State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Chagrin River Watershed

Native Brook Trout (Salvelinus fontinalis) from Woodiebrook

Final Report
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Ted Strickland, Governor
Chris Korleski, Director

TABLE OF CONTENTS

APPENDICES

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Executive Summary

The Chagrin River watershed is located in northeast Ohio, flowing through Portage, Geauga, Cuyahoga and Lake Counties on its way to Lake Erie. This watershed appears on Ohio's 303(d) list (Ohio's impaired waters listing) based on findings from Ohio EPA's monitoring program. These findings indicate that organic enrichment, nutrients, flow alteration and degraded habitats are the primary causes of impairment. Major sources of impairment include land development/suburbanization, sewage treatment plants, wetland filling, removal of riparian vegetation, urban storm water and nonpoint sources.

Stream surveys were conducted in 2003 and 2004; impairments were found for some biological communities as well as elevated phosphorus, nitrates and bacteria. Urban and suburban land use contribute nutrients to the Chagrin River watershed along with the discharges from wastewater treatment plants. Ohio's water quality standards include numerical biological criteria that form the basis of the numerical targets for the TMDLs. The success of the implementation actions resulting from the TMDLs will be evaluated through further monitoring looking for changes in the biological scores. Nutrient targets complement the biocriteria and are used as a tool to help evaluate the impact of nutrient loadings. These nutrient targets were based on an Ohio EPA technical bulletin (Ohio EPA, 1999) that relate instream nutrient concentrations to aquatic community performance.

TMDLs were prepared for phosphorus, nitrates, habitat, bacteria, and total suspended solids.

Reasonable assurances proposed for the Chagrin River watershed include a number of measures designed to address both point and nonpoint sources of pollution. Phase II of the storm water regulations will involve a large portion of the watershed area and will be an essential part of water quality restoration. Riparian zones are also an important part of protecting current water quality as well as the restoration of impacted areas for implementing this TMDL. Protection of headwater streams is also recommended because of their importance to watershed integrity. This TMDL recommends that additional storm water controls be implemented by watershed communities, such as green roof design, rain barrels, rain gardens, and mechanisms to increase infiltration capacity on developed land. The intent of additional controls is to reduce instantaneous runoff peaks and reduce pollutants, including temperature increases which can be caused by existing and future additional impervious surface area.

Table 1.1 Summary of TMDLs for the Chagrin River Watershed

Hydrologic Unit Code (14 digit)	Listed Causes of Impairment	TMDL Action Taken
Chagrin River (headwaters to downstream Aurora Branch) 04110003 020 Assessment Unit Priority Points: 3		
010 020 030 040	Habitat alterations, flow alterations, nutrients, siltation, organic enrichment, unknown toxicity	TMDLs generated for nutrients, suspended solids and bacteria. Actions recommended to protect cold water designated streams and habitat.
Chagrin River (downstream Aurora Branch to mouth) 04110003 030 Assessment Unit Priority Points: 6		
010 020 030	Habitat alterations, flow alterations, siltation, organic enrichment, nutrients, thermal modifications	TMDLs generated for nutrients, suspended solids and bacteria. Actions recommended to protect cold water designated streams and habitat.

1.0 INTRODUCTION

The Clean Water Act (CWA) Section 303(d) requires states, territories, and authorized tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these waters (the section 303(d) lists) are made available to the public and submitted to the U.S. Environmental Protection Agency (U.S. EPA) in even-numbered years. The Ohio Environmental Protection Agency (Ohio EPA) identified the Chagrin River watershed as a priority impaired water on the 2004 and 2006 303(d) lists. A general overview of Ohio's water quality standards is included in Table 2-1. Specific use designations for the Chagrin River (OAC 3745-1-22) are included in Appendix B.

The Clean Water Act and U.S. EPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the section 303(d) lists. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Ultimately, the goal of Ohio's TMDL process is full attainment of biological and chemical Water Quality Standards (WQS) and, subsequently, removal of water bodies from the 303(d) list. The Ohio EPA believes that developing TMDLs on a watershed basis (as opposed to solely focusing on impaired segments within a watershed) is an effective approach towards this goal. Watershed-wide implementation of certain management practices (riparian protection, for example) is important when addressing streams with multiple nonpoint source related impacts.

This report documents the Chagrin River TMDL process and provides tangible actions to restore and maintain this water body. The main objectives of the report are to 1) describe the water quality and habitat condition of the Chagrin River and 2) quantitatively assess the factors affecting non or partial attainment of WQS. A draft implementation plan is also included. This plan identifies actions to address these factors and specifies monitoring to ensure actions are carried out and to measure the success of the actions prescribed. The report is organized in sections forming the progression of the TMDL process.

The primary causes of impairment in the Chagrin River watershed are organic enrichment, nutrient enrichment, flow alteration, and habitat degradation. Nutrient enrichment and organic enrichment are closely tied to each other in the TMDL area. A number or wastewater treatment plants in the watershed contribute nutrients and other contaminants. Runoff from both urban and suburban land is also an important source of nutrients and cause of habitat degradation in the watershed. The implementation plan includes numerous actions which specifically focus on runoff issues.

TMDLs were calculated for phosphorus and nitrates as well as bacteria. Habitat degradation is not a load based quantity; however, the regulations provide for these types of impairing causes and TMDL numbers were calculated for these as well. Habitat survey methods used by Ohio EPA can detect levels of sedimentation and overall habitat quality. Improvements and reductions in siltation, are able to be identified utilizing the QHEI. Additional discussion on habitat and siltation is found in Section 4.2.7.

2.0 WATERBODY OVERVIEW

2.1 Description of Study Area

The Chagrin River is a Lake Erie tributary located in parts of Portage, Geauga, Cuyahoga and Lake Counties. The Chagrin River is placed in the Erie-Ontario Lake Plain, formerly glaciated, which is characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands. The Main Branch of the Chagrin River begins as the Upper Main Branch above Bass Lake in Munson Township (Geauga County) and flows over 49 miles before entering Lake Erie in the City of Eastlake, comprising a drainage area of 267 square miles. Along its path, the Main Branch is joined by the River's other branches - the Aurora Branch, flowing from the City of Aurora and meeting the Main Branch in the Village of Bentleyville, and the East Branch, beginning in Geauga County and joining the Main Branch in the City of Willoughby. The areas within and surrounding the watershed are experiencing significant development pressure as the Cleveland population continues to migrate from the urban core and inner ring communities to outlying suburbs. However, the majority of the river retains its riparian forest cover and nearly fifty percent (50%) of the land in the watershed is zoned for low density, large lot residential uses. The river valley offers a diversity of terrestrial and aquatic plant communities, wildlife, unique rock outcroppings, and extensive headwater wetlands.

Geology

The Chagrin River watershed, like most of northeast Ohio, was shaped by glacial activity thousands of years ago. The resulting soils and geologic deposits contribute to the high quality and varied habitats of the watershed. Since the last glaciers retreated approximately 12,000 years ago, the river has progressed from the upland headwater areas to create deep ravines further downstream. There are many areas on the Chagrin River and its numerous tributaries where thick glacial till has eroded, exposing sandstone and Chagrin Shale bedrock. The Chagrin River watershed lies in two distinct physiographic regions: the glaciated Allegheny Plateau and the Erie Lake plain. Soils with relatively clayey textures in the subsoil and that formed in glacial till predominate in the watershed, and somewhat poorly drained soils are common in areas with six percent slope or less. The soils in the Lower Chagrin watershed are less clayey, but are characterized by low slopes (<4%) and are poorly drained or somewhat poorly drained. Erosion is substantial in steeper areas. The terrain of most of the watershed is generally rolling with a substantial percentage of wooded land. The Chagrin River is deeply entrenched over the lower 25 miles of its length and flows on bedrock in narrow valleys through much of the watershed.

In general, the glacial deposits in the watershed overlay sandstone and shale bedrock. Bedrock is deeper than 60 inches below the soil surface in most of the watershed, but it is 20 to 40 inches below the soil surface in some nearly level or gently sloping areas. The major geologic deposits obvious in the watershed are the uppermost Sharon Conglomerate, which provides rock outcroppings and groundwater input in reaches of the Upper Main and East Branches of the Chagrin River. Formations of Berea Sandstone and Shale outcroppings of both Cleveland and Chagrin Shale predominate in the lower reaches of the river.

2.2 Water Quality Assessment

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters. Table 2-1 provides a brief description of Ohio's water quality standards. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (OAC) or on the web at: (http://www.epa.state.oh.us/dsw/wqs/criteria.html).

In the Chagrin River basin study area, the aquatic life use designations that currently apply to its segments are Exceptional Warmwater Habitat (EWH), Warmwater Habitat (WWH) , Coldwater Habitat (CWH), and Seasonal Salmonid Habitat (SSH). A number of sections in the basin are also designated a State Resource Water. Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms, while those designated EWH are waters capable of supporting and maintaining an exceptional or unusual community of warmwater aquatic organisms. The CWH designation applies to streams that are capable of supporting populations of native coldwater fish and associated vertebrate and invertebrate organisms and plants on an annual basis. Seasonal Salmonid Habitat is a seasonal designation supported by another designation which applies to rivers, streams and embayments capable of supporting the passage of salmonids from October to May and are water bodies large enough to support recreational fishing. The State Resource Water designation applies to the entire Chagrin River, East Branch of the Chagrin and its tributaries, Griswold Creek, Willey Creek, the Aurora Branch and McFarland Creek, Silver Creek and Beaver Creek.

Attainment of WQS is measured utilizing both biological communities and chemical sample analysis. Attainment benchmarks from these least impacted areas are established in the WQS in the form of "biocriteria," which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic insects: Invertebrate Community Index (ICI)) the stream is considered in "non attainment". If the stream measurements achieve some of the biological criteria, but not others, the stream is said to be in "partial attainment." A stream that is in "partial attainment" is not achieving its designated aquatic life use, and requires a TMDL, whereas a stream that meets all of the biocriteria benchmarks, is in “full attainment.” A more detailed explanation of Ohio's biocriteria can be found in the Ohio EPA publication *The Role of Biological Criteria in Water Quality Monitoring, Assessment, and Regulation* (Ohio EPA, 1995).

Another designated use set forth in WQS is for recreational purposes. The recreational use for the Chagrin River study area is Primary Contact Recreation (PCR). The criterion for the PCR designation is being suitable for full-body contact recreation. Ohio EPA assigns the PCR use designation to a stream unless it is demonstrated through a use attainment analysis that the combination of remoteness, accessibility, and depth makes full-body contact recreation by adults or children unlikely. In those cases, the Secondary Contact Recreation (SCR) designation is assigned. The attainment status of PCR and SCR is determined using bacterial indicators; the criteria for each are specified in the Ohio WQS. Ohio currently uses both fecal coliform bacteria and *E. coli* as measures of recreational attainment.

Table 2-1. Summary of the Components and Examples of Ohio's Water Quality Standards

WQS Components	Examples of:	Description
Beneficial Use Designation	1. Water supply •Public (drinking) •Agricultural •Industrial 2. Recreational contact •Beaches (Bathing waters) •Swimming (Primary Contact) •Wading (Secondary Contact) 3. Aquatic life habitats (partial list): •Exceptional Warmwater (EWH) •Warmwater (WWH) •Modified Warmwater (MWH) •Limited Resource Water (LRW) •Cold Water Habitat (CWH) •State Resource Water	Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (they are water body specific). Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent (lower) allowable concentrations of pollutants than would the average stream. Recreational uses indicate whether the water can be potentially used for swimming or if it may only be suitable for wading.
Numeric Criteria	1. Chemical	Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.
	2. Biological *Measures of fish health:* • Index of Biotic Integrity • Modified Index of Well Being *Measure of macroinvertebrate health:* • Invertebrate Community Index	Indicates the health of the instream biological community by using these 3 indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites.
	3. Whole Effluent Toxicity (WET)	Measures the harmful effect of an effluent on living organisms (using toxicity tests).
	4. Bacteriological	Represents the level of bacteria protective of the potential recreational use.
Narrative Criteria (Also known as the "Free Froms")	General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, nutrients in concentrations that may cause algal blooms, and free from a public health nuisance.	
Antidegradation Policy	This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to http://www.epa.state.oh.us/dsw/wqs/wqs.html for more information.	

The Water Quality Standards designations contained in Ohio Administrative Code Chapter 3745-1-22 are included as Appendix B.

The Chagrin River basin was most recently surveyed by Ohio EPA in 2003 and 2004.

Water Quality
Overall, water quality in the Chagrin River basin is fairly good. A brief discussion will follow for each HUC unit.

Chagrin River (headwaters to downstream Aurora Branch) HUC 04110003 020
Water quality in this HUC appeared to indicate moderate human influence from land use impacts and waste water discharges. While ammonia concentrations were low (median 0.079 mg/l), nitrates and phosphorus showed some elevated levels. The maximum nitrate concentration found was 4.34 mg/l with a 95th percentile value of 2.33 mg/l. Phosphorus had a median concentration of 0.07 mg/l with a maximum of 0.798 mg/l.

Of the metals sampled, results indicated compliance with water quality standards. Mercury was detected in one sample in the Aurora Branch at a level of 0.23 µg/l (detection limit 0.2 µg/l).

The average water temperature during the survey time frame in the HUC was 16.8°C with a maximum of 23.1°C.

A minimum dissolved oxygen concentration of 2.65 mg/l was found in the HUC. Of the 134 samples collected in HUC 020, eight (5.9%) had field dissolved oxygen concentrations less than 5 mg/l.

Chagrin River (downstream Aurora Branch to mouth) HUC 04110003 030
Water quality in this HUC appeared to indicate moderate human influence from land use impacts and waste water discharges, although monitored pollutant concentrations were slightly less than those in the other HUC. Ammonia concentrations were low (median 0.059 mg/l), nitrates and phosphorus showed some elevated levels. The maximum nitrate concentration found was 2.96 mg/l with a 95th percentile value of 1.43 mg/l. Phosphorus had a median concentration of 0.047 mg/l with a maximum of 0.466 mg/l. As the drainage area increases, dilution of nutrients occurs through increased base stream flow.

Of the metals sampled, results indicated compliance with water quality standards.

The average water temperature during the survey time frame in the HUC was 16.95°C with a maximum of 25.1°C.

A minimum dissolved oxygen concentration of 2.51 mg/l was found in the HUC. Of the 126 samples collected in HUC 030, two (1.5%) had field dissolved oxygen concentrations less than 5 mg/l.

Biological Communities

As discussed previously in this section, Ohio EPA utilizes both fish and macroinvertebrate communities to evaluate the biological integrity of streams. Biocriteria values applicable to the Chagrin River watershed are presented in Table 3-1.

Chagrin River (headwaters to downstream Aurora Branch) HUC 04110003 020

The upper reaches of the Chagrin River do not completely meet applicable biocriteria. Both fish and macroinvertebrates show signs of impact. The river recovers to Full attainment at river mile 40.0 and maintains Full attainment throughout the HUC (river mile 28.2). Several sites in this area demonstrate exceptional biological communities.

The Aurora Branch shows impairments of both indices. Sample results indicated that 7 of 12 sites are in Full attainment. Possible impacts from toxic blue-green algae in the discharge from Sunny Lake was impairing downstream fish communities. The stream generally recovers to Full attainment except for river mile 3.4 (downstream of the McFarland Creek WWTP) which shows fish community impairment.

McFarland Creek is currently the only designated exceptional warmwater habitat stream in the Chagrin River basin and is in Partial attainment due to low fish community scores.

Dewdale Creek (at river mile 2.6) and Marsh Hawk Run are in NON attainment of biological community goals. Dewdale Creek is recommended to be designated a coldwater habitat stream, it currently is not designated, and presently has no attainment status. Marsh Hawk Run is currently not designated, with a recommendation to be designated warmwater habitat. It presently has no attainment status.

Chagrin River (downstream Aurora Branch to mouth) HUC 04110003 030

The entire lower mainstem Chagrin River in this HUC is in Full attainment of its biocriteria.

Several tributary streams are in NON attainment of biological community goals, they are: Ward Creek, the East Branch (at river mile 2.4) and Griswold Creek (at river mile 0.1).

Native Brook Trout

There are several small cold-water tributaries to the Chagrin River that serve as some of the few remaining streams supporting naturally reproducing brook trout (*Salvelinus fontinalis*) in Ohio. Protection of these streams and their riparian and groundwater recharge areas is vital to maintaining this species. Additional discussion on brook trout is found in Section 7.1.2.

Bacteria

Chagrin River (headwaters to downstream Aurora Branch) HUC 04110003 020

Pooled data analysis for fecal coliform bacteria in the upper Chagrin watershed, including the Aurora Branch, found that the geometric mean for the data pooled from all 36 of the sites sampled by the Ohio EPA form 1999 through 2004 was below the Primary Contact Recreation (PCR) water quality criterion. Analysis of data from individual sites found that the geometric mean was exceeded at 8 locations in the upper Chagrin AU. The 90th

percentile of the pooled data (all sites) exceeded the 10 percent water quality criterion, indicating that this AU is in Partial attainment of the recreational use water quality criteria. The 90th percentile criterion was exceeded at 6 of the 8 sites where the geometric mean was found to be exceeded. These results are indicative of a water quality problem occurring under high flow or runoff events, likely caused by nonpoint sources of pollution rather than from failures at point source dischargers.

Problem areas identified in the upper Chagrin AU included:

1. The upper portion of Dewdale Creek (RM 2.60, STORET ID D01G24): this sampling site is located downstream of Kiwanis Lake, an area with a high density of older housing not served by sewers. Failing on-site home sewage systems are a likely source for the observed problems.
2. Unnamed tributary to the Chagrin River at river mile 38.4 (aka Marsh Hawk Run): this stream drains unsewered suburban housing areas located to the south of the Chesterland area and also is the receiving stream for the Geauga Co. Opalacka WWTP. Nonpoint pollution resulting from small farm livestock management may also be an issue in this stream.
3. Chagrin River mainstem at Sperry Rd. (RM 40.05, STORET ID D01G01): this location was used as a sentinel site for the survey, and both the geometric mean and the 90th percentile of the fecal coliform data exceeded the PCR criteria. Several homes located upstream of this site are located in very close proximity to the river bank. This reach of the Chagrin River is characterized by shallow depth to bedrock, with exposed bedrock in the stream channel throughout this area. Failing septic systems are the likely cause for the observed data.
4. Chagrin River mainstem in the Chagrin Falls area: although much of this area is served by central sewers, it is the most densely developed area within the upper Chagrin AU, and is intermixed with unsewered areas. Urban runoff effects and failing on-site sewage systems, combined with potential wildlife contributions from the park located upstream of the waterfall in Chagrin Falls, potentially all contribute to the observed problems.
5. The lower Aurora Branch: the geometric mean and 90th percentile criteria were exceeded at both sentinel sites positioned on the Aurora Branch, both upstream and downstream of McFarland Creek and the Geauga Co. McFarland Creek WWTP. Depths to bedrock, especially near the stream corridor, are very shallow throughout these reaches of the stream, increasing the likelihood of on-site system failure and transport to the stream from the numerous homes located in close proximity to the stream in the areas north of Aurora (Portage County) and in Bainbridge Township (Geauga County). Urban runoff from the more heavily developed suburban areas of Solon and Bainbridge as well as runoff from small-scale livestock management such as small horse farms may also be contributing to this situation.

It should be noted that although the site near the mouth of Beaver Creek (Sherman Rd., STORET ID D01G09) is flagged as exceeding the PCR geometric mean criterion, only one sample was collected at this site. Use of a single sample to determine attainment of the water quality criteria is not possible. However, this site is located just downstream of an agricultural area where cattle have unrestricted access to the stream, so it is very likely that the value reported is representative of conditions at this location. Similarly, the Silver Creek subwatershed (14 digit HUC 04110003020020) had no results exceeding the water quality criteria. However, only 6 samples were collected from this area during the survey, and the results may not be representative of all flow conditions occurring during a typical recreation season.

In general, the upper reaches of the Aurora Branch demonstrated the highest degree of attainment of the recreational use criteria in the entire Chagrin River watershed. It should be noted that all of the sentinel sites data exceeded the geometric mean and 90th percentile PCR criteria in the upper Chagrin AU. These sites were sampled more frequently and under more varying flow conditions than the other sites utilized in the survey. These results indicate that results from the other sites used in the survey should be analyzed with some caution and that problems relating to meeting the PCR water quality criteria may be more widespread than indicated by the present data set.

Chagrin River (downstream Aurora Branch to mouth) HUC 04110003 030
Analysis of the pooled data for the lower Chagrin AU found that this portion of the chagrin watershed is also in Partial attainment of its designated Recreational Use. The geometric mean of the pooled results was below the PCR criterion, while the 90th percentile exceeded the criterion. As with the upper Chagrin AU, causes of the Partial attainment generally appear to be related to nonpointsources rather than permitted wastewater discharges.

Problem areas noted in the lower Chagrin AU included the following:

1. The sites throughout the East Branch subwatershed were the most elevated for the 90th percentile of any of the streams monitored during the survey. However, only the sentinel site located at Markell Rd. (STORET ID D01P01) was found to have exceeded the geometric mean PCR criterion. The results indicate that storm event runoff (nonpoint) is driving this problem. Likely sources of the problems observed in the East Branch subwatershed are failing onsite systems and a large number of small-scale equestrian facilities located in this area. Many areas within this watershed have very shallow depth to bedrock or proximity to deeply incised ravines, thereby increasing the likelihood of rapid transport of pollutants to shallow groundwater or nearby streams during spate events. Stream flows often are very low during the summer and base flows do not provide significant dilution to pollutant loads. A very cautious approach to the placement of new housing, innovative management of existing on-site home sewage systems, and manure management programs designed to protect the stream network will all be necessary if the recreational use criteria are to be met in the East Branch watershed.
2. Although the geometric mean for fecal coliform bacteria was met in Stoney Brook, historical problems relating to unsewered areas and the numerous small wastewater treatment plants discharging to Stoney Brook in the Kirtland area are well known. It is likely that bacteria loads to the East Branch from Stoney Brook are a primary source of the elevated fecal coliform counts observed at the downstream sentinel sampling site located on the East Branch at Markell Rd. (RM 2.35, STORET ID D01P01). Plans are currently being developed to provide central sewerage for the Kirtland area, which will result in the abandonment of several small wastewater treatment plants and provide sewer service for several unsewered areas within the Village. Completion of this project will have a positive effect upon attainment with respect to recreational uses.

3. The unnamed tributary to the Chagrin at RM 5.5 (aka Gully Brook) had exceedences for both the geometric mean and 90^{th} percentile criteria. The upper portion of this small watershed is heavily developed, and other portions are impacted by road runoff from the I-90 corridor and mixed residential use.

A positive note regarding the bacteria data collected during the survey was apparent. Bacteriological water quality appears to have improved significantly in Griswold Creek as the result of the construction of the Valley View WWTP servicing the Chesterland area. This plant began operating in May of 1999 and alleviated significant water quality problems noted in Griswold Creek resulting from failing on-site sewage treatment systems. Although the data set was small (n=6), only one sample collected from the sites located on Griswold Creek was found to be above 1,000 cfu/100 ml for fecal coliform during the survey, indicating a significant improvement in water quality.

As observed in the upper Chagrin AU, fecal coliform counts at the sentinel sites were more likely to exceed the geometric mean and 90^{th} percentile criteria for the PCR use. In the lower Chagrin AU, the only sentinel sites where the geometric mean criteria were not exceeded were the Chagrin River at Daniels Park (RM 4.95, STORET ID 502400) and the East Branch at Mitchells Mill Rd. (RM 10.28, STORET ID D01S20). These results indicate that the true nature of the coliform bacteria (and potentially pathogen) pollution problem may be more widespread than would be initially surmised by a review of the data. It is likely that larger data sets at all of the sampling locations, including more data collection during high flow situations, would indicate a greater degree of nonattainment of the recreational use criteria throughout the watershed. Efforts will be needed on a watershed-wide scale to reduce the loading of indicator bacteria in order to assure attainment of the designated recreational uses in the Chagrin River basin.

2.3 Causes and Sources of Impairment

The primary determination of impairment in rivers and streams in Ohio is straightforward – the biocriteria standards that are the principal arbiter of aquatic life use attainment and impairment.

Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent, land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g., agricultural runoff, municipal point sources, septic systems) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear on the section 303(d) list do not necessarily represent a true “cause and effect” relationship. Rather they represent the association of impairments (based on response indicators) along with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

The Chagrin River watershed is impacted by nonpoint sources (e.g., runoff from urban areas, septic tanks), point source discharges, and a number of habitat impairments (such as wetland loss, loss of riparian zones and channel alterations). There are currently 42 NPDES permits existing within the watershed for discharges greater than 1000 gallons per day. A list of NPDES permits in the basin is included as Appendix C.

Physical habitat attributes in much of the free flowing mainstem and tributaries show some characteristics of high quality that typically include natural stream morphology, coarse substrates and wooded riparian corridors. Urbanization in some areas of the watershed has resulted in altered stream hydrology, flashy flow regimes, stream banks denuded of riparian vegetation and has exacerbated nutrient enrichment and sediment production, which impacts aquatic life. This increase in sedimentation has been noted within the watershed during the recent comprehensive survey.

In addition to increasing volumes of sewage needing treatment, changing land use patterns are altering the types of nonpointpollutants and the rates at which they are discharged within the watershed. The land use distribution for the watershed is shown in Figure 2-1 and Table 2-2.

Land cleared for construction can result in greatly accelerated rates of erosion and sedimentation of streams especially when sediment control measures are inadequate. Additionally, increased impervious surface area and storm water drainage systems typically follow new development and result in accelerated rates and volume of runoff that contribute a variety of pollutants including solids, nutrients, oils, increased temperature, and pesticides to streams.

Predicting the degree to which a specific source impairs water quality can be difficult in a watershed with multiple sources. Some impairments, such as dams, are more easily assigned a magnitude. A dam blocks fish passage for non-salmonids upstream. Removal of a dam can result in attainment if it is the source of impact and other upstream contributions are nonexistent or moderate in their impacts. Other sources and impairments are more difficult to assess.

Habitat changes associated with man-induced impacts can be very great. Portions of this watershed have been channelized, bank surfaces hardened, and smaller tributaries culverted. These negative impacts continue today. Riparian vegetation is compromised or removed, which adds to channel destabilization and increased sediment production. Construction in the floodplain can also further impact the stream. In an effort to protect structures within in the floodplain, the stream has been channelized or dredged. Dredging streams exacerbates problems associated with high flow events. Ongoing, long-term maintenance of the dredged area is required. Dredged channels tend to incise more rapidly and cause bank failure, both of which adds suspended material and bedload to a stream. Maintaining a healthy stream corridor and controlling impervious surfaces is capable of helping to address storm water management issues.

Development practices often result in the destruction of soil structure, which only intensifies urbanization impacts. Soil structure is an often overlooked, under-appreciated component of a watershed. The infiltration rate and storage capacity associated with an undisturbed site are much greater than those found in a typical compacted construction site. Natural infiltration will help to moderate high flow and maintain base flow. Urbanized streams lose some ability to self-regulate following storm events. The result of this rapid runoff, accelerated by increased impervious surface areas, is flash flows associated with a lower base flow. These extremes in high and low flows stress both physical habitat and biological communities. Long-term temperature changes can also occur in urbanized streams caused by decreased base flow and increases in heated runoff from pavements and storm ponds due to solar insolation and riparian removal. Instream sources of sediment are also significant within this watershed. Both hillslope failures and channel erosion contribute sediment. While this can be considered part of natural stream geomorphological processes, it is greatly accelerated by changing land use patterns and the resultant storm water runoff pattern changes.

Sunny Lake in Aurora is a hypereutrophic waterbody that impacts the Aurora Branch due to toxins produced by blue-green algae growing in the lake.

Table 2-2. Land use distribution in the Chagrin River Basin

Land Use Category	Sum of Area (Acres)	Land Use Percentages
Bare/Mines	475.53	0.3
Commercial/Industrial/Transportation	7865.03	4.6
Crop	12955.3	7.6
Deciduous Forest	109468.3	64.6
Evergreen Forest	1412.55	0.8
Herbacious Wetlands	209.63	0.1
Open Water	1800.56	1.1
Pasture	1326.84	0.8
Residential	28051.84	16.6
Urban or Recreational Grasses	3984.64	2.4
Woody Wetlands	1826.76	1.1
Total	**169376.9**	

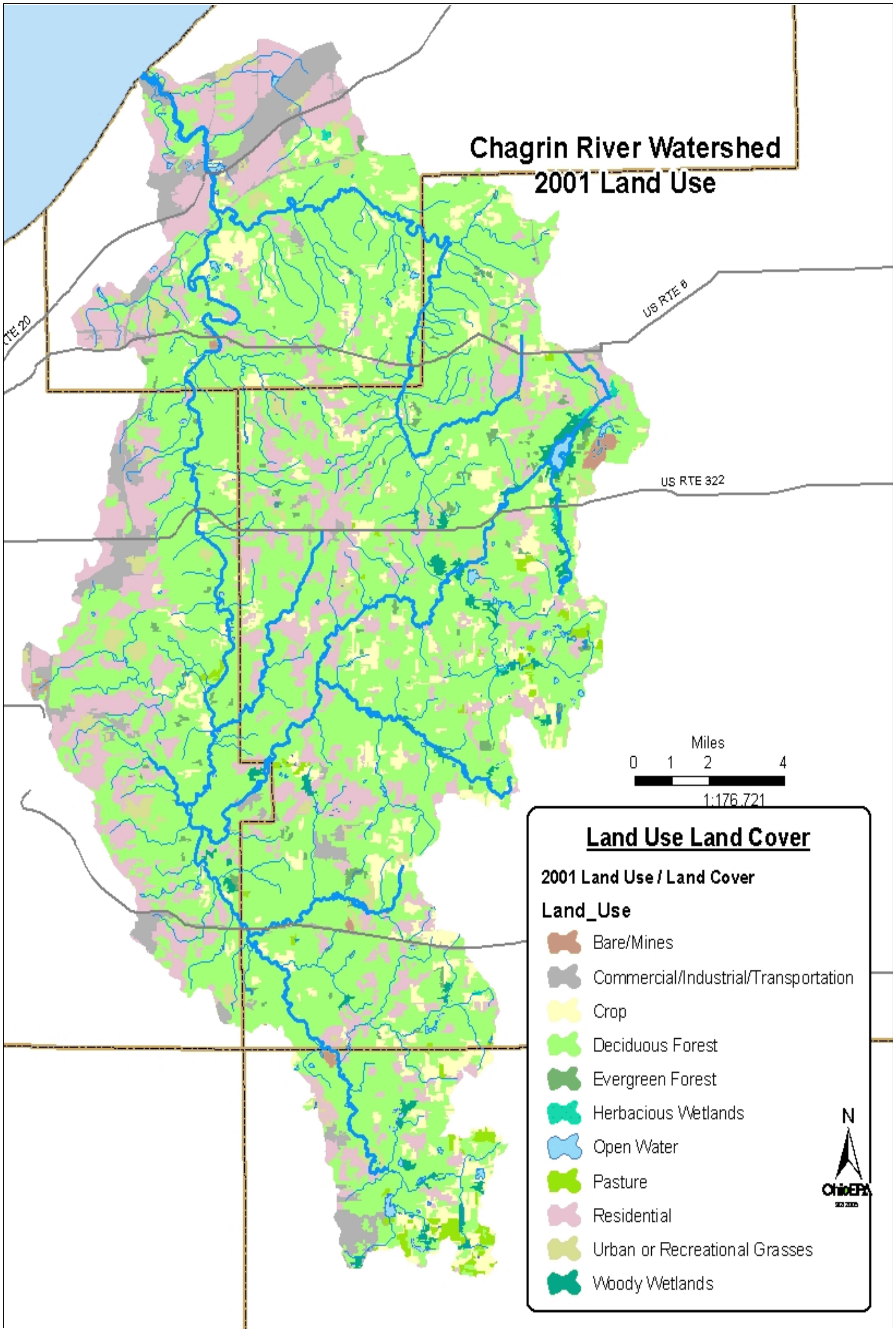

Figure 2-1. Chagrin River Land Use

3.0 PROBLEM STATEMENT

The goal of the TMDL process is full attainment of the WQS, and in particular attainment of the numerical biological criteria. As described in Section 2, the water quality and biological assessment of the Chagrin River watershed indicates that the nonattainment of WQS is primarily due to organic enrichment, flow alteration, and habitat degradation. These correspond to nonattainment of the numeric biocriteria.

3.1 Target Identification

The establishment of load reduction and habitat improvement goals (or targets) is a significant component of the TMDL process. The TMDL identifies the load reductions and other actions that are necessary to meet the target, resulting in the attainment of applicable water quality standards.

Numeric targets are derived directly or indirectly from state narrative or numeric WQS (OAC 3745-1). In Ohio, applicable biocriteria are appropriate numeric targets (see Section 2.2). Determinations of current use attainment are based on a comparison of a stream's biological scores to the appropriate criteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores.

Biocriteria

Biocriteria are the final arbiter of attainment of a use designation. Once control strategies have been implemented, biological measures including the IBI, ICI, QHEI and MIwb will be used to validate biological improvement and biocriteria attainment. The current attainment status of the biocriteria is listed in Appendix A. Applicable biocriteria for the Chagrin River basin are included in Table 3-1.

Table 3-1. Chagrin River basin applicable biocriteria

Ecoregion Biocriteria: Erie/Ontario Lake Plain (EOLP)

INDEX - Site Type		WWH	EWH	MWH	
IBI - Headwaters		40	50	24	
IBI - Wading			38	50	24
IBI - Boat	40	48	24		
Mod. Iwb - Wading		7.9	9.4	6.2	
Mod. Iwb - Boat		8.7	9.6	5.8	
ICI	34	46	22		

Nutrients

In Ohio, applicable biocriteria are appropriate numeric targets (see Section 2.2). Determinations of current use attainment are based on a comparison of a stream's biological scores to the appropriate criteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores.

Ohio EPA currently does not have statewide numeric criteria for nutrients but potential targets have been identified in a technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients on the aquatic assemblages of Ohio streams and rivers. The study reaches a number of conclusions and stresses the importance of habitat and other factors, in addition to instream nutrient concentrations, as having an impact on the health of biologic communities. The study also includes proposed targets for nitrate+nitrite concentrations and total phosphorus concentrations based on observed concentrations at all sampled ecoregional sites. The total nitrate-nitrite and phosphorus targets are shown in Table 3-2. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting. Nitrate targets are consistently met within the watershed.

It has been shown that habitat quality also influences a stream's ability to process nutrients. This TMDL also focuses on habitat quality, both instream and riparian. It is anticipated that improvements in habitat coupled with phosphorus and nitrate reductions toward the target level will result in aquatic biological community attainment.

Table 3-2. Nutrient Targets

Target Concentrations for Phosphorus		
		Target Phosphorus Concentration (mg/l)
Headwaters	<20 mi^2	0.08
Wadable	>20 mi^2 <200 mi^2	0.10
Small Rivers	>200 mi^2 <1000 mi^2	0.17
Target Concentrations for Nitrate-Nitrite		
		Target Nitrate-Nitrite Concentration (mg/l)
Headwaters	<20 mi^2	1.0
Wadable	>20 mi^2 <200 mi^2	1.0
Small Rivers	>200 mi2 <1000 mi^2	1.5

Habitat

Habitat loss has been identified as a cause of impairment in the Chagrin River watershed. OAC 3745-1-04(A) states that all waters of the state shall be free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. However, no statewide numeric criteria have been developed specifically for sediment or Total Suspended Solids (TSS). Instead, target QHEI scores, based on reference data sites for some of the aquatic life use designations, can be used as surrogates.

Table 3-3. QHEI attribute(target) that can serve as management goals for efforts to restore, enhance, or protect aquatic life in streams

	Target	
Attribute	**WWH**	**EWH**
Number of any Modified Attributes	≤4	≤2
High Influence Modified Attributes	≤1	0
Substrate Metric Scores	≥13	≥15
Substrate Embeddedness Score	≥3	4
Channel Metric Score	≥14	≥15
Overall QHEI	≥60	≥75

The QHEI is a quantitative composite of six physical habitat variables used to “score” a stream’s habitat. The variables are: substrate, instream cover, riparian characteristics, channel characteristics, pool/riffle quality, and gradient and drainage area. It can be used to assess and evaluate a stream’s aquatic habitat, and determine which of the six habitat components need to be improved to reach the QHEI target score. The “substrate” parameter accounts for the source and texture of the sediment and its proportional distribution an the substrate. It also accounts for the overall quality of the substrate in the embeddedness metric. These QHEI scores provide a numeric target for sedimentation.

The Warmwater Habitat use designation QHEI target is 60. In addition, since habitat is strongly correlated with the IBI biocriteria, the QHEI provides a target and format to evaluate how habitat issues and impairments affect attainment of the aquatic use designations. Degraded habitat has been identified as a contributing cause of nonattainment in several stream segments within the TMDL area. Targets for habitat characteristics for the Chagrin River watershed are presented in Table 3-3 and have been taken from the technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). Ohio EPA QHEI data are presented in Appendix A. Additional discussion of the Ohio EPA’s QHEI methodology can be found in *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application(Ohio EPA, 1989) web link:* http://www.epa.state.oh.us/dsw/documents/BioCrit88_QHEIIntro.pdf*),* and the 2006 updated manual found at the web link:
http://www.epa.state.oh.us/dsw/documents/QHEIManualJune2006.pdf.

Total Suspended Solids

Ohio EPA does not have numeric targets for TSS and no statewide recommendations have been published. TSS targets were therefore selected by evaluating data from within the watershed. All TSS data from similarly-sized subwatersheds were grouped and the 25th percentile of the data (tiered by flow) was selected as the TMDL target. The lowest 25th percentile of the data is interpreted as the least contaminated 25 percent of all the observed values, which EPA has suggested can be comparable to “reference conditions” (U.S. EPA, 2000). The tiered 25th percentile methodology results in targets that are within the range of natural conditions within the watershed and are believed to be protective of the aquatic community. TSS targets were further refined by identifying high flow targets that apply during the highest 20th percentile of flows and base flow targets that apply during all other flow periods. The targets are presented in Table 3-4. The base flow target is similar to that of other high quality Ohio streams with approved TMDLs (Little Beaver Creek, 6 mg/l).

Table 3-4. TSS Targets

Drainage Area	High Flow Target	Base Flow Target
Headwaters (< 20 square miles)	17 mg/L	5 mg/L
Wadeable (20 < 200 square miles)	53 mg/L	5 mg/L
Small Rivers (200 < 1000 square miles)	70 mg/L	5 mg/L

Temperature

For coldwater habitat (CWH) streams, temperature targets have been set. These targets are based on temperature data gathered by ODNR through placement of instream sensors. A total of 7978 data points were used spanning a three-year period to generate the target values. These target values will be utilized for those streams determined to be capable of supporting brook trout. The monthly temperature targets are identified in Table 3-5 below.

Table 3-5. Coldwater Temperature Targets

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Monthly Average	4.0	4.4	5.5	8.8	11.7	14.3	15.3	15.4	14.3	10.9	9.3	5.1
Monthly Maximum	9.4	8.2	13.4	18.1	18.2	19.8	22.8	20.9	19.4	14.9	12.9	10.2

WQS also contain requirements for CWH. The specific language is found in OAC 3745-1-07, Table 7-1 which states: *"At no time shall the water temperature exceed the temperature which would occur if there were no temperature change attributable to human activities."*

Both targets shall be applied to streams designated as CWH in the Chagrin River watershed (OAC 3745-1-22, included in this report as Appendix B).

Bacteria

Targets for bacteria are contained in Ohio WQS, OAC 3745-1-07 Table 7-13. Standards exist for both fecal coliform bacteria and *E. Coli*. All designated streams in the Chagrin River are listed as PCR. The standards for this designation are listed in Table 3-6.

Table 3-6. Bacteria Standards

Parameter	Bathing Waters		Primary Contact		Secondary Contact
	Geometric Mean	Instantaneous	Geometric Mean	Instantaneous	Instantaneous
Fecal Coliform	200/100 ml	400/100 ml	1,000/100 ml	2,000/100 ml	5,000/100 ml
E. coli	126/100 ml	235/100 ml	126/100 ml	298/100 ml	576/100 ml

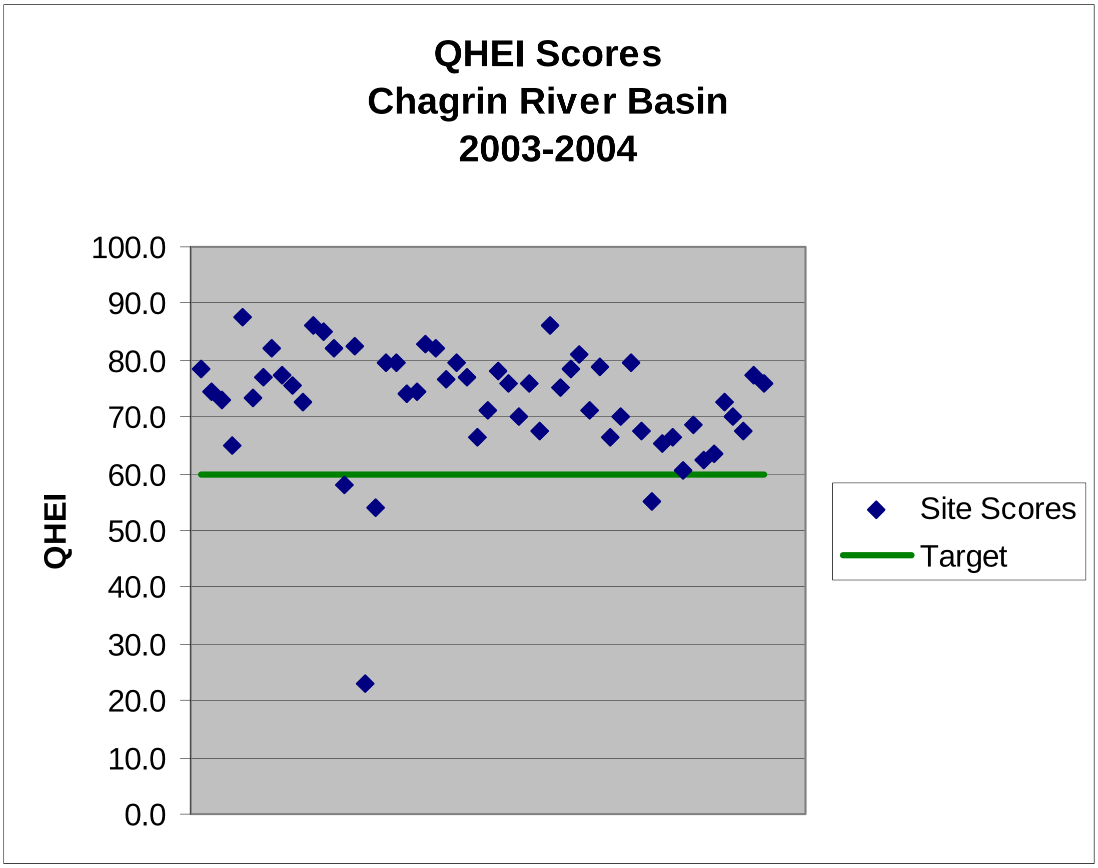

Figure 3-1. Chagrin River watershed QHEI Scores

3.2 Identification of Current Deviation from Target

Habitat

Deviations from habitat goals are those QHEI values less than 60 for WWH streams. Figure 3-1 shows Chagrin River basin QHEI scores. Of the 56 sites assessed, only 4 failed to meet the QHEI target of 60. These sites were:

	River Mile	Year	QHEI
Quarry Creek	0.10	2004	55.0
Chagrin River	49.10	2003	23.0
Aurora Branch	1.00	2003	54.0
Chagrin River	42.60	2003	58.0

Overall, habitat quality in the Chagrin River watershed is very good. QHEI scores are listed in Appendix A.

Nitrates

Target nitrate values are discussed in Section 3.1 and presented in Table 3-2. Achieving this TMDL target, in conjunction with recommended habitat improvements, dam removals, and the implementation of Phase II storm water programs, should result in attainment of applicable biocriteria standards. Deviations from target values are included in Table 3-7.

Phosphorus

Target phosphorus values are discussed in Section 3.1 and presented in Table 3-2. Achieving this TMDL target, in conjunction with recommended habitat improvements, dam removals, and the implementation of Phase II storm water programs, should result in attainment of applicable biocriteria standards. Deviations from target values are included in Table 3-7.

Biocriteria

The most recent biological survey conducted by Ohio EPA found that Chagrin River is not completely meeting biological criteria set forth in Ohio Water Quality Standards, as

Table 3-7. Deviations from nutrient targets

		Percentage of samples greater than target values		
		Headwater	**Wading**	**Small River**
HUC 0411003 020 Chagrin River (headwaters to downstream Aurora Branch)	Nitrates	18.2%	12.5%	N/A
	Phosphorus	41.8%	17.5%	N/A
HUC 0411003 030 Chagrin River (downstream Aurora Branch to mouth)	Nitrates	11.5%	16.0%	0.0%
	Phosphorus	19.2%	6.0%	4.5%

previously described in Table 3-1. A more detailed description of Ohio EPA's biocriteria can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life*, web link at: http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html. Biological assessment scores are found in Appendix A. Figures 3-2 and 3-3 depict biological attainment status for each HUC.

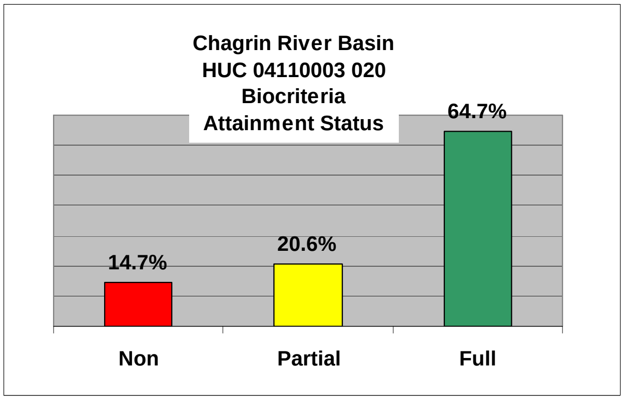

Figure 3-2. HUC 020 Attainment

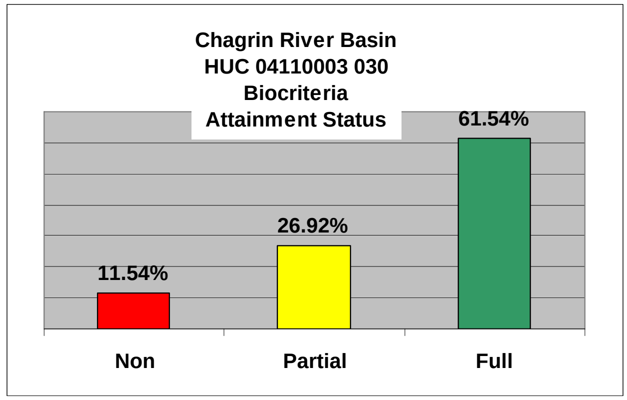

Figure 3-3. HUC 030 Attainment

3.3 Source Identification

Failing or malfunctioning home sewage disposal systems are also identified as a source contributing to nonattainment in the watershed. Home sewage disposal systems consist of both on-lot (e.g., septic tanks and tile field) and off-lot discharges. The following information was assembled in a report titled **Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems**, April 2001. The report was prepared for NOACA by CT Consultants of Willoughby. Information was presented by county and not by watershed, but it is a useful illustration of the potential pollution contribution from these sources.

In addition to the above sources, urbanization and suburbanization also contribute to non attainment. Discharges from storm sewer systems carry oxygen demanding substances, nutrients, suspend solids, and bacteria.

Dams also cause water quality impacts in the Chagrin River TMDL area. Adverse impacts from dams can include a change in thermal and hydraulic regime, chemical water quality degradation, and impaired habitat in the stream. Dams also impede or block migration routes of native fish. The Ohio Department of Natural Resources lists 84 classified dams in the watershed. All dams in the watershed should be evaluated and prioritized for removal.

Changes in the watershed have also impacted the hydrology and nature of runoff events. Increases in impervious surfaces coupled with riparian zone impacts have created a stream system subject to rapid fluctuations in flow volume. This flashiness can accelerate stream bank degradation and create additional hydrologic problems. Responses to changes in runoff patterns including channelization often serve to exacerbate the magnitude of problems and cause an accumulation of downstream impacts such as excess sediment resulting in siltation.

4.0 TOTAL MAXIMUM DAILY LOADS

4.1 Background of TMDL Development Approach

4.1.1 Objective

A TMDL is a means for recommending controls needed to restore and maintain the quality of water resources (U.S. EPA, 1991). TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes allowable loadings for a waterbody based on the relationship between pollution sources and instream water quality conditions. 40 CFR §130.2(I) states that a TMDL calculation is the sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background in a given watershed, and that TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

4.1.2 Application of Water Quality Targets

The attainment of WQS in Ohio requires meeting criteria protective of various beneficial uses including recreational activities, aquatic life, and water supply. Attainment of aquatic life beneficial uses are determined by direct sampling of the aquatic biological community (biocriteria). Chemical water quality criteria are established as a surrogate for direct measurement of the aquatic biological community to allow a determination if a particular pollutant is present in amounts that are projected to cause impairment of the designated aquatic life use. By limiting the loads of critical pollutants, a TMDL establishes a level of the pollutant(s) whereby an impairment to the aquatic life use is projected to be eliminated. In Ohio, this approach will be judged to be successful when direct measurement of the aquatic biological community results in the attainment of appropriate biocriteria designated use. Some pollutants that affect aquatic organisms may be most appropriately measured with indirect, or surrogate, measurements. Based on an extensive database of synoptic measures of the aquatic communities and habitat quality, Ohio EPA has established a direct association between poor habitat quality and impaired biological communities (Ohio EPA, 1999) .

The condition of human-induced physical and hydrologic habitat modification degrades the quantity and the quality of dwelling places for aquatic life, placing additional stress upon the biological community. Where habitat quality is poor, there is also a complex interaction among the remaining biota, and the pollutants heat, sediment, nitrate and phosphorus. This interaction can contribute to excessive algal growth and low dissolved oxygen, particularly during pre-dawn hours as algal colonies respire (Hynes, 1970).

Ohio has designed a functional measure of habitat, the QHEI, that can be used as a surrogate to establish a target by which reduction in the loading of the pollutants heat, sediment, nitrate and phosphorus can occur. Reducing phosphorus pollutant loads and improving habitat will limit the aforementioned negative interactions. As in the case where achieving target loads for the surrogate pollutant $CBOD_5$ is expected to result in an improved dissolved oxygen regime in a stream, achieving habitat targets based on the QHEI is expected to have a similar result.

4.1.3 Linkages between Water Quality Impairments and Pollutants

Phosphorus, nitrates, total suspended solids, and fecal coliform bacteria have been identified as causes of impairment in this watershed. TMDLs have been calculated for phosphorus, nitrates, total suspended solids, and fecal coliform bacteria. Many implementation actions to reduce nutrients are geared toward reducing sediment, which will also reduce nutrient loads since phosphorus can bind to sediment as a delivery mechanism to the stream.

Degraded or poor habitat is also a non-load based cause of impairment in the Chagrin River watershed. Identification of which aspects of the habitat are degraded at particular points in the watershed is provided in this report as are benchmarks that can be used to set habitat goals. This is analogous to allocations of loads for pollutants. These recommended habitat "allocations" are a necessary means to meet biocriteria and water quality standards (in combination with the other TMDLs described above) and as such are a habitat "TMDL."

4.2 Method of Calculation

4.2.1 TMDL Development: Load Duration Curve

Load reductions were determined through the use of load duration curves. This approach involves calculating the allowable loadings over the range of flow conditions expected to occur in the impaired stream by taking the following steps:

1. A flow duration curve for the stream is developed by generating a flow frequency table and plotting the data points.

2. The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the water quality standard and by a conversion factor. The resulting points are graphed.

3. Each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the individual loads are plotted on the TMDL graph.

4. Points plotting above the curve represent deviations from the water quality standard and the daily allowable load. Those plotting below the curve represent compliance with standards and the daily allowable load.

5. The area beneath the TMDL curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards.

The stream flows displayed on a load duration curve may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into 10 groups which can be further categorized into the following five "hydrologic zones" (Cleland, 2005):

1. High flow zone: stream flows that plot in the 0 to 10 percentile range, related to flood flows.
2. Moist zone: flows in the 10 to 40 percentile range, related to wet weather conditions.
3. Mid-range zone: flows in the 40 to 60 percentile range, median stream flow conditions;
4. Dry zone: flows in the 60 to 90 percentile range, related to dry weather flows.
5. Low flow zone: flows in the 90 to 100 percentile range, related to drought conditions.

The load duration approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Table 4-1 summarizes the relationship between the five hydrologic zones and potentially contributing source areas.

The load reduction approach also considers critical conditions and seasonal variation in the TMDL development as required by the Clean Water Act and EPA's implementing regulations. Because the approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

Table 4-1. Hydrologic zones and source areas

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
On-site wastewater systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Storm water: Impervious		H	H	H	
Combined sewer overflow (CSO)	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

4.2.2 Stream Flow Estimates

Daily stream flows for each monitoring site of interest are needed to apply the load duration curve. Continuous stream flow data are available for the Chagrin River at Willoughby, Ohio (U. S. Geological Survey (USGS) station 04209000) from August 1, 1925 to September 30,

2006. Sampling data for October 1, 1994 through September 30, 1995 and from October 1, 1999 through September 30, 2000 are not available. This site drains more than 90 percent of the entire Chagrin River watershed.

Since the load duration approach requires a flow time series for each site where the method is applied, stream flows were extrapolated from the Willoughby stream flow record for each load duration site by using a multiplier based upon the ratio of the upstream drainage area for a given site to the USGS gage drainage area. For example, the ratio of the drainage area at the Aurora Branch monitoring site (D01P22) is 36.67 square miles which, if divided by the drainage area of the USGS gage (246 square miles), equals 0.149. Thus, the observed daily stream flows at the Willoughby USGS gage were multiplied by 0.149 to estimate the daily stream flows at the Aurora Branch monitoring site. Table 4-2 presents the drainage area ratios used to estimate stream flow for all of the load duration sites included in this TMDL; the locations of the sites are shown in Figure 4-1.

Table 4-2. Drainage Area Ratios Used to Estimate Stream Flow for Load Duration Analyses in the Chagrin River Watershed.

11-Digit AU	14-Digit HUC	Station ID	Stream Name	Location	River Mile	Upstream Drainage Area (Sq. mi.)	Drainage Area Ratio
0411003020	030	D01P22	Aurora Branch	At Bainbridge Rd	3.80	36.67	0.149
	040	D01P19	Aurora Branch	At Solon Rd	1.03	56.23	0.229
	010	D01W32	Spring Brook	West of Bass Lake at Old RR Grade	0.10	0.65	0.003
	010	D01G01	Chagrin River	At Sperry Rd	40.05	30.70	0.125
	010	D01S11	Chagrin River	At Miles Rd	28.96	58.44	0.238
0411003030	010	D01P07	Chagrin River	At Chagrin Blvd	25.30	126.96	0.516
	010	D01P04	Chagrin River	At Old Mill Rd	18.08	156.61	0.637
	020	D01S20	East Branch Chagrin River	At Mitchell's Mill Rd	10.28	26.47	0.108
	020	D01P01	East Branch Chagrin River	At Markell Rd	2.35	45.25	0.184
	030	502400	Chagrin River	At Daniels Park	4.95	244.15	0.992

4.2.3 Load Duration Curve Results for Assessment Unit 020

Load duration analyses were conducted for all sites with a sufficient number of samples (typically more than 10) within each of the two major assessment units. Data used in the analyses resulted from sampling conducted by Ohio EPA from 1995 through 2004. Appendix E contains the load duration results for all stations for all four water quality parameters (TSS, total phosphorus, nitrate+nitrite, and fecal coliform). This section summarizes those results by station.

Assessment Unit 020: Chagrin River Headwaters to Downstream Aurora Branch

The load duration approach was applied to five sites located within Assessment Unit 020 (Figure 4-2):

* Two sites are located on the mainstem of the Chagrin River at Sperry Road (D01G01) and at Miles Road (D01S11).
* Two sites are located on the Aurora Branch at Bainbridge Road (D01P22) and at Solon Road (D01P19). One station is located on Spring Brook at the old railroad grade (D01W32).

For each load duration site, all appropriate and available water quality and flow data were used. Table 4-3 summarizes the data used for the load duration analyses in Assessment Unit 020.

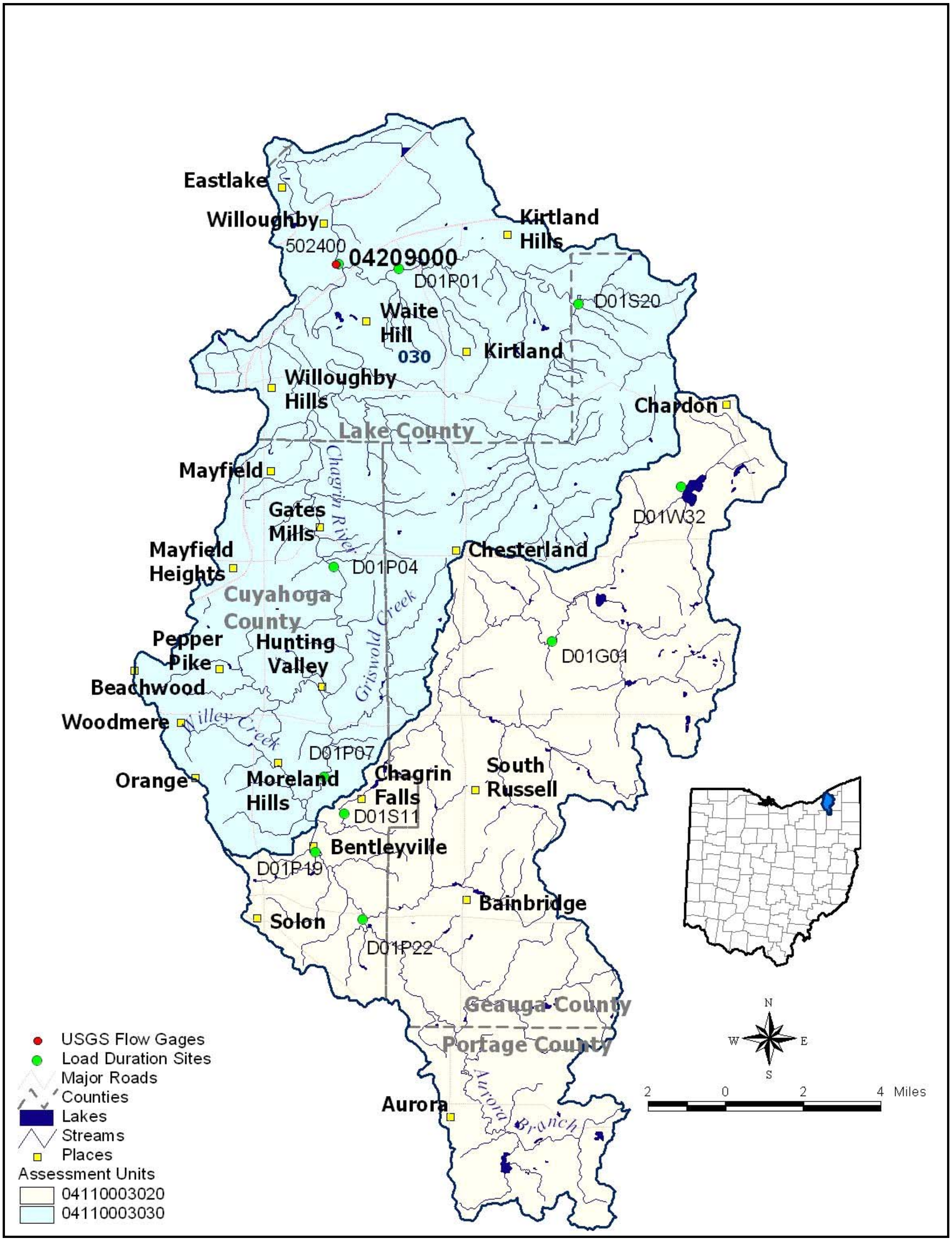

Figure 4-1. Load duration Sites

Table 4-3. Data used for the load duration analyses in Assessment Unit 020

Stream	Location (Monitoring Station)	Parameter	Count	Average (mg/l)	Minimum (mg/l)	Maximum (mg/l)	Period of Record
Aurora Branch	At Bainbridge Road (D01P22)	TP	12	0.05	0.02	0.15	8/27/2003 - 8/16/2004
		NO-2NO3	12	0.49	0.10	0.81	8/27/2003 - 8/16/2004
		TSS	12	22.81	5.00	63.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100ml)	8	9,059	180	60,190	8/27/2003 - 8/16/2004
Aurora Branch	At Solon Road (D01P19)	TP	11	0.10	0.06	0.26	8/27/2003 - 8/16/2004
		NO3-NO2	11	1.22	0.40	2.54	8/27/2003 - 8/16/2004
		TSS	11	38.36	6.00	115.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100m)	8	2,610	50	9,000	8/27/2003 - 8/16/2004
Spring Brook (West of Bass Lake)	At Old RR Grade (D01W32)	TP	28	0.06	0.05	0.12	9/24/1997 - 7/18/2002
		NO3-NO2	30	1.75	0.17	2.28	9/24/1997 - 9/23/2002
		TSS	30	5.57	5.00	20.00	9/24/1997 - 9/23/2002
		Fecal Coliform (#/100ml)	13	267	48	1,200	5/10/1999 - 9/23/2002
Chagrin River	At Sperry Road (D01G01)	TP	11	0.07	0.03	0.20	8/27/2003 - 8/16/2004
		NO3-NO2	11	0.36	0.10	0.51	8/27/2003 - 8/16/2004
		TSS	11	16.45	5.00	51.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100ml)	8	2,239	100	7,500	8/27/2003 - 8/16/2004
Chagrin River	At Miles Road (D01S11)	TP	15	0.08	0.02	0.26	7/13/1995 - 8/16/2004
		NO3-NO2	15	0.36	0.10	0.74	7/13/1995 - 8/16/2004
		TSS	15	30.97	5.00	149.00	7/13/1995 - 8/16/2004
		Fecal Coliform (#/100ml)	9	2,559	130	7,100	7/27/1995 - 8/16/2004

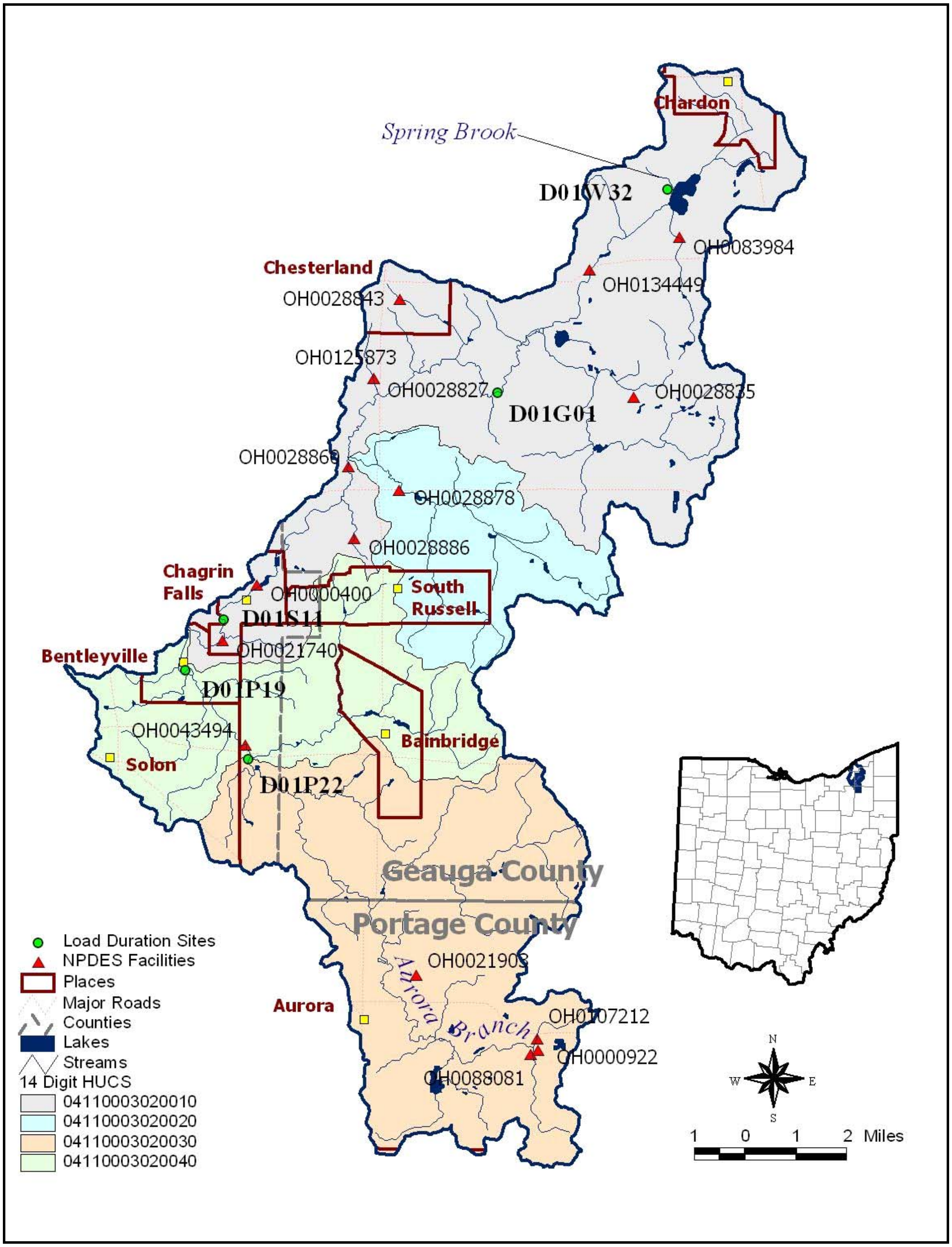

Figure 4-2. Load duration sites for assessment unit 020

Aurora Branch (D01P22)

Existing and allowable loads were calculated for the Aurora Branch at Bainbridge Road (station D01P22). This location drains 37 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (56%) and pasture/hay (22%) land uses. A total of twelve TP, NO3-NO2, and TSS samples and eight fecal coliform samples were available for the load duration analysis at site D01P22 (Table 4-3). Most data were collected during low to dry flow conditions (Appendix E).

Total Phosphorus

The calculated existing and allowable TP loads shown in Appendix E for station D01P22 were grouped based on duration curve zones and Table 4-4 summarizes the results. The table indicates that TP loads need to be reduced by only a very small amount during periods of moist conditions.

Table 4-4. Total Phosphorus Loading Statistics for Load Duration Site D01P22

Zone	Flow Exceedence Ranges	12-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	249.22	61	No Data	No Data
Moist Conditions	10-20	1	98.92	24	24	1.0%
	20-30	1	59.32	15	6	0.0%
	30-40	1	41.90	10	2	0.0%
Mid-Range Flows	40-50	0	31.39	8	No Data	No Data
	50-60	0	22.53	6	No Data	No Data
Dry Conditions	60-70	3	16.52	4	1	0.0%
	70-80	1	12.46	3	1	0.0%
	80-90	4	9.46	2	1	0.0%
Low Flows	90-100	1	6.31	2	1	0.0%

Nitrite-Nitrate (NO3-NO2)

None of the twelve NO3-NO2 observations exceed the loading limit; therefore, Table 4-5 indicates that NO3-NO2 loads do not need to be reduced at site D01P22.

Table 4-5. NO3-NO2 Loading Statistics for Load Duration Site D01P22

Zone	Flow Exceedence Ranges	12-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	249.22	610	No Data	No Data
Moist Conditions	10-20	1	98.92	242	102	0.0%
	20-30	1	59.32	145	135	0.0%
	30-40	1	41.90	103	10	0.0%
Mid-Range Flows	40-50	0	31.39	77	No Data	No Data
	50-60	0	22.53	55	No Data	No Data
Dry Conditions	60-70	3	16.52	40	21	0.0%
	70-80	1	12.46	30	15	0.0%
	80-90	4	9.46	23	12	0.0%
Low Flows	90-100	1	6.31	15	4	0.0%

Total Suspended Solids

All of the twelve TSS observations at site D01P22 are at or exceed the loading limit (Appendix E). The greatest exceedence of the standard is during moist conditions. Table 4-6 summarizes the median of existing loads for each of the duration curve zones and indicates that TSS loads need to be reduced by as much as 90 percent during periods of moist conditions. Sources of TSS loads appear to be associated with all flow regimes and likely include runoff from agricultural lands and potential stream bank erosion.

Table 4-6. TSS Loading Statistics for Load Duration Site D01P22

Zone	Flow Exceedence Ranges	12-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	249.22	32,316	No Data	No Data
Moist Conditions	10-20	1	98.92	12,827	14,537	11.8%
	20-30	1	59.32	726	6,809	89.3%
	30-40	1	41.90	513	999	48.7%
Mid-Range Flows	40-50	0	31.39	384	No Data	No Data
	50-60	0	22.53	276	No Data	No Data
Dry Conditions	60-70	3	16.52	202	262	23.0%
	70-80	1	12.46	152	305	50.0%
	80-90	4	9.46	116	647	82.1%
Low Flows	90-100	1	6.31	77	176	56.3%

Fecal coliform

Three of the eight fecal coliform observations at site D01P22 exceed the loading limit and the loading limit is exceeded within the moist and dry hydrologic zones. Table 4-7 indicates that fecal coliform loads need to be reduced by approximately 80 percent during periods of dry and moist conditions. Sources of fecal coliform loads appear to be associated with both wet weather flows and dry conditions and could include runoff from agricultural lands, livestock with direct access to the stream channel, wildlife, and failing septic systems.

Table 4-7. Fecal Coliform Loading Statistics for Load Duration Site D01P22

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	249.22	6,097,375	No Data	No Data
Moist Conditions	10-20	1	98.92	2,420,212	13,152,254	81.6%
	20-30	0	59.32	1,451,319	No Data	No Data
	30-40	0	41.90	1,025,109	No Data	No Data
Mid-Range Flows	40-50	0	31.39	767,913	No Data	No Data
	50-60	0	22.53	551,134	No Data	No Data
Dry Conditions	60-70	2	16.52	404,165	98,726	0.0%
	70-80	1	12.46	304,961	106,736	0.0%
	80-90	3	9.46	231,476	1,318,312	82.4%
Low Flows	90-100	1	6.31	154,317	37,036	0.0%

Aurora Branch (D01P19)

Existing and allowable loads were calculated for the Aurora Branch at Solon Road (station D01P22). This location drains 56 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (55%), pasture/hay (20%), low intensity residential (7%), and row crop land uses (7%). A total of eleven TP, NO3-NO2, and TSS samples and eight fecal coliform samples were available for the load duration analysis at site D01P19 (Table 4-3). Most data are from the low to dry flow conditions.

Total Phosphorus

Two of the eleven TP observations exceed the loading limit (Appendix E). Table 4-8 indicates that only minor reductions in TP loads are needed during periods of moist conditions and low flows.

Table 4-8. Total Phosphorus Loading Statistics for Load Duration Site D01P19

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	382.17	94	No Data	No Data
Moist Conditions	10-20	1	151.70	37	38	1.0%
	20-30	1	90.97	22	16	0.0%
	30-40	1	64.25	16	9	0.0%
Mid-Range Flows	40-50	0	48.13	12	No Data	No Data
	50-60	0	34.54	8	No Data	No Data
Dry Conditions	60-70	3	25.33	6	4	0.0%
	70-80	1	19.11	5	4	0.0%
	80-90	3	14.51	4	3	0.0%
Low Flows	90-100	1	9.67	2	2	3.8%

Nitrite-Nitrate (NO3-NO2)

Five of the eleven NO3-NO2 observations exceed the loading limit (Appendix E). Table 4-9 indicates that NO3-NO2 loads need to be reduced by approximately 20 percent during periods of moist conditions, 32 percent during dry conditions and 66 percent during low flows. Sources of NO3-NO2 loads appear to be mostly associated with dry weather flows and could include one or more point sources.

Table 4-9. NO3-NO2 Loading Statistics for Load Duration Site D01P19

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	382.17	935	No Data	No Data
Moist Conditions	10-20	1	151.70	371	202	0.0%
	20-30	1	90.97	223	278	19.8%
	30-40	1	64.25	157	61	0.0%
Mid-Range Flows	40-50	0	48.13	118	No Data	No Data
	50-60	0	34.54	85	No Data	No Data
Dry Conditions	60-70	3	25.33	62	90	31.5%
	70-80	1	19.11	47	31	0.0%
	80-90	3	14.51	35	26	0.0%
Low Flows	90-100	1	9.67	24	69	65.6%

TSS

All eleven TSS observations exceed the loading limit (Appendix E). The loading limit is exceeded within all flow conditions. The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-10 summarizes the median of existing loads for each of the duration curve zones. Table 4-10 indicates that TSS loads need to be reduced by approximately 80 percent during all flow periods. Sources of TSS loads appear to be associated with both dry and wet weather flows and could include storm water runoff from residential lands, storm water runoff from row crops, and stream bank erosion.

Table 4-10. TSS Loading Statistics for Load Duration Site D01P19

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	382.17	49,556	No Data	No Data
Moist Conditions	10-20	1	151.70	19,670	21,230	7.3%
	20-30	1	90.97	1,113	10,442	89.3%
	30-40	1	64.25	786	920	14.5%
Mid-Range Flows	40-50	0	48.13	589	No Data	No Data
	50-60	0	34.54	423	No Data	No Data
Dry Conditions	60-70	3	25.33	310	1,437	78.4%
	70-80	1	19.11	234	1,684	86.1%
	80-90	3	14.51	177	1,830	90.3%
Low Flows	90-100	1	9.67	118	730	83.8%

Fecal coliform

Three of the eight fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry conditions by approximately 80 percent as shown in Table 4-11. Potential sources of fecal coliform at this location might include storm water runoff from residential lands, storm water runoff from row crops, failing septic systems, and point sources.

Table 4-11. Fecal Coliform Loading Statistics for Load Duration Site D01P19

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	382.17	9,350,195	No Data	No Data
Moist Conditions	10-20	1	151.70	3,711,343	16,984,169	78.1%
	20-30	0	90.97	2,225,566	No Data	No Data
	30-40	0	64.25	1,571,982	No Data	No Data
Mid-Range Flows	40-50	0	48.13	1,177,578	No Data	No Data
	50-60	0	34.54	845,152	No Data	No Data
Dry Conditions	60-70	2	25.33	619,778	286,675	0.0%
	70-80	1	19.11	467,651	350,738	0.0%
	80-90	3	14.51	354,964	1,943,849	81.7%
Low Flows	90-100	1	9.67	236,642	108,179	0.0%

Spring Brook (D01W32)

Existing and allowable loads were calculated for Spring Brook at the old railroad grade (D01W32). This location drains 0.65 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (56%), pasture/hay (15%), and low intensity residential (14%) land uses. A total of 13 TP samples, 15 NO3-NO2 samples, and 15 TSS samples were available for the load duration analysis at site D01W32 (Table 4-3). Additional samples were taken in 2000 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses. Most data have been collected during low and dry flow conditions.

Total Phosphorus

Four of the thirteen TP observations exceed the loading limit (Appendix E). The loading limit is exceeded within the moist and dry hydrologic zones. Table 4-12 indicates that TP loads need to be reduced by approximately 8 percent during these periods.

Table 4-12. Total Phosphorus Loading Statistics for Load Duration Site D01W32

Zone	Flow Exceedence Ranges	13-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	4.41	0.86	No Data	No Data
Moist Conditions	10-20	1	1.75	0.34	0	7.3%
	20-30	2	1.05	0.21	0	0.0%
	30-40	1	0.74	0.15	0	0.0%
Mid-Range Flows	40-50	1	0.56	0.11	0	0.0%
	50-60	0	0.40	0.08	No Data	No Data
Dry Conditions	60-70	2	0.29	0.06	0	7.9%
	70-80	0	0.22	0.04	No Data	No Data
	80-90	4	0.17	0.03	0	0.0%
Low Flows	90-100	2	0.11	0.02	0	0.0%

Nitrite-Nitrate (NO3-NO2)

All but one of the fifteen NO3-NO2 observations exceed the loading limit (Appendix E) and the loading limit is exceeded within all flow conditions. The greatest exceedence of the target is during dry flow conditions. Table 4-13 indicates that NO3-NO2 loads need to be reduced by approximately 30 to 50 percent, depending on the flow condition. Potential sources include runoff from pasture lands, runoff from residential lands, and failing septic systems.

Table 4-13. NO3-NO2 Loading Statistics for Load Duration Site D01W32

Zone	Flow Exceedence Ranges	15-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	4.41	11	No Data	No Data
Moist Conditions	10-20	1	1.75	4	6	34.0%
	20-30	2	1.05	3	4	35.5%
	30-40	1	0.74	2	3	42.6%
Mid-Range Flows	40-50	1	0.56	1	2	23.7%
	50-60	0	0.40	1	No Data	No Data
Dry Conditions	60-70	2	0.29	1	1	50.2%
	70-80	1	0.22	1	1	43.9%
	80-90	5	0.17	0	1	43.8%
Low Flows	90-100	2	0.11	0	1	47.7%

TSS

Two of the fifteen TSS observations exceed the loading limit (Appendix E). The loading limit is exceeded within during mid-range and dry conditions. The greatest exceedence of the standard is during dry conditions. Table 4-14 indicates that TSS loads need to be reduced by approximately 3 percent during mid-range and dry conditions.

Table 4-14. TSS Loading Statistics for Load Duration Site D01W32

Zone	Flow Exceedence Ranges	15-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	4.41	183	No Data	No Data
Moist Conditions	10-20	1	1.75	73	17	0.0%
	20-30	2	1.05	13	12	0.0%
	30-40	1	0.74	9	9	0.0%
Mid-Range Flows	40-50	1	0.56	7	7	0.0%
	50-60	0	0.40	5	No Data	No Data
Dry Conditions	60-70	2	0.29	4	4	3.1%
	70-80	1	0.22	3	2	0.0%
	80-90	5	0.17	2	2	3.1%
Low Flows	90-100	2	0.11	1	1	0.0%

Fecal coliform

None of the fecal coliform observations exceed the loading limit and therefore no load reductions are needed at this location (Table 4-15).

Table 4-15. Fecal Coliform Loading Statistics for Load Duration Site D01W32.

Zone	Flow Exceedence Ranges	7-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	4.41	107,931	No Data	No Data
Moist Conditions	10-20	1	1.75	42,841	3,699	0.0%
	20-30	0	1.05	25,690	No Data	No Data
	30-40	0	0.74	18,146	No Data	No Data
Mid-Range Flows	40-50	0	0.56	13,593	No Data	No Data
	50-60	0	0.40	9,756	No Data	No Data
Dry Conditions	60-70	0	0.29	7,154	No Data	No Data
	70-80	0	0.22	5,398	No Data	No Data
	80-90	4	0.17	4,097	338	0.0%
Low Flows	90-100	2	0.11	2,732	632	0.0%

Chagrin River (D01G01)

Existing and allowable loads were calculated for the Chagrin River at Sperry Road (D01G01). This location drains 31 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (55%) and pasture/hay (19%) land uses. A total of eleven TP, NO3-NO2, and TSS samples and eight fecal coliform samples were available for the load duration analysis at site D01G01. Most data are from the low to dry flow conditions.

Total Phosphorus

Two of the eleven TP observations exceed the loading limit and observed loads are usually below allowable loads (Appendix E and Table 4-16). No TP load reductions are therefore recommended for this location.

Table 4-16. Total Phosphorus Loading Statistics for Load Duration Site D01G01.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	208.69	51	No Data	No Data
Moist Conditions	10-20	1	82.84	20	20	0.1%
	20-30	1	49.67	12	6	0.0%
	30-40	1	35.09	9	2	0.0%
Mid-Range Flows	40-50	0	26.28	6	No Data	No Data
	50-60	0	18.86	5	No Data	No Data
Dry Conditions	60-70	3	13.83	3	2	0.0%
	70-80	1	10.44	3	2	0.0%
	80-90	3	7.92	2	1	0.0%
Low Flows	90-100	1	5.28	1	1	0.0%

Nitrite-Nitrate (NO3-NO2)

None of the NO3-NO2 observations at site D01G01 exceed the loading limit and therefore no NO3-NO2 reductions are recommended for this location (Appendix E and Table 4-17).

Table 4-17. NO3-NO2 Loading Statistics for Load Duration Site D01G01.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	208.69	511	No Data	No Data
Moist Conditions	10-20	1	82.84	203	48	0.0%
	20-30	1	49.67	122	68	0.0%
	30-40	1	35.09	86	8	0.0%
Mid-Range Flows	40-50	0	26.28	64	No Data	No Data
	50-60	0	18.86	46	No Data	No Data
Dry Conditions	60-70	3	13.83	34	13	0.0%
	70-80	1	10.44	26	13	0.0%
	80-90	3	7.92	19	7	0.0%
Low Flows	90-100	1	5.28	13	5	0.0%

TSS

Seven of the eleven TSS observations exceed the loading limit (Appendix E). Table 4-18 indicates that TSS loads need to be reduced by 36 to 70 percent during moist conditions and by 12 to 80 percent during low flows to dry conditions. Sources of TSS loads appear to be associated with both wet weather and dry weather flows and could include runoff from pasture lands and stream bank erosion.

Table 4-18. TSS Loading Statistics for Load Duration Site D01G01.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	208.69	27,061	No Data	No Data
Moist Conditions	10-20	1	82.84	10,741	9,854	0.0%
	20-30	1	49.67	608	2,086	70.9%
	30-40	1	35.09	429	669	35.9%
Mid-Range Flows	40-50	0	26.28	322	No Data	No Data
	50-60	0	18.86	231	No Data	No Data
Dry Conditions	60-70	3	13.83	169	375	54.9%
	70-80	1	10.44	128	689	81.5%
	80-90	3	7.92	97	286	66.1%
Low Flows	90-100	1	5.28	65	74	12.5%

Fecal coliform

Four of the eight fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry conditions. Table 4-19 indicates that fecal coliform loads need to be reduced by approximately 85 percent during moist conditions and 30 to 75 percent during dry flow periods. Potential sources of fecal coliform upstream of this location include runoff from pasture lands and livestock or wildlife with direct access to the stream channel.

Table 4-19. Fecal Coliform Loading Statistics for Load Duration Site D01G01.

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	208.69	5,105,781	No Data	No Data
Moist Conditions	10-20	1	82.84	2,026,621	14,491,249	86.0%
	20-30	0	49.67	1,215,296	No Data	No Data
	30-40	0	35.09	858,399	No Data	No Data
Mid-Range Flows	40-50	0	26.28	643,030	No Data	No Data
	50-60	0	18.86	461,505	No Data	No Data
Dry Conditions	60-70	2	13.83	338,437	83,932	0.0%
	70-80	1	10.44	255,366	357,512	28.6%
	80-90	3	7.92	193,832	801,234	75.8%
Low Flows	90-100	1	5.28	129,221	14,768	0.0%

Chagrin River (D01S11)

Existing and allowable loads were calculated for the Chagrin River at Miles Road (D01S11).

This location drains 58 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (58%), pasture/hay (18%), low intensity residential (6%), and woody wetland (5%) land uses. A total of ten TP, NO3-NO2, and TSS samples and seven fecal coliform samples were available for the load duration analysis at site D01S11. Five additional samples were taken in 1995 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses. Most data are from the low to dry flow conditions.

Total Phosphorus

Only one of the ten TP observations exceeds the loading limit and this occurred during dry conditions (Appendix E) but Table 4-20 indicates that this results in needing to reduce TP loads by approximately 60 percent during dry conditions.

Table 4-20. Total Phosphorus Loading Statistics for Load Duration Site D01S11.

Zone	Flow Exceedence Ranges	10-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	397.20	97	No Data	No Data
Moist Conditions	10-20	1	157.66	39	37	0.0%
	20-30	1	94.54	23	10	0.0%
	30-40	1	66.78	16	16	0.0%
Mid-Range Flows	40-50	0	50.02	12	No Data	No Data
	50-60	0	35.90	9	No Data	No Data
Dry Conditions	60-70	2	26.33	6	4	0.0%
	70-80	1	19.87	5	12	61.1%
	80-90	3	15.08	4	2	0.0%
Low Flows	90-100	1	10.05	2	1	0.0%

Nitrite-Nitrate (NO3-NO2)

None of the NO3-NO2 observations exceed the loading limit and therefore no load reductions are needed at this location (Appendix E and Table 4-21).

Table 4-21. NO3-NO2 Loading Statistics for Load Duration Site D01S11.

Zone	Flow Exceedence Ranges	10-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	397.20	972	No Data	No Data
Moist Conditions	10-20	1	157.66	386	114	0.0%
	20-30	1	94.54	231	164	0.0%
	30-40	1	66.78	163	16	0.0%
Mid-Range Flows	40-50	0	50.02	122	No Data	No Data
	50-60	0	35.90	88	No Data	No Data
Dry Conditions	60-70	2	26.33	64	25	0.0%
	70-80	1	19.87	49	17	0.0%
	80-90	3	15.08	37	17	0.0%
Low Flows	90-100	1	10.05	25	6	0.0%

TSS

Nine of the ten TSS observations exceed the loading limit and the loading limit is exceeded within all flow conditions where data are available (Appendix E). Table 4-22 indicates that TSS loads need to be reduced by 20 to 60 percent during all moist conditions and by 45 to 80 percent during dry and low flow periods. Potential sources include runoff from pasture lands, runoff from residential lands, and stream bank erosion.

Table 4-22. TSS Loading Statistics for Load Duration Site D01S11.

Zone	Flow Exceedence Ranges	10-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	397.20	51,505	No Data	No Data
Moist Conditions	10-20	1	157.66	20,444	24,639	17.0%
	20-30	1	94.54	1,157	3,176	63.6%
	30-40	1	66.78	817	1,434	43.0%
Mid-Range Flows	40-50	0	50.02	612	No Data	No Data
	50-60	0	35.90	439	No Data	No Data
Dry Conditions	60-70	2	26.33	322	1,041	69.1%
	70-80	1	19.87	243	1,167	79.2%
	80-90	3	15.08	184	866	78.7%
Low Flows	90-100	1	10.05	123	225	45.3%

Fecal coliform

A total of seven fecal coliform samples were available for the load duration analysis at site D01S11. Two additional samples were taken in 1995 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses.

Table 4-23 indicates that fecal coliform loads need to be reduced by approximately 80 percent during moist and dry flow periods. Potential sources of fecal coliform upstream of this location include runoff from pasture lands, runoff from residential lands, and livestock or wildlife with direct access to the stream channel.

Table 4-23. Fecal Coliform Loading Statistics for Load Duration Site D01S11.

Zone	Flow Exceedence Ranges	7-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	397.20	9,717,908	No Data	No Data
Moist Conditions	10-20	1	157.66	3,857,298	26,110,400	85.2%
	20-30	0	94.54	2,313,091	No Data	No Data
	30-40	0	66.78	1,633,803	No Data	No Data
Mid-Range Flows	40-50	0	50.02	1,223,888	No Data	No Data
	50-60	0	35.90	878,389	No Data	No Data
Dry Conditions	60-70	1	26.33	644,152	714,423	9.8%
	70-80	1	19.87	486,042	243,021	0.0%
	80-90	3	15.08	368,923	1,777,859	79.2%
Low Flows	90-100	1	10.05	245,949	81,514	0.0%

4.2.4 Assessment Unit 020 Allocations

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

TMDL = WLA + LA + MOS

A summary of the load reductions needed for all parameters in assessment unit 020 is presented in Table 4-24 and the allocations by each of the various sources and parameters are shown in the following tables. WLAs were established for both facilities with individual National Pollutant Discharge Elimination System (NPDES) permits as well as Municipal Separate Storm Sewer Systems (MS4s) that are regulated under Phase II of EPA's storm water program. Much of the Chagrin River watershed is composed of MS4 entities and therefore a good proportion of the allowable loads are allocated to this source category.

The WLAs for individual facilities are summarized in Table 4-26, Table 4-29, Table 4-32, and Table 4-35 and were established based on the facilities design flow and following parameter concentrations:

* TP: 1 mg/L
* NO3-NO2: 5 mg/L
* TSS: 18 mg/L

In some cases the calculated WLAs exceeded the allowable load during certain (usually low) flow regimes. In these situations the entire allowable load (minus a reserve for the margin of safety) was allocated to the facility WLAs.

WLAs for MS4 communities located within assessment unit 020 stations are summarized in Table 4-27, Table 4-30, Table 4-33, and Table 4-36. MS4 communities were assigned WLAs based on their proportion of a sampling station's drainage area. For example, if a load duration curve sampling station drained 25 square miles and Community X comprised 10 of those square miles, Community X received a WLA equal to 40 percent of the allowable load (after accounting for individual NPDES facility allocations). Furthermore, MS4 communities received a WLA of zero for all low flow and dry conditions as storm water was not considered a significant source during these periods.

Table 4-24. Load Reductions needed with the Chagrin River watershed assessment unit 020 based on load duration curve analysis.

Stream	Location (Monitoring Station)	Parameter	Flow Regimes									
			High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
			0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora Branch	At Bainbridge Road (D01P22)	TP	No Data	1%	0%	0%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	12%	89%	49%	No Data	No Data	23%	50%	82%	56%
		Fecal Coliform	No Data	82%	No Data	No Data	No Data	No Data	0%	0%	82%	0%
	At Solon Road (D01P19)	TP	No Data	1%	0%	0%	No Data	No Data	0%	0%	0%	4%
		NO3-NO2	No Data	0%	20%	0%	No Data	No Data	32%	0%	0%	66%
		TSS	No Data	7%	89%	15%	No Data	No Data	78%	86%	90%	84%
		Fecal Coliform	No Data	78%	No Data	No Data	No Data	No Data	0%	0%	82%	0%
Spring Brook (West of Bass Lake)	At Old RR Grade (D01W32)	TP	No Data	7%	0%	0%	0%	No Data	8%	No Data	0%	0%
		NO3-NO2	No Data	34%	35%	43%	24%	No Data	50%	44%	44%	48%
		TSS	No Data	0%	0%	0%	0%	No Data	3%	0%	3%	0%
		Fecal Coliform	No Data	0%	No Data	No Data	No Data	No Data	No Data	No Data	0%	0%
Chagrin River	At Sperry Road (D01G01)	TP	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	0%	71%	36%	No Data	No Data	55%	81%	66%	13%
		Fecal Coliform	No Data	86%	No Data	No Data	No Data	No Data	0%	29%	76%	0%
	At Miles Road (D01S11)	TP	No Data	0%	0%	0%	No Data	No Data	0%	61%	0%	0%
		NO3-NO2	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	17%	64%	43%	No Data	No Data	69%	79%	79%	45%
		Fecal Coliform	No Data	85%	No Data	No Data	No Data	No Data	10%	0%	79%	0%

Table 4-25. TP TMDL Summary for AU020.

Subwatershed (0411000320___)	Stream	Location (Monitoring Station)	Total Phosphorus (kg/day)	Flow Regimes: High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
030	Aurora Branch	At Bainbridge Road (D01P22)	Current Load	No Data	24.5	6.5	2.3	No Data	No Data	1.2	1.5	1.0	0.7
			% Reduction	No Data	1%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**61.0**	**24.2**	**14.5**	**10.3**	**7.7**	**5.5**	**4.0**	**3.0**	**2.3**	**1.5**
			LA	30.3	9.7	4.2	1.8	0.4	0.0	0.0	0.0	0.0	0.0
			WLA: Facilities	6.6	6.6	6.6	6.6	6.6	5.2	3.8	2.9	2.2	1.5
			WLA: MS4	20.9	6.7	2.9	1.3	0.3	0.0	0.0	0.0	0.0	0.0
			WLA	27.6	13.3	9.6	7.9	6.9	5.2	3.8	2.9	2.2	1.5
			MOS	3.0	1.2	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1
040	Aurora Branch	At Solon Road (D01P19)	Current Load	No Data	37.5	15.8	9.2	No Data	No Data	3.9	3.5	3.3	2.5
			% Reduction	No Data	1%	0%	0%	No Data	No Data	0%	0%	0%	4%
			TMDL= LA+WLA+MOS	**93.5**	**37.1**	**22.3**	**15.7**	**11.8**	**8.5**	**6.2**	**4.7**	**3.5**	**2.4**
			LA	41.1	11.9	4.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0
			WLA: Facilities	13.4	13.4	13.4	13.4	11.2	8.0	5.9	4.4	3.4	2.2
			WLA: MS4	34.3	9.9	3.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0
			WLA	47.8	23.4	16.9	14.1	11.2	8.0	5.9	4.4	3.4	2.2
			MOS	4.7	1.9	1.1	0.8	0.6	0.4	0.3	0.2	0.2	0.1

Table 4-25. TP TMDL Summary for AU020 (cont'd)

Subwatershed (0411000320___)	Stream	Location (Monitoring Station)	Total Phosphorus (kg/day)	High Flows 0-10	Moist Conditions 10-20	Moist Conditions 20-30	Moist Conditions 30-40	Mid-Range Flows 40-50	Mid-Range Flows 50-60	Dry Conditions 60-70	Dry Conditions 70-80	Dry Conditions 80-90	Low Flows 90-100
010	Spring Brook (West of Bass Lake)	At Old RR Grade (D01W32)	Current Load	No Data	0.4	0.1	0.1	0.1	No Data	0.1	No Data	0.0	0.0
			% Reduction	No Data	7%	0%	0%	0%	No Data	8%	No Data	0%	0%
			TMDL= LA+WLA+MOS	**0.9**	**0.3**	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**
			LA	0.8	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
			WLA: Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			WLA: MS4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			WLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			MOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Chagrin River	At Sperry Road (D01G01)	Current Load	No Data	20.3	5.7	2.4	No Data	No Data	1.8	1.9	1.3	0.7
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**51.1**	**20.3**	**12.2**	**8.6**	**6.4**	**4.6**	**3.4**	**2.6**	**1.9**	**1.3**
			LA	47.9	18.7	11.0	7.6	5.5	3.8	2.6	1.8	1.3	0.6
			WLA: Facilities	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
			WLA: MS4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			WLA	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
			MOS	2.6	1.0	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1
		At Miles Road (D01S11)	Current Load	No Data	37.1	9.8	16.2	No Data	No Data	3.6	12.5	2.1	1.3
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	61%	0%	0%
			TMDL= LA+WLA+MOS	**97.2**	**38.6**	**23.1**	**16.3**	**12.2**	**8.8**	**6.4**	**4.9**	**3.7**	**2.5**
			LA	84.2	31.9	18.1	12.1	8.4	5.3	3.2	1.9	0.8	0.0
			WLA: Facilities	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.3
			WLA: MS4	5.4	2.1	1.2	0.8	0.5	0.3	0.2	0.0	0.0	0.0
			WLA	8.1	4.7	3.9	3.5	3.2	3.0	2.9	2.7	2.7	2.3
			MOS	4.9	1.9	1.2	0.8	0.6	0.4	0.3	0.2	0.2	0.1

Table 4-26. TP NPDES WLAs for facilities within AU020.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	TP Limit (mg/L)	TP (kg/day)
Aurora Central WWTP	OH0021903	3PC00016	1.5	1	5.68
Robin MHPs Inc. WWTP	OH0107212	3PV00058	0.066	1	0.25
Yogi Bear's Jellystone Park WWTP	OH0088081	3PR00090	0.03	1	0.11
Geauga Lake Furniture WWTP	OH0045080	3PR00061	0.155	1	0.59
Geauga Co Mcfarland Creek STP	OH0043494	3PK00010	1.8	1	6.81
Fowler Mill WWTP	OH0134449	3PR00368	0.008	1	0.03
Geauga Co Kimberly Estates STP	OH0028835	3PG00004	0.046	1	0.17
Heather Hill Hospital WWTP	OH0083984	3PR00075	0.1	1	0.38
Geauga Co Belle Vernon STP	OH0028827	3PG00010	0.04	1	0.15
Geauga Co Opalocka WWTP	OH0028843	3PH00000	0.155	1	0.59
Geauga Co Russell Park STP	OH0028860	3PG00001	0.08	1	0.30
Geauga Co. Scranton Woods WWTP	OH0125873	3PG00155	0.014	1	0.05
Geauga Co. Surry	OH0028878	3PG00006	0.01	1	0.04
Geauga Co. Wenhaven	OH0028886	3PG00008	0.007	1	0.03
Ivex Packing Corp.	OH0000400	3IA00000	Facility Closed	Facility Closed	Facility Closed
Chagrin Falls WWTP	OH0021740	3PD00038	1	1	3.79

Table 4-27. TP WLAs for MS4s within AU020.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P22 (35.18%)	18.05	5.76	2.52	1.09	0.23	0.00	0.00	0.00	0.00	0.00
	D01P19 (22.94%)	17.30	5.01	1.77	0.34	0.00	0.00	0.00	0.00	0.00	0.00
Bainbridge	D01P22 (2.49%)	1.28	0.41	0.18	0.08	0.02	0.00	0.00	0.00	0.00	0.00
	D01P19 (6.11%)	4.60	1.33	0.47	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Bentleyville	D01P19 (1.98%)	1.49	0.43	0.15	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Chagrin Falls	D01S11 (2.10%)	1.88	0.71	0.40	0.27	0.19	0.12	0.07	0.00	0.00	0.00
Moreland Hills	D01S11 (0.14%)	0.12	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
Solon	D01P22 (3.02%)	1.55	0.49	0.22	0.09	0.02	0.00	0.00	0.00	0.00	0.00
	D01P19 (11.49%)	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Russell	D01P19 (2.92%)	2.20	0.64	0.22	0.04	0.00	0.00	0.00	0.00	0.00	0.00
	D01S11 (3.83%)	3.43	1.30	0.74	0.49	0.34	0.22	0.13	0.00	0.00	0.00
Streetsboro	D01P22 (0.15%)	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D01P19 (0.10%)	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total MS4	D01P22 (40.84%)	20.95	6.68	2.92	1.27	0.27	0.00	0.00	0.00	0.00	0.00
	D01P19 (45.53%)	34.32	9.93	3.51	0.68	0.00	0.00	0.00	0.00	0.00	0.00
	D01S11 (6.06%)	5.43	2.06	1.17	0.78	0.54	0.34	0.21	0.00	0.00	0.00

Table 4-28. NO3-NO2 TMDL Summary for AU020

Subwatershed (041100320___)	Stream	Location (Monitoring Station)	N02N03 (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
030	Aurora Branch	At Bainbridge Road (D01P22)	Current Load	No Data	102	135	10	No Data	No Data	21	15	12	4
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**610**	**242**	**145**	**103**	**77**	**55**	**40**	**30**	**23**	**15**
			LA	323	116	62	38	24	11	3	0	0	0
			WLA: Facilities	33	33	33	33	33	33	33	29	22	15
			WLA: MS4	223	80	43	26	16	8	2	0	0	0
			WLA	256	114	76	59	49	41	35	29	22	15
			MOS	30	12	7	5	4	3	2	2	1	1
040	Aurora Branch	At Solon Road (D01P19)	Current Load	No Data	202	278	61	No Data	No Data	90	31	26	69
			% Reduction	No Data	0%	20%	0%	No Data	No Data	32%	0%	0%	66%
			TMDL= LA+WLA+MOS	**935**	**371**	**223**	**157**	**118**	**85**	**62**	**47**	**35**	**24**
			LA	466	174	97	63	43	26	14	11	1	0
			WLA: Facilities	33	33	33	33	33	33	33	33	33	22
			WLA: MS4	389	145	81	53	36	21	12	0	0	0
			WLA	422	179	114	86	69	55	45	33	33	22
			MOS	47	19	11	8	6	4	3	2	2	1

Table 4-28. NO3-NO2 TMDL Summary for AU020 (cont'd)

Subwatershed (0411000320)	Stream	Location (Monitoring Station)	N02-N03 (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
010	Spring Brook (West of Bass Lake)	At Old RR Grade (D01W32)	Current Load	No Data	6.5	4.0	3.2	1.8	No Data	1.4	1.0	0.7	0.5
			% Reduction	No Data	34%	35%	43%	24%	No Data	50%	44%	44%	48%
			TMDL= LA+WLA+MOS	**10.8**	**4.3**	**2.6**	**1.8**	**1.4**	**1.0**	**0.7**	**0.5**	**0.4**	**0.3**
			LA	10.3	4.1	2.4	1.7	1.3	0.9	0.7	0.5	0.4	0.3
			WLA: Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			WLA: MS4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			WLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			MOS	0.5	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Chagrin River	At Sperry Road (D01G01)	Current Load	No Data	48	68	8	No Data	No Data	13	13	7	5
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**511**	**203**	**122**	**86**	**64**	**46**	**34**	**26**	**19**	**13**
			LA	482	190	113	79	58	41	29	21	15	9
			WLA: Facilities	3	3	3	3	3	3	3	3	3	3
			WLA: MS4	0	0	0	0	0	0	0	0	0	0
			WLA	3	3	3	3	3	3	3	3	3	3
			MOS	26	10	6	4	3	2	2	1	1	1
		At Miles Road (D01S11)	Current Load	No Data	114	164	16	No Data	No Data	25	17	17	6
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**972**	**386**	**231**	**163**	**122**	**88**	**64**	**49**	**37**	**25**
			LA	855	332	194	133	97	66	45	33	22	10
			WLA: Facilities	13	13	13	13	13	13	13	13	13	13
			WLA: MS4	55	21	13	9	6	4	3	0	0	0
			WLA	69	35	26	22	20	18	16	13	13	13
			MOS	49	19	12	8	6	4	3	2	2	1

Table 4-29. N03-N02 NPDES WLAs for facilities within AU020.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	N02-N03 Limit (mg/l)	N02-N03 (kg/day)
Aurora Central WWTP	OH0021903	3PC00016	1.5	5	28.39
Robin Mhps Inc. WWTP	OH0107212	3PV00058	0.066	5	1.25
Yogi Bear'S Jellystone Park WWTP	OH0088081	3PR00090	0.03	5	0.57
Geauga Lake Furniture WWTP	OH0045080	3PR00061	0.155	5	2.93
Geauga Co Mcfarland Creek STP	OH0043494	3PK00010	1.8	5	34.07
Fowler Mill WWTP	OH0134449	3PR00368	0.008	5	0.15
Geauga Co Kimberly Estates STP	OH0028835	3PG00004	0.046	5	0.87
Heather Hill Hospital WWTP	OH0083984	3PR00075	0.1	5	1.89
Geauga Co Belle Vernon STP	OH0028827	3PG00010	0.04	5	0.76
Geauga Co Opalocka WWTP	OH0028843	3PH00000	0.155	5	2.93
Geauga Co Russell Park STP	OH0028860	3PG00001	0.08	5	1.51
Geauga Co. Scranton Woods WWTP	OH0125873	3PG00155	0.014	5	0.26
Geauga Co. Surry	OH0028878	3PG00006	0.01	5	0.19
Geauga Co. Wenhaven	OH0028886	3PG00008	0.007	5	0.13
Ivex Packing Corp.	OH0000400	3IA00000	Facility Closed	Facility Closed	Facility Closed
Chagrin Falls WWTP	OH0021740	3PD00038	1	5	18.93

Table 4-30. N03-N02 MS4 WLAs (kg/day) for facilities within AU020.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P22 (35.18%)	192.13	69.23	36.85	22.60	14.01	6.76	1.85	0.00	0.00	0.00
	D01P19 (22.94%)	196.19	73.29	40.90	26.66	18.06	10.82	5.91	0.00	0.00	0.00
Bainbridge	D01P22 (2.49%)	13.58	4.89	2.60	1.60	0.99	0.48	0.13	0.00	0.00	0.00
	D01P19 (6.11%)	52.23	19.51	10.89	7.10	4.81	2.88	1.57	0.00	0.00	0.00
Bentleyville	D01P19 (1.98%)	16.92	6.32	3.53	2.30	1.56	0.93	0.51	0.00	0.00	0.00
Chagrin Falls	D01S11 (2.10%)	19.06	7.39	4.32	2.97	2.15	1.47	1.00	0.00	0.00	0.00
Moreland Hills	D01S11 (0.14%)	1.25	0.49	0.28	0.20	0.14	0.10	0.07	0.00	0.00	0.00
Solon	D01P22 (3.02%)	16.49	5.94	3.16	1.94	1.20	0.58	0.16	0.00	0.00	0.00
	D01P19 (11.49%)	0.85	0.32	0.18	0.12	0.08	0.05	0.03	0.00	0.00	0.00
South Russell	D01P19 (2.92%)	24.94	9.32	5.20	3.39	2.30	1.37	0.75	0.00	0.00	0.00
	D01S11 (3.83%)	34.82	13.51	7.90	5.43	3.94	2.68	1.83	0.00	0.00	0.00
Streetsboro	D01P22 (0.15%)	0.83	0.30	0.16	0.10	0.06	0.03	0.01	0.00	0.00	0.00
	D01P19 (0.10%)	0.85	0.32	0.18	0.12	0.08	0.05	0.03	0.00	0.00	0.00
Total MS4	D01P22 (40.84%)	223.03	80.36	42.77	26.24	16.26	7.85	2.15	0.00	0.00	0.00
	D01P19 (45.53%)	389.34	145.44	81.17	52.91	35.85	21.47	11.72	0.00	0.00	0.00
	D01S11 (6.06%)	55.13	21.39	12.50	8.59	6.23	4.24	2.89	0.00	0.00	0.00

Table 4-31. TSS TMDL Summary for AU020

Subwatershed (0411000320___)	Stream	Location (Monitoring Station)	TSS (kg/day)	Flow Regimes: High Flows 0-10	Moist Conditions 10-20	Moist Conditions 20-30	Moist Conditions 30-40	Mid-Range Flows 40-50	Mid-Range Flows 50-60	Dry Conditions 60-70	Dry Conditions 70-80	Dry Conditions 80-90	Low Flows 90-100
030	Aurora Branch	At Bainbridge Road (D01P22)	Current Load	No Data	14,537	6,809	999	No Data	No Data	262	305	647	176
			% Reduction	No Data	12%	89%	49%	No Data	No Data	23%	50%	82%	56%
			TMDL= LA+WLA+MOS	**32,316**	**12,827**	**726**	**513**	**384**	**276**	**202**	**152**	**116**	**77**
			LA	18,092	7,139	337	217	145	84	43	26	0	0
			WLA: Facilities	119	119	119	119	119	119	119	119	110	73
			WLA: MS4	12,489	4,928	233	150	100	58	30	0	0	0
			WLA	12,609	5,047	352	269	220	177	149	119	110	73
			MOS	1,616	641	36	26	19	14	10	8	6	4
040	Aurora Branch	At Solon Road (D01P19)	Current Load	No Data	21,230	10,442	920	No Data	No Data	1,437	1,684	1,830	730
			% Reduction	No Data	7%	89%	15%	No Data	No Data	78%	86%	90%	84%
			TMDL= LA+WLA+MOS	**49,556**	**19,670**	**1,113**	**786**	**589**	**423**	**310**	**234**	**177**	**118**
			LA	25,534	10,069	466	297	195	109	51	21	0	0
			WLA: Facilities	201	201	201	201	201	201	201	201	169	112
			WLA: MS4	21,343	8,416	390	248	163	91	42	0	0	0
			WLA	21,544	8,618	591	449	364	292	244	201	169	112
			MOS	2,478	984	56	39	29	21	15	12	9	6

Table 4-31. TSS TMDL Summary for AU020 (cont'd)

Subwatershed (0411000320___)	Stream	Location (Monitoring Station)	TSS (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
010	Spring Brook (West of Bass Lake)	At Old RR Grade (D01W32)	Current Load	No Data	17	12	9	7	No Data	4	2	2	1
			% Reduction	No Data	0%	0%	0%	0%	No Data	3%	0%	3%	0%
			TMDL= LA+WLA+MOS	**183**	**73**	**13**	**9**	**7**	**5**	**4**	**3**	**2**	**1**
			LA	174	69	12	9	6	5	3	3	2	1
			WLA: Facilities	0	0	0	0	0	0	0	0	0	0
			WLA: MS4	0	0	0	0	0	0	0	0	0	0
			WLA	0	0	0	0	0	0	0	0	0	0
			MOS	9	4	1	0	0	0	0	0	0	0
	Chagrin River	At Sperry Road (D01G01)	Current Load	No Data	9,854	2,086	669	No Data	No Data	375	689	286	74
			% Reduction	No Data	0%	71%	36%	No Data	No Data	55%	81%	66%	13%
			TMDL= LA+WLA+MOS	**27,061**	**10,741**	**608**	**429**	**322**	**231**	**169**	**128**	**97**	**65**
			LA	25,700	10,196	569	400	298	211	153	114	84	54
			WLA: Facilities	8	8	8	8	8	8	8	8	8	8
			WLA: MS4	0	0	0	0	0	0	0	0	0	0
			WLA	8	8	8	8	8	8	8	8	8	8
			MOS	1,353	537	30	21	16	12	8	6	5	3
		At Miles Road (D01S11)	Current Load	No Data	24,639	3,176	1,434	No Data	No Data	1,041	1,167	866	225
			% Reduction	No Data	17%	64%	43%	No Data	No Data	69%	79%	79%	45%
			TMDL= LA+WLA+MOS	**51,505**	**20,444**	**1,157**	**817**	**612**	**439**	**322**	**243**	**184**	**123**
			LA	45,938	18,218	1,005	702	519	365	261	202	147	88
			WLA: Facilities	29	29	29	29	29	29	29	29	29	29
			WLA: MS4	2,963	1,175	65	45	33	24	17	0	0	0
			WLA	2,992	1,204	93	74	62	52	45	29	29	29
			MOS	2,575	1,022	58	41	31	22	16	12	9	6

Table 4-32. TSS NPDES WLAs for facilities within AU020.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	TSS Limit (mg/l)	TSS (kg/day)
Aurora Central WWTP	OH0021903	3PC00016	1.5	18.0	102.2
Robin MHPs Inc. WWTP	OH0107212	3PV00058	0.066	18.0	4.5
Yogi Bear's1 Jellystone Park WWTP	OH0088081	3PR00090	0.03	18.0	2.0
Geauga Lake Furniture WWTP	OH0045080	3PR00061	0.155	18.0	10.6
Geauga Co Mcfarland Creek STP	OH0043494	3PK00010	1.8	12.0	81.8
Fowler Mill WWTP	OH0134449	3PR00368	0.008	18.0	0.5
Geauga Co Kimberly Estates STP	OH0028835	3PG00004	0.046	18.0	3.1
Heather Hill Hospital WWTP	OH0083984	3PR00075	0.1	10.8	4.1
Geauga Co Belle Vernon STP	OH0028827	3PG00010	0.04	18.0	2.7
Geauga Co Opalocka WWTP	OH0028843	3PH00000	0.155	18.0	10.6
Geauga Co Russell Park STP	OH0028860	3PG00001	0.08	18.0	5.5
Geauga Co. Scranton Woods WWTP	OH0125873	3PG00155	0.014	18.0	1.0
Geauga Co. Surry	OH0028878	3PG00006	0.01	18.0	0.7
Geauga Co. Wenhaven	OH0028886	3PG00008	0.007	18.0	0.5
Ivex Packing Corp.	OH0000400	3IA00000	Facility Closed	Facility Closed	Facility Closed
Chagrin Falls WWTP	OH0021740	3PD00038	1	18.0	68.1

Table 4-33. TSS WLAs for MS4s within AU020.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P22 (35.18%)	10758.88	4245.17	200.56	129.33	86.35	50.13	25.57	0.00	0.00	0.00
	D01P19 (22.94%)	10754.69	4241.00	196.40	125.18	82.20	45.97	21.41	0.00	0.00	0.00
Bainbridge	D01P22 (2.49%)	760.55	300.09	14.18	9.14	6.10	3.54	1.81	0.00	0.00	0.00
	D01P19 (6.11%)	2863.34	1129.13	52.29	33.33	21.88	12.24	5.70	0.00	0.00	0.00
Bentleyville	D01P19 (1.98%)	927.44	365.73	16.94	10.79	7.09	3.96	1.85	0.00	0.00	0.00
Chagrin Falls	D01S11 (2.10%)	1024.30	406.21	22.41	15.66	11.58	8.14	5.81	0.00	0.00	0.00
Moreland Hills	D01S11 (0.14%)	67.28	26.68	1.47	1.03	0.76	0.53	0.38	0.00	0.00	0.00
Solon	D01P22 (3.02%)	923.30	364.31	17.21	11.10	7.41	4.30	2.19	0.00	0.00	0.00
	D01P19 (11.49%)	46.53	18.35	0.85	0.54	0.36	0.20	0.09	0.00	0.00	0.00
South Russell	D01P19 (2.92%)	1366.99	539.06	24.96	15.91	10.45	5.84	2.72	0.00	0.00	0.00
	D01S11 (3.83%)	1871.82	742.32	40.96	28.61	21.16	14.88	10.62	0.00	0.00	0.00
Streetsboro	D01P22 (0.15%)	46.54	18.37	0.87	0.56	0.37	0.22	0.11	0.00	0.00	0.00
	D01P19 (0.10%)	46.53	18.35	0.85	0.54	0.36	0.20	0.09	0.00	0.00	0.00
Total MS4	D01P22 (40.84%)	12489.27	4927.94	232.82	150.14	100.24	58.19	29.68	0.00	0.00	0.00
	D01P19 (45.53%)	21343.17	8416.47	389.77	248.42	163.12	91.23	42.49	0.00	0.00	0.00
	D01S11 (6.06%)	2963.40	1175.21	64.85	45.29	33.50	23.55	16.81	0.00	0.00	0.00

Table 4-34. Fecal coliform TMDL Summary for AU020

Subwatershed (0411000320___)	Stream	Location (Monitoring Station)	Fecal Coliform (million/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
030	Aurora Branch	At Bainbridge Road (D01P22)	Current Load	No Data	13,152,254	No Data	No Data	No Data	No Data	98,726	106,736	1,318,312	37,036
			% Reduction	No Data	82%	No Data	No Data	No Data	No Data	0%	0%	82%	0%
			TMDL= LA+WLA+MOS	**6,097,375**	**2,420,212**	**1,451,319**	**1,025,109**	**767,913**	**551,134**	**404,165**	**304,961**	**231,476**	**154,317**
			LA	3,387,634	1,320,995	776,457	536,919	392,370	270,535	187,936	223,430	153,620	80,319
			WLA: Facilities	66,283	66,283	66,283	66,283	66,283	66,283	66,283	66,283	66,283	66,283
			WLA: MS4	2,338,590	911,924	536,013	370,652	270,865	186,759	129,738	0	0	0
			WLA	2,404,872	978,206	602,295	436,934	337,148	253,042	196,021	66,283	66,283	66,283
			MOS	304,869	121,011	72,566	51,255	38,396	27,557	20,208	15,248	11,574	7,716
040	Aurora Branch	At Solon Road (D01P19)	Current Load	No Data	16,984,169	No Data	No Data	No Data	No Data	286,675	350,738	1,943,849	108,179
			% Reduction	No Data	78%	No Data	No Data	No Data	No Data	0%	0%	82%	0%
			TMDL= LA+WLA+MOS	**9,350,195**	**3,711,343**	**2,225,566**	**1,571,982**	**1,177,578**	**845,152**	**619,778**	**467,651**	**354,964**	**236,642**
			LA	4,765,180	1,847,272	1,078,434	740,227	536,137	364,118	247,495	309,848	202,796	90,390
			WLA: Facilities	134,420	134,420	134,420	134,420	134,420	134,420	134,420	134,420	134,420	134,420
			WLA: MS4	3,983,085	1,544,084	901,434	618,736	448,142	304,356	206,874	0	0	0
			WLA	4,117,505	1,678,504	1,035,854	753,156	582,562	438,776	341,294	134,420	134,420	134,420
			MOS	467,510	185,567	111,278	78,599	58,879	42,258	30,989	23,383	17,748	11,832

Table 4-34. Fecal coliform TMDL Summary for AU020 (cont'd)

Subwatershed (0411000320___)	Stream	Location	Fecal Coliform (million/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
010	Spring Brook	At Old RR Grade (D01W32)	Current Load	No Data	3,699	No Data	No Data	No Data	No Data	No Data	No Data	338	632
			% Reduction	No Data	0%	No Data	No Data	No Data	No Data	No Data	No Data	0%	0%
			TMDL= LA+WLA+MOS	**107,931**	**42,841**	**25,690**	**18,146**	**13,593**	**9,756**	**7,154**	**5,398**	**4,097**	**2,732**
			LA	102,535	40,699	24,406	17,238	12,913	9,268	6,797	5,128	3,893	2,595
			WLA: Facilities	0	0	0	0	0	0	0	0	0	0
			WLA: MS4	0	0	0	0	0	0	0	0	0	0
			WLA	0	0	0	0	0	0	0	0	0	0
			MOS	5,397	2,142	1,285	907	680	488	358	270	205	137
	Chagrin River	At Sperry Road (D01G01)	Current Load	No Data	14,491,249	No Data	No Data	No Data	No Data	83,932	357,512	801,234	14,768
			% Reduction	No Data	86%	No Data	No Data	No Data	No Data	0%	29%	76%	0%
			TMDL= LA+WLA+MOS	**5,105,781**	**2,026,621**	**1,215,296**	**858,399**	**643,030**	**461,505**	**338,437**	**255,366**	**193,832**	**129,221**
			LA	4,844,662	1,919,461	1,148,702	809,649	605,049	432,600	315,685	236,768	178,311	116,931
			WLA: Facilities	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830
			WLA: MS4	0	0	0	0	0	0	0	0	0	0
			WLA	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830	5,830
			MOS	255,289	101,331	60,765	42,920	32,151	23,075	16,922	12,768	9,692	6,461
		At Miles Road (D01S11)	Current Load	No Data	26,110,400	No Data	No Data	No Data	No Data	714,423	243,021	1,777,859	81,514
			% Reduction	No Data	85%	No Data	No Data	No Data	No Data	10%	0%	79%	0%
			TMDL= LA+WLA+MOS	**9,717,908**	**3,857,298**	**2,313,091**	**1,633,803**	**1,223,888**	**878,389**	**644,152**	**486,042**	**368,923**	**245,949**
			LA	8,647,305	3,417,121	2,039,024	1,432,807	1,066,987	758,653	549,613	434,863	323,601	206,775
			WLA: Facilities	26,876	26,876	26,876	26,876	26,876	26,876	26,876	26,876	26,876	26,876
			WLA: MS4	557,831	220,436	131,536	92,429	68,831	48,940	35,455	0	0	0
			WLA	584,708	247,312	158,412	119,306	95,707	75,817	62,332	26,876	26,876	26,876
			MOS	485,895	192,865	115,655	81,690	61,194	43,919	32,208	24,302	18,446	12,297

Table 4-35. Fecal coliform NPDES WLAs for facilities within AU020.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	Fecal coliform limit (#/100 ml)	Fecal Coliform (million/day)
Aurora Central WWTP	OH0021903	3PC00016	1.5	1000	56,781
Robin Mhps Inc. WWTP	OH0107212	3PV00058	0.066	1000	2,498
Yogi Bear'S Jellystone Park WWTP	OH0088081	3PR00090	0.03	1000	1,136
Geauga Lake Furniture WWTP	OH0045080	3PR00061	0.155	1000	5,867
Geauga Co Mcfarland Creek STP	OH0043494	3PK00010	1.8	1000	68,137
Fowler Mill WWTP	OH0134449	3PR00368	0.008	1000	303
Geauga Co Kimberly Estates STP	OH0028835	3PG00004	0.046	1000	1,741
Heather Hill Hospital WWTP	OH0083984	3PR00075	0.1	1000	3,785
Geauga Co Belle Vernon STP	OH0028827	3PG00010	0.04	1000	1,514
Geauga Co Opalocka WWTP	OH0028843	3PH00000	0.155	1000	5,867
Geauga Co Russell Park STP	OH0028860	3PG00001	0.08	1000	3,028
Geauga Co. Scranton Woods WWTP	OH0125873	3PG00155	0.014	1000	530
Geauga Co. Surry	OH0028878	3PG00006	0.01	1000	379
Geauga Co. Wenhaven	OH0028886	3PG00008	0.007	1000	265
Ivex Packing Corp.	OH0000400	3IA00000	Facility Closed	Facility Closed	Facility Closed
Chagrin Falls WWTP	OH0021740	3PD00038	1	1000	37,854

Table 4-36. Fecal coliform WLAs for MS4s within AU020.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P22 (35.18%)	2,014,577	785,576	461,748	319,298	233,337	160,883	111,763	0	0	0
	D01P19 (22.94%)	2,007,052	778,054	454,227	311,777	225,816	153,363	104,243	0	0	0
Bainbridge	D01P22 (2.49%)	142,412	55,533	32,641	22,571	16,495	11,373	7,901	0	0	0
	D01P19 (6.11%)	534,360	207,150	120,934	83,008	60,122	40,832	27,754	0	0	0
Bentleyville	D01P19 (1.98%)	173,079	67,096	39,171	26,886	19,473	13,225	8,989	0	0	0
Chagrin Falls	D01S11 (2.10%)	192,815	76,194	45,465	31,948	23,791	16,916	12,255	0	0	0
Moreland Hills	D01S11 (0.14%)	12,664	5,005	2,986	2,098	1,563	1,111	805	0	0	0
Solon	D01P22 (3.02%)	172,886	67,416	39,626	27,401	20,024	13,807	9,591	0	0	0
	D01P19 (11.49%)	8,683	3,366	1,965	1,349	977	663	451	0	0	0
South Russell	D01P19 (2.92%)	255,108	98,895	57,735	39,629	28,703	19,493	13,250	0	0	0
	D01S11 (3.83%)	352,352	139,238	83,084	58,383	43,477	30,913	22,395	0	0	0
Streetsboro	D01P22 (0.15%)	8,715	3,399	1,998	1,381	1,009	696	484	0	0	0
	D01P19 (0.10%)	8,683	3,366	1,965	1,349	977	663	451	0	0	0
Total MS4	D01P22 (40.84%)	2,338,590	911,924	536,013	370,652	270,865	186,759	129,738	0	0	0
	D01P19 (45.53%)	3,983,085	1,544,084	901,434	618,736	448,142	304,356	206,874	0	0	0
	D01S11 (6.06%)	557,831	220,436	131,536	92,429	68,831	48,940	35,455	0	0	0

4.2.5 Load Duration Curve Results for Assessment Unit 030

The load duration approach was applied to five sites located within Assessment Unit 030 (Figure 4-3):

* Three sites are located on the mainstem of the Chagrin River at Chagrin Boulevard (D01P07), Old Mill Road (D01P04), and at Daniels Park (502400).
* Two sites are located on East Branch Chagrin River at Mitchell's Mill Road (D01S20) and at Markell Road (D01P01).

For each load duration site, all appropriate and available water quality and flow data were used. Table 4-37 summarizes all data used for the load duration analyses in Assessment Unit 030.

Table 4-37. Summary of Available Data for Load Duration Sites in Assessment Units 030.

Stream	Location (Monitoring Station)	Parameter	Count	Ave (mg/l)	Min (mg/l)	Max (mg/l)	Period of Record
Chagrin River	At Chagrin Boulevard (D01P07)	TP	16	0.07	0.03	0.11	7/13/1995 - 8/16/2004
		NO3-NO2	16	0.91	0.13	1.82	7/13/1995 - 8/16/2004
		TSS	16	41.84	5.00	142.00	7/13/1995 - 8/16/2004
		Fecal Coliform (#/100ml)	10	2,562	160	14,900	7/27/1995 - 8/16/2004
Chagrin River	At Old Mill Road (D01P04)	TP	11	0.05	0.02	0.10	8/27/2003 - 8/16/2004
		NO3-NO2	11	0.72	0.17	1.10	8/27/2003 - 8/16/2004
		TSS	11	27.14	5.00	123.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100ml)	9	1,136	40	5,600	8/27/2003 - 8/16/2004
East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	TP	11	0.09	0.01	0.47	8/27/2003 - 8/16/2004
		NO3-NO2	11	0.29	0.10	0.60	8/27/2003 - 8/16/2004
		TSS	11	16.91	5.00	48.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100ml)	8	1,244	48	3,300	8/27/2003 - 8/16/2004
East Branch Chagrin River	At Markell Road (D01P01)	TP	10	0.03	0.01	0.07	8/27/2003 - 8/16/2004
		NO3-NO2	10	0.26	0.10	0.50	8/27/2003 - 8/16/2004
		TSS	11	16.23	5.00	46.00	8/27/2003 - 8/16/2004
		Fecal Coliform (#/100ml)	8	1,657	88	5,900	8/27/2003 - 8/16/2004
Chagrin River	At Daniels Park (502400)	TP	114	0.07	0.00	0.66	1/25/1995 - 11/4/2004
		NO3-NO2	115	0.51	0.10	3.71	1/25/1995 - 11/4/2004
		TSS	118	65.88	5.00	1150.0 0	1/25/1995 - 11/4/2004
		Fecal Coliform (#/100ml)	61	1,236	10	14,000	1/25/1995 - 8/16/2004

Chagrin River (D01P07)

Existing and allowable loads were calculated for the Chagrin River at Chagrin Boulevard (D01P07). This location drains 127 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (56%), pasture/hay (18%), and low intensity residential (8%) land uses. Eleven TP, NO3-NO2, and TSS samples and eight fecal coliform samples were available for the loading analysis. Most samples were taken during low to dry flow conditions. Five additional TP, NO3-NO2, and TSS samples were taken in

1995 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses.

Total Phosphorus

A total of eleven TP samples were available for the load duration analysis at site D01P07. Two of the eleven TP observations exceed the loading limit (Appendix E). The loading limit is exceeded within the moist and dry hydrologic zones. The calculated existing and allowable TP loads were grouped based on duration curve zones and Table 4-38 summarizes the median of existing loads for each of the duration curve zones. Table 4-38 indicates that TP loads need to be reduced by approximately 6 percent during periods of moist conditions.

Table 4-38. Total Phosphorus Loading Statistics for Load Duration Site D01P07.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	862.95	211.13	No Data	No Data
Moist Conditions	10-20	1	342.53	83.80	89	6.3%
	20-30	1	205.40	50.25	27	0.0%
	30-40	1	145.08	35.50	9	0.0%
Mid-Range Flows	40-50	0	108.68	26.59	No Data	No Data
	50-60	0	78.00	19.08	No Data	No Data
Dry Conditions	60-70	3	57.20	13.99	8	0.0%
	70-80	1	43.16	10.56	10	0.0%
	80-90	3	32.76	8.02	6	0.0%
Low Flows	90-100	1	21.84	5.34	3	0.0%

Nitrite-Nitrate (NO3-NO2)

A total of eleven NO3-NO2 samples were available for the load duration analysis at site D01P07. Four of the eleven NO3-NO2 observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist, dry and low flow conditions. The greatest exceedence of the standard is during dry flow conditions. The calculated existing and allowable NO3-NO2 loads were grouped based on duration curve zones and Table 4-39 summarizes the median of existing loads for each of the duration curve zones. Table 4-39 indicates that NO3-NO2 loads need to be reduced by approximately 2 percent during periods of moist conditions and by 38 percent during low flows.

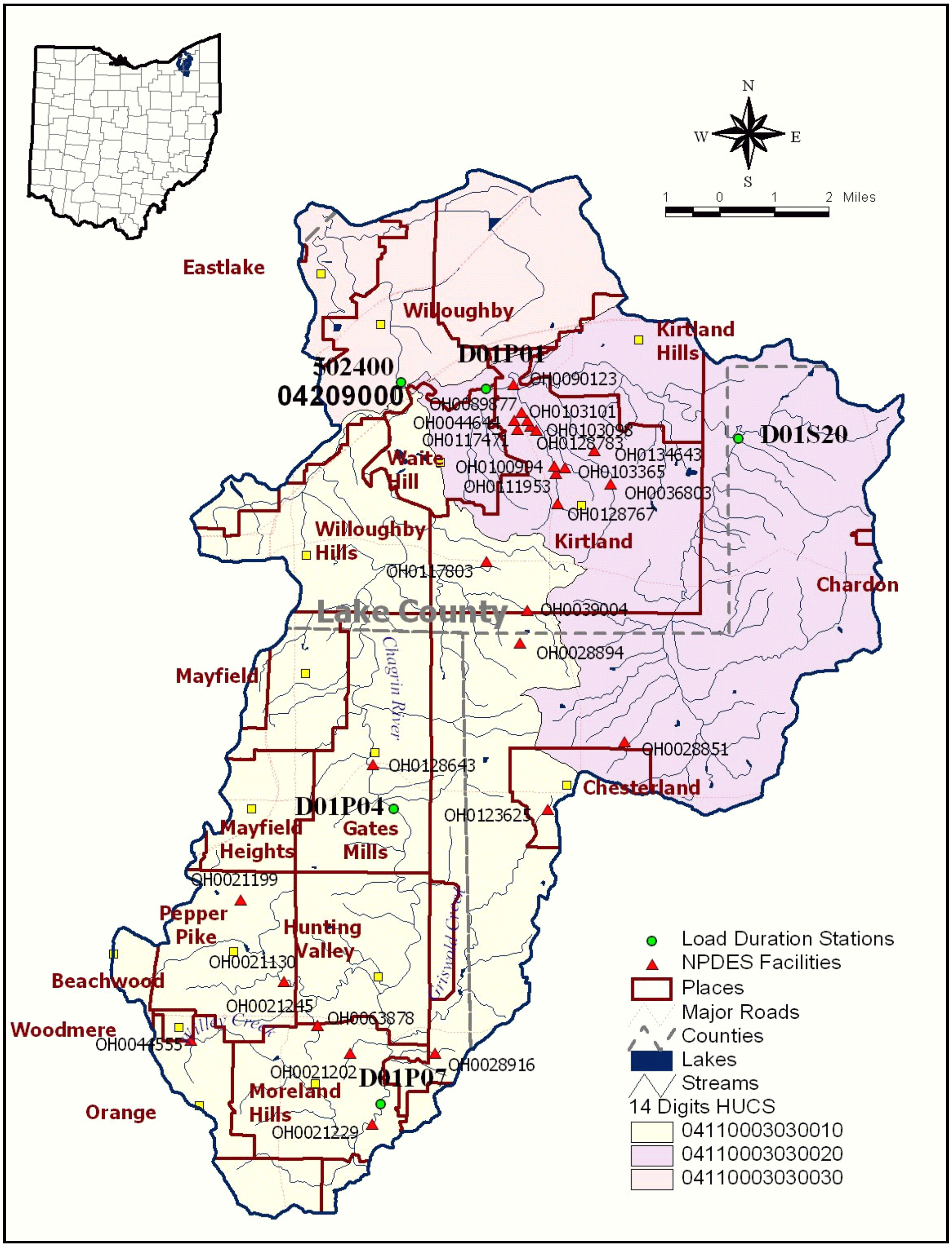

Figure 4-3. Load duration sites within the Chagrin River Downstream Aurora Branch to Mouth, Assessment Unit 030.

Table 4-39. NO3-NO2 Loading Statistics for Load Duration Site D01P07.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	862.95	2,111.27	No Data	No Data
Moist Conditions	10-20	1	342.53	838.02	368	0.0%
	20-30	1	205.40	502.53	512	1.8%
	30-40	1	145.08	354.95	45	0.0%
Mid-Range Flows	40-50	0	108.68	265.90	No Data	No Data
	50-60	0	78.00	190.83	No Data	No Data
Dry Conditions	60-70	3	57.20	139.95	122	0.0%
	70-80	1	43.16	105.60	94	0.0%
	80-90	3	32.76	80.15	63	0.0%
Low Flows	90-100	1	21.84	53.43	87	38.4%

TSS

A total of eleven TSS samples were available for the load duration analysis at site D01P07 and all eleven TSS observations exceed the loading limit (Appendix E). The loading limit is exceeded within all flow conditions with data. The greatest exceedence of the standard is during dry flow conditions. The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-40 summarizes the median of existing loads for each of the duration curve zones. Table 4-40 indicates that TSS loads need to be reduced by approximately 50 to 60 percent during all flow periods.

Table 4-40. TSS Loading Statistics for Load Duration Site D01P07.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	862.95	111,897	No Data	No Data
Moist Conditions	10-20	1	342.53	44,415	92,679	52.1%
	20-30	1	205.40	2,513	17,251	85.4%
	30-40	1	145.08	1,775	3,114	43.0%
Mid-Range Flows	40-50	0	108.68	1,329	No Data	No Data
	50-60	0	78.00	954	No Data	No Data
Dry Conditions	60-70	3	57.20	700	1,168	40.1%
	70-80	1	43.16	528	2,112	75.0%
	80-90	3	32.76	401	4,981	92.0%
Low Flows	90-100	1	21.84	267	550	51.4%

Fecal coliform

A total of eight fecal coliform samples were available for the load duration analysis at site D01P07. Three of the eight fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry conditions. The greatest exceedence of the standard is during dry flow conditions. The calculated existing and allowable fecal coliform loads were grouped based on duration curve zones and Table 4-41 summarizes the median of existing loads for each of the duration curve zones. Table 4-41 indicates that fecal coliform loads need to be reduced by approximately 68 percent during moist conditions and 76 percent during dry flow periods.

Table 4-41. Fecal Coliform Loading Statistics for Load Duration Site D01P07.

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	862.95	21,112,669.98	No Data	No Data
Moist Conditions	10-20	1	342.53	8,380,184.22	26,365,711	68.2%
	20-30	0	205.40	5,025,311.63	No Data	No Data
	30-40	0	145.08	3,549,523.91	No Data	No Data
Mid-Range Flows	40-50	0	108.68	2,658,962.35	No Data	No Data
	50-60	0	78.00	1,908,346.19	No Data	No Data
Dry Conditions	60-70	2	57.20	1,399,453.87	502,277	0.0%
	70-80	1	43.16	1,055,951.56	369,583	0.0%
	80-90	3	32.76	801,505.40	3,335,789	76.0%
Low Flows	90-100	1	21.84	534,336.93	122,134	0.0%

Chagrin River (D01P04)

Existing and allowable loads were calculated for the Chagrin River at Old Mill Road (D01P04). This location drains 157 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (55%), pasture/hay (17%), and low intensity residential (10%) land uses. Eleven TP, NO3-NO2, and TSS samples and nine fecal coliform samples were available for the loading analysis. Most samples were taken during low to dry flow conditions.

Total Phosphorus

A total of eleven TP samples were available for the load duration analysis at site D01P04. None of the TP observations exceed the loading limit and therefore no reductions are needed at this location (Appendix E and Table 4-42).

Table 4-42. Total Phosphorus Loading Statistics for Load Duration Site D01P04.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	1,064.51	260.44	No Data	No Data
Moist Conditions	10-20	1	422.53	103.38	99	0.0%
	20-30	1	253.38	61.99	49	0.0%
	30-40	1	178.97	43.79	9	0.0%
Mid-Range Flows	40-50	0	134.07	32.80	No Data	No Data
	50-60	0	96.22	23.54	No Data	No Data
Dry Conditions	60-70	3	70.56	17.26	6	0.0%
	70-80	1	53.24	13.03	5	0.0%
	80-90	3	40.41	9.89	3	0.0%
Low Flows	90-100	1	26.94	6.59	3	0.0%

Nitrite-Nitrate (NO3-NO2)

A total of eleven NO3-NO2 samples were available for the load duration analysis at site D01P04. Three of the eleven NO3-NO2 observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry flow conditions. The calculated existing and allowable NO3-NO2 loads were grouped based on duration curve zones and Table 4-43 summarizes the median of existing loads for each of the duration curve zones. Table 4-43 indicates that NO3-NO2 loads need to be reduced by approximately 14 percent during periods of moist conditions.

Table 4-43. NO3-NO2 Loading Statistics for Load Duration Site D01P04.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	1,064.51	2,604.41	No Data	No Data
Moist Conditions	10-20	1	422.53	1,033.76	527	0.0%
	20-30	1	253.38	619.91	716	13.5%
	30-40	1	178.97	437.86	73	0.0%
Mid-Range Flows	40-50	0	134.07	328.00	No Data	No Data
	50-60	0	96.22	235.41	No Data	No Data
Dry Conditions	60-70	3	70.56	172.63	135	0.0%
	70-80	1	53.24	130.26	89	0.0%
	80-90	3	40.41	98.87	86	0.0%
Low Flows	90-100	1	26.94	65.91	54	0.0%

TSS

A total of eleven TSS samples were available for the load duration analysis at site D01P04. All eleven TSS observations are at or exceed the loading limit (Appendix E). The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-44 summarizes the median of existing loads for each of the duration curve zones. Table 4-44 indicates that TSS loads need to be reduced by approximately 60 to 80 percent during all flow periods with data.

Table 4-44. TSS Loading Statistics for Load Duration Site D01P04.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	1,064.51	138,034	No Data	No Data
Moist Conditions	10-20	1	422.53	54,789	121,226	54.8%
	20-30	1	253.38	3,100	9,931	68.8%
	30-40	1	178.97	2,189	2,988	26.7%
Mid-Range Flows	40-50	0	134.07	1,640	No Data	No Data
	50-60	0	96.22	1,177	No Data	No Data
Dry Conditions	60-70	3	70.56	863	2,081	58.5%
	70-80	1	53.24	651	2,996	78.3%
	80-90	3	40.41	494	866	42.9%
Low Flows	90-100	1	26.94	330	1,507	78.1%

Fecal coliform

A total of nine fecal coliform samples were available for the load duration analysis at site D01P04 and two of the nine fecal coliform observations exceed the loading limit (Appendix E). The calculated existing and allowable fecal coliform loads were grouped based on duration curve zones and Table 4-45 summarizes the median of existing loads for each of the duration curve zones. Table 4-45 indicates that fecal coliform loads need to be reduced by approximately 80 percent during moist conditions. Sources of fecal coliform loads appear to be mostly associated with wet weather flows.

Table 4-45. Fecal Coliform Loading Statistics for Load Duration Site D01P04.

Zone	Flow Exceedence Ranges	9-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	1,064.51	26,044,058.07	No Data	No Data
Moist Conditions	10-20	1	422.53	10,337,584.24	55,192,373	81.3%
	20-30	0	253.38	6,199,097.88	No Data	No Data
	30-40	1	178.97	4,378,603.32	221,975	0.0%
Mid-Range Flows	40-50	0	134.07	3,280,029.01	No Data	No Data
	50-60	0	96.22	2,354,087.80	No Data	No Data
Dry Conditions	60-70	2	70.56	1,726,331.06	491,690	0.0%
	70-80	1	53.24	1,302,595.25	208,415	0.0%
	80-90	3	40.41	988,716.88	476,467	0.0%
Low Flows	90-100	1	26.94	659,144.59	112,996	0.0%

East Branch Chagrin River (D01S20)

Existing and allowable loads were calculated for the East Branch Chagrin River at Mitchell's Mill Road (D01S20). This location drains 26 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (70%) and pasture/hay (22%) land uses. Eleven TP, NO3-NO2, and TSS samples and eight fecal coliform samples were available for the loading analysis. Most samples were taken during low to dry flow conditions.

Total Phosphorus

A total of eleven TP samples were available for the load duration analysis at site D01S20. Two of the eleven TP observations exceed the loading limit (Appendix E). The loading limit is exceeded within the moist and dry hydrologic zones. The calculated existing and allowable TP loads were grouped based on duration curve zones and Table 4-46 summarizes the median of existing loads for each of the duration curve zones. Table 4-46 indicates that TP loads need to be reduced by approximately 78 percent during periods of moist conditions.

Table 4-46. Total Phosphorus Loading Statistics for Load Duration Site D01S20.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	179.94	44.02	No Data	No Data
Moist Conditions	10-20	1	71.42	17.47	10	0.0%
	20-30	1	42.83	10.48	8	0.0%
	30-40	1	30.25	7.40	34	78.0%
Mid-Range Flows	40-50	0	22.66	5.54	No Data	No Data
	50-60	0	16.26	3.98	No Data	No Data
Dry Conditions	60-70	3	11.93	2.92	0	0.0%
	70-80	1	9.00	2.20	1	0.0%
	80-90	3	6.83	1.67	0	0.0%
Low Flows	90-100	1	4.55	1.11	0	0.0%

Nitrite-Nitrate (NO3-NO2)

A total of eleven NO3-NO2 samples were available for the load duration analysis at site D01S20. None of the NO3-NO2 observations exceed the loading limit and therefore no load reductions are necessary for this location (Appendix E and Table 4-47).

Table 4-47. NO3-NO2 Loading Statistics for Load Duration Site D01S20.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	179.94	440.25	No Data	No Data
Moist Conditions	10-20	1	71.42	174.75	70	0.0%
	20-30	1	42.83	104.79	72	0.0%
	30-40	1	30.25	74.02	7	0.0%
Mid-Range Flows	40-50	0	22.66	55.45	No Data	No Data
	50-60	0	16.26	39.79	No Data	No Data
Dry Conditions	60-70	3	11.93	29.18	9	0.0%
	70-80	1	9.00	22.02	8	0.0%
	80-90	3	6.83	16.71	4	0.0%
Low Flows	90-100	1	4.55	11.14	1	0.0%

TSS

A total of eleven TSS samples were available for the load duration analysis at site D01S20. Five of the eleven TSS observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist, dry, and low flow conditions. The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-48 summarizes the median of existing loads for each of the duration curve zones. Table 4-48 indicates that TSS loads need to be reduced by 90 percent during moist conditions, by approximately 60 percent during dry conditions and approximately 13 percent during low flow periods.

Table 4-48. TSS Loading Statistics for Load Duration Site D01S20.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	179.94	23,333	No Data	No Data
Moist Conditions	10-20	1	71.42	9,261	5,498	0.0%
	20-30	1	42.83	524	5,516	90.5%
	30-40	1	30.25	370	361	0.0%
Mid-Range Flows	40-50	0	22.66	277	No Data	No Data
	50-60	0	16.26	199	No Data	No Data
Dry Conditions	60-70	3	11.93	146	135	0.0%
	70-80	1	9.00	110	330	66.7%
	80-90	3	6.83	84	215	61.2%
Low Flows	90-100	1	4.55	56	64	12.5%

Fecal coliform

A total of eight fecal coliform samples were available for the load duration analysis at site D01S20. Three of the eight fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry conditions. The calculated existing and allowable fecal coliform loads were grouped based on duration curve zones and Table 4-49 summarizes the median of existing loads for each of the duration curve zones. Table 4-49 indicates that fecal coliform loads need to be reduced by approximately 70 percent during moist conditions and by 55 percent during dry flow periods.

Table 4-49. Fecal Coliform Loading Statistics for Load Duration Site D01S20.

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	179.94	4,402,452.01	No Data	No Data
Moist Conditions	10-20	1	71.42	1,747,451.12	5,497,826	68.2%
	20-30	0	42.83	1,047,887.04	No Data	No Data
	30-40	0	30.25	740,153.12	No Data	No Data
Mid-Range Flows	40-50	0	22.66	554,451.62	No Data	No Data
	50-60	0	16.26	397,931.79	No Data	No Data
Dry Conditions	60-70	2	11.93	291,816.64	59,913	0.0%
	70-80	1	9.00	220,188.92	202,574	0.0%
	80-90	3	6.83	167,131.35	366,203	54.4%
Low Flows	90-100	1	4.55	111,420.90	66,216	0.0%

East Branch Chagrin River (D01P01)

Existing and allowable loads were calculated for the East Branch Chagrin River at Markell Road (D01P01). This location drains 45 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (70%) and pasture/hay (15%) land uses. Ten TP and NO3-NO2, eleven TSS, and eight fecal coliform samples were available for the loading analysis. Most samples were taken during low to dry flow conditions.

Total Phosphorus

A total of ten TP samples were available for the load duration analysis at site D01P01. None of the TP observations exceed the loading limit and therefore no load reductions are recommended for this location (Appendix E and Table 4-50).

Table 4-50. Total Phosphorus Loading Statistics for Load Duration Site D01P01.

Zone	Flow Exceedence Ranges	10-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	307.58	75.25	No Data	No Data
Moist Conditions	10-20	1	122.09	29.87	20	0.0%
	20-30	1	73.21	17.91	10	0.0%
	30-40	1	51.71	12.65	2	0.0%
Mid-Range Flows	40-50	0	38.74	9.48	No Data	No Data
	50-60	0	27.80	6.80	No Data	No Data
Dry Conditions	60-70	2	20.39	4.99	1	0.0%
	70-80	1	15.38	3.76	1	0.0%
	80-90	3	11.68	2.86	1	0.0%
Low Flows	90-100	1	7.78	1.90	0	0.0%

Nitrite-Nitrate (NO3-NO2)

A total of ten NO3-NO2 samples were available for the load duration analysis at site D01P01. None of the NO3-NO2 observations exceed the loading limit and therefore no load reductions are recommended for this location (Appendix E and Table 4-51).

Table 4-51. NO3-NO2 Loading Statistics for Load Duration Site D01P01.

Zone	Flow Exceedence Ranges	10-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	307.58	752.53	No Data	No Data
Moist Conditions	10-20	1	122.09	298.70	120	0.0%
	20-30	1	73.21	179.12	102	0.0%
	30-40	1	51.71	126.52	27	0.0%
Mid-Range Flows	40-50	0	38.74	94.77	No Data	No Data
	50-60	0	27.80	68.02	No Data	No Data
Dry Conditions	60-70	2	20.39	49.88	15	0.0%
	70-80	1	15.38	37.64	7	0.0%
	80-90	3	11.68	28.57	3	0.0%
Low Flows	90-100	1	7.78	19.05	2	0.0%

TSS

A total of eleven TSS samples were available for the load duration analysis at site D01P01. Five of the eleven TSS observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist, dry, and low flow conditions. The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-52 summarizes the median of existing loads for each of the duration curve zones. Table 4-52 indicates that TSS loads need to be reduced by approximately 80 percent during moist and dry conditions and by 13 percent during low flow periods.

Table 4-52. TSS Loading Statistics for Load Duration Site D01P01.

Zone	Flow Exceedence Ranges	11-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	0	307.58	39,884	No Data	No Data
Moist Conditions	10-20	1	122.09	15,831	13,100	0.0%
	20-30	1	73.21	896	5,124	82.5%
	30-40	1	51.71	633	617	0.0%
Mid-Range Flows	40-50	0	38.74	474	No Data	No Data
	50-60	0	27.80	340	No Data	No Data
Dry Conditions	60-70	3	20.39	249	231	0.0%
	70-80	1	15.38	188	1,355	86.1%
	80-90	3	11.68	143	532	73.1%
Low Flows	90-100	1	7.78	95	109	12.5%

Fecal coliform

A total of eight fecal coliform samples were available for the load duration analysis at site D01P01. Three of the eight fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within moist and dry conditions. The calculated existing and allowable fecal coliform loads were grouped based on duration curve zones and Table 4-53 summarizes the median of existing loads for each of the duration curve zones. Table 4-53 indicates that fecal coliform loads need to be reduced by approximately 80 percent during moist and dry flow periods.

Table 4-53. Fecal Coliform Loading Statistics for Load Duration Site D01P01.

Zone	Flow Exceedence Ranges	8-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	0	307.58	7,525,288.79	No Data	No Data
Moist Conditions	10-20	1	122.09	2,986,988.69	11,960,652	75.0%
	20-30	0	73.21	1,791,195.58	No Data	No Data
	30-40	0	51.71	1,265,173.59	No Data	No Data
Mid-Range Flows	40-50	0	38.74	947,746.52	No Data	No Data
	50-60	0	27.80	680,200.85	No Data	No Data
Dry Conditions	60-70	2	20.39	498,813.96	137,038	0.0%
	70-80	1	15.38	376,377.81	2,220,629	83.1%
	80-90	3	11.68	285,684.36	234,080	0.0%
Low Flows	90-100	1	7.78	190,456.24	56,593	0.0%

Chagrin River (502400)

Existing and allowable loads were calculated for the Chagrin River at Daniels Park (502400). This location drains 244 square miles and land use/land cover upstream of this station consists primarily of deciduous forest (58%), pasture/hay (16%), and low intensity residential (10%) land uses. Many TP, NO3-NO2, TSS, and fecal coliform samples were available for the loading analysis as this location is routinely sampled by Ohio EPA. Samples are available during all flow conditions. Some data could not be used during the load duration analysis because the USGS gage was not operational at the time of the sampling.

Total Phosphorus

A total of seventy-eight TP samples were available for the load duration analysis at site 502400. Eleven additional samples were taken in 1995 and twenty-five additional samples were taken in 2000 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses.

Seven of the seventy-eight TP observations exceed the loading limit (Appendix E). The loading limit is exceeded within the high flow, moist, mid-range, and dry hydrologic zones. The greatest exceedence of the standard is during high flow conditions. The calculated existing and allowable TP loads were grouped based on duration curve zones and Table 4-54 summarizes the median of existing loads for each of the duration curve zones. Table 4-54 indicates that TP loads need to be reduced by approximately 20 percent during periods of high flows. Sources of TP loads appear to be associated with wet weather flows and might be related to high suspended sediment loads during these periods.

Table 4-54. Total Phosphorus Loading Statistics for Load Duration Site 502400.

Zone	Flow Exceedence Ranges	78-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	6	1,659.50	690.22	890	22.4%
Moist Conditions	10-20	6	658.70	273.97	184	0.0%
	20-30	6	395.00	164.29	58	0.0%
	30-40	12	279.00	116.04	38	0.0%
Mid-Range Flows	40-50	4	209.00	86.93	25	0.0%
	50-60	5	150.00	62.39	20	0.0%
Dry Conditions	60-70	11	110.00	45.75	14	0.0%
	70-80	9	83.00	34.52	9	0.0%
	80-90	11	63.00	26.20	9	0.0%
Low Flows	90-100	8	42.00	17.47	5	0.0%

Nitrite-Nitrate (NO3-NO2)

A total of seventy-eight NO3-NO2 samples were available for the load duration analysis at site 502400. Twelve additional samples were taken in 1995 and twenty-five additional samples were taken in 2000 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses. Only one of the seventy-eight NO3-NO2 observations exceeds the loading limit and therefore no load reductions are recommended for this location (Appendix E and Table 4-55).

Table 4-55. NO3-NO2 Loading Statistics for Load Duration Site 502400.

Zone	Flow Exceedence Ranges	78-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	6	1,659.50	6,090.14	2,533	0.0%
Moist Conditions	10-20	6	658.70	2,417.34	1,043	0.0%
	20-30	6	395.00	1,449.60	522	0.0%
	30-40	12	279.00	1,023.89	320	0.0%
Mid-Range Flows	40-50	4	209.00	767.00	99	0.0%
	50-60	5	150.00	550.48	98	0.0%
Dry Conditions	60-70	11	110.00	403.68	173	0.0%
	70-80	9	83.00	304.60	96	0.0%
	80-90	11	63.00	231.20	47	0.0%
Low Flows	90-100	8	42.00	154.13	17	0.0%

TSS

A total of eighty-one TSS samples were available for the load duration analysis at site 502400. Twelve additional samples were taken in 1995 and twenty-five additional samples were taken in 2000 when the USGS flow gage was not operational

Sixty of the eighty-one TSS observations exceed the loading limit (Appendix E) and the loading limit is exceeded within all flow conditions. The greatest exceedence of the standard is during moist conditions. The calculated existing and allowable TSS loads were grouped based on duration curve zones and Table 4-56 summarizes the median of existing loads for each of the duration curve zones. Table 4-56 indicates that TSS loads need to be reduced during all flow periods.

Table 4-56. TSS Loading Statistics for Load Duration Site 502400.

Zone	Flow Exceedence Ranges	81-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
High Flows	0-10	6	1,659.50	284,206	1,083,735	73.8%
Moist Conditions	10-20	8	658.70	112,809	164,289	31.3%
	20-30	6	395.00	4,832	25,085	80.7%
	30-40	12	279.00	3,413	6,001	43.1%
Mid-Range Flows	40-50	4	209.00	2,557	3,308	22.7%
	50-60	5	150.00	1,835	1,969	6.8%
Dry Conditions	60-70	11	110.00	1,346	1,468	8.3%
	70-80	9	83.00	1,015	1,468	30.8%
	80-90	12	63.00	771	2,347	67.2%
Low Flows	90-100	8	42.00	514	1,680	69.4%

Fecal coliform

A total of forty-one fecal coliform samples were available for the load duration analysis at site 502400. Nine additional samples were taken in 1995 and eleven additional samples were taken in 2000 when the USGS flow gage was not operational so those samples could not be used in the load duration analyses. Nine of the forty-one fecal coliform observations exceed the loading limit (Appendix E). The loading limit is exceeded within high flows, moist, and dry conditions. The greatest exceedence of the standard is during moist conditions. The calculated existing and allowable fecal coliform loads were grouped based on duration curve zones and Table 4-57 summarizes the median of existing loads for each of the duration curve zones. Table 4-57 indicates that fecal coliform loads need to be reduced by 85 percent during high flows and by 50 to 80 percent during moist conditions. Fecal coliform sources at station 502400 appear to be associated mostly with wet weather flows and could be related to high sediment loads during these periods.

Table 4-57. Fecal Coliform Loading Statistics for Load Duration Site 502400.

Zone	Flow Exceedence Ranges	41-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
High Flows	0-10	1	1,659.50	40,600,921.18	298,726,874	86.4%
Moist Conditions	10-20	3	658.70	16,115,593.12	78,358,922	79.4%
	20-30	1	395.00	9,663,973.40	20,673,563	53.3%
	30-40	6	279.00	6,825,945.77	4,845,443	0.0%
Mid-Range Flows	40-50	2	209.00	5,113,342.89	153,437	0.0%
	50-60	1	150.00	3,669,863.32	113,766	0.0%
Dry Conditions	60-70	3	110.00	2,691,233.10	776,054	0.0%
	70-80	5	83.00	2,030,657.70	445,277	0.0%
	80-90	11	63.00	1,541,342.59	272,304	0.0%
Low Flows	90-100	8	42.00	1,027,561.73	244,046	0.0%

4.2.6 Assessment Unit 030 Allocations

A summary of load reductions needed for all parameters in assessment unit 030 is presented in Table 4-58. The allocations of TP loads for the assessment unit 030 TMDLs are summarized in Table 4-59, NO3-NO2 loads are summarized in Table 4-62, TSS loads in Table 4-65, and fecal coliform loads in Table 4-68.

The WLAs for individual facilities are summarized in Table 4-60, Table 4-63, Table 4-66, and Table 4-69. The same procedure described in Section 4.2.4 was used to determine the WLAs for individual facilities.

WLAs for MS4 communities located within assessment unit 030 stations are summarized in Table 4-61, Table 4-64, Table 4-67, and Table 4-70. MS4 communities were assigned WLAs based on their proportion of a sampling station's drainage area as explained in Section 4.2.4.

Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). An explicit MOS has been applied as part of all of the Chagrin River TMDLs by reserving five percent of the allowable load (see allocation tables in Sections 4.2). A relatively low MOS was selected based on the use of load duration curves, which minimize potential uncertainties associated with calculating the allowable loads (i.e., the allowable loads are based on observed data rather than modeling simulations).

An additional implicit MOS has been applied as part of the fecal coliform TMDLs by comparing individual samples to the geometric mean component of the standard to determine the needed load reductions. This is considered conservative because the geometric mean component of the standard is intended to be used when five samples in a 30 day period are available (i.e., taking the geometric mean of five samples will "dampen" the effect of high values).

Critical Conditions and Seasonality

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions are needed for specific flow conditions; however, the critical conditions (the periods when the greatest reductions are required) vary by location and are inherently addressed by specifying different levels of reduction according to flow.

The allocation of point source loads (i.e., the WLA) also takes into account critical conditions by assuming the facilities will always discharge at their maximum design flows. In reality, many facilities discharge at below their design flows.

The Clean Water Act also requires that TMDLs be established with consideration of seasonal variations. Seasonal variations are addressed in this TMDL by only assessing conditions during the season when the water quality standard applies (May through October). The load duration approach also accounts for seasonality by evaluating allowable loads on a daily basis over the entire range of observed flows and presenting daily allowable loads that vary by flow.

Table 4-58. Load Reductions needed with the Chagrin River watershed assessment unit 030 based on load duration curve analysis.

Stream	Location (Monitoring Station)	Parameter	Flow Regimes									
			High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
			0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Chagrin River	At Chagrin Boulevard (D01P07)	TP	No Data	6%	0%	0%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	2%	0%	No Data	No Data	0%	0%	0%	38%
		TSS	No Data	52%	85%	43%	No Data	No Data	40%	75%	92%	51%
		Fecal Coliform	No Data	68%	No Data	No Data	No Data	No Data	0%	0%	76%	0%
	At Old Mill Road (D01P04)	TP	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	13%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	55%	69%	27%	No Data	No Data	59%	78%	43%	78%
		Fecal Coliform	No Data	81%	No Data	0%	No Data	No Data	0%	0%	0%	0%
East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	TP	No Data	0%	0%	78%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	0%	91%	0%	No Data	No Data	0%	67%	61%	13%
		Fecal Coliform	No Data	68%	No Data	No Data	No Data	No Data	0%	0%	54%	0%
	At Markell Road (D01P01)	TP	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		NO3-NO2	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
		TSS	No Data	0%	83%	0%	No Data	No Data	0%	86%	73%	13%
		Fecal Coliform	No Data	75%	No Data	No Data	No Data	No Data	0%	83%	0%	0%
Chagrin River	At Daniels Park (502400)	TP	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		NO3-NO2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		TSS	74%	31%	81%	43%	23%	7%	8%	31%	67%	69%
		Fecal Coliform	86%	79%	53%	0%	0%	0%	0%	0%	0%	0%

Table 4-59. TP TMDL Summary for AU030

Subwatershed (0411000330___)	Stream	Location (Monitoring Station)	Total Phosphorus (kg/day)	Flow Regimes									
				High Flows	**Moist Conditions**			**Mid-Range Flows**		**Dry Conditions**			**Low Flows**
				0-10	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**
010	Chagrin River	At Chagrin Boulevard (D01P07)	Current Load	No Data	89.5	27.0	8.7	No Data	No Data	8.0	9.9	5.9	2.7
			% Reduction	No Data	6%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**211.1**	**83.8**	**50.3**	**35.5**	**26.6**	**19.1**	**14.0**	**10.6**	**8.0**	**5.3**
			LA	122.4	40.0	18.2	8.7	2.9	0.0	0.0	0.0	0.0	0.0
			WLA: Facilities	21.0	21.0	21.0	21.0	21.0	18.1	13.3	10.0	7.6	5.1
			WLA: MS4	57.2	18.7	8.5	4.1	1.4	0.0	0.0	0.0	0.0	0.0
			WLA	78.2	39.6	29.5	25.0	22.3	18.1	13.3	10.0	7.6	5.1
			MOS	10.6	4.2	2.5	1.8	1.3	1.0	0.7	0.5	0.4	0.3
		At Old Mill Road (D01P04)	Current Load	No Data	99.1	48.9	9.0	No Data	No Data	5.5	5.2	2.9	3.1
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**260.4**	**103.4**	**62.0**	**43.8**	**32.8**	**23.5**	**17.3**	**13.0**	**9.9**	**6.6**
			LA	148.0	49.1	23.0	11.6	4.7	0.0	0.0	0.0	0.0	0.0
			WLA: Facilities	24.1	24.1	24.1	24.1	24.1	22.4	16.4	12.4	9.4	6.3
			WLA: MS4	75.3	25.0	11.7	5.9	2.4	0.0	0.0	0.0	0.0	0.0
			WLA	99.4	49.1	35.8	30.0	26.5	22.4	16.4	12.4	9.4	6.3
			MOS	13.0	5.2	3.1	2.2	1.6	1.2	0.9	0.7	0.5	0.3

Table 4-59. TP TMDL Summary for AU030 (cont'd)

Subwatershed (0411000330___)	Stream	Location (Monitoring Station)	Total Phosphorus (kg/day)	Flow Regimes									
				High Flows	**Moist Conditions**			**Mid-Range Flows**		**Dry Conditions**			**Low Flows**
				0-10	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**
020	East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	Current Load	No Data	10.3	7.7	33.6	No Data	No Data	0.4	0.6	0.3	0.1
			% Reduction	No Data	0%	0%	78%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**44.0**	**17.5**	**10.5**	**7.4**	**5.5**	**4.0**	**2.9**	**2.2**	**1.7**	**1.1**
			LA	36.8	14.5	8.7	6.1	4.5	3.2	2.3	1.9	1.4	0.9
			WLA: Facilities	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
			WLA: MS4	4.9	1.9	1.1	0.8	0.6	0.4	0.3	0.0	0.0	0.0
			WLA	5.0	2.1	1.3	1.0	0.7	0.6	0.5	0.2	0.2	0.2
			MOS	2.2	0.9	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1
		At Markell Road (D01P01)	Current Load	No Data	19.6	9.6	2.2	No Data	No Data	0.5	1.2	1.0	0.2
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**75.3**	**29.9**	**17.9**	**12.7**	**9.5**	**6.8**	**5.0**	**3.8**	**2.9**	**1.9**
			LA	53.9	21.0	12.3	8.5	6.2	4.2	2.9	2.7	1.8	0.9
			WLA: Facilities	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
			WLA: MS4	16.7	6.5	3.8	2.6	1.9	1.3	0.9	0.0	0.0	0.0
			WLA	17.6	7.4	4.7	3.5	2.8	2.2	1.8	0.9	0.9	0.9
			MOS	3.8	1.5	0.9	0.6	0.5	0.3	0.2	0.2	0.1	0.1
030	Chagrin River	At Daniels Park (502400)	Current Load	889.6	184.1	58.0	38.0	25.3	19.7	13.6	9.4	8.6	5.4
			% Reduction	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**690.2**	**274.0**	**164.3**	**116.0**	**86.9**	**62.4**	**45.8**	**34.5**	**26.2**	**17.5**
			LA	387.7	144.6	80.5	52.3	35.3	21.0	11.2	7.6	0.0	0.0
			WLA: Facilities	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	24.9	16.6
			WLA: MS4	242.8	90.5	50.4	32.8	22.1	13.1	7.0	0.0	0.0	0.0
			WLA	268.0	115.7	75.6	57.9	47.3	38.3	32.2	25.2	24.9	16.6
			MOS	34.5	13.7	8.2	5.8	4.3	3.1	2.3	1.7	1.3	0.9

Table 4-60. TP NPDES WLAs for facilities within AU030.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	TP Limit (mg/l)	TP (kg/day)
Moreland Hills Greentree STP	OH0021229	3PA00010	0.01	1	0.04
Woodbran Realty Corp Woodbran	OH0044555	3PU00001	0.52	1	1.97
Cuyahoga Co Commissioners	OH0021199	3PG00048	0.094	1	0.36
Geauga Co Scarsdale STP	OH0028916	3PG00000	0.026	1	0.10
Geauga Co. Valley View WWTP	OH0123625	3PG00153	0.2	1	0.76
Moreland Hills Jackson Valley WWTP	OH0063878	3PA00023	0.06	1	0.23
Moreland Hills Quail Hollow St	OH0021202	3PA00009	0.02	1	0.08
Moreland Hills Woodland WWTP	OH0021245	3PA00011	0.08	1	0.30
Pepper Pike/Creekside WWTP	OH0021130	3PH00018	0.35	1	1.32
Geauga Co. Sherman Hills WWTP	OH0028851	3PG00005	0.04	1	0.15
Eagle Road Mhp WWTP	OH0103365	3PV00071	0.025	1	0.09
Edgewood Condominiums WWTP	OH0103098	3PW00022	0.0025	1	0.01
Hilltop Apartments WWTP	OH0089877	3PR00106	0.02	1	0.08
Kirtland City Tavern WWTP	OH0128767	3PR00238	0.002	1	0.01
Kirtland Hickory Hills STP	OH0036803	3PG00059	0.03	1	0.11
Kirtland Local Schools WWTP	OH0044644	3PT00023	0.03	1	0.11
Kirtland Mhp WWTP	OH0111953	3PV00074	0.02	1	0.08
Kirtland Plaza WWTP	OH0117471	3PR00160	0.01	1	0.04
Kirtland Shopping Center WWTP	OH0103101	3PR00152	0.006	1	0.02
Lake Metroparks Penitentiary Glen WWTP	OH0134643	3PR00375	0.005	1	0.02
Latter Day Saints Church	OH0090123	3PR00115	0.005	1	0.02
Western Reserve Health Center WWTP	OH0100994	3PR00137	0.041	1	0.16
Gates Mills WWTP	OH0128643	3PA00035	0.015	1	0.06
Geauga Co. Willow Hill WWTP	OH0028894	3PG00009	0.013	1	0.05
Olde Towne Tavern WWTP	OH0117803	3PR00170	0.0025	1	0.01
Shenandoah Estates WWTP	OH0039004	3PG00065	0.0125	1	0.05

Table 4-61. TP WLAs for MS4s within AU030.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P07 (10.16%	18.25	5.96	2.72	1.30	0.44	0.00	0.00	0.00	0.00	0.00
	D01P04 (8.24%)	18.40	6.10	2.86	1.44	0.58	0.00	0.00	0.00	0.00	0.00
	502400 (5.28%)	33.31	12.42	6.92	4.49	3.03	1.80	0.97	0.00	0.00	0.00
Bainbridge	D01P07 (2.71%)	4.86	1.59	0.72	0.34	0.12	0.00	0.00	0.00	0.00	0.00
	D01P04 (2.19%)	4.90	1.62	0.76	0.38	0.15	0.00	0.00	0.00	0.00	0.00
	502400 (1.41%)	8.87	3.31	1.84	1.20	0.81	0.48	0.26	0.00	0.00	0.00
Beachwood	D01P07 (0.01%)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D01P04 (0.56%)	1.25	0.42	0.20	0.10	0.04	0.00	0.00	0.00	0.00	0.00
	502400 (0.36%)	2.27	0.85	0.47	0.31	0.21	0.12	0.07	0.00	0.00	0.00
Bentleyville	D01P07 (2.06%)	3.70	1.21	0.55	0.26	0.09	0.00	0.00	0.00	0.00	0.00
	D01P04 (1.67%)	3.73	1.24	0.58	0.29	0.12	0.00	0.00	0.00	0.00	0.00
	502400 (1.07%)	6.75	2.52	1.40	0.91	0.61	0.37	0.20	0.00	0.00	0.00
Chagrin Falls	D01P07 (1.58%)	2.84	0.93	0.42	0.20	0.07	0.00	0.00	0.00	0.00	0.00
	D01P04 (1.34%)	3.00	1.00	0.47	0.24	0.09	0.00	0.00	0.00	0.00	0.00
	502400 (0.86%)	5.44	2.03	1.13	0.73	0.50	0.29	0.16	0.00	0.00	0.00
Gates Mills	D01P04 (1.08%)	2.40	0.80	0.37	0.19	0.08	0.00	0.00	0.00	0.00	0.00
	502400 (3.72%)	23.48	8.75	4.87	3.17	2.14	1.27	0.68	0.00	0.00	0.00
Highland Heights	502400 (0.20%)	1.29	0.48	0.27	0.17	0.12	0.07	0.04	0.00	0.00	0.00
Kirtland	D01S20 (11.69%)	4.87	1.92	1.15	0.80	0.60	0.42	0.31	0.00	0.00	0.00

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
	D01P01 (23.28%)	16.43	6.40	3.75	2.59	1.89	1.29	0.89	0.00	0.00	0.00
	502400 (6.78%)	42.75	15.94	8.87	5.77	3.89	2.31	1.24	0.00	0.00	0.00
Lyndhurst	D01P04 (0.03%)	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	502400 (0.02%)	0.11	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
Mayfield	502400 (1.50%)	9.46	3.53	1.96	1.28	0.86	0.51	0.27	0.00	0.00	0.00
Mayfield Heights	D01P04 (0.43%)	0.97	0.32	0.15	0.08	0.03	0.00	0.00	0.00	0.00	0.00
	502400 (1.36%)	8.57	3.20	1.78	1.16	0.78	0.46	0.25	0.00	0.00	0.00
Mentor	D01P01 (0.06%)	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	502400 (0.01%)	0.07	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Moreland Hills	D01P07 (3.74%)	6.72	2.19	1.00	0.48	0.16	0.00	0.00	0.00	0.00	0.00
	D01P04 (4.63%)	10.33	3.43	1.61	0.81	0.33	0.00	0.00	0.00	0.00	0.00
	502400 (2.97%)	18.71	6.98	3.89	2.52	1.70	1.01	0.54	0.00	0.00	0.00
Orange	D01P07 (1.59%)	2.86	0.93	0.43	0.20	0.07	0.00	0.00	0.00	0.00	0.00
	D01P04 (1.30%)	2.91	0.96	0.45	0.23	0.09	0.00	0.00	0.00	0.00	0.00
	502400 (0.84%)	5.27	1.96	1.09	0.71	0.48	0.28	0.15	0.00	0.00	0.00
Pepper Pike	D01P07 (0.13%)	0.23	0.08	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	D01P04 (4.23%)	9.45	3.14	1.47	0.74	0.30	0.00	0.00	0.00	0.00	0.00
	502400 (2.72%)	17.13	6.39	3.56	2.31	1.56	0.93	0.50	0.00	0.00	0.00
Solon	D01P07 (6.52%)	11.72	3.83	1.75	0.83	0.28	0.00	0.00	0.00	0.00	0.00
	D01P04 (5.29%)	11.81	3.92	1.84	0.92	0.37	0.00	0.00	0.00	0.00	0.00
	502400 (3.39%)	21.39	7.98	4.44	2.89	1.95	1.16	0.62	0.00	0.00	0.00

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
South Russell	D01P07 (3.06%)	5.49	1.79	0.82	0.39	0.13	0.00	0.00	0.00	0.00	0.00
	D01P04 (2.48%)	5.53	1.84	0.86	0.43	0.17	0.00	0.00	0.00	0.00	0.00
	502400 (1.59%)	10.02	3.74	2.08	1.35	0.91	0.54	0.29	0.00	0.00	0.00
Streetsboro	D01P07 (0.04%)	0.08	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	D01P04 (0.04%)	0.08	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	502400 (0.02%)	0.14	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
Wickliffe	502400 (0.38%)	2.39	0.89	0.50	0.32	0.22	0.13	0.07	0.00	0.00	0.00
Willoughby	502400 (0.58%)	3.63	1.35	0.75	0.49	0.33	0.20	0.11	0.00	0.00	0.00
Willoughby Hills	D01P01 (0.35%)	0.24	0.10	0.06	0.04	0.03	0.02	0.01	0.00	0.00	0.00
	502400 (3.32%)	20.92	7.80	4.34	2.82	1.90	1.13	0.61	0.00	0.00	0.00
Woodmere	D01P07 (0.24%)	0.43	0.14	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	D01P04 (0.21%)	0.47	0.16	0.07	0.04	0.01	0.00	0.00	0.00	0.00	0.00
	502400 (0.13%)	0.85	0.32	0.18	0.11	0.08	0.05	0.02	0.00	0.00	0.00
Total MS4	D01P07 (31.84%)	57.18	18.67	8.52	4.06	1.36	0.00	0.00	0.00	0.00	0.00
	D01P04 (33.72%)	75.30	24.98	11.73	5.89	2.38	0.00	0.00	0.00	0.00	0.00
	D01S20 (11.69%)	4.87	1.92	1.15	0.80	0.60	0.42	0.31	0.00	0.00	0.00
	D01P01 (23.68%)	16.72	6.51	3.82	2.63	1.92	1.32	0.91	0.00	0.00	0.00
	502400 (38.51%)	242.82	90.53	50.41	32.76	22.11	13.13	7.04	0.00	0.00	0.00

Table 4-62. NO3-NO2 Summary for AU030

Subwatershed (04110003 30___)	Stream	Location (Monitoring Station)	N02N03 (kg/day)	Flow Regimes: High Flows 0-10	Moist Conditions 10-20	Moist Conditions 20-30	Moist Conditions 30-40	Mid-Range Flows 40-50	Mid-Range Flows 50-60	Dry Conditions 60-70	Dry Conditions 70-80	Dry Conditions 80-90	Low Flows 90-100
010	Chagrin River	At Chagrin Boulevard (D01P07)	Current Load	No Data	368	512	45	No Data	No Data	122	94	63	87
			% Reduction	No Data	0%	2%	0%	No Data	No Data	0%	0%	0%	38%
			TMDL= LA+WLA+MOS	**2,111**	**838**	**503**	**355**	**266**	**191**	**140**	**106**	**80**	**53**
			LA	1,296	471	254	158	101	52	19	0	0	0
			WLA: Facilities	105	105	105	105	105	105	105	100	76	51
			WLA: MS4	605	220	119	74	47	24	9	0	0	0
			WLA	710	325	223	179	152	129	114	100	76	51
			MOS	106	42	25	18	13	10	7	5	4	3
		At Old Mill Road (D01P04)	Current Load	No Data	527	716	73	No Data	No Data	135	89	86	54
			% Reduction	No Data	0%	13%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**2,604**	**1,034**	**620**	**438**	**328**	**235**	**173**	**130**	**99**	**66**
			LA	1,560	571	310	196	127	68	29	3	0	0
			WLA: Facilities	121	121	121	121	121	121	121	121	94	63
			WLA: MS4	794	290	158	100	64	35	15	0	0	0
			WLA	914	411	279	220	185	155	135	121	94	63
			MOS	130	52	31	22	16	12	9	7	5	3

Table 4-62. NO3-NO2 Summary for AU030 (cont'd)

Subwatershed (0411000330___)	Stream	Location (Monitoring Station)	N02N03 (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
020	East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	Current Load	No Data	70	72	7	No Data	No Data	9	8	4	1
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**440**	**175**	**105**	**74**	**55**	**40**	**29**	**22**	**17**	**11**
			LA	369	146	87	61	46	33	24	20	15	10
			WLA: Facilities	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
			WLA: MS4	49	19	12	8	6	4	3	0	0	0
			WLA	50	20	12	9	7	5	4	1	1	1
			MOS	22	9	5	4	3	2	1	1	1	1
		At Markell Road (D01P01)	Current Load	No Data	120	102	27	No Data	No Data	15	7	3	2
			% Reduction	No Data	0%	0%	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**753**	**299**	**179**	**127**	**95**	**68**	**50**	**38**	**29**	**19**
			LA	542	213	126	88	65	46	33	31	23	14
			WLA: Facilities	4	4	4	4	4	4	4	4	4	4
			WLA: MS4	168	66	39	27	20	14	10	0	0	0
			WLA	173	71	44	32	25	19	15	4	4	4
			MOS	38	15	9	6	5	3	2	2	1	1
030	Chagrin River	At Daniels Park (502400)	Current Load	2,533	1,043	522	320	99	98	173	96	47	17
			% Reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**6,090**	**2,417**	**1,450**	**1,024**	**767**	**550**	**404**	**305**	**231**	**154**
			LA	3,480	1,335	769	521	371	244	158	163	94	21
			WLA: Facilities	126	126	126	126	126	126	126	126	126	126
			WLA: MS4	2,180	836	482	326	232	153	99	0	0	0

Subwatershed (0411000330___)	**Stream**	Location (Monitoring Station)	**N02N03 (kg/day)**	**Flow Regimes**									
				High Flows	**Moist Conditions**			**Mid-Range Flows**		**Dry Conditions**			**Low Flows**
				0-10	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**
			WLA	2,305	962	608	452	358	279	225	126	126	126
			MOS	305	121	72	51	38	28	20	15	12	8

Table 4-63. N02-N03 NPDES WLAs for facilities within AU030.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	N02N03 Limit (mg/l)	N02N03 (kg/day)
Moreland Hills Greentree STP	OH0021229	3PA00010	0.01	5	0.19
Woodbran Realty Corp Woodbran	OH0044555	3PU00001	0.52	5	9.84
Cuyahoga Co Commissioners	OH0021199	3PG00048	0.094	5	1.78
Geauga Co Scarsdale STP	OH0028916	3PG00000	0.026	5	0.49
Geauga Co. Valley View WWTP	OH0123625	3PG00153	0.2	5	3.79
Moreland Hills Jackson Valley WWTP	OH0063878	3PA00023	0.06	5	1.14
Moreland Hills Quail Hollow St	OH0021202	3PA00009	0.02	5	0.38
Moreland Hills Woodland WWTP	OH0021245	3PA00011	0.08	5	1.51
Pepper Pike/Creekside WWTP	OH0021130	3PH00018	0.35	5	6.62
Geauga Co. Sherman Hills WWTP	OH0028851	3PG00005	0.04	5	0.76
Eagle Road Mhp WWTP	OH0103365	3PV00071	0.025	5	0.47
Edgewood Condominiums WWTP	OH0103098	3PW00022	0.0025	5	0.05
Hilltop Apartments WWTP	OH0089877	3PR00106	0.02	5	0.38
Kirtland City Tavern WWTP	OH0128767	3PR00238	0.002	5	0.04
Kirtland Hickory Hills STP	OH0036803	3PG00059	0.03	5	0.57
Kirtland Local Schools WWTP	OH0044644	3PT00023	0.03	5	0.57
Kirtland Mhp WWTP	OH0111953	3PV00074	0.02	5	0.38
Kirtland Plaza WWTP	OH0117471	3PR00160	0.01	5	0.19
Kirtland Shopping Center WWTP	OH0103101	3PR00152	0.006	5	0.11
Lake Metroparks Penitentiary Glen WWTP	OH0134643	3PR00375	0.005	5	0.09
Latter Day Saints Church	OH0090123	3PR00115	0.005	5	0.09
Western Reserve Health Center WWTP	OH0100994	3PR00137	0.041	5	0.78
Gates Mills WWTP	OH0128643	3PA00035	0.015	5	0.28
Geauga Co. Willow Hill WWTP	OH0028894	3PG00009	0.013	5	0.25
Olde Towne Tavern WWTP	OH0117803	3PR00170	0.0025	5	0.05
Shenandoah Estates WWTP	OH0039004	3PG00065	0.0125	5	0.24

Table 4-64. N02-N03 WLAs for MS4s within AU030.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P07 (10.16%	193.15	70.24	37.85	23.61	15.01	7.76	2.85	0.00	0.00	0.00
	D01P04 (8.24%)	193.89	70.97	38.58	24.33	15.74	8.49	3.58	0.00	0.00	0.00
	502400 (5.28%)	299.03	114.68	66.11	44.74	31.85	20.98	13.61	0.00	0.00	0.00
Bainbridge	D01P07 (2.71%)	51.42	18.70	10.08	6.29	4.00	2.07	0.76	0.00	0.00	0.00
	D01P04 (2.19%)	51.62	18.89	10.27	6.48	4.19	2.26	0.95	0.00	0.00	0.00
	502400 (1.41%)	79.61	30.53	17.60	11.91	8.48	5.59	3.62	0.00	0.00	0.00
Beachwood	D01P07 (0.01%)	0.09	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	D01P04 (0.56%)	13.20	4.83	2.63	1.66	1.07	0.58	0.24	0.00	0.00	0.00
	502400 (0.36%)	20.36	7.81	4.50	3.05	2.17	1.43	0.93	0.00	0.00	0.00
Bentleyville	D01P07 (2.06%)	39.16	14.24	7.67	4.79	3.04	1.57	0.58	0.00	0.00	0.00
	D01P04 (1.67%)	39.31	14.39	7.82	4.93	3.19	1.72	0.73	0.00	0.00	0.00
	502400 (1.07%)	60.63	23.25	13.40	9.07	6.46	4.25	2.76	0.00	0.00	0.00
Chagrin Falls	D01P07 (1.58%)	30.03	10.92	5.89	3.67	2.33	1.21	0.44	0.00	0.00	0.00
	D01P04 (1.34%)	31.65	11.59	6.30	3.97	2.57	1.39	0.58	0.00	0.00	0.00
	502400 (0.86%)	48.82	18.72	10.79	7.30	5.20	3.43	2.22	0.00	0.00	0.00
Gates Mills	D01P04 (1.08%)	25.32	9.27	5.04	3.18	2.06	1.11	0.47	0.00	0.00	0.00
	502400 (3.72%)	210.73	80.82	46.59	31.53	22.44	14.78	9.59	0.00	0.00	0.00
Highland Heights	502400 (0.20%)	11.55	4.43	2.55	1.73	1.23	0.81	0.53	0.00	0.00	0.00
Kirtland	D01S20 (11.69%)	48.80	19.32	11.55	8.13	6.07	4.33	3.15	0.00	0.00	0.00
	D01P01 (23.28%)	165.36	65.01	38.57	26.93	19.91	14.00	9.99	0.00	0.00	0.00
	502400 (6.78%)	383.71	147.16	84.83	57.41	40.87	26.92	17.47	0.00	0.00	0.00
Lyndhurst	D01P04 (0.03%)	0.64	0.24	0.13	0.08	0.05	0.03	0.01	0.00	0.00	0.00
	502400 (0.02%)	1.00	0.38	0.22	0.15	0.11	0.07	0.05	0.00	0.00	0.00
Mayfield	502400 (1.50%)	84.87	32.55	18.76	12.70	9.04	5.95	3.86	0.00	0.00	0.00
Mayfield Heights	D01P04 (0.43%)	10.21	3.74	2.03	1.28	0.83	0.45	0.19	0.00	0.00	0.00
	502400 (1.36%)	76.95	29.51	17.01	11.51	8.20	5.40	3.50	0.00	0.00	0.00
Mentor	D01P01 (0.06%)	0.40	0.16	0.09	0.07	0.05	0.03	0.02	0.00	0.00	0.00
	502400 (0.01%)	0.59	0.23	0.13	0.09	0.06	0.04	0.03	0.00	0.00	0.00
Moreland Hills	D01P07 (3.74%)	71.08	25.85	13.93	8.69	5.52	2.86	1.05	0.00	0.00	0.00
	D01P04 (4.63%)	108.92	39.87	21.67	13.67	8.84	4.77	2.01	0.00	0.00	0.00
	502400 (2.97%)	167.99	64.42	37.14	25.13	17.89	11.79	7.65	0.00	0.00	0.00
Orange	D01P07 (1.59%)	30.30	11.02	5.94	3.70	2.35	1.22	0.45	0.00	0.00	0.00

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
	D01P04 (1.30%)	30.64	11.22	6.10	3.85	2.49	1.34	0.57	0.00	0.00	0.00
	502400 (0.84%)	47.26	18.12	10.45	7.07	5.03	3.32	2.15	0.00	0.00	0.00
	D01P07 (0.13%)	2.46	0.89	0.48	0.30	0.19	0.10	0.04	0.00	0.00	0.00
	D01P04 (4.23%)	99.61	36.46	19.82	12.50	8.08	4.36	1.84	0.00	0.00	0.00
Pepper Pike	502400 (2.72%)	153.75	58.97	33.99	23.00	16.37	10.79	7.00	0.00	0.00	0.00
	D01P07 (6.52%)	124.03	45.10	24.31	15.16	9.64	4.99	1.83	0.00	0.00	0.00
	D01P04 (5.29%)	124.50	45.57	24.77	15.63	10.10	5.45	2.30	0.00	0.00	0.00
Solon	502400 (3.39%)	192.02	73.64	42.45	28.73	20.45	13.47	8.74	0.00	0.00	0.00
	D01P07 (3.06%)	58.11	21.13	11.39	7.10	4.52	2.34	0.86	0.00	0.00	0.00
	D01P04 (2.48%)	58.33	21.35	11.61	7.32	4.73	2.55	1.08	0.00	0.00	0.00
South Russell	502400 (1.59%)	89.96	34.50	19.89	13.46	9.58	6.31	4.10	0.00	0.00	0.00
	D01P07 (0.04%)	0.84	0.30	0.16	0.10	0.06	0.03	0.01	0.00	0.00	0.00
	D01P04 (0.04%)	0.84	0.31	0.17	0.11	0.07	0.04	0.02	0.00	0.00	0.00
Streetsboro	502400 (0.02%)	1.29	0.50	0.29	0.19	0.14	0.09	0.06	0.00	0.00	0.00
Wickliffe	502400 (0.38%)	21.47	8.24	4.75	3.21	2.29	1.51	0.98	0.00	0.00	0.00
Willoughby	502400 (0.58%)	32.57	12.49	7.20	4.87	3.47	2.29	1.48	0.00	0.00	0.00
	D01P01 (0.35%)	2.46	0.97	0.57	0.40	0.30	0.21	0.15	0.00	0.00	0.00
Willoughby Hills	502400 (3.32%)	187.76	72.01	41.51	28.09	20.00	13.17	8.55	0.00	0.00	0.00
	D01P07 (0.24%)	4.56	1.66	0.89	0.56	0.35	0.18	0.07	0.00	0.00	0.00
	D01P04 (0.21%)	4.94	1.81	0.98	0.62	0.40	0.22	0.09	0.00	0.00	0.00
Woodmere	502400 (0.13%)	7.62	2.92	1.69	1.14	0.81	0.53	0.35	0.00	0.00	0.00
	D01P07 (31.84%)	605.22	220.09	118.61	73.97	47.04	24.33	8.94	0.00	0.00	0.00
	D01P04 (33.72%)	793.63	290.49	157.92	99.60	64.41	34.75	14.64	0.00	0.00	0.00
	D01S20 (11.69%)	48.80	19.32	11.55	8.13	6.07	4.33	3.15	0.00	0.00	0.00
	D01P01 (23.68%)	168.23	66.13	39.23	27.40	20.26	14.24	10.16	0.00	0.00	0.00
Total MS4	502400 (38.51%)	2179.57	835.90	481.85	326.11	232.13	152.92	99.21	0.00	0.00	0.00

Table 4-65. TSS TMDL Summary for AU030

Subwatershed (04110003300__)	Stream	Location (Monitoring Station)	TSS (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
010	Chagrin River	At Chagrin Boulevard (D01P07)	Current Load	No Data	92,679	17,251	3,114	No Data	No Data	1,168	2,112	4,981	550
			% Reduction	No Data	52%	85%	43%	No Data	No Data	40%	75%	92%	51%
			TMDL= LA+WLA+MOS	**111,897**	**44,415**	**2,513**	**1,775**	**1,329**	**954**	**700**	**528**	**401**	**267**
			LA	72,228	28,532	1,399	922	633	390	225	168	47	0
			WLA: Facilities	334	334	334	334	334	334	334	334	334	254
			WLA: MS4	33,740	13,328	654	431	296	182	105	0	0	0
			WLA	34,074	13,662	988	764	630	516	439	334	334	254
			MOS	5,595	2,221	126	89	66	48	35	26	20	13
		At Old Mill Road (D01P04)	Current Load	No Data	121,226	9,931	2,988	No Data	No Data	2,081	2,996	866	1,507
			% Reduction	No Data	55%	69%	27%	No Data	No Data	59%	78%	43%	78%
			TMDL= LA+WLA+MOS	**138,034**	**54,789**	**3,100**	**2,189**	**1,640**	**1,177**	**863**	**651**	**494**	**330**
			LA	86,651	34,235	1,688	1,115	769	478	280	221	72	0
			WLA: Facilities	397	397	397	397	397	397	397	397	397	313
			WLA: MS4	44,084	17,417	859	567	391	243	143	0	0	0
			WLA	44,481	17,815	1,256	965	789	640	540	397	397	313
			MOS	6,902	2,739	155	109	82	59	43	33	25	16

Table 4-65. TSS TMDL Summary for AU030 (cont'd)

Subwatershed (0411000330___)	Stream	Location (Monitoring Station)	TSS (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
020	East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	Current Load	No Data	5,498	5,516	361	No Data	No Data	135	330	215	64
			% Reduction	No Data	0%	91%	0%	No Data	No Data	0%	67%	61%	13%
			TMDL= LA+WLA+MOS	**23,333**	**9,261**	**524**	**370**	**277**	**199**	**146**	**110**	**84**	**56**
			LA	19,573	7,767	437	308	230	165	120	102	77	50
			WLA: Facilities	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
			WLA: MS4	2,591	1,028	58	41	30	22	16	0	0	0
			WLA	2,594	1,031	61	44	33	25	19	3	3	3
			MOS	1,167	463	26	19	14	10	7	6	4	3
		At Markell Road (D01P01)	Current Load	No Data	13,100	5,124	617	No Data	No Data	231	1,355	532	109
			% Reduction	No Data	0%	83%	0%	No Data	No Data	0%	86%	73%	13%
			TMDL= LA+WLA+MOS	**39,884**	**15,831**	**896**	**633**	**474**	**340**	**249**	**188**	**143**	**95**
			LA	28,905	11,466	637	446	331	234	169	163	120	74
			WLA: Facilities	16	16	16	16	16	16	16	16	16	16
			WLA: MS4	8,968	3,558	198	138	103	73	52	0	0	0
			WLA	8,985	3,574	214	155	119	89	68	16	16	16
			MOS	1,994	792	45	32	24	17	12	9	7	5
030	Chagrin River	At Daniels Park (502400)	Current Load	1,083,735	164,289	25,085	6,001	3,308	1,969	1,468	1,468	2,347	1,680
			% Reduction	74%	31%	81%	43%	23%	7%	8%	31%	67%	69%
			TMDL= LA+WLA+MOS	**284,206**	**112,809**	**4,832**	**3,413**	**2,557**	**1,835**	**1,346**	**1,015**	**771**	**514**
			LA	165,765	65,642	2,567	1,738	1,237	816	530	548	316	72
			WLA: Facilities	416	416	416	416	416	416	416	416	416	416
			WLA: MS4	103,815	41,110	1,607	1,088	775	511	332	0	0	0

Subwatershed (0411000330___)	Stream	Location (Monitoring Station)	TSS (kg/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
			WLA	104,232	41,527	2,024	1,505	1,191	927	748	416	416	416
			MOS	14,210	5,640	242	171	128	92	67	51	39	26

Table 4-66. TSS NPDES WLAs for facilities within AU030.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	TSS Limit (mg/l)	TSS (kg/day)
Moreland Hills Greentree STP	OH0021229	3PA00010	0.01	18.0	0.7
Woodbran Realty Corp Woodbran	OH0044555	3PU00001	0.52	18.0	35.4
Cuyahoga Co Commissioners	OH0021199	3PG00048	0.094	45.0	16.0
Geauga Co Scarsdale STP	OH0028916	3PG00000	0.026	18.0	1.8
Geauga Co. Valley View WWTP	OH0123625	3PG00153	0.2	18.0	13.6
Moreland Hills Jackson Valley WWTP	OH0063878	3PA00023	0.06	18.0	4.1
Moreland Hills Quail Hollow St	OH0021202	3PA00009	0.02	18.0	1.4
Moreland Hills Woodland WWTP	OH0021245	3PA00011	0.08	9.0	2.7
Pepper Pike/Creekside WWTP	OH0021130	3PH00018	0.35	18.0	23.8
Geauga Co. Sherman Hills WWTP	OH0028851	3PG00005	0.04	18.0	2.7
Eagle Road MHP WWTP	OH0103365	3PV00071	0.025	18.0	1.7
Edgewood Condominiums WWTP	OH0103098	3PW00022	0.0025	18.0	0.2
Hilltop Apartments WWTP	OH0089877	3PR00106	0.02	18.0	1.4
Kirtland City Tavern WWTP	OH0128767	3PR00238	0.002	18.0	0.1
Kirtland Hickory Hills STP	OH0036803	3PG00059	0.03	18.0	2.0
Kirtland Local Schools WWTP	OH0044644	3PT00023	0.03	18.0	2.0
Kirtland MHP WWTP	OH0111953	3PV00074	0.02	18.0	1.4
Kirtland Plaza WWTP	OH0117471	3PR00160	0.01	18.0	0.7
Kirtland Shopping Center WWTP	OH0103101	3PR00152	0.006	18.0	0.4
Lake Metroparks Penitentiary Glen WWTP	OH0134643	3PR00375	0.005	18.0	0.3
Latter Day Saints Church	OH0090123	3PR00115	0.005	18.0	0.3
Western Reserve Health Center WWTP	OH0100994	3PR00137	0.041	18.0	2.8
Gates Mills WWTP	OH0128643	3PA00035	0.015	18.0	1.0
Geauga Co. Willow Hill WWTP	OH0028894	3PG00009	0.013	18.0	0.9
Olde Towne Tavern WWTP	OH0117803	3PR00170	0.0025	18.0	0.2
Shenandoah Estates WWTP	OH0039004	3PG00065	0.0125	18.0	0.9

Table 4-67. TSS WLAs for MS4s within AU030.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P07 (10.16%	10767.64	4253.50	208.62	137.39	94.40	58.18	33.61	0.00	0.00	0.00
	D01P04 (8.24%)	10769.77	4255.07	209.84	138.60	95.61	59.38	34.82	0.00	0.00	0.00
	502400 (5.28%)	14243.22	5640.25	220.53	149.31	106.33	70.10	45.54	0.00	0.00	0.00
Bainbridge	D01P07 (2.71%)	2866.79	1132.46	55.54	36.58	25.13	15.49	8.95	0.00	0.00	0.00
	D01P04 (2.19%)	2867.36	1132.88	55.87	36.90	25.46	15.81	9.27	0.00	0.00	0.00
	502400 (1.41%)	3792.14	1501.67	58.71	39.75	28.31	18.66	12.12	0.00	0.00	0.00
Beachwood	D01P07 (0.01%)	4.83	1.91	0.09	0.06	0.04	0.03	0.02	0.00	0.00	0.00
	D01P04 (0.56%)	733.21	289.69	14.29	9.44	6.51	4.04	2.37	0.00	0.00	0.00
	502400 (0.36%)	969.68	383.99	15.01	10.16	7.24	4.77	3.10	0.00	0.00	0.00
Bentleyville	D01P07 (2.06%)	2183.20	862.42	42.30	27.86	19.14	11.80	6.82	0.00	0.00	0.00
	D01P04 (1.67%)	2183.63	862.74	42.55	28.10	19.39	12.04	7.06	0.00	0.00	0.00
	502400 (1.07%)	2887.89	1143.59	44.71	30.27	21.56	14.21	9.23	0.00	0.00	0.00
Chagrin Falls	D01P07 (1.58%)	1674.37	661.42	32.44	21.36	14.68	9.05	5.23	0.00	0.00	0.00
	D01P04 (1.34%)	1758.19	694.65	34.26	22.63	15.61	9.69	5.68	0.00	0.00	0.00
	502400 (0.86%)	2325.24	920.79	36.00	24.37	17.36	11.44	7.43	0.00	0.00	0.00
Gates Mills	D01P04 (1.08%)	1406.57	555.72	27.41	18.10	12.49	7.76	4.55	0.00	0.00	0.00
	502400 (3.72%)	10037.23	3974.69	155.41	105.22	74.93	49.40	32.09	0.00	0.00	0.00
Highland Heights	502400 (0.20%)	550.30	217.92	8.52	5.77	4.11	2.71	1.76	0.00	0.00	0.00
Kirtland	D01S20 (11.69%)	2590.93	1028.22	57.87	40.78	30.47	21.78	15.89	0.00	0.00	0.00
	D01P01 (23.28%)	8815.83	3496.98	194.29	136.13	101.04	71.46	51.40	0.00	0.00	0.00
	502400 (6.78%)	18276.27	7237.32	282.98	191.58	136.43	89.95	58.43	0.00	0.00	0.00
Lyndhurst	D01P04 (0.03%)	35.76	14.13	0.70	0.46	0.32	0.20	0.12	0.00	0.00	0.00
	502400 (0.02%)	47.69	18.89	0.74	0.50	0.36	0.23	0.15	0.00	0.00	0.00
Mayfield	502400 (1.50%)	4042.66	1600.88	62.59	42.38	30.18	19.90	12.93	0.00	0.00	0.00
Mayfield Heights	D01P04 (0.43%)	567.00	224.02	11.05	7.30	5.03	3.13	1.83	0.00	0.00	0.00
	502400 (1.36%)	3665.40	1451.48	56.75	38.42	27.36	18.04	11.72	0.00	0.00	0.00
Mentor	D01P01 (0.06%)	21.36	8.47	0.47	0.33	0.24	0.17	0.12	0.00	0.00	0.00
	502400 (0.01%)	28.18	11.16	0.44	0.30	0.21	0.14	0.09	0.00	0.00	0.00
Moreland Hills	D01P07 (3.74%)	3962.61	1565.34	76.77	50.56	34.74	21.41	12.37	0.00	0.00	0.00
	D01P04 (4.63%)	6050.04	2390.33	117.88	77.86	53.71	33.36	19.56	0.00	0.00	0.00
	502400 (2.97%)	8001.29	3168.47	123.89	83.87	59.73	39.38	25.58	0.00	0.00	0.00
Orange	D01P07 (1.59%)	1689.19	667.28	32.73	21.55	14.81	9.13	5.27	0.00	0.00	0.00

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
	D01P04 (1.30%)	1702.08	672.48	33.16	21.90	15.11	9.38	5.50	0.00	0.00	0.00
	502400 (0.84%)	2251.04	891.40	34.85	23.60	16.80	11.08	7.20	0.00	0.00	0.00
	D01P07 (0.13%)	137.03	54.13	2.65	1.75	1.20	0.74	0.43	0.00	0.00	0.00
	D01P04 (4.23%)	5533.09	2186.09	107.81	71.21	49.12	30.51	17.89	0.00	0.00	0.00
Pepper Pike	502400 (2.72%)	7323.29	2899.99	113.39	76.77	54.67	36.04	23.41	0.00	0.00	0.00
	D01P07 (6.52%)	6914.33	2731.34	133.96	88.22	60.62	37.36	21.58	0.00	0.00	0.00
	D01P04 (5.29%)	6915.70	2732.35	134.74	89.00	61.40	38.13	22.36	0.00	0.00	0.00
Solon	502400 (3.39%)	9146.14	3621.83	141.61	95.88	68.28	45.01	29.24	0.00	0.00	0.00
	D01P07 (3.06%)	3239.46	1279.67	62.76	41.33	28.40	17.50	10.11	0.00	0.00	0.00
	D01P04 (2.48%)	3240.10	1280.14	63.13	41.70	28.76	17.86	10.47	0.00	0.00	0.00
South Russell	502400 (1.59%)	4285.09	1696.87	66.35	44.92	31.99	21.09	13.70	0.00	0.00	0.00
	D01P07 (0.04%)	46.58	18.40	0.90	0.59	0.41	0.25	0.15	0.00	0.00	0.00
	D01P04 (0.04%)	46.59	18.41	0.91	0.60	0.41	0.26	0.15	0.00	0.00	0.00
Streetsboro	502400 (0.02%)	61.62	24.40	0.95	0.65	0.46	0.30	0.20	0.00	0.00	0.00
Wickliffe	502400 (0.38%)	1022.86	405.05	15.84	10.72	7.64	5.03	3.27	0.00	0.00	0.00
Willoughby	502400 (0.58%)	1551.53	614.40	24.02	16.26	11.58	7.64	4.96	0.00	0.00	0.00
	D01P01 (0.35%)	131.31	52.09	2.89	2.03	1.50	1.06	0.77	0.00	0.00	0.00
Willoughby Hills	502400 (3.32%)	8943.25	3541.48	138.47	93.75	66.76	44.02	28.59	0.00	0.00	0.00
	D01P07 (0.24%)	254.28	100.45	4.93	3.24	2.23	1.37	0.79	0.00	0.00	0.00
	D01P04 (0.21%)	274.57	108.48	5.35	3.53	2.44	1.51	0.89	0.00	0.00	0.00
Woodmere	502400 (0.13%)	363.12	143.80	5.62	3.81	2.71	1.79	1.16	0.00	0.00	0.00
	D01P07 (31.84%)	33740.32	13328.32	653.70	430.50	295.81	182.29	105.33	0.00	0.00	0.00
	D01P04 (33.72%)	44083.66	17417.18	858.91	567.33	391.37	243.06	142.51	0.00	0.00	0.00
	D01S20 (11.69%)	2590.93	1028.22	57.87	40.78	30.47	21.78	15.89	0.00	0.00	0.00
	D01P01 (23.68%)	8968.50	3557.53	197.66	138.49	102.79	72.69	52.29	0.00	0.00	0.00
Total MS4	502400 (38.51%)	103815.14	41110.30	1607.39	1088.26	774.98	510.94	331.92	0.00	0.00	0.00

Table 4-68. Fecal coliform TMDL Summary for AU030

Subwatershed (04110003300__)	Stream	Location (Monitoring Station)	Fecal Coliform (million/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
010	Chagrin River	At Chagrin Boulevard (D01P07)	Current Load	No Data	26,365,711	No Data	No Data	No Data	No Data	502,277	369,583	3,335,789	122,134
			% Reduction	No Data	68%	No Data	No Data	No Data	No Data	0%	0%	76%	0%
			TMDL= LA+WLA+MOS	**21,112,670**	**8,380,184**	**5,025,312**	**3,549,524**	**2,658,962**	**1,908,346**	**1,399,454**	**1,055,952**	**801,505**	**534,337**
			LA	13,527,911	5,283,372	3,111,024	2,155,422	1,578,766	1,092,727	763,209	793,404	551,680	297,870
			WLA: Facilities	209,750	209,750	209,750	209,750	209,750	209,750	209,750	209,750	209,750	209,750
			WLA: MS4	6,319,376	2,468,054	1,453,272	1,006,876	737,499	510,452	356,523	0	0	0
			WLA	6,529,126	2,677,803	1,663,022	1,216,625	947,248	720,202	566,272	209,750	209,750	209,750
			MOS	1,055,633	419,009	251,266	177,476	132,948	95,417	69,973	52,798	40,075	26,717
		At Old Mill Road (D01P04)	Current Load	No Data	55,192,373	No Data	221,975	No Data	No Data	491,690	208,415	476,467	112,996
			% Reduction	No Data	81%	No Data	0%	No Data	No Data	0%	0%	0%	0%
			TMDL= LA+WLA+MOS	**26,044,058**	**10,337,584**	**6,199,098**	**4,378,603**	**3,280,029**	**2,354,088**	**1,726,331**	**1,302,595**	**988,717**	**659,145**
			LA	16,239,055	6,349,317	3,743,477	2,597,185	1,905,457	1,322,428	927,155	996,297	698,112	385,019
			WLA: Facilities	241,169	241,169	241,169	241,169	241,169	241,169	241,169	241,169	241,169	241,169
			WLA: MS4	8,261,632	3,230,220	1,904,497	1,321,320	969,402	672,786	471,691	0	0	0
			WLA	8,502,800	3,471,388	2,145,666	1,562,488	1,210,571	913,955	712,859	241,169	241,169	241,169
			MOS	1,302,203	516,879	309,955	218,930	164,001	117,704	86,317	65,130	49,436	32,957

Table 4-68. Fecal coliform TMDL Summary for AU030 (cont'd)

Subwatershed (0411000330)	Stream	Location (Monitoring Station)	Fecal Coliform (million/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
020	East Branch Chagrin River	At Mitchell's Mill Road (D01S20)	Current Load	No Data	5,497,826	No Data	No Data	No Data	No Data	59,913	202,574	366,203	66,216
			% Reduction	No Data	68%	No Data	No Data	No Data	No Data	0%	0%	54%	0%
			TMDL= LA+WLA+ MOS	**4,402,452**	**1,747,451**	**1,047,887**	**740,153**	**554,452**	**397,932**	**291,817**	**220,189**	**167,131**	**111,421**
			LA	3,692,078	1,464,678	877,782	619,611	463,817	332,506	243,481	207,665	157,261	104,336
			WLA: Facilities	1,514	1,514	1,514	1,514	1,514	1,514	1,514	1,514	1,514	1,514
			WLA: MS4	488,737	193,886	116,196	82,021	61,398	44,015	32,231	0	0	0
			WLA	490,251	195,400	117,710	83,535	62,912	45,529	33,745	1,514	1,514	1,514
			MOS	220,123	87,373	52,394	37,008	27,723	19,897	14,591	11,009	8,357	5,571
		At Markell Road (D01P01)	Current Load	No Data	11,960,652	No Data	No Data	No Data	No Data	137,038	2,220,629	234,080	56,593
			% Reduction	No Data	75%	No Data	No Data	No Data	No Data	0%	83%	0%	0%
			TMDL= LA+WLA+ MOS	**7,525,289**	**2,986,989**	**1,791,196**	**1,265,174**	**947,747**	**680,201**	**498,814**	**376,378**	**285,684**	**190,456**
			LA	5,449,303	2,158,854	1,291,856	910,469	680,322	486,340	354,828	348,606	262,448	171,981
			WLA: Facilities	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953
			WLA: MS4	1,690,769	669,833	400,827	282,493	211,085	150,898	110,093	0	0	0
			WLA	1,699,722	678,786	409,780	291,446	220,038	159,851	119,046	8,953	8,953	8,953
			MOS	376,264	149,349	89,560	63,259	47,387	34,010	24,941	18,819	14,284	9,523

Subwatershed (0411000330)	Stream	Location (Monitoring Station)	Fecal Coliform (million/day)	Flow Regimes									
				High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
				0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
030	Chagrin River	At Daniels Park (502400)	Current Load	298,726,874	78,358,922	20,673,563	4,845,443	153,437	113,766	776,054	445,277	272,304	244,046
			% Reduction	86%	79%	53%	0%	0%	0%	0%	0%	0%	0%
			TMDL= LA+WLA+ MOS	**40,600,921**	**16,115,593**	**9,663,973**	**6,825,946**	**5,113,343**	**3,669,863**	**2,691,233**	**2,030,658**	**1,541,343**	**1,027,562**
			LA	23,562,431	9,259,204	5,490,458	3,832,610	2,832,185	1,988,969	1,417,297	1,677,376	1,212,527	724,435
			WLA: Facilities	251,749	251,749	251,749	251,749	251,749	251,749	251,749	251,749	251,749	251,749
			WLA: MS4	14,756,696	5,798,861	3,438,568	2,400,290	1,773,742	1,245,653	887,626	0	0	0
			WLA	15,008,444	6,050,609	3,690,317	2,652,038	2,025,491	1,497,401	1,139,374	251,749	251,749	251,749
			MOS	2,030,046	805,780	483,199	341,297	255,667	183,493	134,562	101,533	77,067	51,378

Table 4-69. Fecal coliform NPDES WLAs for facilities within AU030.

Facility	U.S. EPA ID	Permit #	Design Flow (MGD)	Fecal coliform limit (#/100 ml)	Fecal Coliform (million/day)
Moreland Hills Greentree STP	OH0021229	3PA00010	0.01	1000	379
Woodbran Realty Corp Woodbran	OH0044555	3PU00001	0.52	1000	19,684
Cuyahoga Co Commissioners	OH0021199	3PG00048	0.094	1000	3,558
Geauga Co Scarsdale STP	OH0028916	3PG00000	0.026	1000	984
Geauga Co. Valley View WWTP	OH0123625	3PG00153	0.2	1000	7,571
Moreland Hills Jackson Valley WWTP	OH0063878	3PA00023	0.06	1000	2,271
Moreland Hills Quail Hollow St	OH0021202	3PA00009	0.02	1000	757
Moreland Hills Woodland WWTP	OH0021245	3PA00011	0.08	1000	3,028
Pepper Pike/Creekside WWTP	OH0021130	3PH00018	0.35	1000	13,249
Geauga Co. Sherman Hills WWTP	OH0028851	3PG00005	0.04	1000	1,514
Eagle Road MHP WWTP	OH0103365	3PV00071	0.025	1000	946
Edgewood Condominiums WWTP	OH0103098	3PW00022	0.0025	1000	95
Hilltop Apartments WWTP	OH0089877	3PR00106	0.02	1000	757
Kirtland City Tavern WWTP	OH0128767	3PR00238	0.002	1000	76
Kirtland Hickory Hills STP	OH0036803	3PG00059	0.03	1000	1,136
Kirtland Local Schools WWTP	OH0044644	3PT00023	0.03	1000	1,136
Kirtland Mhp WWTP	OH0111953	3PV00074	0.02	1000	757
Kirtland Plaza WWTP	OH0117471	3PR00160	0.01	1000	379
Kirtland Shopping Center WWTP	OH0103101	3PR00152	0.006	1000	227
Lake Metroparks Penitentiary Glen WWTP	OH0134643	3PR00375	0.005	1000	189
Latter Day Saints Church	OH0090123	3PR00115	0.005	1000	189
Western Reserve Health Center WWTP	OH0100994	3PR00137	0.041	1000	1,552
Gates Mills WWTP	OH0128643	3PA00035	0.015	1000	568
Geauga Co. Willow Hill WWTP	OH0028894	3PG00009	0.013	1000	492
Olde Towne Tavern WWTP	OH0117803	3PR00170	0.0025	1000	95
Shenandoah Estates WWTP	OH0039004	3PG00065	0.0125	1000	473

Table 4-70. Fecal coliform WLAs for MS4s within AU030.

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Aurora	D01P07 (10.16%	2,016,720	787,637	463,787	321,327	235,360	162,902	113,778	0	0	0
	D01P04 (8.24%)	2,018,342	789,153	465,274	322,802	236,828	164,364	115,236	0	0	0
	502400 (5.28%)	2,024,588	795,592	471,764	329,315	243,354	170,901	121,780	0	0	0
Bainbridge	D01P07 (2.71%)	536,934	209,702	123,479	85,551	62,663	43,371	30,292	0	0	0
	D01P04 (2.19%)	537,366	210,105	123,875	85,943	63,053	43,760	30,680	0	0	0
	502400 (1.41%)	539,029	211,819	125,603	87,677	64,791	45,501	32,423	0	0	0
Beachwood	D01P07 (0.01%)	905	353	208	144	106	73	51	0	0	0
	D01P04 (0.56%)	137,409	53,726	31,676	21,976	16,123	11,190	7,845	0	0	0
	502400 (0.36%)	137,835	54,164	32,118	22,420	16,568	11,635	8,291	0	0	0
Bentleyville	D01P07 (2.06%)	408,901	159,698	94,035	65,151	47,721	33,029	23,069	0	0	0
	D01P04 (1.67%)	409,230	160,005	94,337	65,450	48,018	33,326	23,365	0	0	0
	502400 (1.07%)	410,496	161,311	95,653	66,770	49,341	34,651	24,692	0	0	0
Chagrin Falls	D01P07 (1.58%)	313,601	122,478	72,119	49,967	36,599	25,331	17,693	0	0	0
	D01P04 (1.34%)	329,500	128,831	75,957	52,698	38,663	26,833	18,813	0	0	0
	502400 (0.86%)	330,520	129,883	77,017	53,762	39,728	27,900	19,881	0	0	0
Gates Mills	D01P04 (1.08%)	263,602	103,066	60,766	42,159	30,930	21,466	15,050	0	0	0
	502400 (3.72%)	1,426,731	560,655	332,453	232,069	171,492	120,434	85,819	0	0	0
Highland Heights	502400 (0.20%)	78,222	30,739	18,227	12,723	9,402	6,603	4,705	0	0	0
Kirtland	D01S20 (11.69%)	488,737	193,886	116,196	82,021	61,398	44,015	32,231	0	0	0
	D01P01 (23.28%)	1,661,987	658,431	394,004	277,685	207,492	148,329	108,219	0	0	0
	502400 (6.78%)	2,597,862	1,020,868	605,347	422,562	312,261	219,293	156,263	0	0	0
Lyndhurst	D01P04 (0.03%)	6,701	2,620	1,545	1,072	786	546	383	0	0	0
	502400 (0.02%)	6,779	2,664	1,580	1,103	815	572	408	0	0	0
Mayfield	502400 (1.50%)	574,640	225,813	133,901	93,470	69,071	48,507	34,565	0	0	0
Mayfield Heights	D01P04 (0.43%)	106,260	41,547	24,495	16,995	12,468	8,653	6,067	0	0	0
	502400 (1.36%)	521,014	204,740	121,405	84,747	62,625	43,980	31,339	0	0	0
Mentor	D01P01 (0.06%)	4,027	1,595	955	673	503	359	262	0	0	0
	502400 (0.01%)	4,005	1,574	933	652	481	338	241	0	0	0
Moreland Hills	D01P07 (3.74%)	742,175	289,859	170,679	118,252	86,615	59,950	41,872	0	0	0
	D01P04 (4.63%)	1,133,827	443,315	261,373	181,338	133,041	92,333	64,735	0	0	0
	502400 (2.97%)	1,137,335	446,933	265,019	184,996	136,707	96,006	68,412	0	0	0

MS4 Community	Proportion of MS4 Community at Each Load Duration Site	Flow Regimes									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
	D01P07 (1.59%)	316,376	123,562	72,757	50,409	36,922	25,556	17,849	0	0	0
	D01P04 (1.30%)	318,984	124,720	73,533	51,017	37,429	25,976	18,212	0	0	0
Orange	502400 (0.84%)	319,971	125,737	74,559	52,046	38,460	27,010	19,246	0	0	0
	D01P07 (0.13%)	25,665	10,024	5,902	4,089	2,995	2,073	1,448	0	0	0
	D01P04 (4.23%)	1,036,946	405,436	239,040	165,843	121,673	84,444	59,204	0	0	0
Pepper Pike	502400 (2.72%)	1,040,962	409,061	242,562	169,320	125,123	87,870	62,615	0	0	0
	D01P07 (6.52%)	1,295,016	505,773	297,816	206,337	151,134	104,606	73,061	0	0	0
	D01P04 (5.29%)	1,296,057	506,746	298,771	207,284	152,077	105,545	73,997	0	0	0
Solon	502400 (3.39%)	1,300,068	510,881	302,939	211,466	156,267	109,742	78,200	0	0	0
	D01P07 (3.06%)	606,732	236,961	139,531	96,672	70,808	49,009	34,230	0	0	0
	D01P04 (2.48%)	607,220	237,417	139,978	97,115	71,250	49,449	34,669	0	0	0
South Russell	502400 (1.59%)	609,099	239,355	141,931	99,075	73,213	51,416	36,638	0	0	0
	D01P07 (0.04%)	8,725	3,407	2,006	1,390	1,018	705	492	0	0	0
	D01P04 (0.04%)	8,732	3,414	2,013	1,396	1,025	711	499	0	0	0
Streetsboro	502400 (0.02%)	8,759	3,442	2,041	1,425	1,053	739	527	0	0	0
Wickliffe	502400 (0.38%)	145,394	57,135	33,879	23,649	17,476	12,273	8,746	0	0	0
Willoughby	502400 (0.58%)	220,541	86,665	51,390	35,873	26,509	18,616	13,266	0	0	0
	D01P01 (0.35%)	24,755	9,807	5,869	4,136	3,090	2,209	1,612	0	0	0
Willoughby Hills	502400 (3.32%)	1,271,229	499,548	296,218	206,775	152,801	107,308	76,465	0	0	0
	D01P07 (0.24%)	47,626	18,600	10,953	7,588	5,558	3,847	2,687	0	0	0
	D01P04 (0.21%)	51,457	20,119	11,862	8,230	6,038	4,190	2,938	0	0	0
Woodmere	502400 (0.13%)	51,616	20,283	12,027	8,396	6,204	4,357	3,105	0	0	0
	D01P07 (31.84%)	6,319,376	2,468,054	1,453,272	1,006,876	737,499	510,452	356,523	0	0	0
	D01P04 (33.72%)	8,261,632	3,230,220	1,904,497	1,321,320	969,402	672,786	471,691	0	0	0
	D01S20 (11.69%)	488,737	193,886	116,196	82,021	61,398	44,015	32,231	0	0	0
	D01P01 (23.68%)	1,690,769	669,833	400,827	282,493	211,085	150,898	110,093	0	0	0
Total MS4	502400 (38.51%)	14,756,696	5,798,861	3,438,568	2,400,290	1,773,742	1,245,653	887,626	0	0	0

4.2.7 Habitat, Siltation, and the QHEI

Description of Method

The Qualitative Habitat Evaluation Index (QHEI) is a quantitative expression of a qualitative, visual assessment of habitat in free flowing streams, and was developed by the Ohio EPA to assess available habitat for fish communities (Rankin 1989, 1994, 2006). It is a composite score of six physical habitat categories: 1) substrate, 2) instream cover, 3) channel morphology, 4) riparian zone and bank erosion, 5) pool/glide and riffle/run quality, and 6) gradient. Each of these categories is subdivided into specific attributes that are assigned a point value reflective of the attribute's impact on the aquatic life. Highest scores are assigned to the attributes correlated to streams with high biological diversity and integrity and lower scores are progressively assigned to less desirable habitat features. A QHEI evaluation form is used by a trained evaluator while in the stream itself. Each of the components is evaluated on-site, recorded on the form, the score totaled, and the data later analyzed in an electronic database. QHEI scores can range from 12 to 100. Scores greater than 75 indicate excellent stream habitat, scores between 60 and 75 indicate good habitat quality, and scores less than 45 demonstrate habitat not conducive to WWH. Scores between 45 and 60 need separate evaluation by trained field staff to determine the potential aquatic life use for the stream.

In free flowing typical riverine streams, a concept analogous to a loading capacity for habitat is the use of a target QHEI score. The appropriate target QHEI score was determined by statistical analysis of Ohio's statewide database of paired QHEI and IBI scores. Simple linear and exponential regressions and frequency analyses of combined and individual components of QHEI metrics in relation to the IBI were examined. The regressions indicated the QHEI is significantly correlated with the IBI with the exponential model providing a better fit to the data than the linear. Sites with QHEI scores greater than or equal to 60 were generally associated with IBI scores supportive of a WWH use designation.

Further analysis of the QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and were classified as high influence or moderate-influence attributes based on the statistical strength of the relationships. The presence of these modified attributes can strongly influence aquatic biology to a degree that the QHEI score itself may not reflect. The analysis indicates that a stream with more than one high-influence or more than four moderate-influence attributes usually precludes attainment of the WWH biocriteria (using an IBI of 40 as a representative WWH biocriterion). The implication of which is a stream segment can be impaired even with a QHEI score above 60 (because other less-influential habitat components are in place).

The habitat TMDL equation presented below reflects the relationship between the QHEI score, modified attributes, and aquatic community performance. It is based upon a target of three (3), and is the sum of three component scores. Individual component scores exist for the observed QHEI score to target QHEI score ratio, and for the presence/absence of high and/or moderate-influence attributes. A QHEI score less than the target, the presence of more than one high-influence attribute, or more than four moderate-influence attributes will prevent a stream segment from achieving the target.

The sediment TMDL equation presented below is a subset of those factors of the QHEI most directly related to sediment type, quality, build up, and source origin. The sediment TMDL is based upon a target score of 33, which is analogous to a loading capacity. The individual components of the sediment TMDL (substrate, channel, and riparian) have individual targets that are analogous to allocations.

- Habitat TMDL = QHEI Score to Target Ratio + Modified Attribute Score + High Influence Attribute Score
  = 1 + 1 + 1
  = 3

- Sediment TMDL = Substrate + Channel Morphology + Riparian Zone/Bank Erosion
  = 14 + 14 + 5 (minimum numbers)
  = 33 (greater than or equal to)

Table 4-71 provides additional detail describing the habitat and sediment TMDLs.

Table 4-71. Details of Habitat and Sediment TMDLs

QHEI Categories		Modified Attributes			
Category	**Target**	**High Influence**		**Moderate Influence**	
Substrate	≥14	• Channelized or No Recovery • Silt/Muck Substrate •Low Sinuosity • Sparse/No Cover • Max Pool Depth < 40 cm		• Recovering Channel • Sand Substrate (boat sites) • Hardpan Substrate Origin • Fair/Poor Development • Only 1-2 Cover Types • No Fast Current • High/Moderate Embeddedness • Ext/Mod Riffle Embeddedness • No Riffle	
Channel	≥14				
Instream Cover	≥12				
Riparian	≥5				
Pool/Current	Sum of these ≥15				
Riffle/Run					
Gradient					
QHEI Score	≥60				
QHEI to target ratio ≥1	+1	One or less high influence attributes present	+1	Four or less moderate influence attributes present	+1

Method Evaluation and Assumptions

The QHEI is a macro-scale approach that measures the emergent properties of habitat (sinuosity, pool/riffle development) rather than the individual factors that shape these properties (current velocity, depth, substrate size). The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar.

This method assumes that the significant variables that influence fish communities are included in the index, and that the index is able to distinguish between the relative effects of habitat versus water quality issues. The index is empirically derived and assumes that the empirical relationships remain similar for streams of similar size and type within an ecoregion. The evaluation is somewhat subjective and requires the evaluator to be experienced in the use of the index. The variability between evaluations from different trained investigators and the variability in time at a particular site have been determined to be minimal within the same season and if the investigators are experienced with the method (Rankin, 1989).

The QHEI provides a thorough evaluation of the physical habitat in a quantitative manner. Many of the metrics that comprise the QHEI are surrogate measures of load-based stressors. Some of the metrics may also provide a measure of a cause of impairment, such as the substrate category as a measure of siltation, or the QHEI itself when habitat is listed as the cause of impairment. Because habitat is strongly correlated with the IBI biocriterion, the QHEI can be an indicator for pollutants such as sediment. Therefore, the QHEI can provide a numeric target and framework to help evaluate how habitat or surrogate issues affect attainment of the aquatic life use designations.

The empirical nature of the QHEI and the data that underlie it provide measurable targets that are parallel concepts to a loading capacity for a pollutant. The components provide a way to evaluate whether habitat is a limiting factor for the fish community and which attributes are the likely stressors. It can assess both the source of the sediment (riparian corridor, bank stability) and the effects on the stream itself (i.e., the historic sediment deposition) and thus has aspects of both a loading model and a receiving stream model. When used with biological indices, the index provides a means to monitor progress when implementing a TMDL and to validate that a target has been reached. Because stream physical habitat quality is influenced by surrounding land use, and because nonpoint load reductions are accomplished by changing land uses, habitat quality can be an important measure of TMDL success even when degraded habitat is not the cause of impairment.

Siltation has not historically been listed as a high magnitude cause of impairment in Chagrin River. As development in the upper watershed increases it is anticipated that siltation will increase in the smaller low gradient streams. The sediment TMDL will allow for assessment of this issue. Total Suspended Solids were also identified as exceeding load allocations in both Assessment Units, demonstrating a need for reductions in TSS loadings from both point and nonpoint sources. In addition, instream channel erosion has been shown in some studies to be a significant contributor to TSS loadings (Nelson & Booth, 2002).

5.0 MODELING THE POTENTIAL IMPACT OF BETTER STORM WATER MANAGEMENT

The load duration analysis presented in Section 4 suggests that water quality is generally very good in the Chagrin River watershed. However, high TSS concentrations have been observed at various locations (especially during high flow periods) and these high concentrations may be due to excessive storm water runoff from the developed areas of the watershed. Excessive storm water runoff carries pollutants into streams and can also cause increased stream channel erosion, both of which can result in elevated instream TSS concentrations as well as increased siltation of the streambed.

Most storm water discharges in the Chagrin River watershed are considered point sources and require coverage by a National Pollutant Discharge Elimination System (NPDES) permit. The primary method to control storm water discharges is through the use of best management practices (BMPs). As part of TMDL development for the Chagrin River watershed, a modeling analysis was conducted to assess the potential benefits of widespread adoption of storm water BMPs. A watershed model was setup and calibrated to the watershed (see Appendix D for details) and then used to evaluate three different "what if" scenarios:

1. Current Conditions: This scenario serves as the baseline to which other scenarios are compared. Inputs to the model for this scenario are based on current storm water practices and land use/land cover.
2. Natural Conditions: This scenario provides an indication of what flow conditions might have looked like prior to widespread conversion of forests and wetlands to agricultural, residential and commercial land uses. Inputs to the model for this scenario are based on converting all developed land uses back to forest.
3. Increased Storm Water Management: This scenario provides an indication of the potential for a variety of storm water BMPs to mitigate the impacts of increased development. Inputs to the model for this scenario are based on current land use/land cover but runoff from 50 percent of the impervious area is routed to either infiltration (e.g., bioretention facilities, rain gardens, wetlands) or detention (wet ponds) BMPs. The simulation of the BMPs results in "clipping" of flow peaks (particularly peaks for small events in which most of the direct runoff comes from impervious surfaces) and lengthening of the hydrograph tails. Appendix D provides more details of how these BMPs were modeled.

These three model scenarios were assessed at a representative upstream location that drains the area around Pepper Pike and at the USGS gage located on the Chagrin River at Daniels Park. The model was run using hourly weather data for the year 2004 and the results were assessed for a variety of hydrologic metrics including: total runoff, peak discharge, and the Richards Baker Flashiness Index (Baker et al., 2004).

The modeling results are shown in Figure 5-1 to Figure 5-4 and summarized in Table 5-1. They indicate that the widespread adoption of storm water BMPs indeed has the potential to mitigate the hydrologic effects of increased development. Flashiness values and peak discharge rates under the Increased Storm Water Management scenario approach those for Natural Conditions, and total runoff is reduced slightly at the downstream location and more significantly at the upstream site. Although the water quality benefits of these BMPs were not simulated, they are also expected to be significant.

Table 5-1. Summary of Chagrin River modeling scenarios

Metric	Chagrin River at Daniels Park			Unnamed Tributary Draining the Pepper Pike Area		
	Current Condition	Natural Condition	Increased Storm Water Management	Current Condition	Natural Condition	Increased Storm Water Management
Flashiness	0.44	0.38	0.39	0.64	0.42	0.51
% Change from Current	0.0%	-12.9%	-10.6%	0.0%	-33.8%	-21.1%
Total Runoff (trillion cubic feet)	30.00	27.10	29.95	1.34	1.09	1.29
% Change from Current	0.0%	-9.6%	-0.2%	0.0%	-18.5%	-3.2%
Peak Flow (cfs)	6,345	5,993	5,776	311	253	262
% Change from Current	0.0%	-5.6%	-9.0%	0.0%	-18.7%	-15.9%

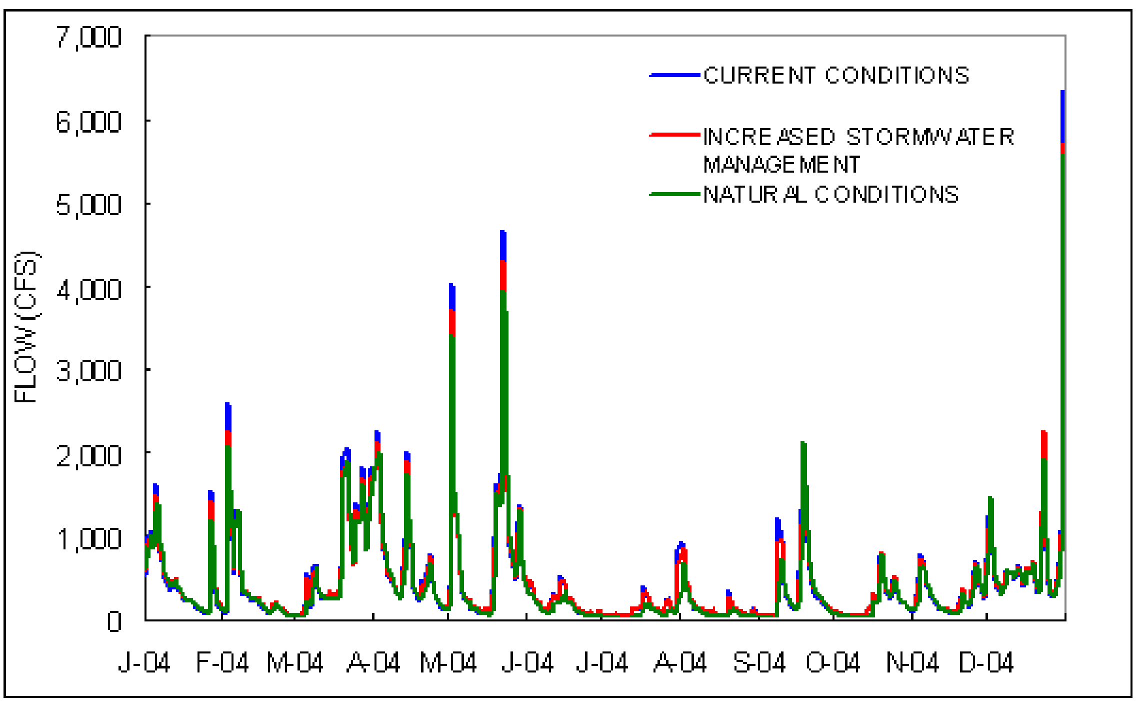

Figure 5-1. Comparison of full-year model scenario results at the Chagrin River at the USGS gage at Daniels Park.

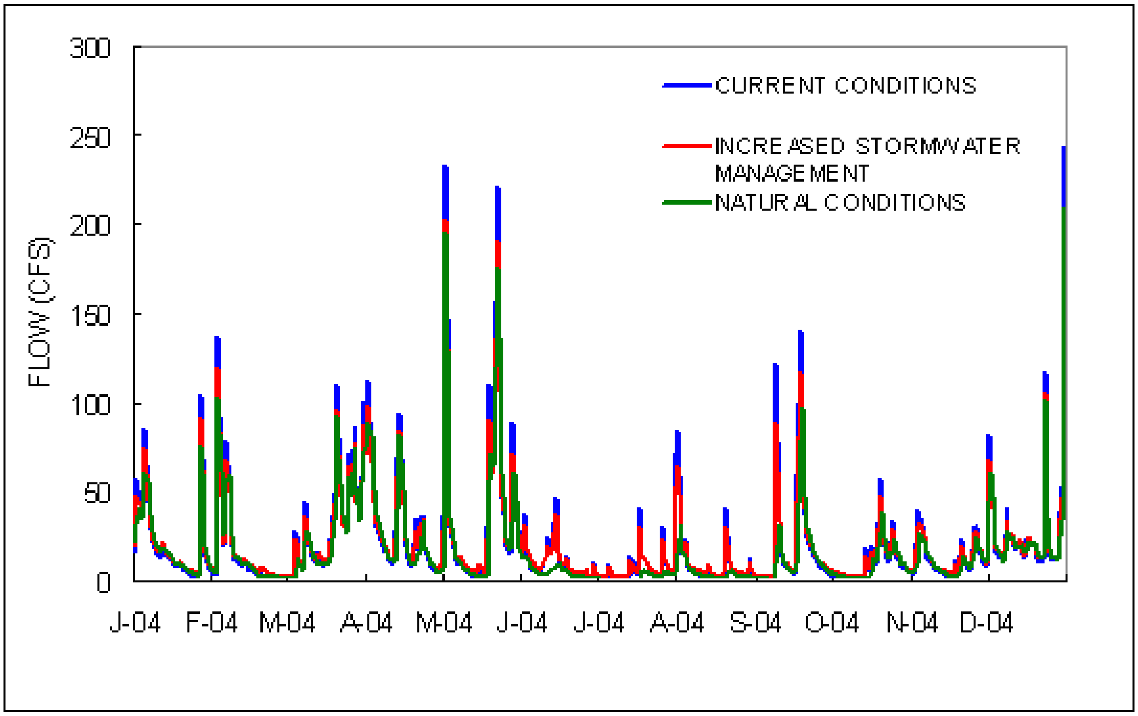

Figure 5-2. Comparison of full-year model scenario results at unnamed tributary draining the Pepper Pike area.

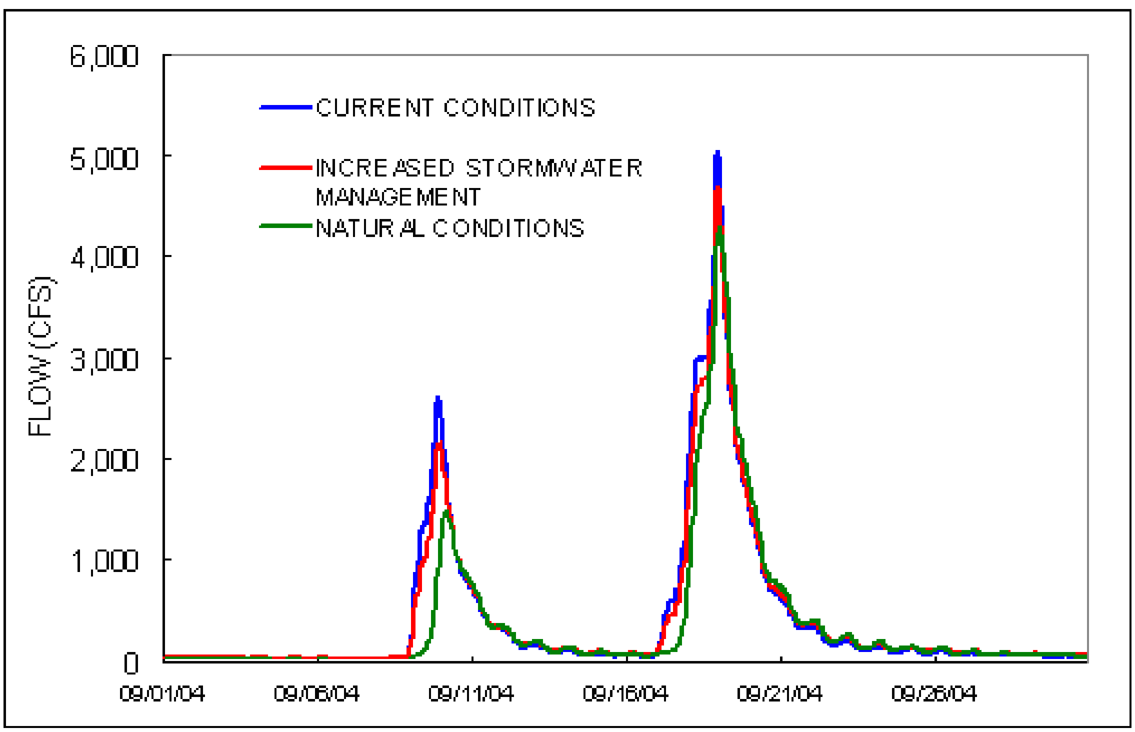

Figure 5-3. Comparison of model results for two storms at the Chagrin River at the USGS gage at Daniels Park.

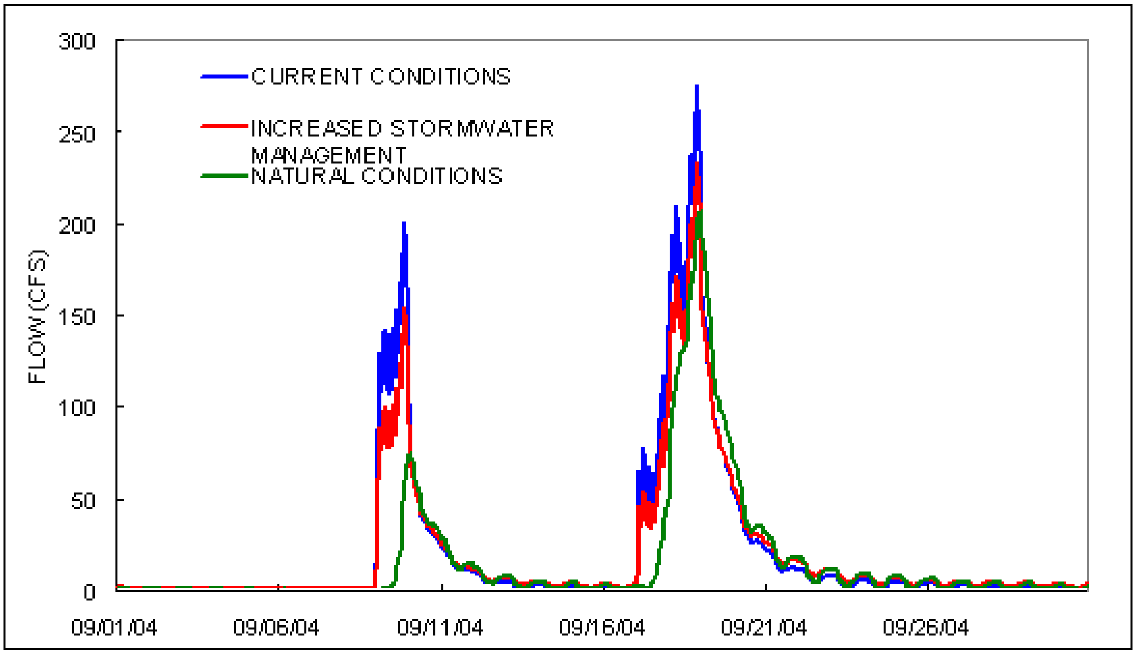

Figure 5-4. Comparison of model scenario results for two storms at unnamed tributary draining the Pepper Pike area.

6.0 PUBLIC PARTICIPATION

The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency with the development of the TMDL program in Ohio. The EAG met multiple times over eighteen months and in July, 2000, issued a report to the Director of Ohio EPA on their findings and recommendations. The Chagrin River watershed TMDL project has been completed utilizing the process endorsed by the advisory group.

The initial Chagrin River TMDL stakeholders public meeting was held on February 22, 2006. The meeting was held in conjunction with the Chagrin River Watershed Partners who also presented their Watershed Action Plan at the meeting.

A meeting on the draft TMDL report was held on February 7, 2007. Ohio EPA issued a news release on February 2, 2007 providing notification of the meeting.

In accordance with Ohio's continuous planning process, the outreach activities also included a comment period (from February 7 through March 12, 2007) to allow the public to review of the draft TMDL report prior to its submittal to U.S. EPA Region 5. A copy of the draft report was posted on Ohio EPA's web page on February 2. A response summary to the public comments received is included as Appendix G in this report.

Public involvement is key to the success of this TMDL project. Ohio EPA will continue to support the implementation process and will facilitate to the fullest extent possible an agreement acceptable to the communities and stakeholders in the study area and Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions to bring these sections of the Chagrin River watershed into attainment.

7.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Restoration methods to bring an impaired waterbody into attainment with water quality standards generally involve an increase in the waterbody's capacity to assimilate pollutants, a reduction of pollutant loads to the waterbody, or some combination of both. As described in Section 2.0, the causes of impairment in the Chagrin River are primarily nutrient enrichment, sedimentation, and stream habitat degradation. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads combined with additional stream protection through land purchase, easements, and riparian setback zoning.

7.1 Reasonable Assurances

As part of an implementation plan, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The stakeholders will develop and document a list that differentiates the enforceable and non-enforceable selected actions necessary to achieve the protection and restoration targets. Reasonable assurances for any new point sources, will be a schedule for implementation of planned NPDES permit actions. For non-enforceable actions (certain nonpoint source activities), assurances must include 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs that contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities among all parties within the watershed.

7.1.1 Minimum Elements of an Approvable Implementation Plan

Whether an implementation plan is for one TMDL or a group of TMDLs, it must include at a minimum the following eight elements:

- Implementation actions/management measures (Table 7-1),
- Time line for implementation (Table 7-2),
- Reasonable assurances (Table 7-2),
- Legal or regulatory controls (Table 7-2),
- Time required to attain water quality standards (Table 7-3),
- Monitoring plan (Table 7-3),
- Milestones for attaining water quality standards (Table 7-3),
- TMDL revision procedures.

7.1.2 Reasonable Assurances Summary

This is a summary of the regulatory, non-regulatory and incentive based actions applicable to or recommended for the Chagrin River TMDL Area. Many of these activities deal specifically with the protection, restoration, or enhancement of habitat.

Regulatory:

- Phase I and II storm water requirements
- Riparian regulations (model language is currently available, the Chagrin Model)
- 208 plans- NOACA ,NEFCO
  http://www.noaca.org/Clean_Water_2000/clean_water_2000.html)
- County oversight of the inspection of semi-public wastewater treatment systems (HB 110 activities)
- Zoning and conservation development
- Erosion and sediment control
- Section 401 and 404 of the Clean Water Act
- Ohio Department of Health home sewage disposal regulations (OAC 3701-29)

Non-regulatory:

- Finalization of an implementation plan (see 7.1.1) that includes these components:
  -septic system management
  -riparian corridor initiatives
  -point source controls
  -storm water management
  -education
  -dam removal
- Ohio EPA will continue to conduct chemical and biological sampling in the basin, following the basin rotation strategy as resources are available
- Development and implementation of the watershed action plan

Incentive-based:

- 319-funded projects for the Chagrin River basin that support the goals of this TMDL
- Pursue various loan opportunities for WWTP, septic system, and riparian/habitat protection and restoration (e.g. WRRSP, Revolving Loan Fund, Clean Ohio, conservation easements)
- Low Impact Development (CRWP projects)

7.1.3 Implementation Actions, Time line, and Reasonable Assurances

The implementation actions and measures are described in the following section and Table 7-1, reasonable assurances are described in Table 7-2. A time line for implementation actions is included in both Tables 7-2 and 7-3.

Storm Water Management

On December 8, 1999, U.S. EPA promulgated the expansion of the existing National Pollutant Discharge Elimination System (NPDES) Storm Water Program by designating additional sources of storm water for regulation to protect water quality. Entities were required to obtain permit coverage by March 10, 2003.

Municipalities located in urbanized areas and that operate municipal separate storm sewer systems (MS4s) will be included in the program in the State of Ohio. Pollutants from MS4s include floatables, oil and grease, as well as other pollutants from illicit discharges.

Operators of small MS4s will be required to develop a storm water management program that implements six minimum measures (listed below) that focus on a Best Management Practice (BMP) approach. The BMPs chosen by the MS4 must significantly reduce pollutants in urban storm water compared to existing levels in a cost-effective manner.

The six minimum control measures:

- Public education and outreach program on the impacts of storm water on surface water and possible steps to reduce storm water pollution. The program must be targeted at both the general community and commercial, industrial and institutional dischargers.
- Public involvement and participation in developing and implementing the Storm Water Management Plan.
- Elimination of illicit discharges to the MS4.
- Construction site storm water runoff regulations that require the use of appropriate BMPs, pre-construction review of Storm Water Pollution Prevention Plans (SWP3s), site inspections during construction for compliance with the SWP3, and penalties for non-compliance.
- Post-construction storm water management regulations that require the implementation of structural and non-structural BMPs within new development and redevelopment areas, including assurances of the long-term operation of these BMPs.
- Pollution prevention and good housekeeping for municipal operations such as efforts to reduce storm water pollution from the maintenance of open space, parks and vehicle fleets.

Storm water control measures will help to improve water quality in the Chagrin River watershed. Reduction in the sediment load will improve both habitat and chemical water quality. Identification and elimination of illicit discharges to storm sewer systems will also improve water quality. Improved site design under the storm water regulations will reduce increases in water quantity resulting in decreases in sediment loads. It is the intent of Ohio EPA to develop a basin specific storm water permit for construction activities.

It is recommended that this Alternative NPDES General Permit for Storm Water Associated with Construction Activity Located within the Chagrin River Watershed include additional requirements, beyond the current statewide construction storm water general permit requirements, to address TMDL recommendations. The additional requirements should include requiring submittal and approval of the storm water pollution prevention (SWP3), riparian setback requirements, groundwater recharge requirements, requirements to protect the thermal regime within cold water stream drainage areas and more stringent sediment and erosion controls which include performance standards.

It is also recommended that watershed stakeholders and citizens investigate and implement, when possible, additional storm water control measures. Human induced changes have dramatically altered watershed hydrology. In most cases restoration to a pre-disturbance condition is not possible. This TMDL will list several innovative techniques that can be implemented at a local and even household level to help restore watershed functions.

Rapid runoff is associated with increases in impervious surface area. Such surfaces include roofs, parking lots, roads, as well as many grassed areas. Development often pursues a course of removing topsoil over a site prior to construction. While necessary where roads and structures are to be built, remaining areas are compacted and soil structure, essential to water retention, is destroyed. Fields and forested areas are not uniform in their surface structure. These variations allow for some areas to be lower than others resulting in what is known as depressional storage. Regrading a site removes this valuable function.

Alternate methods of managing storm water should be used when possible. Methods should be geared to address water quality and water quantity.

Rain Barrels

For residential properties the use of rain barrels (Figure 7-1) is encouraged. They are intended to help with storm flow control. Nutrient reduction is not associated with rain barrels as a BMP. Onsite use of rainwater however will aid in groundwater recharge and nutrient load reduction due to decreased overland flow, which is a dominant transport mechanism. In smaller watersheds they will help to reduce peak flows, which can cause degradation of water quality and biological resources.

Rain barrels are low-cost, effective, and easily maintainable retention devices applicable to both residential and commercial/industrial sites. Rain barrels operate by retaining a predetermined volume of rooftop runoff (i.e., they provide permanent storage for a design volume); an overflow pipe provides some detention beyond the retention capacity of the rain barrel. Rain barrels also can be used to store runoff for later reuse in lawn and garden watering.

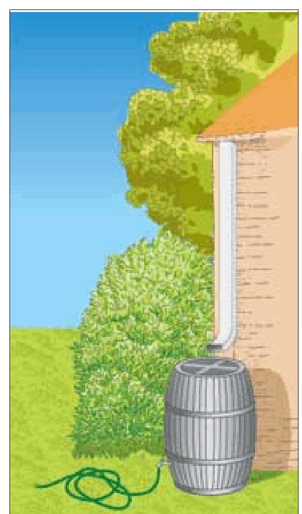

Figure 7-1. Rain Barrel

Rainwater from any type of roofing material can be directed to rain barrels. To be aesthetically acceptable, rain barrels can be incorporated into a landscaping plan, patio or decking design. Rain barrels placed at each corner of the front side of the house should be landscaped for visual screening. Gutters and down spouts are used to convey water from rooftops to rain barrels. Filtration screens should be used on gutters to prevent clogging of debris. Rain barrels should also be equipped with a drain spigot that has garden hose threading, suitable for connection to a drip irrigation system. An overflow outlet must be provided to bypass runoff from large storm events. Rain barrels must be designed with removable, child-resistant covers and mosquito screening on water entry holes. The size of the rain barrel is a function of the rooftop surface area that drains to the barrel, as well as the inches of rainfall to be stored. For example, one 42-gallon barrel provides 0.5 inch of runoff storage for a rooftop area of approximately 133 square feet. This method is most useful for small runoff events and will help to reduce peak flows. Large storm events will generate runoff volumes greater than the available capacity of rain barrels.

Rain Gardens/Bioretention

Bioretention (rain gardens) is possibly one of the most recognized alternative storm water management practices. Used in residential, commercial, and certain industrial settings, bioretention has the potential to offer developers significant cost savings and environmental benefits over conventional storm water management systems. Significant design differences exist between a bioretention basin used for storm water permit compliance and a rain garden commonly utilized for residences. Bioretention areas (Figure 7-2) are shallow, topographic depressions filled with engineered soils and vegetation that retain, treat, and infiltrate water.

Bioretention systems are designed for the temporary storage of rainwater. They successfully remove pollutants through increased contact time with soils and plant materials. As compared with conventional storm water management systems, bioretention areas more closely mimic the natural hydrologic cycle, allowing soils and plants to filter pollutants from storm water and permitting the processes of infiltration, evaporation, and transpiration to occur. The systems can also create wildlife habitat, minimize erosion, and recharge local groundwater supplies.

Figure 7-2. Rain Garden (courtesy of Rain Gardens of Western Michigan)

In parking lots, storm water should be conveyed directly to the bioretention area through a system of grassed swales. For residential applications, treatment areas are generally located some distance away from houses to increase flow paths and treat runoff from rooftops and driveways. In either case, bioretention systems route storm water to bioretention areas that are designed to accumulate water to depths not exceeding six to 12 inches. In the event that storm water volumes exceed treatment capacities, bioretention areas are usually equipped with overflow drop inlets routed to municipal storm water systems. In certain industrial and commercial areas, pollutant loadings may be too concentrated for the successful use of bioretention areas. In such areas, termed “hotspots,” the use of structural practices to infiltrate storm water may be deleterious to groundwater supplies. In these instances, designers are advised to use alternative practices, such as exfiltration trenches, to convey filtered water into a conventional storm water management system for proper treatment. A manual for home rain garden installation may be found on the internet at:

http://clean-water.uwex.edu/pubs/raingarden/rgmanual.pdf. Rain Gardens of Western Michigan also maintains an informative web page with useful information for Great Lake States (http://www.raingardens.org/Index.php).

Additional information on bioretention design will be presented as part of the Low-Impact Development discussion later in this section.

Evaluation of dams within the Chagrin River watershed for removal

Adverse impacts from dams can include a change in thermal and hydraulic regimes, chemical water quality degradation, and impaired habitat in the stream or river where they are located. A variety of impacts can result from the siting, construction, and operation of these facilities. Habitat quality expected in a healthy stream is degraded by impoundments by elimination of riffles, increased substrate sedimentation, and an overall decrease in QHEI scores. Dams can also impede or block migration routes of native fish. Coldwater streams can also see increased temperatures downstream of impounded areas, which can jeapordize attainment.

There are currently 84 known dams in the basin. All dams within the Chagrin River TMDL study area should be evaluated for the feasibility of removal. The process will begin by compiling an inventory of all dams in the study area. The inventory shall be prioritized for removal opportunities based on ecological benefits of removal and feasibility.

Bass Lake and its dam have been extensively studied (Ohio EPA 2005, Davey Resource Group 1998, Chagrin River Land Conservancy 2001). Removal evaluations at this impoundment will need to take into consideration existing high quality peripheral wetlands and tributary watersheds when determining a course of action. In the case of this impoundment, total removal may not be preferred ecologically.

Several projects will be specifically listed below.

ALCOA/IVEX, Chagrin Falls Village, Mainstem

As this former industrial property is planned for redevelopment activities, the status of the existing dam is being considered. Several maintenance and safety issues were noted by a 2005 dam safety inspection report by ODNR, including that the lake drain has not functioned properly since 1994 and seepage has been a concern on the right embankment. In addition, further studies noted that the dam will not safely pass the required design flood. Several concerns have been raised regarding the historic value of the structures on the site. In 2006, the Village formed a committee to investigate the issues related to redevelopment of this property. Removal or repair of the dam is targeted to be addressed as this parcel is redeveloped.

Kenston Lake, Bainbridge Township, Linton Creek

Kenston Lake dam was constructed in 1959, damming up Linton Creek to create a recreational lake for a subdivision. The impoundment is approximately 7 acres and the dam is owned entirely by the four parcels on which the dam is physically located. Since the construction of this dam, high flows and obstructions in the outlet structure have caused the dam to overtop on several occasions. CRWP is working with the Bainbridge Township Trustees and the dam owners to implement one of the following three options: (1) bring the dam into full compliance with Ohio's dam safety laws, (2) drain the lake and modify the structure so it is no longer a dam, or (3) lower the dam embankment to meet one of the exemptions to the dam safety laws available in the Ohio Revised Code. Three of the dam owners have indicated their intention to remove the dam structure. Construction drawings and funding for dam removal have not been obtained.

West Hill Colony Lake, City of Pepper Pike, Pepper/Luce Creek

The impoundment at the West Hill Colony subdivision in Pepper Pike was created for aesthetic and recreational purposes. This subdivision is on Pepper Creek, a tributary to the mainstem of the Chagrin River and is located between The Country Club and the Pepper Pike Country Club. The approximately 7 acre lake is nearly filled with sediment and average water depth is about one foot. The homeowners association has long discussed options for rehabilitating the lake through dredging, restoration of a stream through the existing lake bed sediments, or removal of the dam and completion of a stream restoration.

Semipublic Sewage Disposal Systems

Improperly maintained small (generally less than 25,000 gallons) sewage treatment systems can contribute oxygen demanding substances, nutrients, and bacteria to the Chagrin River TMDL area. House Bill 110 programs are in place in Cuyahoga, Geauga, Lake, and Portage counties. These programs allow county health departments to register and inspect semipublic sewage disposal systems. Increased oversight will allow for improved operation and identification of malfunctioning systems, allowing for corrective actions. Enforcement of regulations will still be conducted by the Ohio EPA. New regulations effective on January 1, 2007 now allow health departments to assume responsibility for small on-site sewage treatment systems. Currently the Cuyahoga County Board of Health has assumed this responsibility.

Household Sewage Disposal Systems

Septic systems and other forms of home sewage disposal can contribute to water quality impairments. They have been identified as major sources and failure rates can be fairly high (**Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems**, April 2001).

Improvements in treatment systems and elimination of discharges from unsewered areas will result in decreased loadings of oxygen demanding substances, nutrients, and bacteria. This is also tied in to Phase II of the storm water regulations, which require elimination of illicit discharges. Existing local health department inspection programs will be helpful in identifying problem areas. Adequate resources need to be provided to the health departments both financially and through legislation to ensure their ability to address this issue.

Proposed standards for inspection of home sewage disposal systems are included in the NOACA (Final) 208 plan.

New regulations addressing home sewage treatment systems have become effective January 1, 2007.

Ohio EPA is currently preparing to order an 85 home subdivision in Mantua Township to eliminate discharges of failing septic systems to an unnamed tributary of the Aurora Branch. These 85 homes generate an estimated 34,000 gpd of partially treated sewage. Based on sampling data it is estimated that elimination of the wastewater generated by the Aurora Meadows subdivision will reduce the TMDL fecal coliform load at the Aurora Branch (station D01P22) by 5% during dry conditions (80-90% flow exceedence ranges). This elimination will also see an estimated reduction in TSS of 2% during dry conditions (80-90% flow exceedence ranges) and 7.3% during low flow conditions (90-100% flow exceedence ranges) when compared to the current observed TMDL loads.

208 Plan Updates

Currently 208 (Areawide Waste Treatment Management Plan prepared pursuant to Section 208 of the Clean Water Act) plans for the Chagrin River TMDL area have been completed. The purpose of the plan is to address municipal wastewater treatment issues and nonpoint source pollution. The Chagrin River TMDL area involves the Northeast Ohio Areawide Coordinating Agency (NOACA) for Cuyahoga, Geauga and Lake Counties and Northeast Ohio (NEFCO) for Portage County. Resources are needed to sustain the Water Quality Management planning efforts at the area wide level so that plan recommendations will be acted on and adopted by local communities. Identifying an action in the 208 Plan for local government attention is only the first step.

Wetlands Protection

Wetlands are an important part of the watershed and perform many useful functions that relate to water quality. Preservation and enhancement of wetlands in the Chagrin River TMDL area will help to improve water quality and help to attenuate increased flow during runoff events. It is recommended that no new permits to impact Category 2 and 3 wetlands be issued in the Chagrin River TMDL area. All permits issued for impacts to Category 1 wetlands should ensure that mitigation is conducted on-site if possible and at a minimum within the watershed area. If mitigation cannot be conducted on-site or within the watershed area, then a permit should not be issued for the proposed project.

Riparian Protection / Restoration

Protection of riparian zones plays an important role in stream integrity. Small streams are able to maintain thermal regimes with riparian protection. Open streams lacking riparian protection are influenced by sunlight which in addition to temperature increases, can stimulate algae and macrophyte growth. Additionally, protection and restoration of riparian zones along streams can help to mitigate some of the effects caused by increasing impervious area such as flooding and erosion resulting in increased infrastructure. Stream bank protection afforded by riparian zones also helps to reduce sediment and nutrient loading.

Two mechanisms are proposed to promote riparian protection. The first mechanism proposed is the passage of stream setback regulations. Another mechanism to promote riparian protection is comprehensive land use planning and better site design which avoids important resources. Through the identification of sensitive natural areas communities can promote wise land use policy. These mechanisms are also promoted in the 208 plan and the CRWP Watershed Action Plan. The adoption of setbacks may also be considered a nonstructural BMP for purposes of complying with Phase II storm water permits.

Evaluation of all 401/404 permit applications in the Chagrin River TMDL area should require mitigation to be conducted on-site if possible and at a minimum within the watershed area. If mitigation cannot be conducted on-site or within the watershed area, then a permit should not be issued for the proposed project. Export of both wetland mitigation and stream mitigation out of the watershed is a threat to restoration and improvement of habitat in the watershed.

Instream erosion has been identified as a source of Total Suspended Solids in this report (see section 4 for specific load allocations). Nelson and Booth (2002) found that a lower value of 20% of their studied stream sediment load originated from channel erosion. They also identified landslides as a source of 51% of the sediment load. Both issues occur in the Chagrin River watershed.

Stream bank restoration along with storm water control will both need to be implemented to help reduce erosion in the basin. Reductions in flashiness (described in section 5) will help to attenuate some of the storm water flow increases associated with runoff events.

Changing land-use patterns may also exert an impact outside the watershed. A recent publication by Anderson et. Al. (2006) predicts a reduced walleye larval survival rate with reductions in forested land percentages. The discussion also indicates that the Chagrin River is more sensitive to land use changes than other examined watersheds placing a priority on preserving the forested watershed of the Chagrin River.

The Chagrin River Watershed Partners have been working on identifying restoration sites within the basin. One example of a potential restoration site is listed below.

Stream Restoration along Griswold Creek, Russell Township and Village of Hunting Valley

Griswold Creek has experienced numerous changes due to the construction of inline ponds and the eventual breaching of these dams, suburbanization, and road construction. The changes to this stream have caused it to experience downcutting and excessive erosion in numerous locations. Restoration opportunities exist in stabilizing banks, removing historic road beds, and modifying offline ponds near the stream.

Headwater Streams

Headwater streams are a critical water resource within the watershed. They provide a source of perennial cold ground water that maintains the summer base flow of larger downstream segments and can harbor many unique species of fish, amphibians, and benthic macroinvertebrates. The Ohio EPA (2002) has developed a three tiered classification scheme for the smallest headwater streams of watersheds, termed "primary headwater habitats" (PHWH). Additional information may be found at: http://www.epa.state.oh.us/dsw/wqs/headwaters/PHWHManual_2002_102402.pdf.

Class III PHWH streams are unique water resources that may be directly connected to ground water springs with biological communities having a large number of cold to cool water adapted species not present in other types of environments. Vertebrate species of Class III-PHWH streams include fish such as mottled sculpins, redside dace, brook stickleback and salamander species with long-lived larval periods such as the spring salamander, red salamander, and two-lined salamander. A large number of cool water and pollution sensitive benthic macroinvertebrates such as mayflies, stoneflies, and caddisflies also are uniquely adapted to the habitat conditions provided by Class III-PHWH streams (Ohio EPA, 2002). It is a recommendation of this TMDL that the location of Class III-PHWH streams should be identified within small watershed units (e.g., the HUC-14 spatial level) for the entire Chagrin River basin using the Ohio EPA (2002) assessment techniques. Where Class III-PHWH streams are identified, all efforts should be made to ensure that their biological and hydraulic functions are protected and maintained. In situations where impacts to Class III-PHWH streams are required under Section 401 water quality certification, a high priority should be given to ensure that mitigation of impacts occurs within the local HUC-14 watershed unit. Impacts to other classes of PHWH streams should follow standard Section 401 mitigation protocols.

Scenic River Designation

Parts of the Chagrin River watershed were designated a Scenic River by the Director of the Ohio Department of Natural Resources on July 2, 1979. The Upper Chagrin was designated Scenic in November 2002.

The Scenic River designation applies to approximately 71 river miles. The Aurora Branch, East Branch and mainstem are included in the State of Ohio Scenic River system.

Scenic Rivers Act

Ohio pioneered the river preservation movement in 1968 with the passage of the nation's first scenic rivers act. This legislation created a state program to protect Ohio's remaining high quality streams for future generations. Scenic rivers retain most of their natural characteristics at a time when many rivers reflect the negative impacts of human activities.

Restoration of streamside forests is the single most important ingredient in maintaining the health of streams and rivers. The removal of forested corridors along waterways increases erosion, runoff and sedimentation, resulting in the degradation of water quality and the reduction of the natural diversity of aquatic communities.

Scenic River Designation

Scenic rivers are classified and designated according to the outstanding qualities a stream possesses. The Scenic Rivers Act provides three categories for river classification: wild, scenic and recreational. These criteria examine the stream's length, adjacent forest cover, biological characteristics, water quality, present use and natural conditions.

Scenic river designation is a cooperative venture among state and local government, citizen groups, and local communities within a watershed. The designation process depends ultimately upon support and protection authority of local governments and citizens. The Ohio Department of Natural Resources (ODNR) studies the proposed river to determine whether it meets the scenic river criteria. All interested parties, including state and local officials, community groups and concerned citizens, meet to discuss the scenic rivers program and to encourage local support for the protection of the river as a natural resource.

Protection of Scenic Rivers

The protection and preservation of a designated stream depend heavily upon local input and community involvement. The Scenic Rivers Act requires a citizens' advisory council, representing local officials, landowners and conservation organizations, to be appointed for each designated river. The council provides advice about local river protection and preservation concerns.

Three approaches are used in scenic river protection:

- Public project review plays a major role in river preservation. The possible environmental impact of the construction of dams, bridges, roads or other publicly funded projects is carefully considered. ODNR has the authority to approve or disapprove all publicly funded projects on designated scenic rivers outside municipal corporation limits.
- Landowner assistance and education are vitally important components of river protection. ODNR scenic river staff advise landowners about streamside protection techniques and provide technical assistance in river corridor restoration. Scenic river designation does not affect private property rights.
- Water resource protection balances the relationship between the streamside forest buffer, aquatic habitat and water quality. While the maintenance and improvement of responsibility of the Ohio EPA, the most effective watershed protection involves cooperation among Ohio EPA, ODNR and local governments. A stream quality monitoring and biological survey project using volunteers has been developed by the Division of Natural Areas and Preserves to supplement this effort. Division staff also work with federal, state and local agencies to reduce nonpoint source pollution, which causes serious environmental damage to rivers and streams.

Natural Areas Act

The Natural Areas Preservation Act became law in 1970, authorizing the Department of Natural Resources to acquire, dedicate and accept donations of public and privately owned lands as nature preserves. This act was amended in 1976 to create within Ohio Department of Natural Resources the Division of Natural Areas and Preserves, which established and administers a statewide system of nature preserves and wild, scenic and recreational rivers. The Division has the legal authority to manage and protect such lands and waters for education, scientific use and public visitation.

Added water quality protection is also afforded scenic rivers in Ohio Water Quality Standards such as the need for individual wetland and stream impact permits.

Watershed Action Plan

A watershed action plan is an itemization of the problems, priorities and activities the local watershed group would like to address. To access funding from U.S. EPA, Ohio EPA or ODNR, the overall purpose of the watershed plan is to restore and maintain the chemical, physical and biological integrity of waterbodies within the watershed, an objective of the Clean Water Act of 1972. The Chagrin River Watershed Partners have taken the lead role in developing a Watershed Action Plan. The process has followed guidance set forth in the Ohio EPA document: *A Guide to Developing Local Watershed Action Plans in Ohio,* which may be found on Ohio EPA's website, http://www.epa.state.oh.us/dsw/nps/wsguide.pdf. Additions to the watershed plan requirements (also known as Appendix 8) can be found at:

http://www.epa.state.oh.us/dsw/nps/NPS_WAP_APP8.pdf. The Chagrin River Watershed Action Plan has is available on the internet at: http://www.crwp.org/watershed_action_plan/watershed_action_plan.htm.

Point Source Control

Adequate point source control mechanisms shall be utilized for all existing and proposed direct discharges in the Chagrin River TMDL area. NPDES permits for existing and proposed point sources shall be prepared and issued with limits and conditions necessary to protect and restore water quality in the Chagrin River TMDL area. When appropriate, Ohio EPA shall take enforcement actions necessary to maintain compliance with discharge permit limits. Currently there are 42 sewage treatment plants in the watershed permitted to discharge greater than 1,000 gallons per day. Permits are listed in Appendix C. A recent (end of December 2006) elimination of the Pepper Pike plant (3PG00048) will result in a TMDL TSS load reduction of 16 kg/d at the Chagrin River at Old Mill Road (site D01P07). This will account for 1.3% of the low flow reduction needed at this site for the 90-100 flow exceedence range and a 4.3% TSS reduction at the 80-90 flow exceedence range.

This TMDL also recommends setting maximum permit limits at 15 mg/l for TSS in all renewal permits that have current maximum limits of 18 mg/l. This reduction will result in an elimination of 51.3 kg/d (12.4% reduction). When coupled with the elimination of the Pepper Pike Plant this results in an elimination of 67.3 kg/d (16.2% reduction) during low flow conditions.

Low Impact Development

Low Impact Development (LID), or distributed storm water management, is a decentralized approach to storm water management that controls storm water at the source using a combination of structural and non-structural systems. Surface water is distributed across the development site with the purpose of increasing infiltration and water quality and reducing the quantity of water leaving a site. LID focuses on-site design to minimize the generation of storm water runoff and treat storm water where it is generated to maintain and enhance predevelopment runoff in urban and developing watersheds. Specifically the purpose of LID is to:

- Maintain open space and reduce land disturbance;
- Preserve and protect natural systems and processes;
- Customize site design to existing site features;
- Integrate existing site systems such as wetlands, stream corridors, and mature forests as design elements; and
- Decentralize and manage storm water at its source to minimize reliance on centralized, costly, and maintenance intensive storm water features.

(Low Impact Development Center. *Municipal Guide to Low Impact Development.* http://www.lowimpactdevelopment.org/brochures.htm. November 14, 2006.)

Non-structural low impact development BMPs focus on the reduction of storm water runoff impacts through good site planning and design. Non-structural LID BMPs include minimizing site disturbance, preserving important site features, reducing and disconnecting impervious cover, using native vegetation, minimizing turf grass lawns, and maintaining a site's natural drainage features and characteristics.

Structural LID BMPs are used to control and treat storm water runoff at the sources through small-scale structures that are dispersed throughout a site and distribute water uniformly across a site. These small-scale integrated management practices may include, but are not limited to:

- Bioretention cells
- Vegetated swales
- Tree box filters
- Curbless roads with swales
- Pervious pavements
- Rain gardens

Using these LID practices to disperse storm water across sites allows downsizing or elimination of storm water ponds, curbs, and gutters, thereby reducing infrastructure, operation, health and safety concerns, and maintenance costs for landowners and communities. The primary benefits of using low impact development are to:

- Prevent degradation of water quality and natural resources;
- Manage storm water and associated management costs more effectively, and
- Protect ground water and drinking water supplies.

For these reasons, the TMDL recommends that new development in the Chagrin River watershed use low impact development principles to maintain or restore natural hydrological functions and mimic predevelopment hydrology on development and redevelopment sites to reduce the impacts of land use change.

To encourage the use of LID and address barriers to widespread application of distributed storm water management in Northeast Ohio, Chagrin River Watershed Partners, Inc. (CRWP) and its partners have obtained funding to install a minimum of three (3) demonstration projects, and provide technical support and public education based on the demonstration projects. The project, *Demonstrating Innovative Approaches to Distributed Storm Water Management in Northeast Ohio,* is part of the U.S. Environmental Protection Agency's National Community Decentralized Demonstration Project and was awarded for 2004 through 2009.

CRWP's project includes funding for the design, construction, monitoring, operation, and maintenance of demonstration projects that highlight various components of distributed storm water management or LID. The projects will be monitored to provide long-term data and education to advance LID in Northeast Ohio. In addition, CRWP is providing review and consultation for development projects in the Chagrin watershed that are using innovative site design and LID BMPs. CRWP is also working with their members to adopt zoning and storm water management regulations that facilitate the use of distributed storm water structural and non-structural practices to minimize development impacts. Under this project these practices include riparian and wetland setbacks, conservation design, bioretention, alternative flow paths, vegetated swales, functioning open space and other site design and storm water BMPs that collectively serve to maintain, to the extent possible, the pre-development runoff hydrology of development or redevelopment sites.

Additional Sources and LID Guidance Manuals:

Low Impact Development Center
http://www.lowimpactdevelopment.org/home.htm

Low Impact Development Design Strategies: An Integrated Design Approach
http://www.epa.gov/owow/nps/lidnatl.pdf

Low Impact Development: Technical Guidance Manual Puget Sound
http://www.co.king.wa.us/dnrp/swd/greenbuilding/documents/Low_Impact_Development-manual.pdf

Lake County Stormwater Management Department: Bioretention Guidance Manual
http://www2.lakecountyohio.org/smd/Final%20Report%203-17-06.pdf

Sunny Lake Discharge Improvements

The outflow from Sunny Lake in Aurora exerts a negative impact on the Aurora Branch of the Chagrin River for approximately three stream miles below the discharge. Fish communities downstream showed the lowest fish community scores (IBI) in the entire watershed. The cause of this is lake discharge toxicity associated with toxins produced by blue-green algae during blooms.

This TMDL recommends that the lake be returned to a more historically natural state allowing for a restoration of ecological balance. Reduction of upstream nutrients, restoration of the lake bathymetry, and habitat enhancement should help to eliminate blue-green algae. Ohio EPA is currently working with the City of Aurora and interested parties to generate a management plan by the Summer/Fall of 2007.

Coldwater Stream Protection

Due to its geology and high rate of groundwater-dominated first and second order streams, a number of these streams have been designated as Cold Water Habitat (CWH) by the Ohio EPA. In addition to those streams currently designated, the most recent survey conducted by Ohio EPA indicates that additional streams are meriting a CWH designation. This will be addressed in an upcoming rule revision.

Of great importance in the Chagrin River basin are those cold water streams harboring native populations of brook trout. These streams harbor some of the remaining naturally reproducing populations of brook trout, which are listed by the Ohio Department of Natural Resources as a threatened species. Temperature targets presented in section 3.1 were developed to be protective of the needed thermal regime. A watershed-specific general storm water construction permit, when developed, should contain requirements for activities conducted within cold water stream drainage areas. Additional discussion will be initiated as this permit is developed.

In addition, the Eastern Brook Trout Joint Venture, a group of public and private entities was formed as a collaborative to help preserve, protect, and restore native brook trout populations. Information may be found on their web site at:
http://www.easternbrooktrout.org/index.html.

Two critical streams harboring reproducing populations of native brook trout are Woodiebrook and Spring Brook. Both watershed have seen some recent developments which pose possible threats to these fish. In Woodiebrook, a new housing development on Wilson Mills Road needs to be monitored for potential impacts. Downcutting in the stream caused by destabilization and altered flow patterns needs to be addressed. In the Spring Brook watershed, deed restrictions placed on recent new housing need to be monitored for their effectiveness. The stream needs to be protected from hydraulic changes associated with housing developments as well as chemicals in runoff which may exert toxic influences on brook trout. The county SWCD should continue monitoring the area to ensure proper storm water management is taking place.

In addition, all coldwater streams need to be considered sensitive to potable water well drilling. Wells should be developed in deeper aquifers to protect the streams from flow regime alterations associated with withdrawals.

When evaluating drainage, county engineers should work with fisheries professionals to conduct work in a manner sensitive to protecting native brook trout populations.

Appendix F of this TMDL contains excerpts from the Eastern Brook Trout Joint Venture's Conservation Strategy (Working Draft v.6). This strategy should serve as a general guideline for preservation and restoration goals relating to brook trout in the Chagrin River watershed.

Balanced Growth Initiative (Provided by Chagrin River Watershed Partners, Inc.)
In 2004, the Ohio Lake Erie Commission finalized the Balanced Growth Program, *defined as a local planning framework to coordinate decisions about how growth and conservation should be promoted by State and local investments*. The Balanced Growth Program produced the following documents:

- **Planning Framework**: Recommends the formation of Watershed Planning Partnerships to draft Watershed Balanced Growth Plans through which communities designate Priority Conservation Areas and Priority Development Areas. These areas are defined as:
- **Priority Conservation Areas** are locally designated areas for protection and restoration. They may be important ecological, recreational, heritage, agricultural, and public access areas that are significant for their contribution to Lake Erie water quality and general quality of life.
- **Priority Development Areas** are locally designated areas where development and/or redevelopment is to be encouraged in order to maximize development potential, maximize the efficient use of infrastructure, promote the revitalization of cities and towns, and contribute to the restoration of Lake Erie.
- **Best Local Land Use Practices Document:** Recommends model regulations and programs for better land use and development. These are consistent with CRWP recommendations.

For additional information on the Ohio Lake Erie Commission and the Balanced Growth Program, please see http://www.epa.state.oh.us/oleo/.

In April 2005, the Ohio Lake Erie Commission requested proposals for pilot projects to develop Watershed Balanced Growth Plans. The goal of these pilots is to demonstrate the possible approaches at the local level that would encourage local governments to participate in a balanced growth planning process and to implement development practices based on Priority Conservation Areas and Priority Development Areas. CRWP submitted an application under this pilot in July 2005 and was selected as one of three pilots in September. The project will begin in 2006 and run through 2008.

The Chagrin River Balanced Growth Plan

Through the pilot project, CRWP will work with member local governments to develop the *Chagrin River Balanced Growth Plan* and to advance the implementation of best local land use practices through the development of the following products:

- Designation of Priority Conservation Areas and Priority Development Areas. This will be based on best available data and community input.
- A methodology for developing these designations and a process for revising these lists and maps.
- Two updated comprehensive plans in member communities incorporating Priority Conservation Areas and Priority Development Areas and associated regulatory changes necessary for implementation. CRWP will provide limited matching funds for these updates through the pilot project.
- Discuss Transfer of Development Rights programs as an additional tool to facilitate implementation of Priority Conservation Areas and Priority Development Areas.

Implementation of the Priority Conservation Areas and Priority Development Areas will be through the tools currently available to local governments in Ohio, including comprehensive planning; zoning; land purchases; and conservation easements. These actions will be at local government direction and no actions will be imposed on communities as a result of this planning effort. CRWP member communities will benefit from participating in the development of the *Chagrin River Balanced Growth Plan* through:

- Increased State assistance for local projects. State agencies, including the Departments of Transportation, Development, and Natural Resources, will review the *Chagrin River Balanced Growth Plan* as part of this Pilot Project. In doing this review, these departments may look for funding throughout the State system for appropriate and member supported projects in Priority Conservation Areas and Priority Development Areas.
- Support for Local Zoning: State endorsement of the Chagrin River Balanced Growth Plan, a community driven Plan to balance conservation and development, will provide additional support for low-density zoning and other tools to maintain natural resource functions as communities grow.
- Additional State Incentives: The Ohio Lake Erie Commission is coordinating with State agencies to create a list of other State incentives such as additional points for Clean Ohio applications.

To receive these benefits, local governments will select the Priority Conservation Areas and Priority Development Areas for their community and consider comprehensive planning and zoning changes necessary to implement these designations. Such changes will be of benefit to these communities regardless of the Balanced Growth Program because they will minimize long-term infrastructure and storm water management costs.

CRWP will present draft Priority Conservation Areas and Priority Development Areas to member communities in 2007 and plans to submit the *Chagrin River Balanced Growth Plan* for endorsement in 2008.

Small Farming Operations
A number of small agricultural operations exist within the Chagrin River watershed. These consist of both crop and animal facilities, including horse stables. Farm owners are encouraged to work with the Ohio Department of Natural Resources, the Ohio Department of Agriculture, and local Soil and Water Conservation Districts (SWCDs) to develop conservation plans for these properties. Programs such as the Conservation Reserve Enhancement Program (CREP) should be utilized to protect stream riparian zones.

Table 7-1. Description of Implementation Actions and Measures

#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
1	Phase II Storm water	Chagrin River TMDL area.	Storm water control will reduce sediment loading, eliminate illicit discharges to MS4s	Very good.
2	Wetlands protection	Chagrin River and tributaries	Wetlands benefit the watershed by improving water quality and providing flood protection.	Preservation, restoration, and enhancement of wetlands will be effective.
3	Riparian protection	Chagrin River and tributaries	Stream bank stability, water quality, biological integrity	Very good, if communities adopt riparian protection regulations.
4	Low Impact Development Practices	Chagrin River and its tributaries/ All watershed stakeholders	Practices when implemented will promote better land use decisions. Associated storm water controls will help to reduce impacts associated with development.	Very good.
5	Headwater stream protection	Chagrin River and tributaries	Stream bank stability, water quality, thermal regime stability, biological integrity.	Very good, if the guidance, statutes, and regulations are followed, and communities adopt riparian protection regulations
6	208 updates	Chagrin River and tributaries/ NOACA, NEFCO	Comprehensive planning will help to promote better land use decisions and provide guidance to Ohio EPA and local sewer authorities. Storm water controls will help to reduce impacts associated with development.	Very good.
7	Evaluation of all dams in Chagrin River TMDL area for removal.	Chagrin River and its tributaries.	Biological communities will be improved by addressing impacts associated with the dam. Dissolved oxygen deficits often found in the impounded areas behind dams will be eliminated. Recreational opportunities will be enhanced and made safer.	Dam removal will be effective at removing one barrier to upstream attainment of water quality standards

Table 7-1. Description of Implementation Actions and Measures

#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
8	Household sewage disposal systems - Inspection and maintenance programs	Chagrin River and tributaries/ Local Health Departments, Home Owners	Inspections and proper maintenance of household sewage disposal systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	Very good. Proper functioning sewage disposal systems will reduce pollution. Unsewered areas and streams benefit.
9	House Bill 110 program	Chagrin River and tributaries/ County Health Departments, Ohio EPA, Regulated Entities	Inspections and proper maintenance of semipublic sewage treatment systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	Very good. Properly functioning sewage disposal systems will reduce pollution. Unsewered areas and streams within them will benefit.
10	NPDES permit limits (Reduce TSS permit limits from 18 mg/l max to 15 mg/l max)	Chagrin River and tributaries / All NPDES permit holders in TMDL area potentially effected	Pollutant reduction.	Very good when main source of impairment is from NPDES permitted dischargers.
11	Watershed Action Plan	Chagrin River and its tributaries/ All watershed stakeholders	Establish stream protection and restoration targets, provide watershed education, possible source of funding.	Very good.
12	Educational Programs	Entire Chagrin River TMDL area	Educational programs within the area are existing and relatively strong. Education allows the public to better understand the processes within the watershed and their impacts to it.	Informed citizens and public officials will be effective in restoring water quality in the Chagrin River TMDL area

Table 7-2. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
1	Phase II Storm water programs	Ohio EPA, Local Soil Water Conservation Districts, Local Communities	Compliance beginning in March of 2003	U.S. EPA Phase II storm water regulations
2	Wetlands protection	Ohio EPA US Army Corps of Engineers	Existing rules	Sections 401 and 404 of the Clean Water Act. State of Ohio wetland regulations (OAC 3745)
3	Riparian protection	Local Governments, land protection agencies	Some existing, some proposed	No direct reasonable assurances. Ancillary assurances may be tied to Phase II storm water regulations and comprehensive planning for local communities.
4	Low Impact Development Practices	Local Governments	Proposed	Local Regulations
5	Headwater stream protection	Ohio EPA, US Army Corps of Engineers, Local Governments	Ongoing	Sections 401 and 404 of the Clean Water Act.
6	208 updates	NOACA, NEFCO	NOACA completed in Nov. 2000 (for Cuyahoga and Lake counties	Section 208 of the Clean Water Act
7	Evaluation of all dams in Chagrin River TMDL area for removal.	Ohio EPA, Individual dam owners, local park departments	Ongoing	Ohio Water Quality Standards
8	Household sewage disposal systems	Local Health Departments, Ohio Department of Health	Ongoing	State and local home sewage treatment system regulations.
9	House Bill 110 program	Local Health Departments, Ohio EPA	Ongoing	House Bill 110 allows health departments and Ohio EPA to enter into contract for the purpose of licensing and inspecting semipublic sewage disposal systems. Existing regulations are utilized (ORC 6111)

Table 7-2. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
10	NPDES permit limits	Ohio EPA	Ongoing	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)
11	Watershed Action Plan	Ohio DNR/ Local Watershed Coordinator	Ongoing	319 Funding obligations
12	Educational Programs	Ohio EPA, Chagrin River Watershed Partners, Local Soil Water Conservation Districts	Ongoing	Continuation and expansion of existing educational programs.

Table 7-3. Time line: Monitoring, Tracking and Implementation

<table>
<tr><th>Action</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th></tr>
<tr><td rowspan="2">Phase II Storm water</td><td colspan="9"></td></tr>
<tr><td colspan="9">MS4 programs developed and being implemented within five years of being issued general permit coverage. MS4 general permit renewal in December 2007. Development of an Alternative NPDES General Permit for Storm Water Discharges Associated with Construction Activity Located within the Chagrin River Watershed. Program ongoing.</td></tr>
<tr><td>Educational</td><td colspan="9">Educational programs strong and ongoing.</td></tr>
<tr><td>House Bill</td><td colspan="9">Program approved for Cuyahoga and Lake Counties. Ongoing.</td></tr>
<tr><td>Household sewage disposal systems</td><td colspan="9">Local Health Departments currently conduct inspections of home sewage disposal systems. Not all systems are inspected by all local health departments.</td></tr>
<tr><td rowspan="2">208 updates</td><td colspan="9"></td></tr>
<tr><td colspan="9">NOACA 208 finalized in November 2000.</td></tr>
<tr><td rowspan="2">Wetlands protection</td><td colspan="9"></td></tr>
<tr><td colspan="9">Program ongoing.</td></tr>
<tr><td rowspan="2">Riparian Protection</td><td colspan="9"></td></tr>
<tr><td colspan="9">Work with and assist local governments to enact riparian protection regulations.</td></tr>
<tr><td rowspan="2">Watershed Action Plan</td><td colspan="9"></td></tr>
<tr><td colspan="9">Watershed Action Plan currently in review for full endorsement.</td></tr>
</table>

Note: *This table is a working document. Schedules for some of the implementation actions have not been developed yet*.

7.1.4 Draft Implementation Plan

The draft implementation plan depends greatly upon the local communities for its success. Land use is one of the biggest factors influencing water quality within the watershed. Implementation of Phase II Storm Water regulations and BMPs stands to provide the greatest water quality benefits and protections in the watershed. This impact is anticipated to be due in part to phosphorus, nitrogen, and sediment reductions. Additional improvements in the stream will result from habitat protection and restoration activities. High energy in the immediate time period following a runoff event can create flash flows. Improved storm water controls will help to reduce these events, which have been shown to negatively impact stream biology and habitat and cause increased TSS concentrations.

BMP implementation should be based on a plan developed within the context of the Chagrin River Watershed Partners and Phase II storm water regulations.

7.1.5 Expected Effectiveness of Example Restoration Scenario

Predicting the success of the restoration scenario presents many difficulties. Initially the effectiveness rests on actual implementation of the recommendations. Assuming that they are implemented, some predictions can be made.

Community growth needs to be conducted in ways that are compatible with watershed protection, and watershed protection needs to be compatible with economic development; they are not mutually exclusive. Riparian protection is one way of promoting and improving watershed health. Development of comprehensive land management plans will also provide additional assurances for water quality protection. These issues are currently being addressed as communities integrate the value of natural resources with developmental pressures.

The formation of watershed based groups promotes awareness, stewardship, and education. These groups provide a valuable local grassroots connection to waterways. Activism helps promote education and awareness while helping to keep state and federal agencies focused on issues in the Chagrin River. Their continued involvement is crucial to restoring the water quality in Chagrin River. The following is a list of watershed based groups in the Chagrin River:

- Chagrin River Watershed Partners: http://www.crwp.org/

The Partners are to be commended for their efforts toward improving the Chagrin River and its tributaries.

7.2 Process for Monitoring and Revision

Ohio EPA will continue to monitor and assess the basin's chemical and biological water quality as part of the 5 year monitoring strategy. The next sampling is tentatively scheduled for 2010. Revisions to the TMDL report would be completed the following year.

Upon reassessment of the stream in the next monitoring cycle, stream segments remaining in nonattainment will go through the TMDL process.

Local involvement in monitoring is encouraged. The Watershed Action Plan will help to strengthen and encourage additional community involvement. Valuable educational resources currently exist in the Chagrin River area. Grade schools can also offer opportunities for education. Efforts have already begun to help students better understand their watershed. The watershed coordinator is in an ideal position to facilitate this interaction. Water quality data will be collected in accordance with the credible data rules when they are finalized.

Citizen monitoring of the watershed will also prove useful. Tools such as the use of sediment sticks and the ODNR Scenic River stream survey methods will help to further increase our understanding of the Chagrin River. In addition to providing data, more frequent stream observations can help to alert Ohio EPA and other regulatory agencies to observed water quality impacts, enabling quicker response times to potential impacts.

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