michigan's Year 2002 Clean Water Act Section 303(d) list of impaired water bodies requiring

the development of a TMDL in 2003. In addition, a TMDL for polychlorinated biphenyls (PCBs) is scheduled to be developed by 2010 for Mona Lake, which will address Black Creek for PCBs as well. Available water and sediment data indicate the absence (less than levels of detection) of PCBs in Black Creek.

Black Creek is a designated coldwater stream located in Muskegon County and within the Southern Michigan Northern Indiana Till Plain ecoregion. Stream temperatures measured during the 1991, 1996, and 2001 (Wuycheck, 2003; Walker, 2000; Walker, 2002) surveys all indicate that Black Creek summer stream temperatures ($\leq$ 68°F) are adequate to support a brown trout population.

The stream is the major tributary to Mona Lake, a drowned river mouth lake tributary to Lake Michigan. The 49 square mile (31,134 acre) Black Creek Watershed is dominated by sandy soils with substantial growths of hardwood forest and wooded wetland along the stream's riparian zone (Denning, 2003 – personal communication). The hydrology of the headwaters of Black Creek are substantially altered by extensive dredging and channelization performed to facilitate agricultural land-use development of the available fertile muck soils of what once were shrub swamps and emergent wetlands. Also, construction of the Muskegon County WWMS in the headwaters area in the early to mid-1970s has also contributed to a modified hydrology in the headwaters of Black Creek. This land application, wastewater treatment, and under drainage collection system occupies a 20 square mile area that includes two 850 storage lagoons and over 7,500 acres of land application sites to treat domestic and industrial wastewater via spray irrigation onto crop production sites and collection and discharge of under drainage. Interconnecting collection ditches within the 20 square mile area of the facility convey under drainage (final effluent) from the land application sites to either the headwaters of Black Creek or the Muskegon River at discharge design flows of 4.2 and 43.0 million gallons per day (mgd), respectively. The Muskegon County Wastewater Management System's (WWMS) Outfall 002 pump station discharges to Black Creek via the Muskegon Newaygo Drain (Big Drain) at Ensley Road just north of Laketon Road. Black Creek at this point has a 95% exceedance flow of 0 cubic feet per second (cfs). Some of the under drainage from the Muskegon County WWMS site also discharges to Black Creek via Cranberry Creek and Hall Drain. During the winter (non-spray irrigation season), the storage lagoons seep into interception ditches that transport the water to rapid infiltration basins treated with ferric chloride before discharge (Berdinski, 2003 – personal communication). The resulting discharge to Black Creek is 2 to 4 mgd. The Muskegon County WWMS currently meets the National Pollutant Discharge Elimination System (NPDES) permit effluent limits that are designed to protect Black Creek's coldwater designation.

Substantial residential and business development has occurred in the lower portion of the Black Creek Watershed, as indicated by the presence of a large number of municipal storm sewers that discharge to Black Creek and Kruis Drain (tributary to Black Creek) (Figure 2 and Table 2).

Black Creek is not actively managed as a trout stream by the Michigan Department of Natural Resources (MDNR), Fisheries Division. Harrington (2003 - personal communication) indicates that Black Creek is not managed by the Fisheries Division because of the elevated deposits of sand throughout the stream that displaces and covers desired substrates and overall habitat. Cranberry Creek and Kruis Drain are the only major feeder streams to Black Creek. They are also dominated with sand substrate and lack suitable spawning substrates (clean gravel beds) that are crucial to a successful reproductive cycle of trout.

Black Creek has historically been noted to support its coldwater designated use through the presence of trout populations (Willson, 1968; Doyle, 1967). Harrington (2003 - personal

communication) indicated that brook trout and brown trout were stocked in Black Creek between 1936 and 1944. In conjunction with the MDNR, Fisheries Division's intent to stock trout in Black Creek, Wuycheck (1986) conducted a pre-fish (trout) stocking survey of Black Creek in March 1986 to characterize the fish community. Three locations were assessed. Only one lake-run rainbow trout was collected from the Black Creek Road site just upstream from Mona Lake. No other trout or salmonid species were present upstream at Broadway Avenue and Wolf Lake Road sites. Sculpins (representative of a coldwater stream fish species) were relatively abundant at each site but overall numbers of fish collected at each site was less than 50 indicating an impaired fishery. The MDNR Fisheries Division staff subsequently rotenoned the stream in 1987, collecting one brown trout in the process. The stream was then stocked with brook trout from 1987 through 1989, but again stocking was discontinued since all indications were that a self-sustaining (reproducing) trout fishery was not being established based on a declining trout population. Also, the site is not a stocking priority since there is a lack of safe public access sites or parks on the stream.

In June 1991, Wuycheck (2003) conducted fish community assessments at seven sites in the Black Creek Watershed including Cranberry Creek. Results once again indicated the absence of trout at all seven sites and fewer than 50 fish were collected at six of these sites assessed on Black Creek proper. Cranberry Creek contained adequate numbers of fish (121), few taxa (3), and no trout. In the absence of trout, all seven sites were rated poor since the coldwater designated use was not being supported. Walker (2000) was able to collect more than 50 fish at Mill Iron Road and Wolf Lake Road, but no trout were found during the August 1996 survey of Black Creek. Therefore, WQS were not attained. Of the habitat surveys conducted in 1991, 1996, and 2001, no spawning gravel deposits were observed within Black Creek and Cranberry Creek that would facilitate trout spawning and successful eye-up/swim-up of trout young-of-the-year. Macroinvertebrate communities assessed by Wuycheck in 1991 (2003), Walker in 1996 (2000), and Walker in 2001 (2002), continue to demonstrate acceptable to excellent macroinvertebrate communities throughout Black Creek, although they were limited to the few microhabitat areas not impaired by sand deposits. Exposed woody debris is representative of available microhabitat in Black Creek that when present, provides colonizable habitat. Even though the macroinvertebrate community is rated as acceptable to excellent, supportive habitat is minimized by substantial sand deposits, sometimes one to four feet in depth.

Habitat quality of Black Creek was evaluated in 1991, 1996, and 2001 at seven, three, and six stations, respectively, and all sites were impaired by substantial bed loads of sand that obscured important habitat sites, such as deadfalls, clumps of woody debris, cobble, and gravels (Wuycheck, 2003; Walker, 2000; Walker; 2002). Expectations are that with continued, excessive runoff/washoff solids and hydrologic loadings, sediments will continue to impair Black Creek's biological community and not support its coldwater fish and other aquatic life designated uses. Reductions in runoff rates and solids loads from both controllable industrial and municipal storm water runoff sites in the lower reach, along with reduced loads from agricultural sources in the upper reach, are necessary to reduce impacts on the aquatic life and restore WQS support.

Stream temperatures measured during the 1991, 1996, and 2001 (Wuycheck, 2003; Walker, 2000; and Walker, 2002) stream surveys all indicate that Black Creek summer stream temperatures ($\leq$ 68°F) are adequate to support a brown trout population.

Therefore, a review of the overall available data indicates that the primary stressor causing a poor fish community and nonattainment of its coldwater designation is excessive sand bed load in the channel.

NUMERIC TARGETS

Black Creek is classified as having impaired water quality since it does not support its coldwater designated use characterized by the presence of a trout population. Michigan's WQS require, as a minimum, the protection of a variety of designated uses, including coldwater fisheries (Rule 100). The fish community of Black Creek is impacted due to the loss of suitable habitat resulting from excessive sand deposition. Achievement of WQS for the coldwater designated use is to be demonstrated via assessments of the integrity of the fish community and habitat quality.

The development of this biota TMDL included the review of the following documents (year of assessment and publication date) used to define necessary targets: 1967 (Willson, 1968); 1970 (MWRC, 1970); 1975 (Jackson, 1975); 1978 (Evans, 1979); 1980 (Evans, 1980); 1986 (Wuycheck, 1986); 1991 (Wuycheck, 2003); 1996 (Walker, 2000); and 2001 (Walker, 2002).

Evans (1979) noted in 1978, that un-permitted discharges from the Muskegon County WWMS Metro Sullivan Pump station to Hall Drain resulted in a two-mile reach of Black Creek that was degraded because of elevated water temperatures, nutrient enrichment, and nuisance algal growths.

Two CERCLA superfund sites with contaminated (volatile organic compounds (VOCs)) groundwater capture and treatment facilities (Bofors-Nobel, Inc. [previously Lakeway Chemical] and Thermo-Chem, Inc.) adjacent to the stream are located between Wolf Lake Road and Mill Iron Road (Figure 2). Prior to the installation of groundwater capture and treatment systems in 1976, contaminated water seepages to Black Creek caused degradation in at least 3.3 miles of stream (MWRC, 1970). Jackson (1977) found no significant improvement in the biological community and physical habitat during a stream assessment in July 1975. Recent remedial actions at these two sites consist of VOC contaminated groundwater capture and treatment prior to discharge to Black Creek (Wagaw, 2003 - personal communication). Wagaw reports that the Bofors-Nobel, Inc. system is in compliance with permit requirements, whereas, modeling of the contaminated groundwater capture and extraction system at Thermo-Chem, Inc. indicates probable exceedances of VOCs in the Black Creek floodplain. The Michigan Department of Environmental Quality (MDEQ) continues to work with the USEPA and Thermo-Chem, Inc., to assure complete capture and treatment of the contaminated plume thereby preventing contaminated groundwater venting to Black Creek that contain VOCs at concentrations that exceed WQS.

The recent stream surveys indicate that pollutant control measures by the Muskegon County WWMS and the groundwater cleanup efforts at the two superfund sites have substantially minimized and eliminated observable impacts from pollutant loads to Black Creek. The MDEQ's Remediation and Redevelopment Division continues to work with the USEPA and companies to assure the effectiveness of these two USEPA supervised treatment sites in capturing and effectively treating the contaminated groundwater to meet WQS. The 95% exceedances flows for Black Creek at these two locations based on watersheds of 34 and 38 square miles, respectively, result in monthly average stream flows 12 to 38 cfs and 14 to 42 cfs (Lesmez, 2003).

Further, analytical results of water samples collected in June 1991, from six locations throughout the Black Creek Watershed, each analyzed for 45 organic compounds, indicated concentrations in all samples were less than their respective levels of detection (Wuycheck, 2003). Follow-up water chemistry assessments in August 1996 (three sites) and August 2001 (five sites) indicated that some metal, nutrient, and organic parameters, even though detected,

were all well below WQS criteria (Walker, 2000; Walker, 2002). The year 2002 permit application submitted by the Muskegon County WWMS also indicated compliance with their NPDES permit (Muskegon County NPDES Permit Application, 2002).

During stream surveys, MDEQ staff conducted sediment deposit sampling by collecting fine sediments (minimizing sand) from depositional zones or eddies in order to characterize worst-case concentrations in the stream environment. Sediment chemical analytical results from the June 1991 survey (Wuycheck, 2003) showed that concentrations of none of the 31 organic compound parameters analyzed exceeded their respective analytical level of detection. Chromium, copper, nickel, and zinc concentrations at the sediment samples collected from all six locations exceeded statewide average background concentrations (Gerard and Jones, 1999) but were substantially lower than probable effects levels (MacDonald, et. al., 2000) used by MDEQ staff to evaluate potential sediment toxicity effects to the biological community. Follow-up sediment chemistry assessments in August 1996 (three sites) and August 2001 (three sites) indicated a substantial increase in sediment lead concentration (from 11 and 15 milligrams per kilogram (mg/kg) to 110 mg/kg) at Black Creek Road during the three survey dates (Walker, 2000; Walker, 2002, respectively). Otherwise, sediment concentrations of the various inorganic parameters and organic compounds during both the August 1996 and August 2001 assessments were not at sufficient concentrations to impair the biological community when compared to probable effect levels.

Therefore, the primary numeric targets involve the use of Michigan's biological community and habitat quality assessment Procedure #51 (MDEQ, 2002). The biota TMDL target is to achieve a fish community containing trout that represent a minimum of 1% of the number of fish collected (>50, and typically 100 or more). The presence of trout will be evaluated based on a minimum of two Procedure #51 fish community assessments conducted in consecutive years, following the implementation of Best Management Practices (BMPs) and other control measures to minimize sediment loads, improve spawning areas for trout in the subject TMDL reach, and trout stocking.

Procedure #51's stream habitat quality assessment evaluation metrics have been updated and will also be used (MDEQ, 2002). Prior to the revision, a minimum habitat quality score of 65 (approaching the upper end of the fair habitat score range of 35 to 70) was established as the minimum target for the habitat quality at all locations assessed. The habitat assessment target score of 65 was used to represent adequate control of anthropogenic sediment sources, so as to improve habitat quality and the biological community. This level of conservation is appropriately high enough to minimize both temporal and spatial variability within the watershed and buffer variability within the biological community and habitat assessment protocol. The habitat assessment score of 96 of the most recent Procedure #51 habitat assessment procedure proportionately equates to the score of 65 of the previous assessment procedure. Therefore, a habitat target score of 96 (approaches the upper range of the marginal score range of 56 to 104, which equates to the 35 to 70 point score of the previous habitat rating system) or greater will also be used to demonstrate acceptable stream quality conditions. To further demonstrate improvement in habitat quality, specific metrics will be evaluated to determine if a sufficient reduction in sedimentation has occurred. These Procedure #51 habitat quality metrics are *Substrate and Available Cover*; *Embeddedness* and *Bottom Deposition, and/or Pool/Riffle Complexes*. Greater scores will indicate reduced total suspended solids (TSS) loads, reduced deposition, and improved habitat quality.

A secondary numeric target is for TSS, which will be used to further assess improvements in Black Creek. The secondary target goal is represented by a mean annual, in-stream TSS

concentration of 80 milligrams per liter (mg/l) to characterize wet-weather runoff/washoff events. This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated. Achievement of the secondary numeric target will help guide proper control over NPS of excessive TSS loads from runoff, as well as the runoff discharge rates and instantaneous runoff volumes that affect increased stream flow instability, stream bank erosion, and increased TSS concentrations.

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

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

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

Since the TMDL purpose is to restore the biological community to an acceptable condition and attain WQS, a value of 80 mg/l, as an in-stream mean annual TSS target for wet-weather runoff/washoff events was chosen for Black Creek.

Overall, the secondary target of 80 mg/l TSS is intended to evaluate solids loading affects and assist in orienting and focusing corrective actions for source reductions. Additional TSS targets, based on flow related considerations, may be developed as additional data on Black Creek becomes available.

SOURCE ASSESSMENT

From the Mona Lake confluence upstream, land use (as acres) in the Black Creek Watershed is dominated by forestland (43%), agriculture (23%), and (14%) residential development (Table 3). Substantial channelization and alteration of the streams in the upper watershed has occurred to facilitate runoff from agricultural land uses, as well as the groundwater drainage from the Muskegon County WWMS spray irrigation and under drainage site encompassing at least a 20 square mile area. Such development within a watershed alters its hydrologic characteristics because drainage and runoff/washoff from the increased areas of agricultural and wastewater spray-irrigation land use are commonly directed to streams within the watershed. Agricultural land-use was estimated to contribute substantial TSS loads to the upper watershed based on an average runoff concentration of 145 mg/l. Urbanization and build up of the lower reach of Black Creek also alters the hydrologic characteristics and TSS loads because of increased runoff/washoff from increased impervious surface areas that are directed to the stream via

storm sewers. Typically, such development and associated land use modification practices increase rapid precipitation runoff/ washoff of suspended solids and contaminant loads to the receiving waters (Fonger and Fulcher, 2001). Substantial reductions in vegetative riparian zones and pervious areas, especially in the lower watershed of Black Creek and the increasing use of structural features, including paved impervious surface areas (e.g., roads and parking lots), curb and gutter, and numerous direct storm sewer discharges, dominate portions of the landscape and contribute to rapid precipitation runoff rates to Black Creek. This condition fosters stream bank erosion, unstable flow conditions, and sedimentation of desirable habitat in Black Creek. Therefore, the sources of sediment loads to Black Creek are, in part, attributable to storm water runoff/washoff from impervious surfaces associated with the urban, residential, industrial, and commercial sites in the watershed.

Five point source facilities discharge treated effluent to Black Creek. The Muskegon County WWMS has an individual NPDES permit; the Marathon Oil Company and a MDEQ-Environmental Response Division (ERD) Cloverville Pump facility have general NPDES permits; and the two chemical facilities have substantive requirement documents (SRDs), since they are overseen as USEPA Superfund sites (Table 1 and Figure 2). All three facilities discharge treated groundwater to Black Creek. Other defined sources, including one NPDES permitted industrial storm water permit (Bekaert Corporation) and 39 (municipal, township, road commission, county drain commission, and/or private) Phase II – MS4 program storm water runoff sites discharge to Black Creek during wet-weather events (Tables 1 and 2; Figure 2).

A TSS permit compliance limit of 25 mg/l (maximum monthly average) applies to the Muskegon County WWMS, but there are no specific TSS limits that apply to the two general permitted facilities or the two Superfund facility discharges to Black Creek. Based on a combined maximum daily design discharge total of about 6.2 mgd, or an annual discharge of 2263 million gallons for these five facilities (Table 1), a worst-case estimate of the point source TSS load to Black Creek was made assuming a TSS maximum monthly average concentration of 25 mg/l which is the same as the Muskegon County WWMS limit. The estimated total daily load from five permitted point source facilities (individual, general and Superfund sites) is 1299 pounds or 474,095 pounds annually.

The Black Creek Watershed is about 31,134 acres (49 square miles). Approximately 90% of the watershed's acreage consists of the following largest land-use categories (Table 3): Background: 18,256 acres (59%); Agriculture: 7,235 acres (23%); and Urban/Industrial/Built-Up Land: 5,643 acres (18%). Estimated annual TSS loads from these land-use categories are 397,898 (16%); 451,137 (18%), and 1,248,672 (49%) pounds, respectively. Overall, the current total estimated annual TSS load to the Black Creek from all accountable sources including point, storm water, and NPS is about 2,571,802 pounds (Table 3).

In summary, major land use hydrologic modifications (channelization and enhanced drainage), wastewater treatment facility placement and agricultural development in the headwaters of Black Creek, and increasing runoff from suburban/urban/industrial/built-up areas in the lower Black Creek reach contributes to excessive runoff/washoff and TSS loads resulting in flashy flows and periods of outwash following wet-weather events. These alterations to the Black Creek Watershed have destabilize stream banks, increased TSS loads, and minimized or eliminated desirable fish spawning and rearing habitat, and limited habitat suitable for macroinvertebrate colonization. Robust macroinvertebrate communities, as a food source, are essential to sustaining a desirable fish community.

LINKAGE ANALYSIS

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

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

TMDL DEVELOPMENT

The TMDL represents the maximum load of a pollutant that can be tolerated by a water body and still meet WQS. Because the biotic community has been impaired by excessive sedimentation and flow instability, this TMDL will be based on the response of the fish community to the reduction of sedimentation. The TMDL is based on reducing sediment loads throughout the watershed to a level that supports a fish community of the stream that meets WQS. Using Procedure #51, the presence of a trout population of at least 1% of the fish community and a habitat score of 96 or greater will serve as primary targets for this biota TMDL.

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

The secondary, in-stream target of 80 mg/l TSS is used to develop a secondary TMDL loading goal for TSS during wet-weather runoff/washoff events.

ALLOCATIONS

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

The TMDL represents a maximum load of a pollutant or stressor that can be discharged to a receiving water and still meet WQS. The overall TMDL load capacity is allocated among the three TMDL components: **WLA** for point sources, **LA** for NPS and background loads, and the **MOS**.

WLA

Presently, the estimated total annual TSS load to Black Creek from all accountable sources is about 2,571,802 pounds. The NPDES permitted point source TSS load to Black Creek is estimated at 474,095 pounds/year (Table 1). A total annual TSS load estimate of about 1,248,672 pounds is attributable to point source storm water runoff/washoff discharges to the Black Creek Watershed associated with the urban/industrial/built-up source category (Table 3). The projected annual TSS load (474,095 pounds) from the individual NPDES permitted and Superfund site point sources is considered acceptable based on a 25 mg/l maximum monthly average effluent concentration for each. However, the combined effect on Black Creek by runoff/washoff loads of TSS from the urban/industrial/built-up storm water runoff category should be reduced by about 76,869 pounds (a 6% reduction from 1,248,672 to 1,171,803 pounds) in order to achieve the in-stream mean annual wet-weather TSS concentration goal of 80 mg/l or less by reducing runoff/washoff delivery rates to Black Creek. This will result in a projected annual WLA of 1,645,898 pounds of TSS. Reduced wet-weather runoff/washoff delivery rates to Black Creek will play an important role in achieving the 80 mg/l goal by reducing stream bank erosion and resuspension of in-place TSS.

For treated NPDES permitted point source discharges, the receiving stream design flow equals the lowest 95% exceedance flow. However, it is proposed that any TSS limits in NPDES point source permits be established at the target of 25 mg/l or less (mean monthly maximum), which makes it unnecessary to consider mixing zone scenarios. The point source contributions to the WLA are considered controllable through the existing NPDES permit requirements and storm water through the Phase II MS4 program.

LA

The LA component defines the load capacity for a pollutant that is nonpoint in origin that includes the following land use categories: Agricultural, forested/shrub/open land, wetland, and water bodies (Table 3). An estimated annual TSS load of 397,898 pounds is attributed to these land-use categories of NPS in the watershed. All but the agricultural land-use are considered as background load sources. Therefore, the only targeted load reduction source is from agricultural sources. A 202,234 pound reduction (45% annual TSS load reduction from 451,137 to 248,903 pounds) from cropland areas in primarily the upper watershed is recommended. This TSS load reduction target is based on the 80 mg/l in-stream TSS target concentration during wet-weather runoff and discharge events versus an estimated average TSS concentration of 145 mg/l used to estimate current agricultural land-use loads.

In summary, the estimated accumulative annual TSS load reduction to Black Creek (WLA + LA) is 279,103 pounds/year, an overall 11% reduction (from 2,571,802 to 2,292,699 pounds). The WLA represents 72% (1,645,898 pounds) of the total annual TSS load as allocated to the NPDES permitted point source component (474,095 pounds) along with 1,171,803 pounds allocated to the NPDES permitted industrial storm water and municipal storm water outfalls, the latter, covered under the Phase II MS4 storm water program. The LA (agriculture plus background) represents the remaining 28% or 646,801 pounds of the total TSS load target and

consists of 248,903 pounds from agricultural sources and 397,898 pounds from background sources (Table 3).

To achieve the WLA, a reduction in the storm water runoff/washoff of TSS load is recommended, especially, in the urban/industrial/built-up land use categories located in the lower half of the watershed. To achieve the LA, TSS load reductions are recommended in the agriculture land-use categories primarily associated in the upper half of the watershed. The percent reduction in both the WLA and LA TSS load is based on a reduction of wet-weather runoff event TSS loads with a goal of an annual average in-stream target concentration of 80 mg/l TSS during wet-weather runoff/washoff events. TSS concentrations are typically less than 15 mg/l during stable flow conditions.

MOS

The MOS in a TMDL is used, in part, to account for variability of source inputs to the system and is either implicit or explicit. A MOS is implicit for a biota TMDL because the quality of the biological community, its integrity, and overall composition represent an integration of the effects of the spatial and temporal variability in sediment loadings in the aquatic environment. For comparison of survey assessment results experienced in 2001, follow-up biological and habitat assessments will be conducted between June and August during stable flow conditions. The results collected will best reflect a MOS that is implicit and express an integration of the effects of the variability in sediment loadings in the aquatic environment and minimize seasonal variability.

The habitat target score of 96 or greater will be used to demonstrate acceptable stream quality conditions and represent adequate control of anthropogenic sediment sources to assure improved habitat quality and the biological communities. This targeted score is closely associated with macroinvertebrate community scores of -3 or greater, providing better results than a minimally acceptable value of -4.

SEASONALITY

Seasonality is addressed in the TMDL in terms of sampling periods for fish. To minimize temporal variability in the fish community, sampling will be conducted during June through September each year during stable flow conditions. For assessing TSS loads to Black Creek, seasonal wet-weather event monitoring will be conducted to define and characterize both hydraulic and TSS loads from the Black Creek Watershed.

MONITORING PLAN

Monitoring will be conducted by the MDEQ to assess progress towards meeting the biota TMDL targets, following implementation of applicable BMPs and other control measures. Subsequently, annual sampling of the fish community and habitat quality at Black Creek Road, Mill Iron Road, Wolf Lake Road, and Maple Island Road, as a minimum, will be conducted until assessment results from two consecutive years demonstrate attainment of TMDL targets at these sites. For best comparative purposes, follow-up biological and habitat assessments will be conducted in a June to August time frame, during stable flow conditions. Every effort will be made to sample during similar stream conditions and assess the same sampling locations.

Once the BMPs are in place to minimize the effects of runoff and flashy conditions that exist in Black Creek, stream flow and TSS sampling can be implemented so as to measure progress towards the secondary numeric target of 80 mg/l as a mean annual TSS value during wet-weather runoff events. Multiple sampling during critical high flow events, as well as low flow events will be conducted to better estimate TSS loads in Black Creek.

REASONABLE ASSURANCE

The focus of the actions to protect Black Creek is directed towards installing BMPs and other control measures to reduce and minimize sediment loads and excessive runoff/washoff discharge rates to the TMDL reach. The former action is to reduce sedimentation impacts, the latter to minimize the erosive effects to the stream. Overall, control measures include: individual and general NPDES permit limits, storm water permit limits or other control measures to restrict TSS loads, and approved BMPs for areas currently not under any permit.

For the WLA, existing individual and general NPDES permit requirements for these sources may be adequate to meet the target.

Storm water permits, pursuant to Part 21, Wastewater Discharge Permits, of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, require the collective units of government within a watershed to develop a watershed management plan that includes the detailing of short- and long-term goals and attainment actions, public education plans, illicit discharge elimination plans, and the development (by each local unit of government within the Black Creek Watershed) of their individual storm water pollution prevention plans.

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

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

- Upgrade and maintain the current vegetative riparian zone to reduce soil erosion and loadings to the Black Creek from sources within the watershed. BMPs need to be employed within the riparian zone adjacent to the urbanized, residential, industrialized, and commercial areas to minimize the loss through erosion and direct runoff/washoff, thereby minimizing habitat impairment of the Black Creek.

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

There is a Mona Lake Watershed Project that is being conducted and involves the Community Foundation of Muskegon County, Grand Valley State University's Annis Water Resource

Institute, the communities of Muskegon Heights, Norton Shore, and Muskegon. Findings from this project are expected to enhance and augment the development of the Black Creek TMDL implementation plan.

Prepared by: John Wuycheck
Surface Water Quality Assessment Section
Water Division
Michigan Department of Environmental Quality
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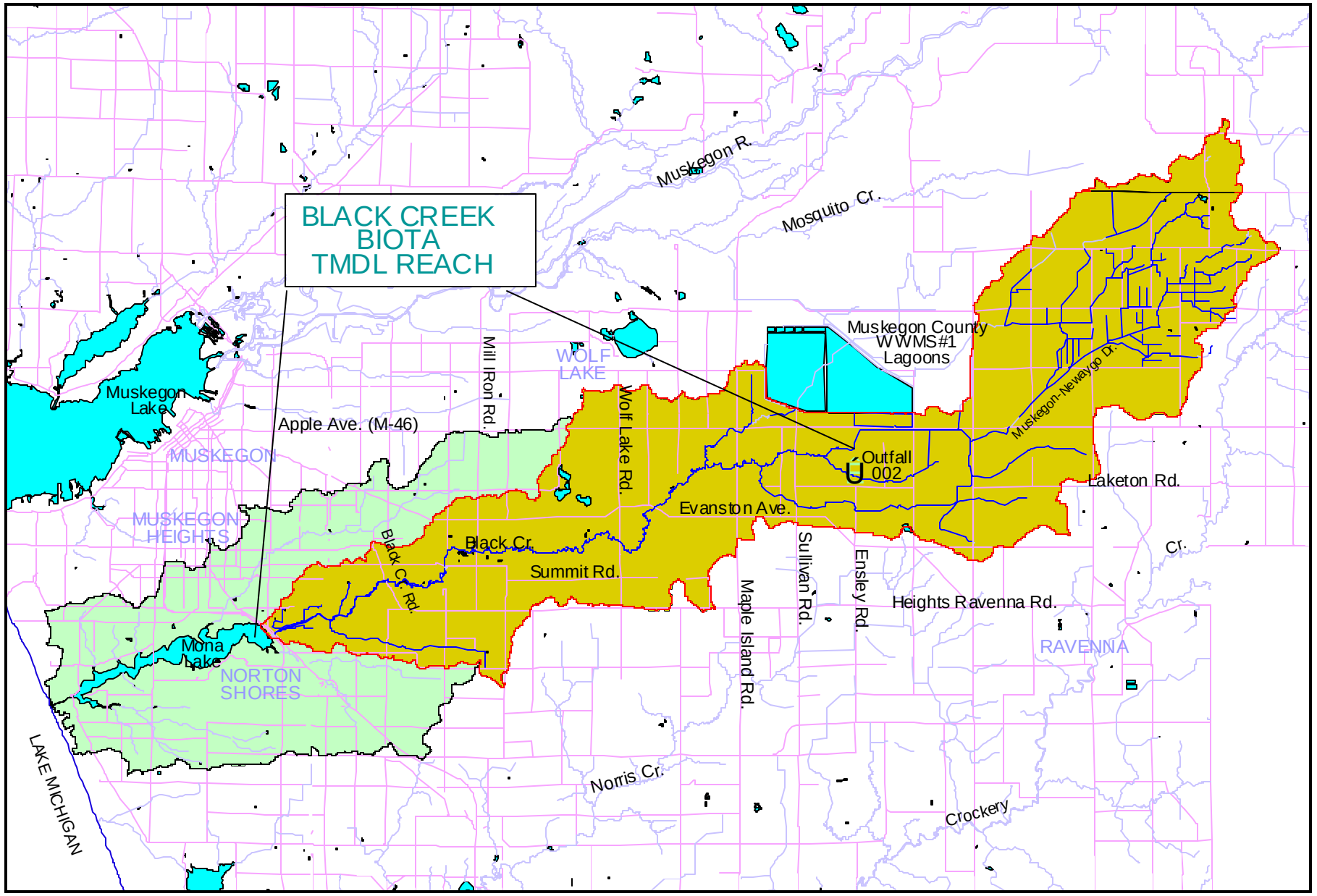

Figure 1. Black Creek Biota TMDL Reach, Muskegon County, Michigan.

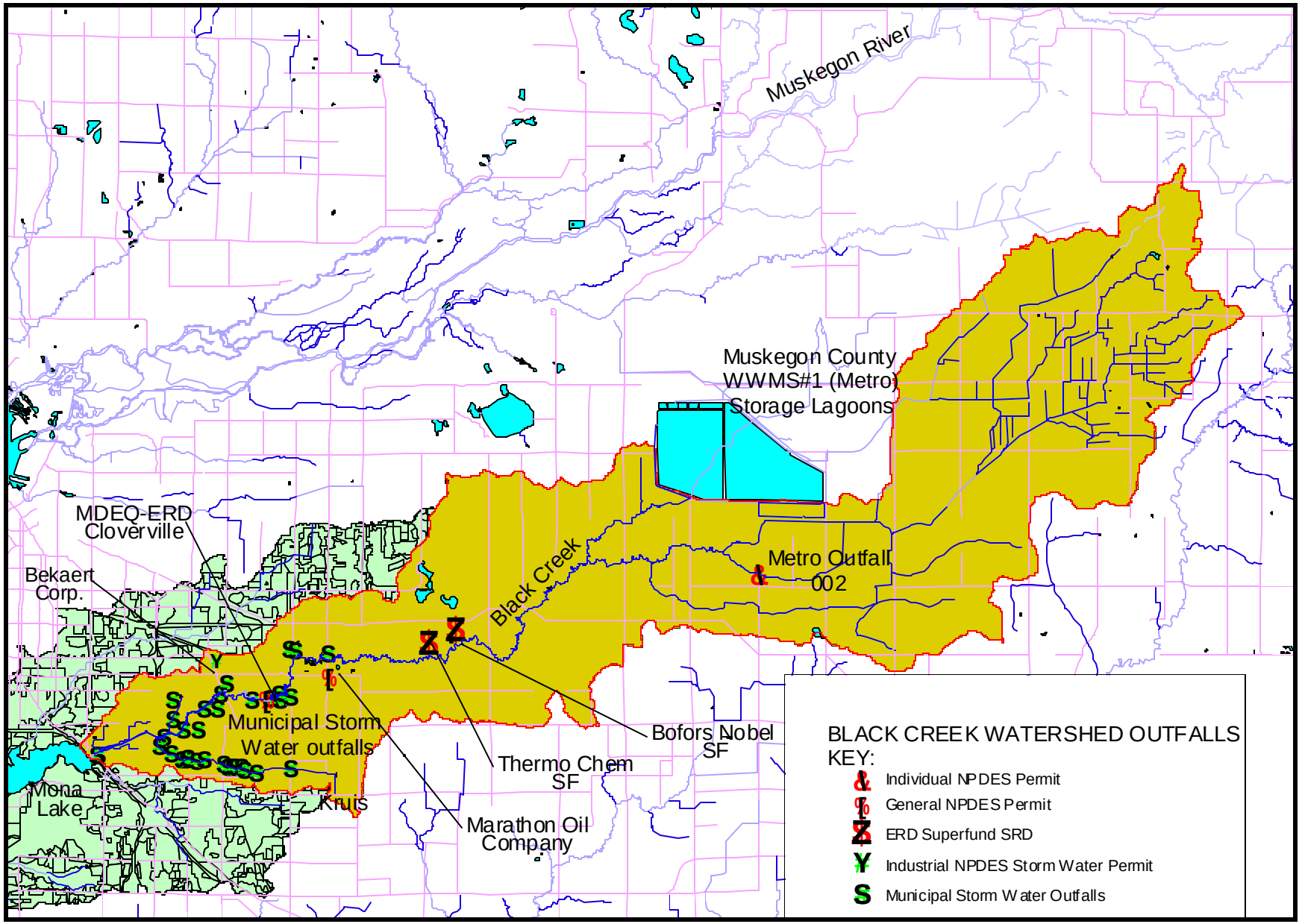

Figure 2. NPDES permitted (individual, general, and industrial/municipal storm sewer) facility outfalls to the Black Creek Watershed, Muskegon, Muskegon County, Michigan.

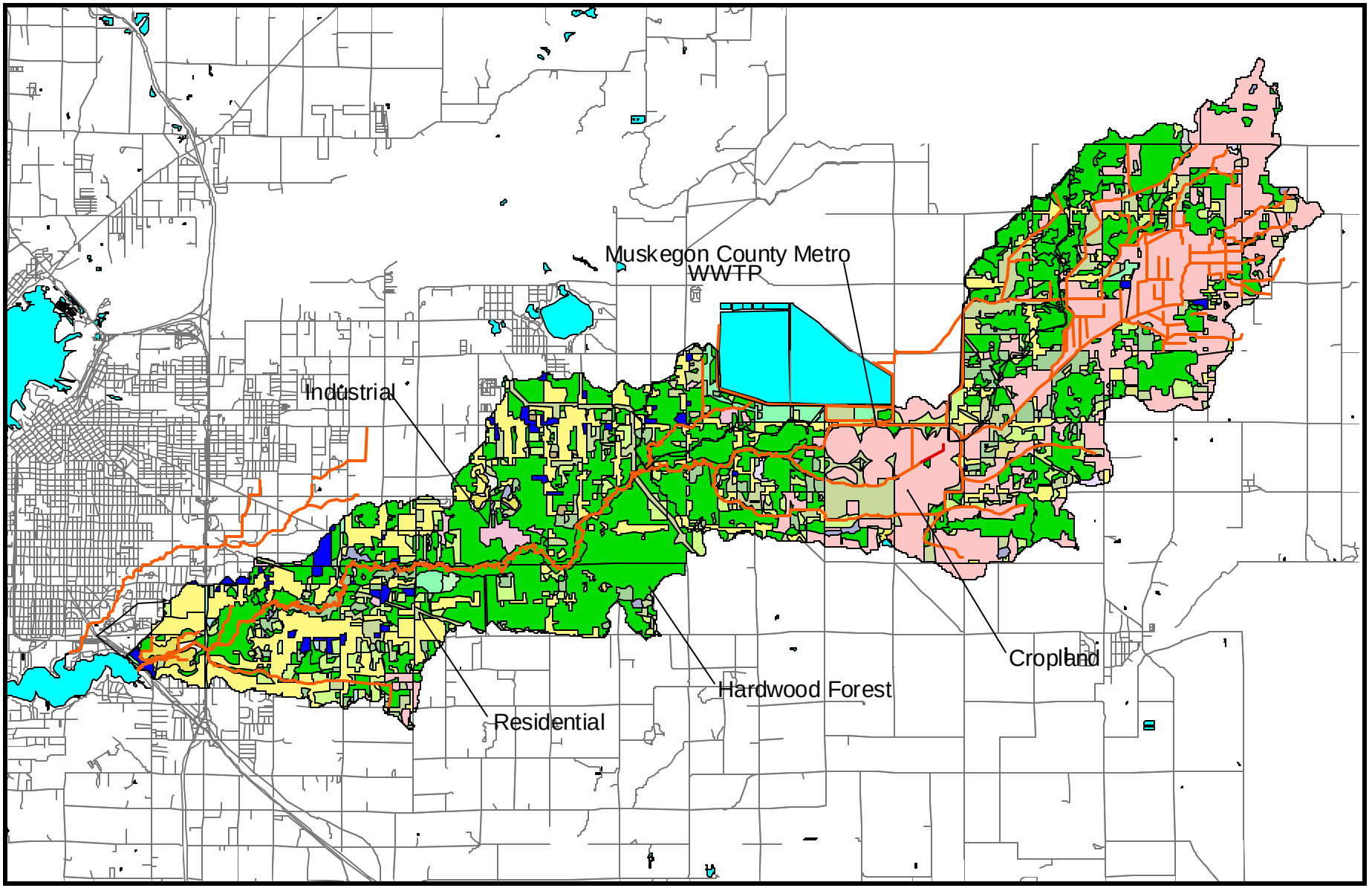

Figure 3. Land use categories in the Black Creek Watershed, Muskegon County, Michigan. (Source: Denning 2003 – 1998 coverage).

Table 1. Individual and industrial storm water NPDES permitted outfalls and Superfund Sites that discharge to Black Creek and estimated TSS loads for non-storm water outfalls.
Source: MDEQ/WD NPDES permit management system. *mgd = million gallons per day.

Permit Number	Facility	Design Flow (mgd*)	Latitude (decimal degrees)	Longitude (decimal degrees)	Annual TSS Load (pounds)
Individual NPDES Permit:					
MI0027391	Muskegon County WWMS (002)	4.2	43.2234	-86.0279	319,820
GENERAL NPDES Permit:					
MIG080898	Marathon Oil Co. – Mill Iron Rd.	0.3	43.19583	-86.15417	22,844
MIG080157	MDEQ-ERD Cloverville Pump	0.3	43.19611	-86.17278	22,844
US EPA Superfund SRD:					
MIU990006	MDEQ-ERD-Bofors/Nobel SF Site	1.1	43.2111	-86.1164	85,743
MIU990010	Thermo Chem SF Site	0.3	43.2116	-86.1242	22,844
	Total:	6.2			474,095
Industrial Storm Water NPDES Permit:					
MIS310269	Bekaert Corporation		43.20417	-86.18750	

Table 2. Muskegon County storm water outfalls to Black Creek Watershed under private, township, County Drain Commission, and County Road Commission jurisdiction tributary.
Source: Fishbeck, Thompson, Carr, and Huber: Project No. G01513A for Muskegon County.

Outfall Number	Jurisdiction	Location	Latitude_DD	Longitude_DD
Black Creek				
NS0901	City of Norton Shores	Airline Road	43.18386	-86.22252
NS0902	City of Norton Shores	Airline Road	43.18393	-86.22292
MT3504	Private & Township/Municipal	West of Dangl Road	43.20687	-86.16643
MT3602	Road Commission	Dangl Road	43.20646	-86.16461
MT3604	Road Commission	Mill Iron Road	43.20585	-86.15478
FT1008	Private & Township/Municipal	Eloise Drive	43.18781	-86.20336
FT0304	Private & Township/Municipal	Vandenberg Road	43.19164	-86.20085
FT0303	Private & Township/Municipal	Vandenberg Road	43.19605	-86.20054
FT1009	Private & Township/Municipal	Filinow Drive	43.18926	-86.19731
FT0302	Private & Township/Municipal	Jem Pine Lane	43.19379	-86.19132
FT1010	Private & Township/Municipal	Valley View Drive	43.18942	-86.19301
FT0301	Road Commission	Black Creek Road	43.19699	-86.18652
FT0206	Private & Township/Municipal	East of Sheridan	43.19942	-86.18479
FT0205	Private & Township/Municipal	Walker Road	43.19572	-86.17731
FT0204	Private & Township/Municipal	Debaker Road	43.19619	-86.17211
FT0203	Private & Township/Municipal	Devowe Street	43.19719	-86.16924
FT0202	Road Commission	Raffle Street	43.19392	-86.18695
FT0201	Private & Township/Municipal	Raffle Street	43.19591	-86.16860
FT0101	Private & Township/Municipal	Dangl Road	43.19672	-86.16560
Kruis Drain (tributary to Black Creek)				
FT1007	County Drain	US-31	43.18589	-86.20447
FT1006	County Drain	Ellen Street	43.18450	-86.20115
FT1005	County Drain	East David Avenue	43.18310	-86.19757
FT1004	Private & Township/Municipal	Eloise Drive	43.18314	-86.19661
FT1003	Private & Township/Municipal	Eloise Drive	43.18329	-86.19603
FT1002	Private & Township/Municipal	Swanson Lane	43.18265	-86.19341
FT1001	Private & Township/Municipal	East Swanson Court	43.18296	-86.19128
FT1108	Road Commission	Sheridan Road	43.18212	-86.18559
FT1107	Road Commission	Manning Street	43.18151	-86.18418
FT1106	Road Commission	Manning Street	43.18140	-86.18418
FT1105	Road Commission	Thona Street	43.18127	-86.18292
FT1104	Road Commission	Woodlawn Street	43.18126	-86.18161
FT1103	Road Commission	Westbrook Street	43.18127	-86.18019
FT1102	Road Commission	Eastbrook Street	43.18078	-86.17924
FT1101	Private & Township/Municipal	Walker Street	43.18036	-86.17560
FT1201	Road Commission	Dangl Road	43.18115	-86.16576

Table 3. Annual TSS loads based on NPDES permitted point sources and various land use categories in the Black Creek Watershed. Estimated annual TSS loads and recommended TSS reductions (WLA and LA) are derived.

Load Source Category	Acres	Estimated Current TSS (Pounds/Year)*	TMDL TSS Target TSS (Pounds/Year)
WLA Components:			
NPDES Individual Permitted Point Source TSS Load:		474,095	474,095
Urban/Industrial/Built-Up – Storm Water			
Residential	4,469	835,028	
Industrial	240	165,991	
Commercial and Service	431	116,271	
Trans., Comm., Util., and Disposal	451	121,666	
Other Urban/Built-Up Land	52	9,716	
Subtotal:		*1,248,672*	*1,171,803* (6% reduction)
WLA Totals:	5,643	**1,722,767**	**1,645,898**
LA Components:			
Agricultural Land			
Cropland	7,009	437,044	241,128
Orchards and Specialty Crops	120	7,483	4,128
Confined Feeding/Permanent Past.	106	6,610	3,647
Subtotal:	*7,235*	*451,137*	*248,903* (45% reduction)
(Background Source)			
Forested/Shrub/Open Land			
Deciduous Forest	11,984	262,829	262,829
Open Land	4,525	99,241	99,241
Coniferous Forest	1,240	27,195	27,195
Wetland			
Forested	138	2,665	2,665
Non-Forested	83	1,603	1,603
Water Body			
Lakes/Ponds/Reservoirs	226	4,365	4,365
Barren Land			
Sand Dunes	60	-	-
Subtotal:	*18,256*	*397,898*	*397,898*
LA Total:	*25,491*	***849,035***	**646,801**
Overall Totals:	31,134	**2,571,802**	**2,292,699** (11% reduction)

**Load estimates based on PLoad Version 3 model (USEPA, 2001), land use acres derived from Grand Valley State University's – 1997-98 database coverage (Denning, 2003) and a mean annual rainfall value of 31 inches.*