CITY of TRAVERSE CITY MICHIGAN

CWSRF WASTEWATER IMPROVEMENTS PROJECT PLAN

PREPARED BY:

MAY 2026

HRC
HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, Michigan 49506

HRC Job Number 20260067

Versions:

Draft April 2, 2026 (PUBLIC REVIEW)

Draft

Final

Table of Contents

1 Executive Summary 1-1
1.1 Summary 1-1
1.2 Conclusions 1-1
1.3 Recommendations 1-1
2 Project Background 2-1
2.1 Study Area Description 2-1
2.2 Existing Facilities – General 2-16
2.3 Existing WWTP Facilities 2-19
2.4 Need for Project 2-26
3 Alternative Analysis 3-1
3.1 Alternatives Considered 3-1
3.2 No Action 3-1
3.3 Sewer Rehabilitation and Replacement Projects 3-1
3.4 Front Street Lift Station and Forcemain Upgrade 3-1
3.5 WWTP Membrane Bioreactor Upgrades 3-3
3.6 East Collection System Force Main Replacements 3-3
3.7 WWTP Odor Control Improvements 3-3
3.8 East Front Sewer Improvements 3-3
3.9 WWTP Anaerobic Digester 4 Rehabilitation and Improvements 3-4
3.10 Cost of Alternatives 3-4
3.11 Impacts of Alternatives 3-4
4 Selected Alternatives 4-1
4.1 Proposed Facilities 4-1
4.2 Proposed Schedule 4-2
4.3 Cost Estimate 4-2
4.4 User Costs and Cost Sharing 4-2
4.5 Authority to Implement Selected Alternative 4-3
5 Fiscal Sustainability Plan 5-1
6 Environmental Impacts 6-1
6.1 General 6-1
6.2 Analysis of Impacts 6-2
7 Mitigation 7-1
7.1 Short-Term, Construction Related Mitigation 7-1
7.2 Mitigation of Long-Term Impacts 7-1
7.3 Mitigation of Indirect Impacts 7-1
8 Public Participation 8-1
8.1 General 8-1
8.2 Public Hearing 8-1
8.3 Resolution 8-1

List of Figures

Figure 2-1. Sanitary Sewer System Map 2-5
Figure 2-2. City of Traverse City Sanitary Sewer Collection System 2-6
Figure 2-3. City of Traverse City Current Zoning Districts 2-7
Figure 2-4. City of Traverse City Future Land Use 2-8
Figure 2-5. Wetlands Map 2-9
Figure 2-6. FEMA Floodplain Map 2-10
Figure 2-7. Terrain Map A 2-11
Figure 2-8. Terrain Map B 2-12
Figure 2-9. Terrain Map C 2-13
Figure 2-10. Terrain Map D 2-14
Figure 2-11. Terrain Map E 2-15
Figure 2-12. Flow Monitoring 2-18
Figure 2-13. Overall Site Plan 2-20
Figure 2-14. Process Flow Schematic 2-21
Figure 3-1. Proposed CWSRF Projects 3-2

List of Tables

Table 2-1. Population Projections 2-1
Table 2-2. Study Area Household Income 2-2
Table 2-3. City of Traverse City Lift Stations 2-16
Table 3-1. Summary of CWSRF Projects (by Fiscal Year) 3-5
Table 4-1. Fiscal Year of CWSRF Projects 4-1
Table 4-2. CWSRF Project Plan Task Schedule 4-2
Table 4-3. Estimated User Cost Summary by Phase 4-2

List of Appendices

Appendix A: Agency Correspondance
Appendix B: Web Soils Survey Results
Appendix C: City of Traverse City Current NPDES Permit
Appendix D: Cost Estimates
Appendix E: Wastewater Asset Management Plan
Appendix F: Public Hearing Documentation
Appendix G: Resolution
Appendix H: Project priority list (ppl) scoring data form
Appendix I: Project Plan Submittal Form
Appendix J: Project Cost Analysis Certification Form

1 Executive Summary

1.1 Summary

The Project Plan for the City of Traverse City Wastewater Improvements Program has been prepared using the Project Plan Preparation Guidance of the Clean Water State Revolving Fund (CWSRF) Administrative Rules. While the rates have not been set yet for FY2027, the rate in 2026 is 2.50% for 20-year loans (note 3% was used for cost estimates as a conservative approximation). These rules call for compliance with the basic Federal Planning Requirements and the National Environmental Policy Act (NEPA). This Project Plan will serve as a basis for project prioritization and must be submitted to the Michigan Department of Environment, Great Lakes, & Energy (EGLE) by May 1, 2026, to be on the project priority list for the fiscal year of 2027.

The proposed projects listed herein as part of this CWSRF Project Plan are the Collection System Improvements including sewer and manhole rehabilitation, Front Street Lift Station and Forcemain Replacement, Wastewater Treatment Plant (WWTP) upgrades including improvements to the membrane bioreactor (MBR), odor control, and anaerobic digestion systems. These projects were a result of the conditions found during the recent Stormwater, Asset Management, and Wastewater System (SAW) Program, a Sanitary Sewer Evaluation Survey (SSES), the City's Capital Improvements Plan (CIP), and other evaluations completed. Several of the sanitary sewer collection system projects are long overdue and are needed to ensure the sanitary collection system and WWTP can operate properly. Inflow and Infiltration (I/I) is a concern that needs to be addressed as part of this project plan to address Sanitary Sewer Overflows (SSOs) that have occurred.

1.2 Conclusions

The following is a summary of the existing projects identified by the City of Traverse City:

- Sanitary sewer and manhole rehabilitation to address defects identified in the SSES.
- Front Street Lift Station pump replacement, wet well expansion, and replacement of approximately 2,500 feet of DIP force main to the WWTP and rehabilitation of existing 16-inch force main.
- WWTP membrane bioreactor enclosure to prevent exposure to freezing conditions.
- Replacement of aging force mains from the Coast Guard Lift Station and Industrial Park (TBA) Lift Stations.
- WWTP odor control improvements for the replacement of the existing activated carbon system.
- East Front Street updates including 720 feet of 24-inch sewer lining and 40 lateral replacements subject to high infiltration and inflow to address high dry weather flow.
- WWTP Anaerobic Digester 4 Rehabilitation and Improvements

1.3 Recommendations

The selected projects identified in this Plan are the most cost-effective and environmentally sound alternatives. The following recommendations are therefore made:

- The City Commission should pass a resolution formally adopting this Plan.
- The City should apply for low-interest loans under the CWSRF program.

2 Project Background

2.1 Study Area Description

2.1.1 General

The City of Traverse City is in Grand Traverse County, Michigan. The total City area is approximately 8.66 square miles. The Traverse City Regional Wastewater Treatment Plant (TCRWWTP) is located at 606 Hannah Avenue, Traverse City, MI 49686. The Traverse City Regional WWTP treats the wastewater discharges from the entire City as well as portions of Acme, Blair, East Bay, Elmwood, Garfield, and Peninsula Townships. The sanitary sewer system map is shown in Figure 2-1.

Wastewater from the City's collection system is conveyed to the Traverse City Regional WWTP located in the City of Traverse City along Franklin Street on the northern end of Boardman Lake. Conveyance of wastewater to the Traverse City Regional WWTP is accomplished by a sanitary sewer collection system and nine remote pumping stations. This network of collection and transmission infrastructure is spread throughout the City of Traverse City and portions of East Bay, Garfield, Peninsula, and Elmwood Townships. A map showing the sanitary sewer collection system is provided in Figure 2-2.

2.1.2 Land Use

The largest land-use types within the City of Traverse City (excluding open spaces and utilities) are residential and commercial. A map with the current zoning districts within the City of Traverse City can be seen in the attached Figure 2-3. A map of the future land use within the City of Traverse City can be seen in the attached Figure 2-4. Future land use for the City was obtained from the City of Traverse City Master Plan.

2.1.3 Population Data

Population numbers and projections for Grand Traverse County and the City of Traverse City came from the United States Census Bureau database. The U.S. 2010 Census Bureau data estimated the average household size in the City at 2.18 people per household. The population projections for the City of Traverse City and Grand Traverse County are shown below in Table 2-1. The City services wastewater for a total of approximately 30,623 people.

Table 2-1. Population Projections

Year	Population		Served by City Wastewater System		
	Traverse City	Grand Traverse County	Traverse City	Grand Traverse County	Total
2010	14,674	86,986	14,674	14,129	28,803
2014	14,736	91,701	14,736	14,895	29,631
2019	14,805	94,956	14,805	15,818	30,623
2020	15,669	95,249	14,909	15,929	30,838
2024	15,782	96,625	14,870	16,750	31,620
2025	15,893	97,302	14,974	16,867	31,841

2030	16,457	100,756	15,506	17,466	32,972
2035	17,042	104,332	16,057	18,086	34,143

*Census projections: https://www.census.gov/quickfacts/fact/table/traversecitycitymichigan,grandtraversecountymichigan/PST045219 & https://milmi.org/datasearch/popproj

Recent projections show the 2020 population has increased slightly since the 2010 Census in the City of Traverse City and Grand Traverse County. Projections predict the population will continue to increase through 2035.

Forecast from the Census Bureau projects population in 2035 to be approximately 17,042. This increase in population may also cause an increase in sanitary waste; however, the sanitary sewer collection system was built to handle larger populations and therefore higher flow than it is currently experiencing or will experience based on the projected 2035 population.

2.1.4 Economic Characteristics

The major industries in the City of Traverse City are Health Care & Social Assistance (2,782 people), Retail Trade (2,178 people), and Accommodation & Food Services (1,478 people). The median household income for the City of Traverse City was $74,087 in 2024. The median household income is approximately 0.02% higher than the median Michigan household income and 8.97% less than the U.S. median household income. Table 2-2 shows the City of Traverse City, Grand Traverse County, and Leelanau County median household income comparison below.

Table 2-2. Study Area Household Income

Municipality	Median Annual Household Income
City of Traverse City	$74,087
Grand Traverse County	$81,647
Leelanau County	$99,422

*Source: https://www.census.gov/quickfacts/fact/table/MI,traversecitycitymichigan,grandtraversecountymichigan/PST045219

2.1.5 Cultural and Environmental Settings

Cultural Setting:

The City of Traverse City has 4 historical districts and 5 historical properties listed under the National Register of Historic Places. However, none are within the project limits and will not be impacted by the proposed project. If necessary, the State Historic Preservation Office (SHPO) will be contacted to aid in the identification of significant historical and archeological sites which may be affected by the project

Air Quality:

Mobile source emissions, mainly from automobiles, are the primary source of outdoor air pollution in this area. The area has the noise pollution characteristics of a typical, tourist-driven community. No noise pollution problems exist in residential areas, other than from traffic noise from adjacent major roadways. Commercial and business areas experience only normal traffic noise.

Air quality is not anticipated to be an issue for this project, apart from temporary dust and debris from construction and minimal odors from the CIPP curing material. All necessary notifications will be distributed to the public when this occurs and all regulations for this odor will be followed.

Wetlands:

There are no localized wetlands associated with the existing project footprint where the work is anticipated. For the final design, any wetlands that may be impacted would be flagged and the appropriate EGLE and USACE permits will be applied for. However, it is not anticipated to be an issue for this project. Wetland maps are shown in Figure 2-5.

Great Lake Coastal Zones:

The major body of water north of the City of Traverse City is Grand Traverse Bay, which is approximately 0.5 miles north of the WWTP. The WWTP is located on the North end of Boardman Lake which leads into the Boardman River. The Boardman River carries on for approximately 2 miles until it hits the Grand Traverse Bay which then leads out into Lake Michigan. For this project plan, no impacts will be made to the Bay or tributary areas.

Floodplains & Surface Waters:

The study area is located entirely in the Grand Traverse Bay Watershed. The watershed encompasses 976 square miles with nine sub-watersheds that drain directly into the Grand Traverse Bay.

The City of Traverse City is located along the Grand Traverse Bay. Area groundwater is not used as a source of drinking water within the City. Water supply for the City is obtained via the City of Traverse City Water Treatment Plant. There will be no major impacts to the great lake coastal zones, floodplains, and surface waters, however, proper permits will be acquired, and steps will be taken to avoid any damage or permanent disruption which could affect the nearby floodplain. Any work which impacts the floodplain will only be undertaken after first contacting EGLE and obtaining the appropriate permits.

FEMA floodplain maps are shown in Figure 2-6.

Natural or Wild and Scenic Rivers:

The scope of this project is scattered throughout the City of Traverse City, surrounding Townships, and at the WWTP. Kids Creek is located within the City. The WWTP is located along the shoreline of the Boardman River. The location of these improvements and construction will be planned to not occur or impact the nearby Rivers.

The proposed work will also decrease the amount of TSS discharged to the Boardman River during wet weather events, improving the water quality of the effluent to the river. See Appendix A for attached documentation of the Nationwide Rivers Inventory, showing that no Nationwide Rivers will be impacted by the proposed project.

Recreation Facilities:

The City of Traverse City owns 34 parks and recreational properties, ranging from a small downtown parcel to the larger Hickory Hills Ski Area, Grand Traverse Commons, and Brown Bridge Quiet Area. Much of the park land is heavily concentrated along the Boardman River and along the shoreline of the West Grand Traverse Bay. In total, over 1,600 City-owned acres are currently dedicated to recreational pursuits including Hickory Hills Ski Area and Grand Traverse Commons that are each approximately 125 acres and Brown Bridge Quiet Area, located 10 miles southeast of the City, has nearly two square miles (1,310 acres) of natural area along the Boardman River.

The proposed work will limit all impacts to parks or other publicly owned facilities by ensuring pedestrian access if maintained and maintaining quality aesthetics of facilities.

Topography:

The terrain within the City of Traverse City is characterized as relatively flat but has relatively low spots near the Grand Traverse Bay. The lowest point at about 582 feet above sea level is in the north region of the City on the bay along the shoreline. The highest point is about 950 feet above sea level in the western hillier extents of the City.

A set of United States Geological Survey (USGS) topography maps of the City and surrounding townships are shown in Figure 2-7 through Figure 2-11.

Geology:

The City of Traverse City is typified by eolian, lake, and glacial deposits. The lake sand deposits make up the larger portion of the City of Traverse City. Two types of bedrock make up the bedrock surface in the City of Traverse City, Ellsworth Shale, and Coldwater Shale.

Soils:

According to the USDA Natural Resources Conservation Service Web Soil Survey, the City of Traverse City the 3 main soils located within the City are Loamy Sand (27.53%), Sandy Loam (14.78%), and Sand (39.73%). See Appendix B for documentation of the Web Soil Survey results.

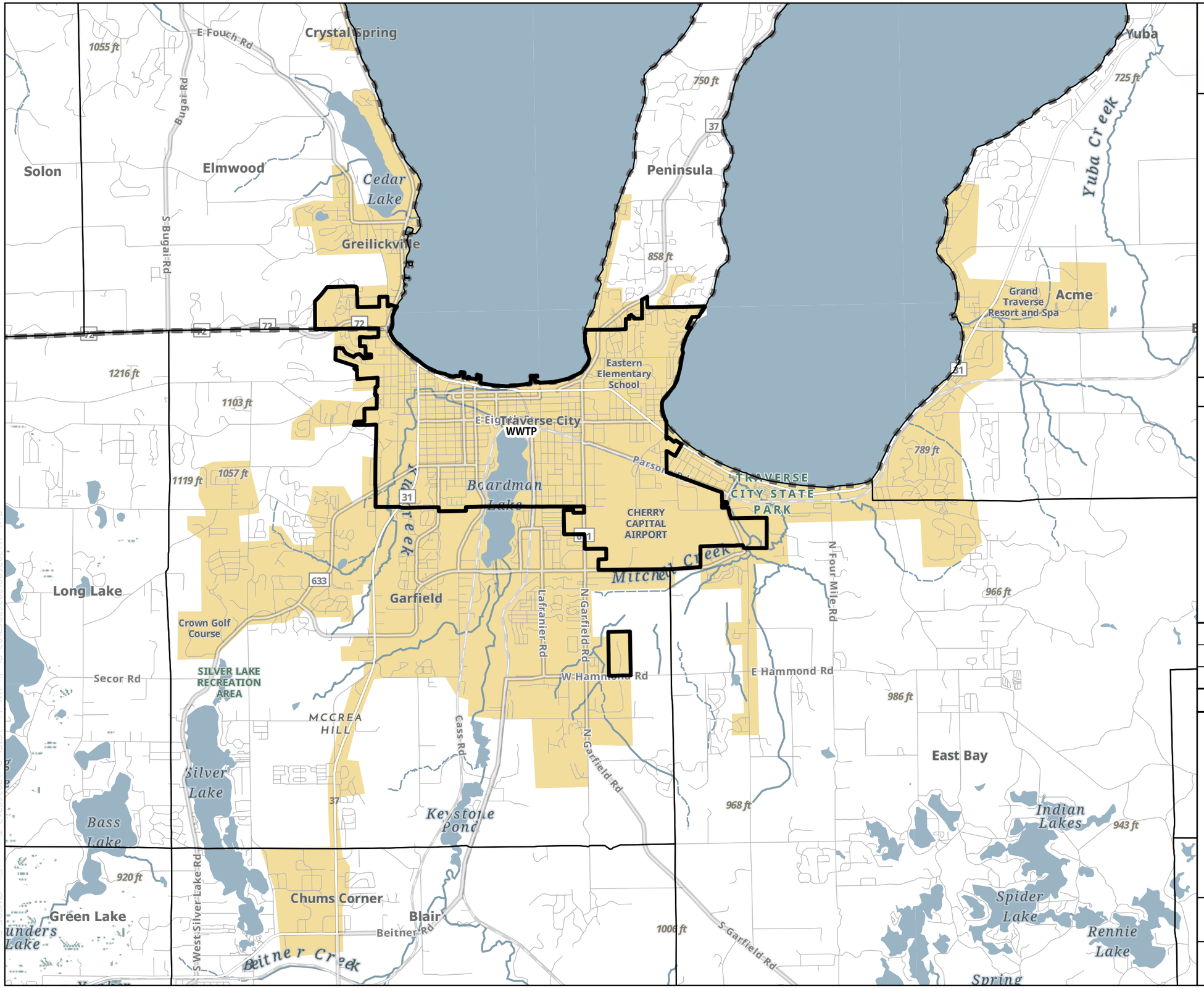
As part of the final design process, soil borings will be taken near the proposed work areas to determine if any special construction methods will be needed.

Agricultural Resources:

There is no agricultural land located within the project limits. The project area is within developed and human use land cover; therefore, no agricultural resources will be impacted by the proposed work.

Existing Plant and Animal Communities:

Wildlife within the study area includes animals and birds normally associated with urban or agricultural environments. However, EGLE will be coordinating with Michigan Natural Feature Inventory (MNFI) and U.S Fish and Wildlife (USFW) Information for Planning and Consultation (IPaC) for an official review of federally or state listed threatened and endangered species within this proposed project area.



CITY OF TRAVERSE CITY

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE Suite 100
Grand Rapids, MI 49506

Phone: (616) 454-4286

WEBSITE: http://www.hrcengr.com

Legend

0 0.5 1 2 Miles

N

- Sanitary Sewer System Extent
- Traverse City Boundary
- Township Boundary
- County Boundary
- Roads

DRAWN: KLH CHECKED: DIU

CWSRF Project Plan Sanitary Sewer System Map

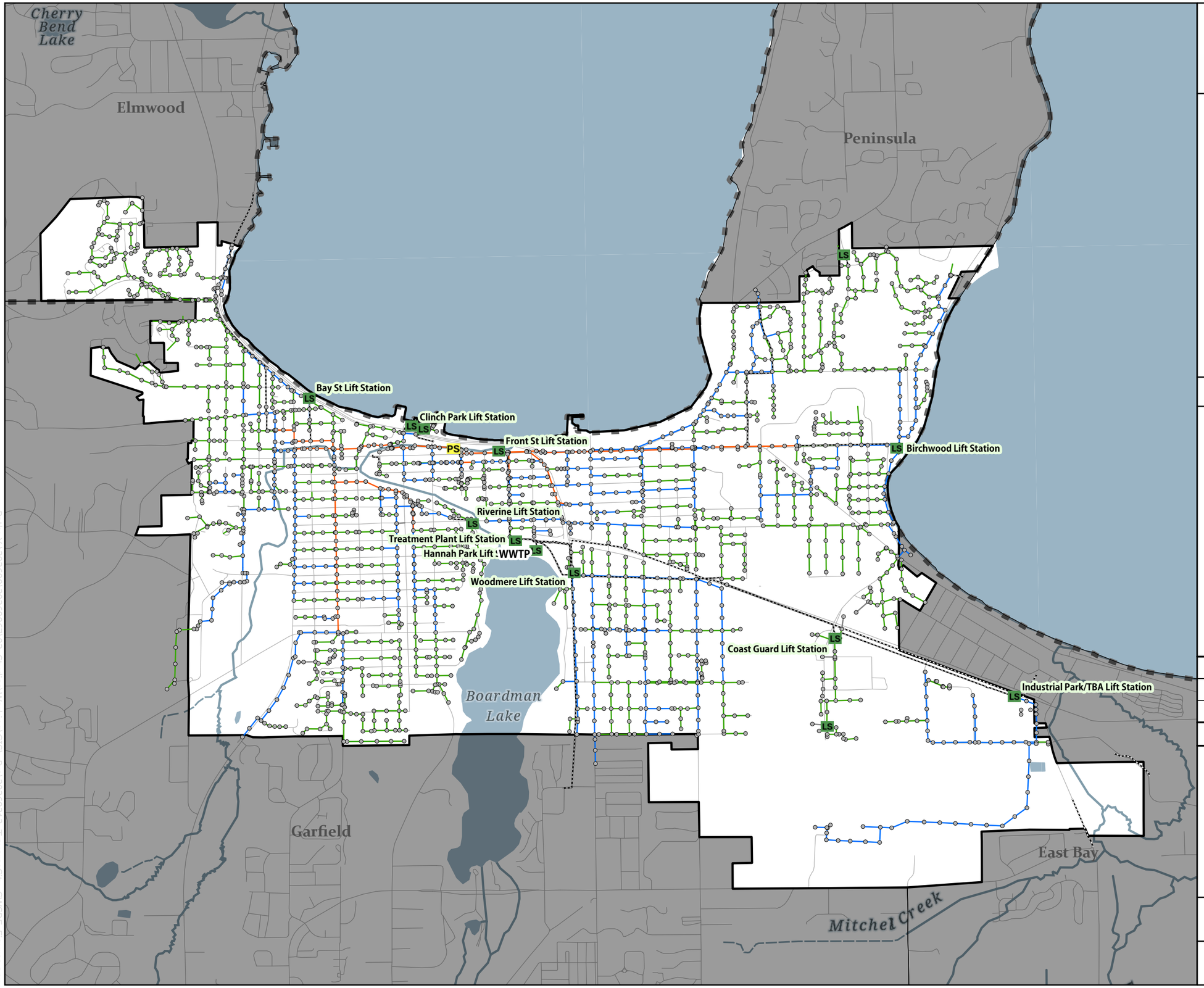
HRC Job No. 20260067

SCALE: AS SHOWN

May 2026

FIGURE 2.1

Path: Y:\2026007\03_Studies\Working\GIS_Pro\20260212_TraverseCity_CWSRF_Figures.aprx



CITY OF TRAVERSE CITY

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE Suite 100
Grand Rapids, MI 49506

Phone: (616) 454-4286

WEBSITE: http://www.hrcengr.com

Legend

0 0.25 0.5 1 Miles

N

Sewer Force Main
- Traverse City Owned
- Owned by Others

Sewer Gravity Main
- 4" - 8"
- 9" - 15"
- 16" - 36"
- Unk. Diameter

- Sanitary Manhole
- LS Lift Station
- PS Pump Station
- Traverse City Boundary
- Outside City Limits
- County Boundary
- Roads

DRAWN: KLH CHECKED: DIU

CWSRF Project Plan City of Traverse City Sanitary Sewer Collection System

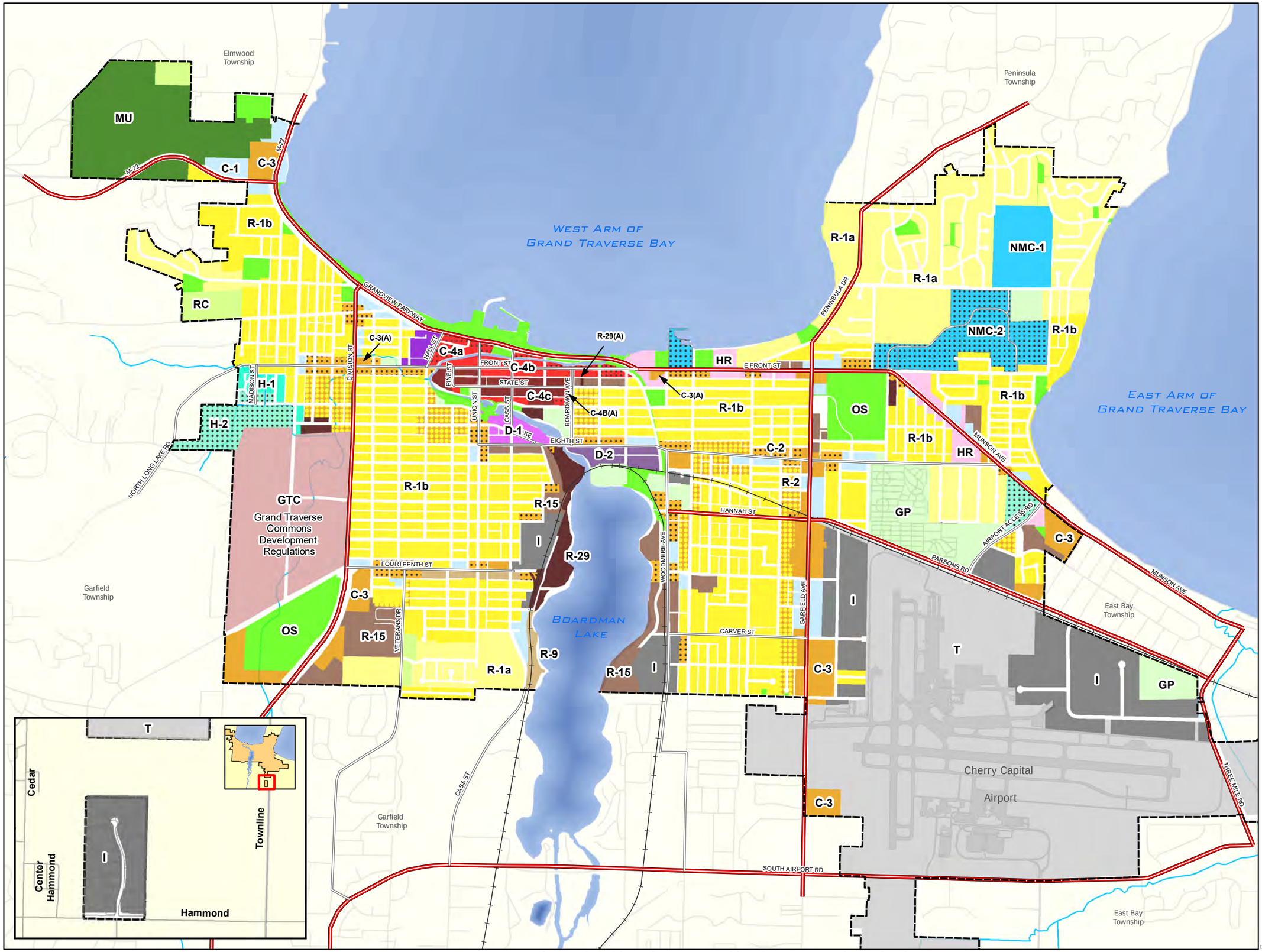
HRC Job No. 20260067

SCALE: AS SHOWN

May 2026

FIGURE 2.2

Path: Y:\20260\20260067\03_Studies\Working\GIS_Pro\20260212_TraverseCity_CWSRF_Figures.aprx



City of Traverse City
Zoning Map

Street Classification

- Arterial
- Collector

Zoning Districts

- C-1 Office Service
- C-2 Neghborhood Center
- C-3 Community Center
- C-4a Regional Center
- C-4b Regional Center
- C-4c Regional Center
- D-1 Development
- D-2 Development
- D-3 Development
- GP Government/Public
- H-1 Hospital
- H-2 Hospital
- HR Hotel Resort
- I Industrial
- R1/b Mixed Use
- NMC-1 University
- NMC-2 University
- OS Open Space
- GTC Grand Traverse Commons
- R-15 Multi Family Dwelling
- R-1a Single Family Dwelling
- R-1b Single Family Dwelling
- R-2 Two Family Dwelling
- R-29 Multi Family Dwelling
- R-9 Multi Family Dwelling
- RC Residental Conservation
- T Transportation
- (A) - Zoning Agreement

Planning Department
Zoning Administrator - Dave Weston
231-922-4464

City of Traverse City Geographic Information Systems

0 1,000 2,000 Feet

5/24/2019 GWS

This map is based on digital databases from the City of Traverse City. Traverse City cannot accept any responsibility for errors, ommissions or positional accuracy. There are no warranties expressed or implied.

Document Path: Z:\GIS\Planning\Zoning Master Map Editing information\Zoning_Master_Update103.mxd

Figure 2-3 City of Traverse City Current Zoning Districts

Courtesy of City of Traverse City

CITY OF TRAVERSE CITY
NEIGHBORHOOD MAP
FUTURE LAND USE

West Arm Grand Traverse Bay

East Arm Grand Traverse Bay

Boardman Lake

SEE BAYFRONT 2010 PLAN

SEE MMC MASTER SITE AND FACILITY PLAN

SEE NMC MASTER SITE AND FACILITY PLAN

SEE GRAND TRAVERSE COMMONS MASTER PLAN

TRAVERSEFIELD INDUSTRIAL PARK

Legend

City Limits

Neighborhood Types

- TC-1 Conservation
- TC-2 Conventional
- TC-3 Traditional
- TC-4 Corridor
- TC-5 Downtown
- TC-C Campus Plan

City of Traverse City
Asset Management/GIS

NOT TO SCALE

ADOPTED BY THE CITY COMMISSION ON JULY 3, 2017.

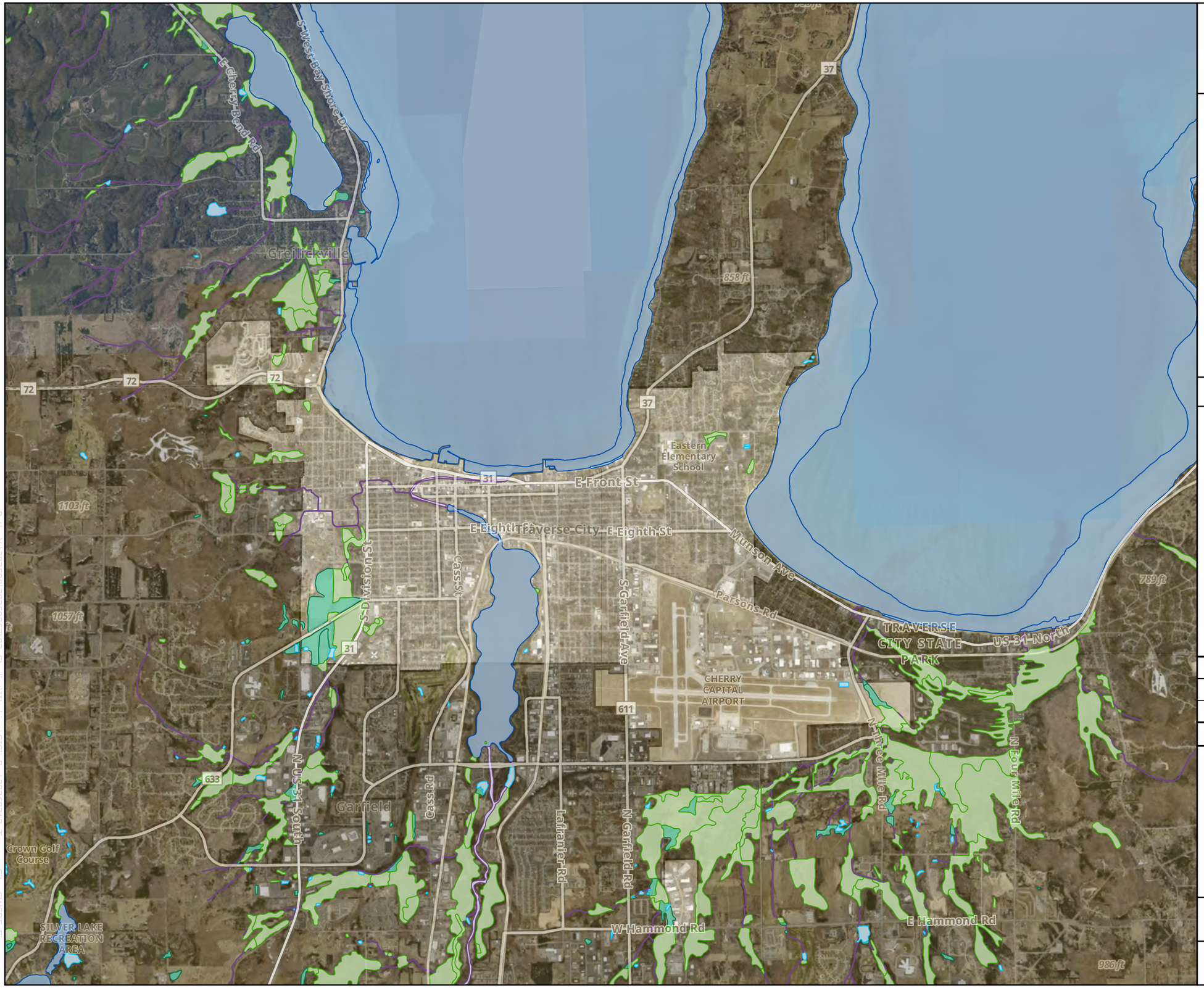
Note:
This future land use map is intended to show generalized neighborhood types and campuses. It is not intended to indicate precise site, shape or dimension areas. These recommendations have a long-range planning horizon and do not necessarily imply that short-term zoning decisions are appropriate.

This Plan is to be used in conjunction with the text of the Master Plan, which guides the height, area, bulk, location, and use of buildings and premises within differing neighborhood types by setting forth the character and intensity of each neighborhood. The campus neighborhoods are intended to be developed according to specific plans approved for the different campuses.

Document Path: G:\GIS\Planning\Future Land Use - Planning\2016\maps\2016_futurelanduse_revisions.mxd 10-05-17 JPT

Figure 2-4 City of Traverse City Future Land Use

Courtesy of City of Traverse City



CITY OF TRAVERSE CITY

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE Suite 100
Grand Rapids, MI 49506

Phone: (616) 454-4286

WEBSITE: http://www.hrcengr.com

Legend

0 0.38 0.75 1.5 Miles

N

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Other

DRAWN: KLH CHECKED: DIU

CWSRF Project Plan
City of Traverse City
Wetlands Map

HRC Job No. 20260067

SCALE: AS SHOWN

May 2026

FIGURE 2.5

Path: Y:\20260067\03_Studies\Working\GIS_Pro\20260212_TraverseCity_CWSRF_Figures.aprx

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the National Agricultural Imagery Program (NAIP). This information was photogrammetrically compiled at a scale of 1:12,000 from aerial photography dated 2007 or later.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Figure 2-6 FEMA Floodplain Map

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% Annual Chance Floodplain Boundary
	0.2% Annual Chance Floodplain Boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 — 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000mN	1000-meter Universal Transverse Mercator grid values, zone 16
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 28, 2018

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0113C

FIRM

FLOOD INSURANCE RATE MAP

GRAND TRAVERSE COUNTY, MICHIGAN (ALL JURISDICTIONS)

PANEL 113 OF 425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PENINSULA, TOWNSHIP OF	260747	0113	C
TRAVERSE CITY, CITY OF	260082	0113	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
26055C0113C
EFFECTIVE DATE
AUGUST 28, 2018

Federal Emergency Management Agency

USGS
science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

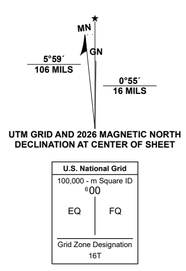
GRAWN QUADRANGLE
MICHIGAN - GRAND TRAVERSE
7.5-MINUTE TOPO

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: UNIVERSAL TRANSVERSE MERCATOR, ZONE 16T

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov



UTM GRID AND 2026 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
EQ FQ
Grid Zone Designation
16T

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

USER DEFINED CONTENT

QUADRANGLE LOCATION

Maple City	Traverse City SW	Traverse City SE
Lake Ann	Grawn	Mayfield
Karlin	Buckley	Kingsley

ADJOINING QUADRANGLES

ROAD CLASSIFICATION

Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route
FS Primary Route
FS Passenger Route
FS High Clearance Route

Check with local Forest Service unit
for current travel conditions and restrictions.

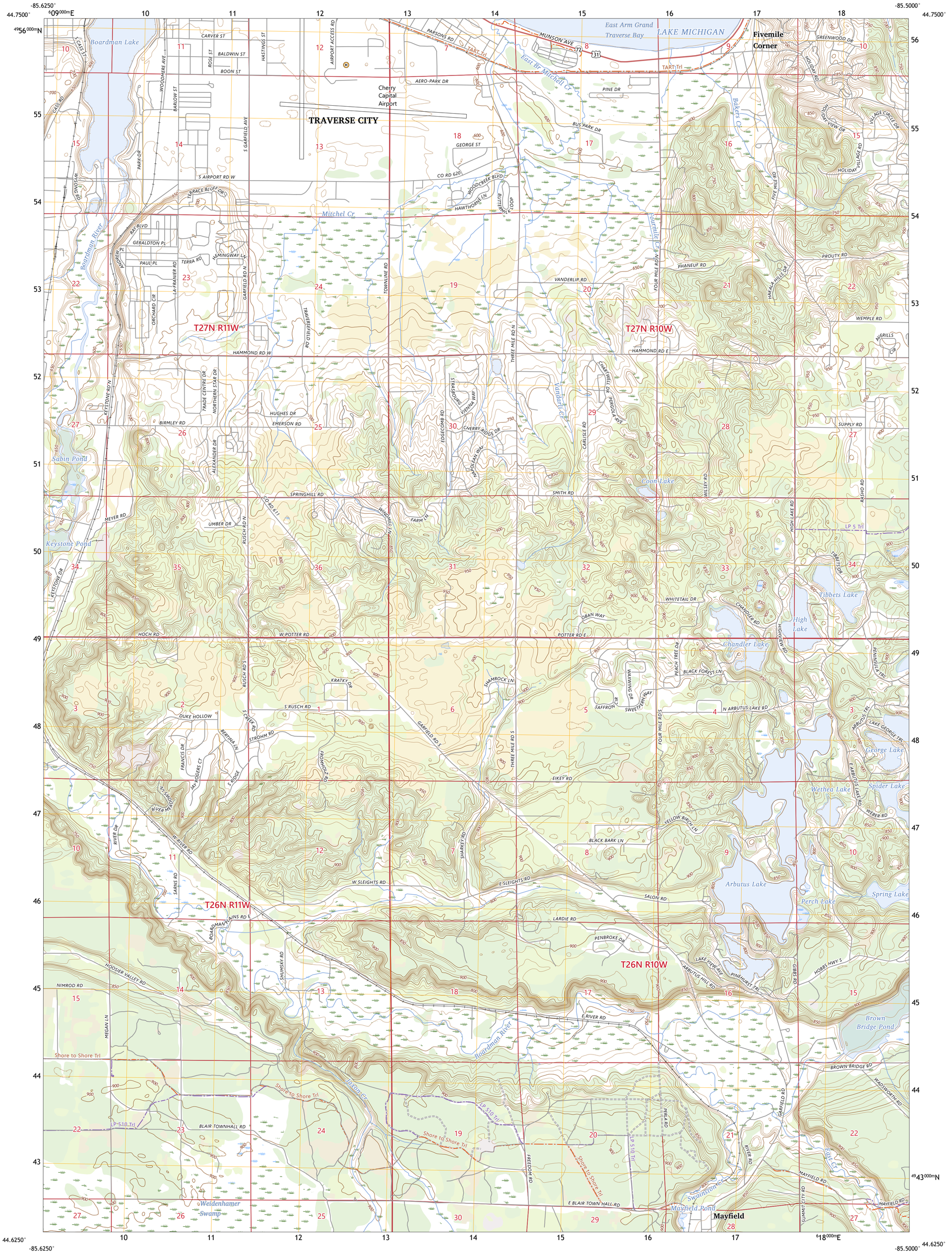
GRAWN, MI
2026

USGS
science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

MAYFIELD QUADRANGLE
MICHIGAN - GRAND TRAVERSE
7.5-MINUTE TOPO

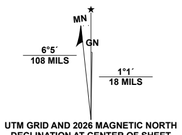


Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: UNIVERSAL TRANSVERSE MERCATOR, ZONE 16T

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov



UTM GRID AND 2026 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
FQ
Grid Zone Designation
16T

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

USER DEFINED CONTENT

QUADRANGLE LOCATION

Traverse City SW	Traverse City SE	Williamsburg
Grawn	Mayfield	Jacks Landing
Buckley	Kingsley	Walton

ADJOINING QUADRANGLES

ROAD CLASSIFICATION

Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD

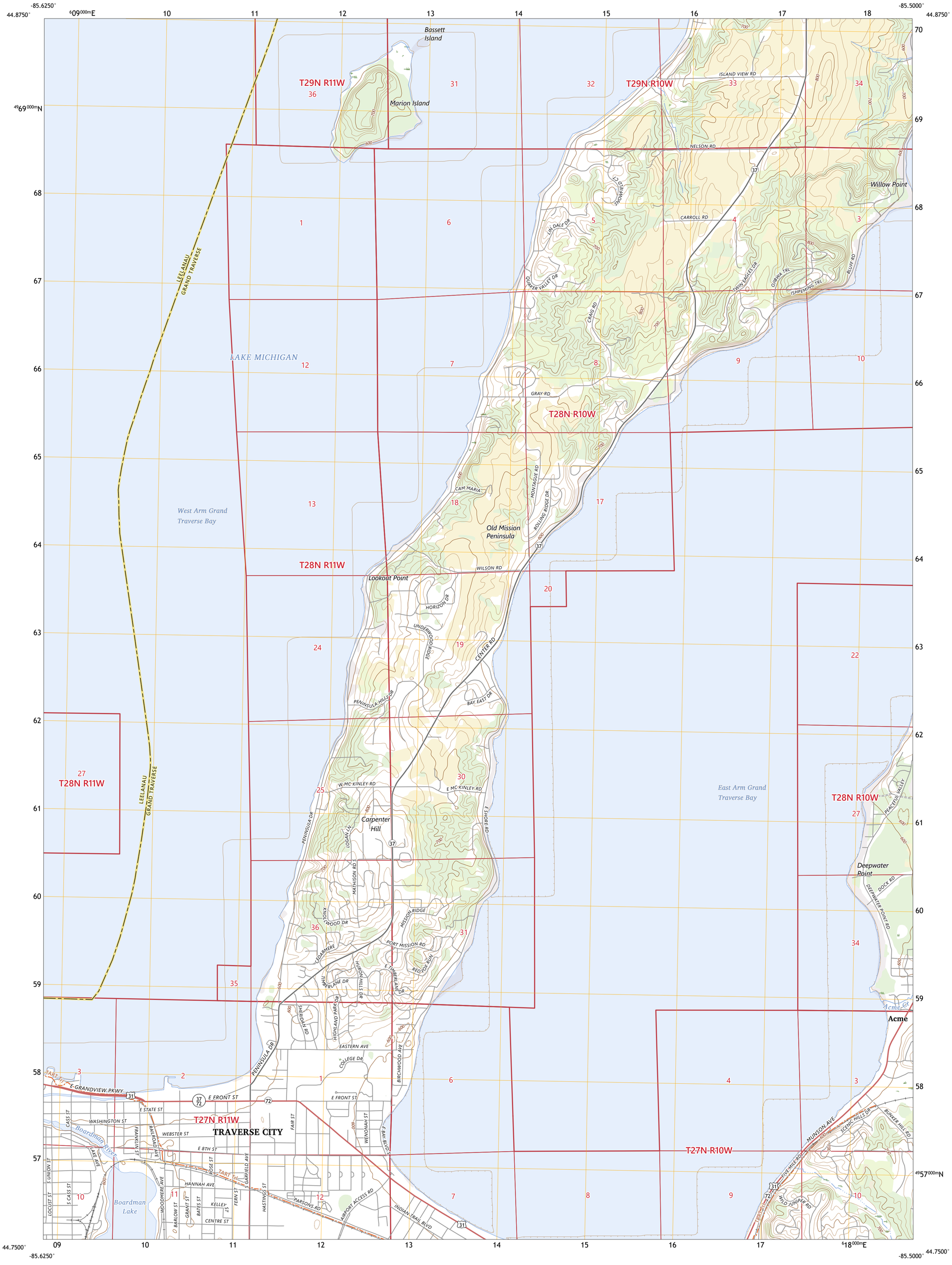
Interstate Route · US Route · State Route

MAYFIELD, MI
2026

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

TRAVERSE CITY SE QUADRANGLE
MICHIGAN
7.5-MINUTE TOPO

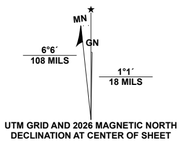


Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: UNIVERSAL TRANSVERSE MERCATOR, ZONE 16T

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov



UTM GRID AND 2026 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
FQ
Grid Zone Designation
16T

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

USER DEFINED CONTENT

QUADRANGLE LOCATION

Suttons Bay	Mapleton	Elk Rapids
Traverse City SW	Traverse City SE	Williamsburg
Grawn	Mayfield	Jacks Landing

ADJOINING QUADRANGLES

ROAD CLASSIFICATION

Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD

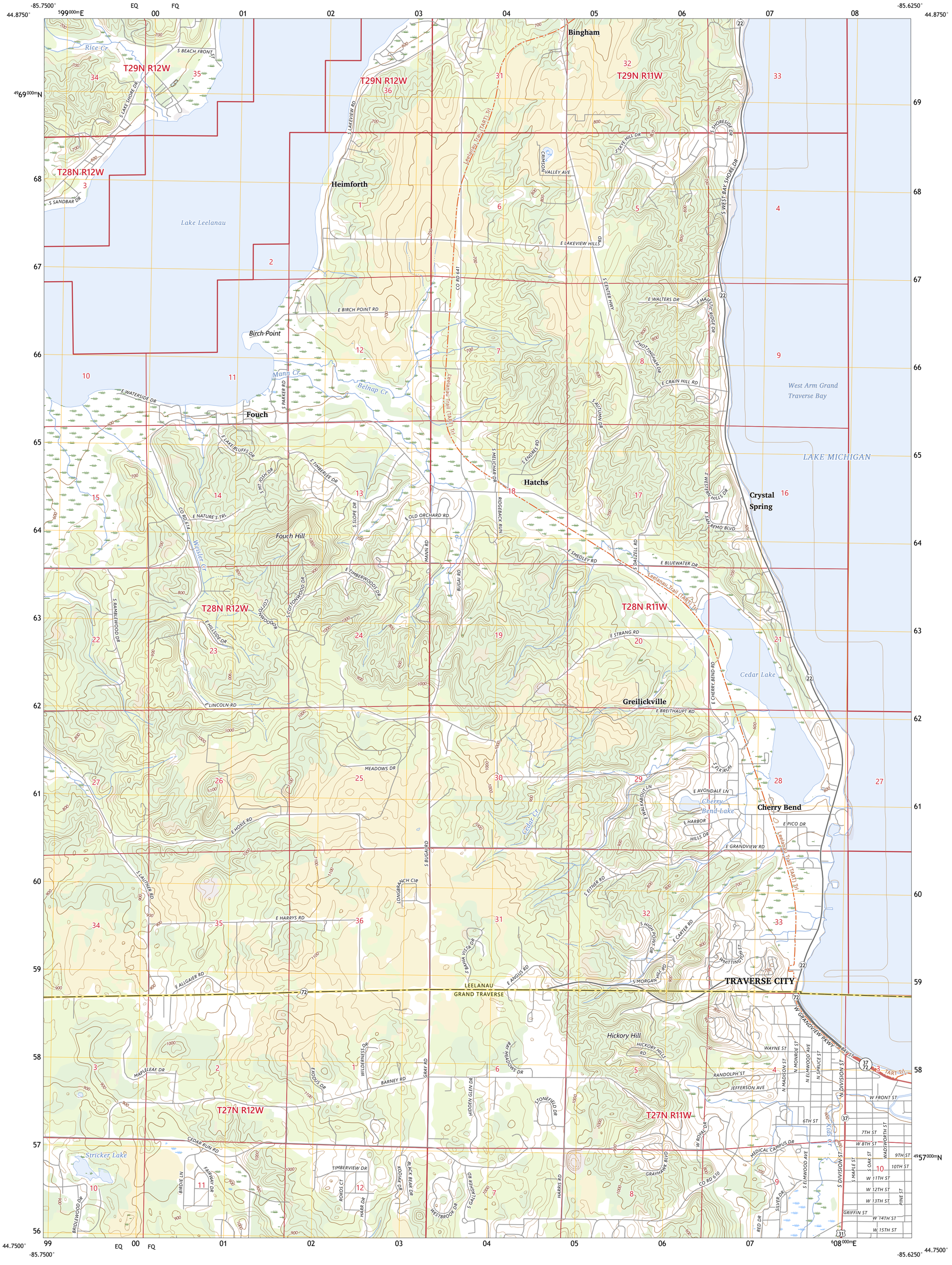
Interstate Route · US Route · State Route

TRAVERSE CITY SE, MI
2026

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

TRAVERSE CITY SW QUADRANGLE
MICHIGAN
7.5-MINUTE TOPO

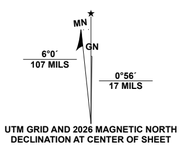


Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: UNIVERSAL TRANSVERSE MERCATOR, ZONE 16T

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov



UTM GRID AND 2026 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
600
EQ
FQ
Grid Zone Designation
16T

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

USER DEFINED CONTENT

QUADRANGLE LOCATION

Good Harbor Bay	Suttons Bay	Mapleton
Maple City	Traverse City SW	Traverse City SE
Lake Ann	Grawn	Mayfield

ADJOINING QUADRANGLES

ROAD CLASSIFICATION

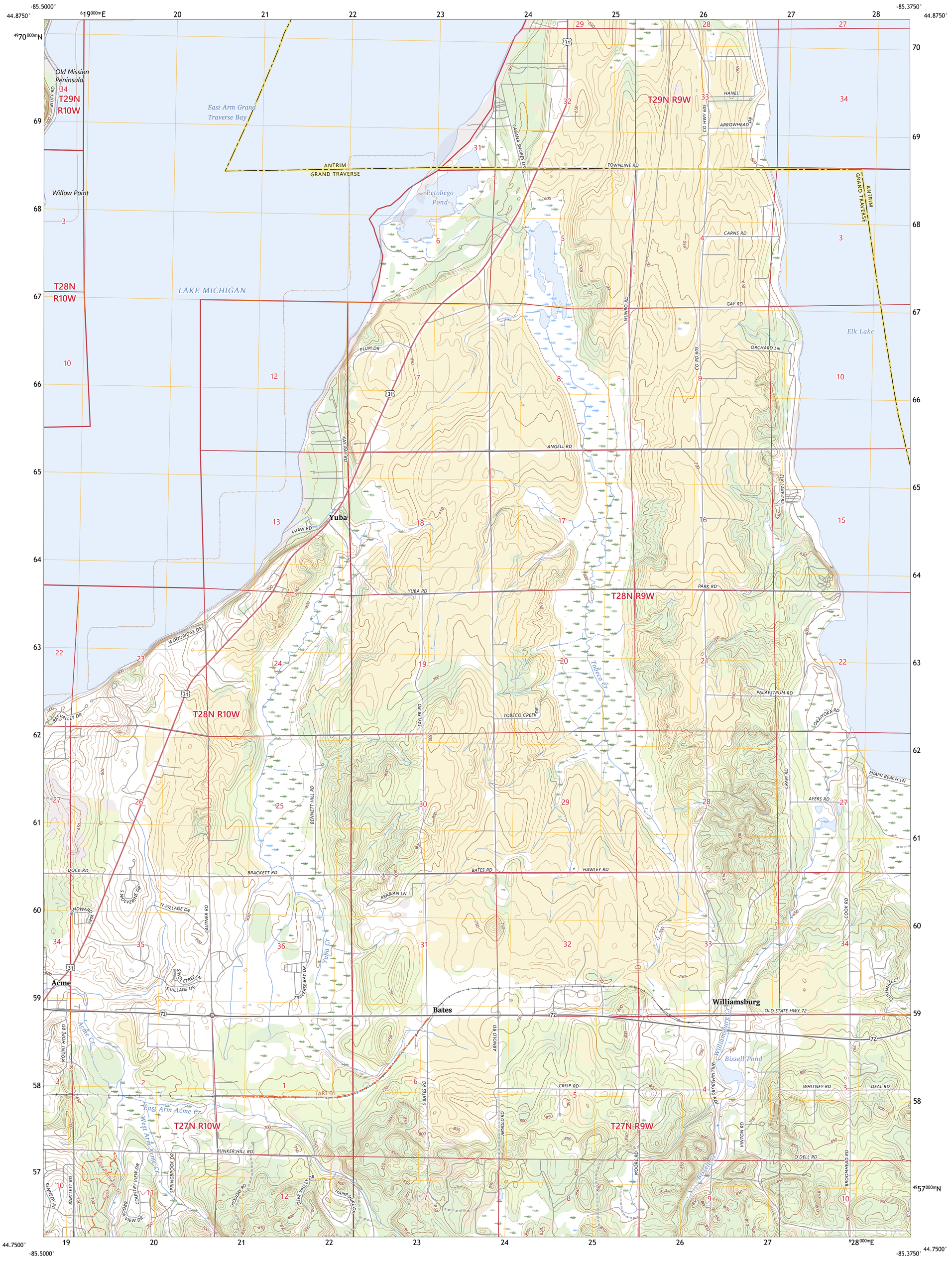
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

TRAVERSE CITY SW, MI
2026

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

WILLIAMSBURG QUADRANGLE
MICHIGAN
7.5-MINUTE TOPO



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: UNIVERSAL TRANSVERSE MERCATOR, ZONE 16T

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov

MN
GN
6°12'
110 MILS
1°6'
20 MILS
UTM GRID AND 2026 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
FQ
Grid Zone Designation
16T

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

USER DEFINED CONTENT

ROAD CLASSIFICATION

Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD

Interstate Route · US Route · State Route

WILLIAMSBURG, MI
2026

2.2 *Existing Facilities – General*

The City of Traverse City sewer and wastewater collection, transmission, and treatment infrastructure are critical assets for conveying and treating waste and preventing the introduction of pollutants into Boardman Lake, Boardman River, and the Grand Traverse Bay. A description of the City's wastewater collection and treatment infrastructure is provided in the following sections.

2.2.1 Sewer Collection System and Lift Stations

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County, and Elmwood Township in Leelanau County.

The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. Flow collected via the collection system can have significant infiltration and inflow contributions to the collection system and WWTP. Wet weather contributions throughout the collection system cause the delivery of low strength waste to the WWTP but simultaneously provide a flushing effect which resuspends settled grit and solids allowing them to travel to the WWTP for treatment. Table 2-3 below lists the locations and capacities of the City of Traverse City lift stations.

Each lift station was constructed with ancillary support systems, such as telemetry, cathodic protection, and emergency power. These systems ensure maintenance staff can respond to alarms and emergencies in a timeframe that keeps the City from violating its level of service goals and protects the buried metal housing from corrosion. Backup emergency power for lift stations is provided through either a standby generator onsite or portable power generation equipment.

Table 2-3. City of Traverse City Lift Stations

	Lift Station	Location	Pump Station	Pumping Capability (gpm at ft TDH)
1	Birchwood	2060 East Front Street	Non-clog dry pit Hydrodynamic (2)	800 gpm at 40 ft TDH
2	Bay Street	580 Bay Street	4-inch submersible 9.4 HP (2)	430 gpm at 32 ft TDH
3	Clinch Park	111 East Grandview Parkway	Submersible 3 inch 2.4 HP Flygt (2)	260 gpm at 17 ft TDH
4	Coast Guard	911 Airport Access Road	Submersible 4 inches 17.5 HP ABS (2)	400 gpm at 70 ft TDH
5	Hull Park	660 Hannah Avenue	Submersible 1 ¼ inch 2.0 HP Hydromatic Grinder (1)	-
6	Front Street	429 East Front Street	Dry Pit VFD ITT A-C (3)	2600 gpm/Ea at 55 ft TDH
7	Riverine	318 East Eight Street	Non-clog Dry Pit 4-inch 7.5 HP (2)	350 gpm at 37 ft TDH
8	Woodmere	643 Woodmere Avenue	Submersible 4 inch 6.4 HP Flygt (2)	450 gpm at 25 ft TDH
9	Ind. Park (TBA)	880 Parsons Road	Dry Pit 5-inch 15 HP	700 gpm at 35 ft TDH

2.2.2 Infiltration and Inflow

Infiltration and inflow have been a concern in the City which can cause the TCRWWTP to treat low strength waste at a higher cost to rate payers. In addition, the substantial volumes of wastewater during wet weather events which reach the plant are difficult to manage. Nine (9) temporary sewer flow meters and one rain gauge were installed for a period of five months, from April – August 2015. The flow meters were used to identify areas for future condition assessment, to assess the system capacity, as an indicator of current system function, and to help capture the amount of infiltration and inflow in the system. Infiltration and inflow mitigation efforts have been completed on portions of the collection system including sump pump disconnections, sealing manholes, and additional inspections.

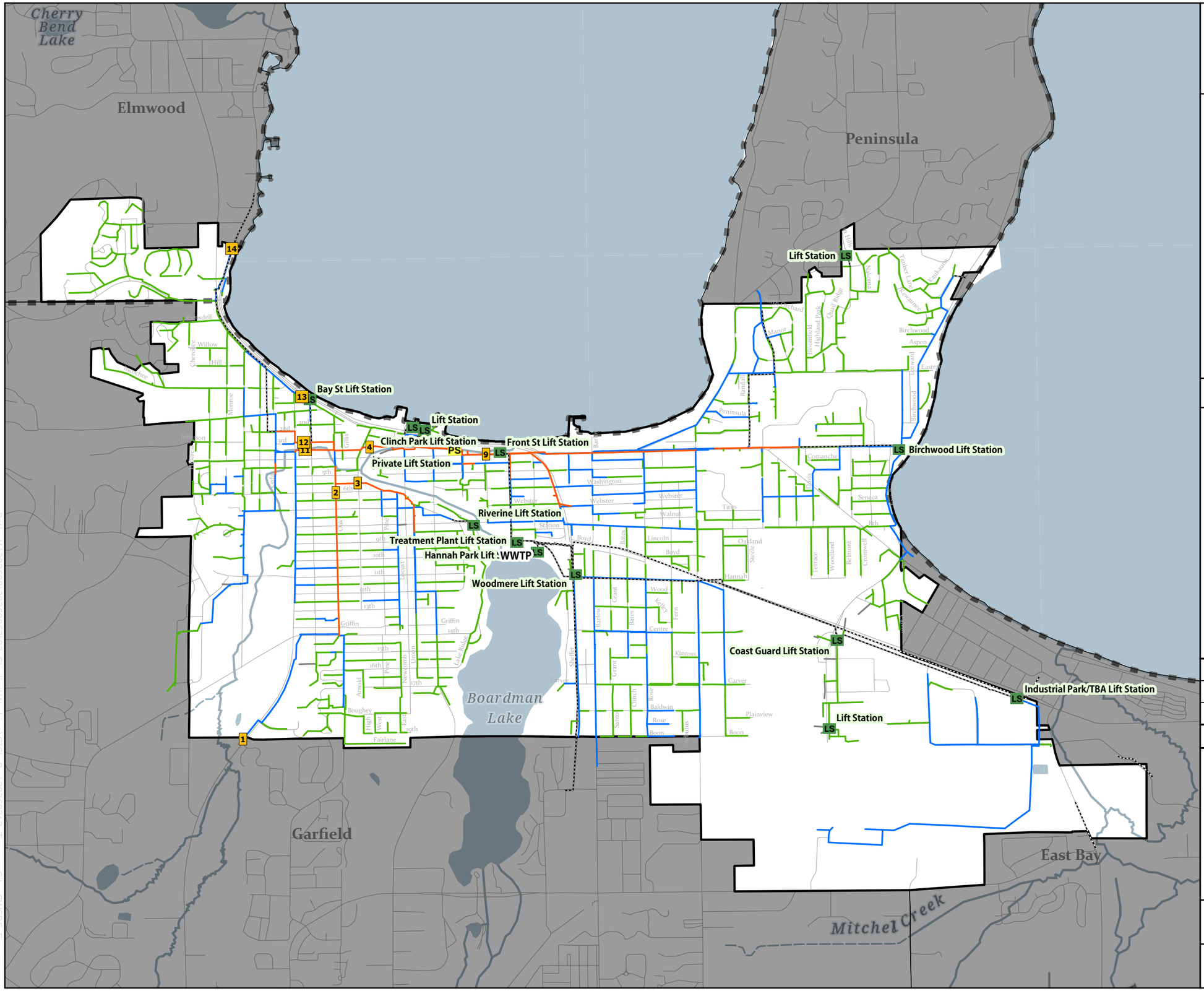
During the spring/summer of 2020, the City of Traverse City (City) experienced three major storm events with >50-year frequency which resulted in sanitary sewer overflows (SSOs) at the downstream end of the Boardman River sanitary sewer siphon. To better understand the sources of high flows, the City purchased four area velocity laser flow meters and installed August 31st, 2020, to further evaluate the flows in the West Front. Flow monitoring locations from the 2015 and 2020 monitoring are shown in Figure 2-12.

High dry weather infiltration in the meter district M09 (West Front; 100 feet west of Front Street Lift Station in SSM-1414) and M04 (Parking Lot; at the corner of the building, CCM-1387) has resulted in increased daily flows. These flows are directly correlated with the high groundwater levels due to the high levels in West Grand Traverse Bay specifically in sewers below the levels of the bay (582.9' NAVD88). CCTV inspections of sewers near Bay Street in August 2020 identified high sources of infiltration from sanitary sewer leads.

The wet weather flows that occurred before this flow monitoring effort appears to have occurred as a result of flooding from Kids Creek in meter district M04. Flooding at Munson hospital recorded peak flows as a result of flooding on May 28th, 2020, in the lower levels to drains connected to the City's gravity sewers. Subsequent storm events did not produce these flows at Munson Hospital.

An initial hydraulic model simulation of the West Front Street Sewer was developed using SewerGEMS, using the City's GIS shapefiles of the sewers and manholes. The estimated design flows from the flow monitoring study completed as part of the Wastewater AMP in addition to the increased dry weather flows from these events as a result of the high groundwater elevations predict SSOs downstream of this siphon in manholes SSM-1395, SSM-1396, and SSM-1397. This modeling effort confirmed the high wet weather flows over the capacity of the sewer downstream of the Boardman River siphon from the three major storm events caused the overflows at the location of the siphon were due to:

1. High infiltration from the elevated water levels of Lake Michigan (WSL 580.5 to 582.9' NAVD88) during these summer events relative to the past monitoring in 2015 (WSL 579.5' to 580.0' NAVD88)
2. Significant rainfall events exceeded the capacity of the sanitary sewer downstream of this siphon causing the surcharging and overflow events. The two storms were 50-yr and one 200-yr events.



CITY OF TRAVERSE CITY

HRC

HUBBELL, ROTH & CLARK, INC

CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE Suite 100
Grand Rapids, MI 49506

Phone: (616) 454-4286

WEBSITE: http://www.hrcengr.com

Legend

0 0.25 0.5 1 Miles

N

Sewer Force Main
- Traverse City Owned
- Owned by Others

Sewer Gravity Main
- 4" - 8"
- 9" - 15"
- 16" - 36"
- Unk. Diameter

- 2020-Current Flow Meter
- LS Lift Station
- PS Pump Station
- Traverse City Boundary
- Outside City Limits
- County Boundary
- Roads

DRAWN: KLH CHECKED: DIU

CWSRF Project Plan
City of Traverse City
Flow Monitoring

HRC Job No. 20260067	SCALE: AS SHOWN
May 2026	**FIGURE 2.12**

Path: Y:\20600\20260067\03_Studies\Working\GIS_Pro\20260212_TraverseCity_CWSRF_Figures.aprx

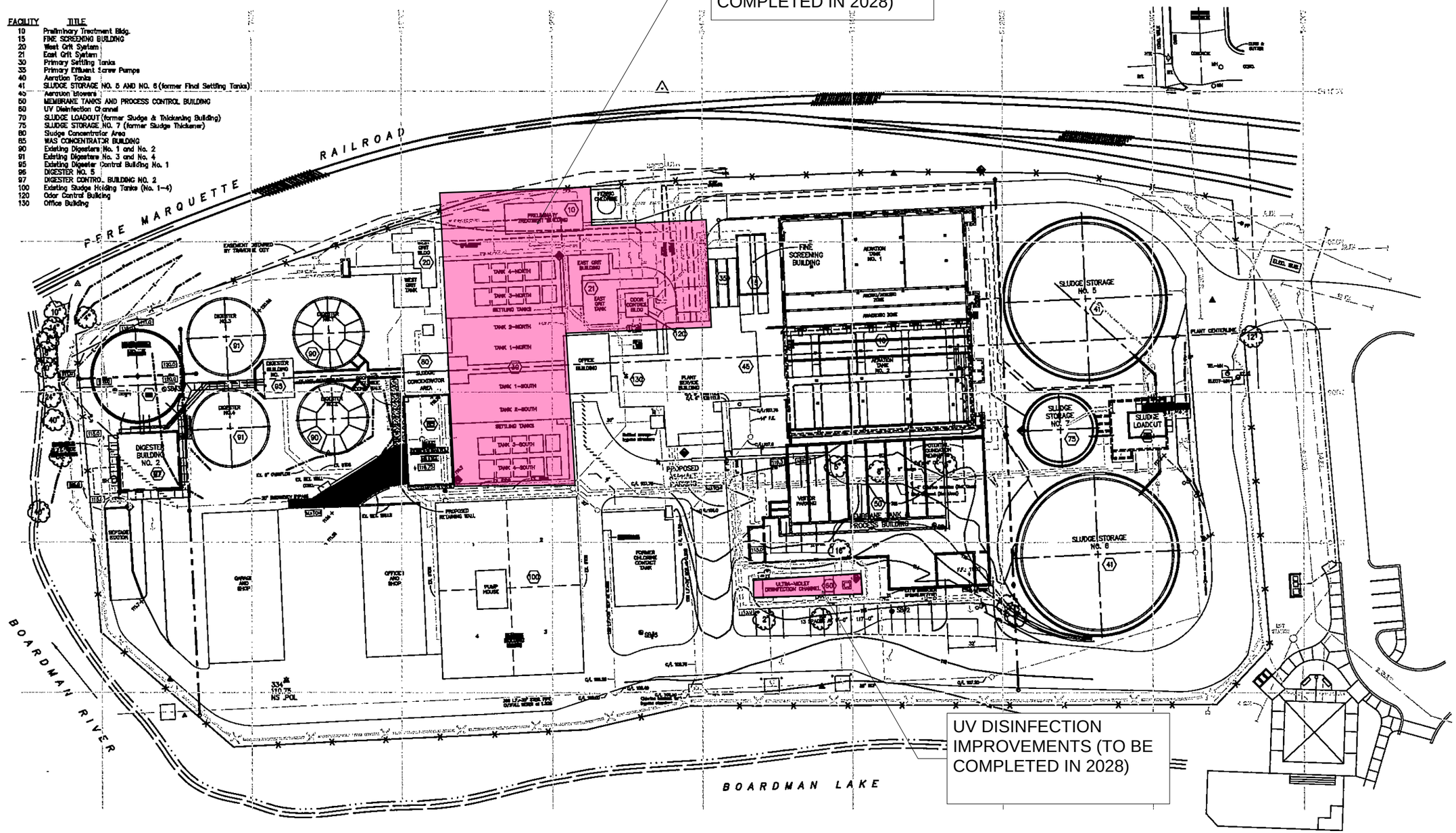
2.3 Existing WWTP Facilities

All wastewater received at the facility is treated and discharged to the Boardman River, in accordance with its National Pollutant Discharge Elimination System (NPDES) permit (MI0027481). Appendix C contains a copy of the City's current NPDES permit. The design and permitted annual average daily flows are 8.5 MGD, with a design peak flow of approximately 17 MGD. An overall site plan of the WWTP is shown in Figure 2-13. The WWTP facilities can be broken up into four sectors: preliminary and primary treatment, secondary treatment, disinfection, and solids handling. A complete hydraulic flow schematic of the WWTP is shown in Figure 2-14.

The TCRWWTP effluent discharges into the Boardman River and ultimately Grand Traverse Bay. The facility has been designed to comply with the EGLE requirements for wastewater treatment including monthly average effluent five-day biochemical oxygen demand (BOD5) and total suspended solids (TSS) of 25 mg/L and 30 mg/L, respectively. The current discharge permit also establishes a seasonal effluent limit for ammonia nitrogen (NH3-N) of 11 mg/L and an effluent total phosphorus (TP) limit of 1 mg/L. The Traverse City effluent objectives have been established as 4 mg/L for BOD5 and TSS, 1 mg NH3-N /L, and 0.5 mg TP/L.

PRELIMINARY AND PRIMARY TREATMENT IMPROVEMENTS (TO BE COMPLETED IN 2028)

FACILITY	TITLE
10	Preliminary Treatment Bldg.
15	FINE SCREENING BUILDING
20	West Grit System
21	East Grit System
30	Primary Settling Tanks
35	Primary Effluent Screw Pumps
40	Aeration Tanks
41	SLUDGE STORAGE NO. 5 AND NO. 6 (former Final Settling Tanks)
45	Aeration Blowers
50	MEMBRANE TANKS AND PROCESS CONTROL BUILDING
60	UV Disinfection Channel
70	SLUDGE LOADOUT (former Sludge & Thickening Building)
75	SLUDGE STORAGE NO. 7 (former Sludge Thickener)
80	Sludge Concentrator Area
85	WAS CONCENTRATOR BUILDING
90	Existing Digesters No. 1 and No. 2
91	Existing Digesters No. 3 and No. 4
95	Existing Digester Control Building No. 1
96	DIGESTER NO. 5
97	DIGESTER CONTRO. BUILDING NO. 2
100	Existing Sludge Holding Tanks (No. 1–4)
120	Odor Control Building
130	Office Building



UV DISINFECTION IMPROVEMENTS (TO BE COMPLETED IN 2028)

Figure 2-13 Overall Site Plan

Courtesy of City of Traverse City

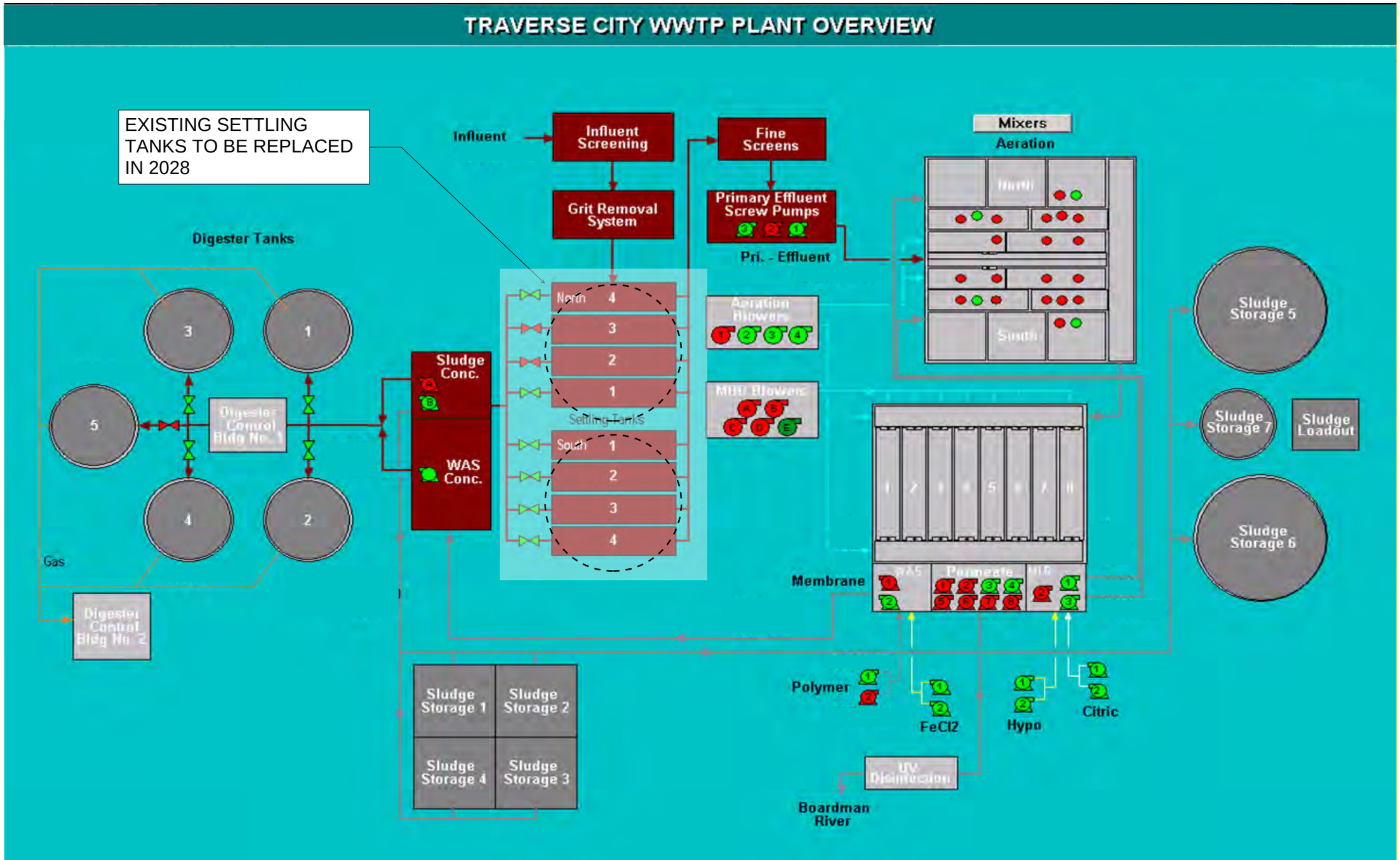


Figure 2-14 Process Flow Schematic

**Courtesy of City of Traverse City*

2.3.1 Primary Treatment

Preliminary Screening

Currently, raw sewage enters the TCRWWTP through four force mains which flow into the influent channel of the Preliminary Treatment Building. The influent channel directs the wastewater through a Rotary (Lakeside Rotamat) Semi-Fine Screen (3/8-inch +/- openings). The screened wastewater then flows by gravity through two 24-inch pipes to the two separate grit removal systems (East and West). The influent wastewater flow is measured through two 24-inch Parshall Flumes located upstream of both grit tanks each with a range of 0–10 MGD. The design capacity of the WWTP is 8.5 MGD with a peak flow capacity of 17 MGD.

If the flow is in excess of the rotary screen's capacity, it can overflow a slide gate and proceed through a bypass channel that is equipped with a manually cleaned coarse bar screen with 1-inch openings. Since it is a manually cleaned screen, it can become blinded rather quickly and result in problematic overflows of both of the channels or bypassing around the rotary screen since the rotary screen has points of overflow that are below the top of the channel walls. It has been indicated that equipping the overflow channel with a fine screen mechanism would be desirable.

The current Preliminary Treatment and UV Disinfection project will replace the existing preliminary screens with two ¼" bar screens each. This work is scheduled for completion in 2028. Two new multi-rake bar screens with washer-compactors will be installed at the new Headworks. The screens will be mechanically cleaned, multi-rake bar screens with ¼" openings. The screens will be used to remove debris from the wastewater and convey them to the washer compactor. The washer-compactor will wash and compact screenings before discharging them into a waste container. The screening system includes its own manufacturer supplied control panel which provides control of the fine screens, screenings washer compactors, associated level control devices, solenoid valves, and control stations. The level control devices will monitor the level differential across each fine screen. A high-level alarm will be signaled based on setpoints in the manufacturer's control panel and a backup float.

Grit Removal

Grit removal is achieved using two 18' x18' square Detritor Style grit chambers (East and West Grit Tanks). The effluent from the West Grit Tank then flows through three cast iron sluice gates to the Primary Settling Tanks: one 24-inch diameter sluice gate/pipe and one 18-inch diameter sluice gate/pipe to the North Primary Settling Tanks and one 24-inch diameter sluice gate/pipe to the South Primary Settling Tanks.

The current Preliminary Treatment and UV Disinfection project will replace the existing preliminary screens with two stacked tray grit separators. This work is scheduled for completion in 2028. The new grit removal system includes two stacked tray, vortex type grit tanks, recessed impeller grit pumps, and two clarifier type grit washing and dewatering units. The system utilizes a hydraulically induced vortex to separate grit from the raw wastewater. The grit tanks will be located outside with covers to reduce odors, and the remainder of the grit system will be in the new Headworks with the fine screens. Stop gates were installed to allow operators to bypass the grit removal system if needed.

Primary Settling

The eight rectangular Primary Settling Tanks (each 66.5 feet long) are used to remove suspended solids and organics via gravity settling. The inner tanks are the original Primary Settling Tanks and located closest to the center plant walkway (original plant axis) are each 14 feet wide and were originally constructed in the 1930s. The newer tanks are each 16-ft wide and were constructed in the 1950s. The sludge that settles to the bottom of the primary settling tanks is collected using chain and flight sludge removal mechanisms. There is some grit carryover from the grit tanks that end up in the primary sludge and can accumulate in the digesters.

The current Preliminary Treatment and UV Disinfection project will replace the existing preliminary screens with two 70 ft diameter circular clarifiers. This work is scheduled for completed in 2028.

Primary sludge will be removed from the clarifiers using positive displacement rotary lobe pumps and automated sludge withdraw. Primary sludge will be pumped to the existing solids handling process for treatment. To promote formation of volatile fatty acid in biological phosphorus removal, primary sludge may be returned to the primary clarifier flow splitter.

Scum will be collected in the clarifiers by the clarifier mechanism in an external scum pit. The scum pit will contain compressed air mixing to limit the formation of a scum mat. Scum will be removed from the scum pits using positive displacement rotary lobe pumps and sent to the existing solids handling process for treatment.

Fine Screening

Fine screen equipment provides for the screening of primary settling tank effluent before conveyance to the secondary treatment system. Two screening channels, each 2 feet wide, are provided with a mechanically cleaned band screen rated at 10 MGD. The channels have a design water surface depth of approximately 3 feet. The channel depth is controlled by a fixed weir, installed in the effluent channel of each screen. The screened effluent discharges to the influent bay of the screw pumps. The screens have perforated openings of 2 mm, which is the opening size preferred by the membrane system manufacturer. Material collected on the screen is lifted out of the channel by the rotating screen and removed using a rotating brush and spray water. Each screen discharges the collected screenings to a screenings flume. Effluent water flushes the screenings from the screen and serves as sluicing water to convey the screenings, via the flume, to a screening compactor for removal of excess water. The compacted or dewatered screenings are bagged to prevent excessive odors with a screening bagger for periodic removal.

Primary Effluent Pumping

Screened primary effluent is conveyed by gravity from the fine screens to the screw pump influent well. Spiral screw pumps lift the screened primary effluent to the level of the Aeration Tanks. The pump discharge is hydraulically split into two parallel Aeration Tank inlet channels. A motorized slide gate is located in each channel and positioned to adjust the desired flow split between the north and south Aeration Tanks. The secondary influent flow is monitored downstream of the motorized slide gates via Parshall flumes.

2.3.2 Membrane Bioreactor Secondary Treatment

The influent to the Membrane Bioreactor (MBR) is pumped from the primary effluent screening facility to two secondary influent channels, each with a Parshall flume and individual sluice gates that are controlled to split the flow to the in-service Aeration Tanks.

The Aeration Tanks are arranged into two parallel trains. The tanks are configured in three passes: an anaerobic zone representing a percentage of the first pass, an anoxic zone for the remainder of the first and all the second pass (with swing zone capabilities), and the final pass an aerated zone. The secondary influent and mixed liquor recycle containing biological solids are introduced into the anaerobic zone. The combined wastewater is referred to as mixed liquor because of the presence of biological solids flows through the anaerobic zone, anoxic zones,

and aerated zones of the Aerations Tanks. The flow pattern is generally plug flow through the individual Aeration Tank zones. The ML ultimately overflows from the discharge end of the aerated zone into a common Membrane Tanks influent channel.

The mixed liquor (ML) from the Aeration Tanks is channeled to the in-service Membrane Tanks. The membrane equipment effectively separates the solids from the liquid phase of the ML by applying suction to the inside of individual membranes with large centrifugal pumps. The separated solids from the ML side (outside) of the membranes, referred to as activated sludge, overflows adjustable gates at the discharge site of the Membrane Tanks. Most of the activated sludge (AS) is recirculated to the front of the aerated zones in the Aeration Tanks as return activated sludge (RAS) and the remaining portion of the activated sludge is directed to the solids handling processes as waste active sludge (WAS).

The membranes require cleaning on a routine basis. Two methods of in-tank cleaning, also referred to as Clean-In-Place (CIP), have been provided. Separate chemical systems are in place to feed sodium hypochlorite or citric acid to the membranes without removing the membrane cassettes from their respective tanks. The citric acid cleaning system is presented first followed by the sodium hypochlorite system.

The Membrane Building contains a chemical storage area and feed systems used for all membrane cleaning operations. Citric acid is fed to the membranes via a system of pumps and delivery piping. Two (2) citric acid dosing pumps are available and operate as duty-standby to deliver chemicals as required. The bulk chemical is delivered in totes to the chemical storage area and transferred to a storage tank in the storage area. Concrete curbs provide containment in the event of a spill.

Biological phosphorus removal is the main mechanism for phosphorus removal, but the chemical may be added to the MBR to supplement the phosphorus removal process.

The process air blower system consists of four (4) inlet throttled constant speed drive centrifugal multistage process air blowers, a low-pressure air piping system, and fine bubble diffusers to supply process air to the aerated zones of the Aeration Tanks. The process air blower output is varied by pneumatic butterfly valves, one valve located on the inlet side of each process air blower, to maintain a pressure set point in the air header.

2.3.3 Ultraviolet Disinfection

Wastewater from the membrane permeate pump enters the UV channel inlet wet well. The inlet wet well splits the flow into two channels. Normally, both UV channels are in service, but isolation gates are available if one channel requires service. Isolation gates are also available to stop the flow to the UV channel and divert it directly to the outfall.

The existing UV disinfection system is achieved using a low-pressure, low-output Aquaray 40 model by Infilco Degremont, Inc. (IDI), now a subsidiary of Suez Environmental (Suez). Suez UV equipment is marketed under the brand name Ozonia. The UV modules contain multiple lamps in a vertical arrangement. The system was designed in 1995 and included two channels with six modules per channel and space for an additional module in each. Design peak flow for the UV system was 11 to 12.2 million gallons per day (mgd) with final effluent. In 1998, two additional modules were added to the available spaces, resulting in up to 14 in-service UV modules.

2.3.4 Sludge Digestion and Solids Handling

WAS Concentration

The waste-activated sludge (WAS) is pumped from the WAS Box to the Gravity Belt Concentrator (GBC). The GBC consists of a permeable, continuous belt that travels horizontally across a series of rollers. Polymer is injected into the WAS in the pump discharge header upstream of the GBC to flocculate the activated sludge solids. Conditioned activated sludge fills a floc tank at the head of the GBC, which is designed to provide adequate

mixing and reaction time of the polymer with the sludge solids. The conditioned activated sludge fills the tank and overflows onto the traveling belt. The belt travel speed is adjustable to optimize the retention time of the conditioned sludge on the belt to allow maximum water release and, therefore, maximize the concentration of the activated sludge at the end of the belt travel. The lateral position of stationary plows or chicanes along the belt is manually adjustable to create furrows and open clear sections of the belt to aid in free water release and belt drainage. A polyethylene doctor blade, with an adjustable tensioning arm, removes the thickened sludge from the belt at the discharge end of the machine. Concentrated waste activated sludge (CWAS) is discharged to a thickened sludge hopper that directly feeds an open throat progressive cavity pump. From there it is pumped to the Anaerobic Digestion system. The liquid released from the sludge drains through the belt to a filtrate collection box. Ferric chloride can be added to the WAS upstream or the CWAS downstream of the GBC to chemically fix the phosphorus that was taken up biologically in the activated sludge system.

Anaerobic Digestion

The anaerobic digestion system consists of five anaerobic digesters, complete with sludge recirculation, sludge heating system, sludge mixing, and digester gas handling. The digesters are equipped with recirculation pumps. The recirculation pumps are used to provide digester mixing by pumping the sludge through mixing nozzles located throughout Digesters 1, 2, and 5. Digester 4 uses gas lift mixers for primary mixing, and their sludge recirculation pump provides secondary mixing. The efficiency of the gas lift mixing is limited and the mixing in Digester 3 was replaced with a linear motion mixer installed in 2020.

Digested sludge is stored in the sludge holding tanks before being transported by tanker truck to be land applied. The thickening of the digested sludge is to both reduce the volume of biosolids to be hauled from the plant, as well as provide a suitable product for land application.

Digested sludge is normally concentrated via two sieve drum concentrators (SDCs). Four digested sludge transfer pumps are used to transfer the digested sludge to the SDCs. Polymer is added upstream of the SDCs to assist the thickening process. The concentrated digested sludge, CDS, is pumped to the sludge storage tanks.

Sludge Storage and Offloading

The sludge storage recirculation and loading system are operated manually. Sludge flows to storage from the sieve drum concentrators are monitored with a flow meter. In the event that both sieve drum concentrators are out of service and the gravity belt concentrator is processing digested sludge, the concentrated digested sludge is conveyed to the sludge storage tanks using a different metered line.

In the Sludge Loadout Building, the piping and recirculation pumps are arranged such that either of the two pumps can be used for any one of the three tanks. Normally, only one pump is in service, mixing one tank at any given time. The incoming concentrated sludge can be directed to the suction line of the operating recirculation pump or conveyed directly to a storage tank without using the recirculation pump.

In the Sludge Storage Facility, sludge is directed to one of the four sludge storage tanks (Tanks 1 to 4) by opening the appropriate inlet valve. Recirculating mixers are available to mix the sludge if needed. Telescoping valves are available for each tank to decant supernatant. Each sludge storage tank is provided with high-level float switches, which will initiate an alarm when the tank liquid level reaches a high level.

2.3.5 Odor Control

Foul air is generated at several locations at the plant. Two odor control systems are provided to capture and treat foul air to control odors. One system uses activated carbon to remove hydrogen sulfide and other odor-producing compounds. The other system uses the aerated zones of the Aeration Tanks to treat foul air. The activated carbon system (Phoenix system) treats foul air from the east and west grit buildings, the primary settling tanks, the sludge concentrator building, and the WAS thickening building. Air is drawn from these buildings by a blower, located

outside of the odor control building. Foul air is delivered to the Phoenix system and flows through the activated carbon canisters and is discharged to the atmosphere.

2.4 Need for Project

The WWTP is generally in compliance with the requirements of their NPDES permit. However, numerous issues need to be addressed immediately due to the age and condition of the plant to ensure the reliability of continued operation. An Asset Management Plan for the plant, which rates the condition of existing assets, was recently completed. It concluded that numerous assets at the plant need immediate replacement or refurbishment largely due to hydraulic limitations and aging equipment.

Without the design, construction, and implementation of these projects, the water quality of the Boardman River, Boardman Lake, and Grand Traverse Bay will eventually degrade because the plant will not be able to provide adequate treatment as mandated by its NPDES permit.

3 Alternative Analysis

3.1 Alternatives Considered

Each project was assessed to follow one of the following alternate classifications. Each upgrade or rehabilitative method was chosen on a technical basis and cost comparisons are presented for each alternative analysis, where applicable.

3.2 No Action

As previously indicated, if no action is taken, the existing plant equipment and structures will continue to degrade to the point that they will not be able to treat wastewater to a degree which complies with NPDES permit requirements or adequately protects public health and the environment. Besides, there are several projects which will mitigate or eliminate the potential for harm to employees and inhabited environs. All projects listed as part of this plan are of absolute necessity and should be implemented as soon as possible to avoid harm to workers, nearby residents, unnecessary upsets at the plant, and failures to the facility.

3.3 Sewer Rehabilitation and Replacement Projects

Completion of sewer rehabilitation to address aging concrete and clay sewers that are structurally deficient. The rehabilitation includes sewer, manhole, and lateral rehabilitation by cured in place pipe (CIPP) and cured in plac manhole (CIPM). The rehabilitation of these structurally defective sewers will also provide effective infiltration and inflow removal.

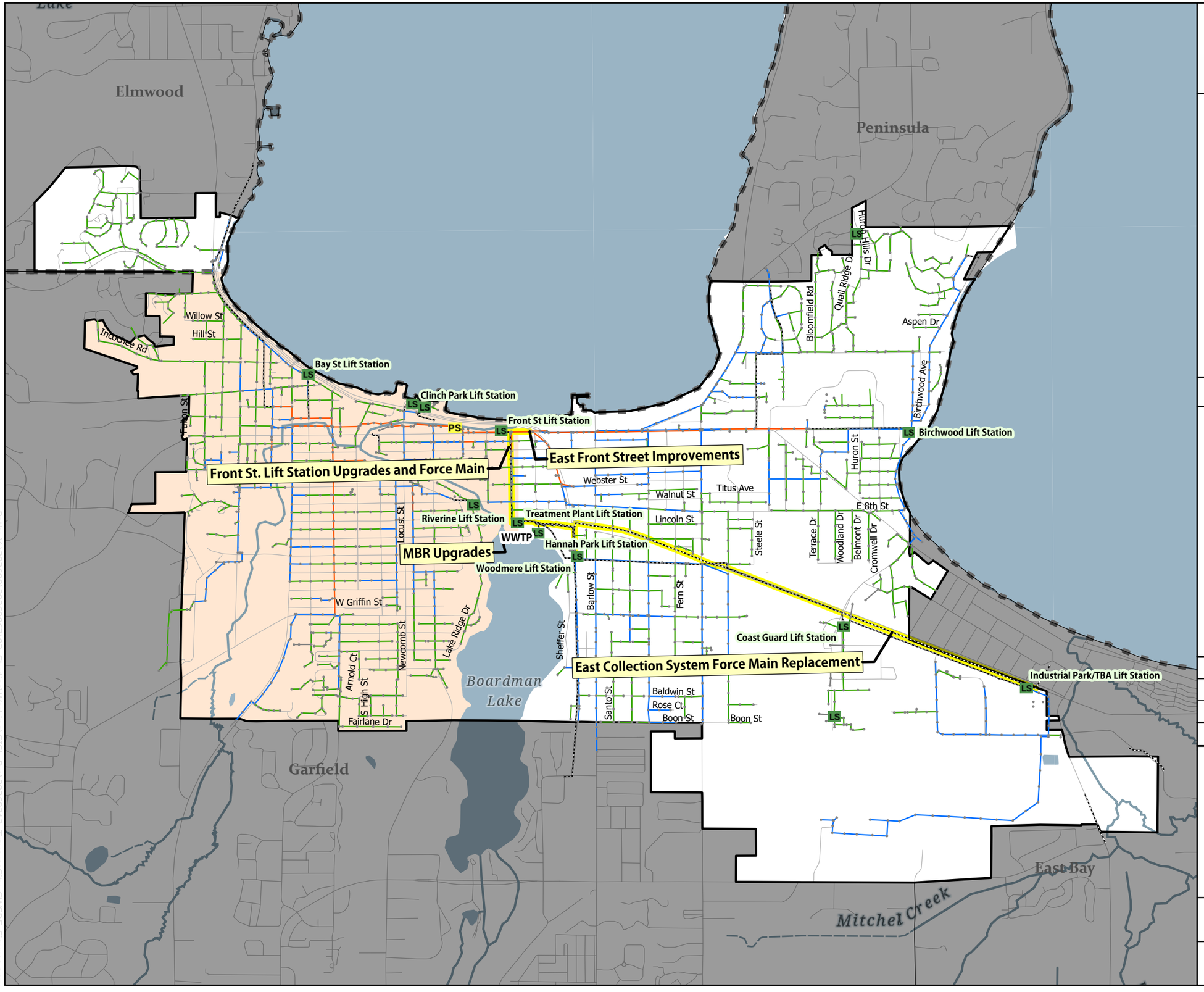
In the development of the wastewater AMP and SSES, sanitary sewers and manholes were inspected per the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) and Manhole Assessment Certification Program (MACP) grading systems. Rehabilitation will address sewer segments and manholes with at least one PACP or MACP defect rating of 4 or 5 will be addressed. This project would be targeted for implementation over multiple years.

3.4 Front Street Lift Station and Forcemain Upgrade

The Front Street Lift Station discharges to a 16-inch cast-iron force main. This pipe is more than 90 years old and is incurring high friction losses due to age and condition. Recommended in 2022 Tetra Tech lift station engineering analysis, it is recommended to replace the entire existing 16-inch force main with 20-inch diameter pipe. The forcemain replacement should include the addition of a magnetic flow meter, which could be located in a vault downstream of the station. Final design of the dry pit pumps would be determined with the forcemain replacement. The existing stand-by pumping arrangement and stand-by power generator are adequate.

The proposed scope of work for the upgrades includes the following:

1. Replacement of the dry-pit pumps with dry-pit submersible pumps.
2. Replacement of piping, valves, and other ancillary equipment
3. Electrical improvements
4. Construction of additional wet well volume
5. Building and architectural improvements



CITY OF TRAVERSE CITY

HRC

HUBBELL, ROTH & CLARK, INC

CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE Suite 100
Grand Rapids, MI 49506

Phone: (616) 454-4286

WEBSITE: http://www.hrcengr.com

Legend

0 0.23 0.45 0.9 Miles

N

Sewer Force Main
- Traverse City Owned
- Owned by Others

Sewer Gravity Main
- 4" - 8"
- 9" - 15"
- 16" - 36"
- Unk. Diameter
- Sanitary Manhole

- LS Lift Station
- PS Pump Station
- Traverse City Boundary
- Outside City Limits
- County Boundary
- Roads
- Sewer Rehabilitation Project Area
- Proposed Improvement

DRAWN: KLH CHECKED: DIU

CWSRF Project Plan
City of Traverse City
Proposed
CWSRF Projects

HRC Job No. 20260067

SCALE: AS SHOWN

May 2026

FIGURE 3.1

Path: Y:\20260012\20260067\03_Studies\Working\GIS_Pro\20260012_TraverseCity_CWSRF_Figures.aprx

3.5 WWTP Membrane Bioreactor Enclosure

The existing membrane bioreactor equipment is in tanks and the equipment is exposed to the environment. Enclosing the membrane decks will eliminate the risk associated with cold weather operations and maintenance and will allow for membrane maintenance to be conducted year round. The membranes should not be subjected to freezing temperatures. This project will include enclosing the MBR tanks with a pre-engineer metal building or similar structure, HVAC to condition the space, and replacement of the existing trolley crane to fit within the enclosed space. Additional structural improvements may be required such as new columns and footings to support the enclosure and crane.

Photo of Existing Membrane Bioreactor (background) to be Enclosed

3.6 East Collection System Force Main Replacements

The force mains from the City's East Collection System from the Coast Guard Lift Station are reaching the end of their service life and need to be replaced to prevent potential breaks. This project includes the replacement of approximately 7,500 linear feet of 12-inch force main from Coast Guard LS to Woodmere LS. The work will include the associated interconnections to the associated lift stations.

3.7 WWTP Odor Control Improvements

All the influent flows to the WWTP are all pumped via force mains. Wastewater in the force mains generates increased levels of odor causing gases such as hydrogen sulfide due to the anaerobic condition of the force mains. The existing activated carbon odor control system is reaching the end of its service life and needs to be replaced. This project will include the recommendations based on an engineering evaluation of the odor control options. The odor control system may include activated carbon, biological filters, scrubbing, or other odor control removal technologies. Included in this project is the associated equipment pad, odor control ducts, as well as the required electrical and controls upgrades for reliable odor control operation.

3.8 East Front Sewer Improvements

Most of the 24-inch and 18-inch sewers in Front Street both east and west of the Front Street Lift Station have been CIPP lined or replaced to address infiltration and inflow issues as well as structural defects. However, two sections of 24-inch concrete sewer constructed in the 1940s should be rehabilitated. Additionally, older leaking sewer laterals

continue to contribute to high dry weather flows as a result of the increased groundwater levels and high-water levels of Grand Traverse Bay (Lake Michigan).

This alternative includes 720 feet of 24-inch sewer lining, and 40 lateral replacements subject to high infiltration and inflow in East Front Street. Infiltration from the leaking laterals will be removed as a result of this project. This project would be completed in concurrence with the Front Street Streetscape project.

3.9 WWTP Anaerobic Digester 4 Rehabilitation and Improvements

This 50-ft diameter digester is used for gas-holding during the digestion process. Due to the age of this concrete tank and cover equipment, the existing floating cover and gas mixing system will be replaced with a new cover for gas holding cover and mixing system as well as other associated gas safety equipment. The existing biogas and sludge piping will also be replaced with this project. The digester walls will be rehabilitated using crack and spall repair methods and then coated to prevent future degradation of the concrete.

Photo of Existing Digester 4 Cover and Mixing to be replaced

Replacement of the cover will improve the gas holding and provide better use of the biogas generated (lower carbon footprint) and used in the WWTP's biogas boiler.

3.10 Cost of Alternatives

The costs of the improvements detailed above are shown in Table 3-1 by Fiscal Year.

3.11 Impacts of Alternatives

The improvements listed in the above projects are a combination of work at the Wastewater Treatment Plant (WWTP) and Collection System. The long and short-term impacts of the alternatives are described in Section 5.

Table 3-1. Summary of CWSRF Projects (by Fiscal Year)

	Projects	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
1	Sanitary Sewer and Manhole Rehabilitation	$3,963,000				
2	Front Street LS and Force Main	$5,930,000				
3	WWTP MBR Enclosure		$4,140,000			
4	East Collection System and Force Main Replacements			$5,690,000		
5	WWTP Odor Control Improvements				$1,730,000	
6	East Front Sewer Improvements					$874,000
7	WWTP Anaerobic Digester Improvements					$4,480,000
	Total FY Project Cost	**$9,893,000**	**$4,140,000**	**$5,690,000**	**$1,730,000**	**$5,354,000**
	Total SRF Projects Cost	**$26,807,000**				

4 Selected Alternatives

4.1 Proposed Facilities

The following projects noted in Table 4-1 are proposed under this CWSRF Project Plan.

Table 4-1. Fiscal Year of CWSRF Projects

Project	Fiscal Year
Front St LS and Forcemain	2027
Sanitary Sewer Rehabilitation	2027
WWTP MBR Enclosure	2028
East Collection System and Force Main Replacements	2029
WWTP Odor Control Improvements	2030
East Front Sewer Improvements	2031
WWTP Anaerobic Digester Improvements	2031

The projects proposed in this Project Plan will begin construction within the next year starting the 2027 fiscal year. It is anticipated that these projects will encompass the needed capital improvements over the next 20-year period. Project locations, including the extents of disturbance, for all projects, have been included in Figure 3.1 for a WWTP and Collection System projects overview. Detailed cost estimates for each project have been included in Appendix F.

4.2 Proposed Schedule

Table 4-2 below shows the completed CWSRF Project Plan submittal task dates.

Table 4-2. CWSRF Project Plan Task Schedule

Project Plan Task	Scheduled Date
Submit Draft Project Plan to EGLE	April 1, 2026
Public Hearing Notice	April 5, 2026
Place Draft Project Plan on Public Records	April 5, 2026
Formal Public Hearing	April 20, 2026
City Commission Resolution of Project Plan Adoption	April 20, 2026
Submit Final Project Plan to EGLE	May 1, 2026

4.3 Cost Estimate

The estimated total project cost for the proposed project is $26,805,000. A cost summary for the wastewater collection system improvements and a detailed opinion of probable project cost for the WWTP improvements are both shown in Appendix F.

4.4 User Costs and Cost Sharing

The estimated costs for all proposed projects and fiscal years are presented below. Table 4-3 presents a summary of the estimated user costs by Fiscal year. The total cost impact of the project is estimated at $9.42 per residential connection per month.

Table 4-3. Estimated User Cost Summary by Phase

Descriptions	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
Total Phase Project Cost	$9,893,000	$4,140,000	$5,690,000	$1,730,000	$5,354,000
Interest Rate	3.0%	3.0%	3.0%	3.0%	3.0%
Term (years)	20	20	20	20	20
No. of Residential Connections	14,350	14,350	14,350	14,350	14,350
Total Annual Debt Repayment	$665,000	$278,300	$382,500	$116,300	$359,900
Total Annual Debt Repayment (Residential)	$598,500	$250,470	$344,250	$104,670	$323,910
Total Monthly Cost of Project per Resident	$3.48	$1.45	$2.00	$0.61	$1.88
Total Cost of Loan	$13,300,000	$5,566,000	$7,650,000	$2,326,000	$7,198,000
Interest Paid	$3,407,000	$1,426,000	$1,960,000	$596,000	$1,844,000

Notes:

1.Assumes interest rate of 3.0%
2.Assumes 90% residential contribution to fund
3.As of April 2026, 6,261 residential connections in Traverse City and an estimated 8,089 residential connections from Townships

4.5 Authority to Implement Selected Alternative

Implementation of the proposed project assumes that the project will be financed by a low-interest loan from the SRF program. The City of Traverse City has the necessary legal, institutional, financial, and managerial resources available to ensure the construction, operation, and maintenance of the proposed facilities.

5 Fiscal Sustainability Plan

A fiscal sustainability plan will be developed for those facilities which are installed, replaced, or rehabilitated under this project. This will be done by building on the Plant's existing asset management plan. The City's asset inventory is a key part of its asset management plan and is provided in Appendix E.

The existing asset registry will be updated with information on facilities impacted by the project. Data for existing equipment will be updated with new model numbers and rehabilitation dates. The new equipment will be added to the inventory. At the conclusion of the projects, the inventory will be fully updated to accurately reflect the equipment that is currently installed at the site.

Condition and performance data will be updated as well. New pumps and blowers will have their duty points recorded during startup. This will provide a benchmark to judge future performance by. Other critical mechanical equipment will have data such as full load amp draws recorded for this purpose as well. Condition information for existing items will be updated to reflect any rehabilitation work that was completed.

Useful life estimates will be updated for rehabilitated assets and solicited from manufacturers of newly installed assets. These estimates will be used to plan for future service and replacement costs. Operations and Maintenance manuals will be provided for all new equipment, along with onsite training. This will ensure that Plant staff have the knowledge necessary to perform maintenance and repairs. Water and energy conservation efforts will be implemented as a part of the fiscal sustainability plan as well.

6 Environmental Impacts

6.1 General

The anticipated environmental impacts resulting from the construction of the selected plan include beneficial & adverse, short-term & long-term, and irreversible impacts. The following is a discussion of the environmental impacts of the selected plan.

6.1.1 Beneficial and Adverse Impacts

The Traverse City Regional Wastewater Treatment Plant (TCRWWTP) is the City of Traverse City's municipal wastewater treatment facility. The TCRWWTP provides treatment to all industrial, commercial, and domestic (residential) wastewater. Wastewater from homes, businesses, and industries is pumped from two pump stations and nine lift stations to the head of the TCRWWTP for treatment in accordance with its NPDES permit with subsequent discharge to the Boardman River. Without the diligent work of TCRWWTP employees to operate and maintain the facilities, the polluted water (sewage) would be discharged into the Boardman River, Boardman Lake, Kids Creek, and the Grand Traverse Bay.

Construction activities associated with the proposed improvements will take place on the existing facilities. Construction and equipment manufacturing-related jobs would be generated, and local contractors would have an equal opportunity to bid on the construction contracts.

Implementation of the Project Plan would create temporary disruption due to required construction. This includes noise & dust generated by the work and possible erosion of spoils from open excavation. The assessment of alternate solutions and sites for the proposed project included identification of any important resources of either historic or environmental value which are protected by law and should be avoided. No registered contamination sites were found within the project area using the EGLE site contamination online mapper tool. Documentation of the research and results can be found in Appendix A.

6.1.2 Short-Term and Long-Term Impacts

The short-term adverse impacts associated with construction activities would be minimal, and mitigatable, in comparison to the resulting long-term beneficial impacts. Short-term impacts include traffic disruption, dust, noise, and temporary partial enclosures. No long-term negative impacts are anticipated.

The long-term positive impacts include improved efficiency at the plant, increased treating capacity, decreased complaints of odor, and the ability to continue providing adequate treatment to protect water quality. These impacts also include improved processing at the plant and reduced wear on the plant equipment.

6.1.3 Irreversible Impacts

The investment in non-recoverable resources committed to the Project Plan would be traded off for the improved performance of the facilities during the life of the system. The commitment of resources includes public capital, energy, labor, and unsalvageable materials. These non-recoverable resources would be foregone for the provision of the proposed improvements.

Construction accidents associated with this project may cause irreversible bodily injuries or death. Accidents may also cause damage to or destruction of equipment and other resources.

6.2 Analysis of Impacts

6.2.1 Direct Impacts

Local Air Quality

There will be minimal direct impacts on local air quality during the construction phases of these projects. Any effects on air quality will be due to dust and emissions from construction equipment and minimal possible styrene emissions from the CIPP curing material.

Archeological, Historical, or Cultural Resources

There are no impacts on archaeological, tribal, historical, or cultural resources due to this project.

Impacts Upon the Existing or Future Quality of Local Groundwater and Surface Waters

Construction will occur on the WWTP site, which is on the north shoreline of Boardman Lake and adjacent to the Boardman River. Additionally, work will take place within the connections systems through Grand Traverse County, the City of Traverse City, and the associated Township: Bair, Acme, East Bay, Elmwood, Garfield, and Peninsula. No impact will be made to the River, but appropriate measures will be taken during construction to avoid impact to these neighboring bodies of water. All necessary permits will be obtained before the proposed activities. There are no impacts anticipated to the local groundwater.

A detailed topographical survey will be conducted before construction to determine if the floodplain will be impacted by the project where construction of the oxidation tank will take place. All other construction and improvements will be made within existing facilities

Impacts Upon Sensitive Features

Since the work is expected to take place within the existing wastewater collection system facilities, the construction will take place outside of the designated floodplain, wetland areas, or other sensitive areas. Any work that takes place within floodplain limits, proper mitigation measures, and permits will be obtained before the proposed activities.

Impacts Upon People and The Local Economy

Short-term impacts on people will occur during the construction phase. Increased construction traffic will occur in the localized project areas of the connection system. All sanitary sewer users will experience beneficial long-term impacts due to the level of service to which they expect to be maintained by these improvements. The local economy will be stimulated for contractors and suppliers of the materials, labor, and equipment necessary to construct the project.

Operational Impacts

The proposed project will improve the operational efficiency of the WWTP and lower future operation and maintenance (O&M) costs for the wastewater collection system.

6.2.1 Indirect Impacts

Changes in Rate, Density, Or Type of Residential, Commercial, or Industrial Development and the Associated Transportation Changes

No changes are anticipated to the above.

Changes in Land Use

No changes are anticipated to the above. All improvements to the WWTP and the wastewater collection system will be completed on the existing WWTP site and to existing system structures.

Changes in Air or Water Quality Due to Facilitated Development

There will be no changes to air quality due to development. The proposed work will decrease the amount of total suspended solids discharged to the Boardman River during wet weather events, improving the water quality of the effluent to the river.

Changes to The Natural Setting or Sensitive Features Resulting from Secondary Growth

There should be no changes to the natural setting or sensitive features resulting from secondary growth.

Impacts on Cultural, Human, Social and Economic Resources

No changes are anticipated to the above.

Impacts of Area Aesthetics

All the proposed WWTP work will be completed on the existing sites which are largely isolated from public view.

Resource Consumption Over the Useful Life of the Treatment Works, Especially the Generation of Solid Wastes

No changes are anticipated to the above.

6.2.1 Cumulative Impacts

Siltation

Siltation may occur during the construction phase of the project. Proper soil erosion and sedimentation control practices will be followed to reduce the impacts of siltation on surrounding areas.

Water Quality Impacts from Direct Discharges and Non-Point Sources

The proposed work will decrease the amount of total suspended solids and biological solids discharged to the Boardman River during SSOs caused by wet weather events, improving the water quality of the effluent to the river.

Indirect Impacts from Development

There should be no impacts on development as a result of this project.

The Impacts from Multiple Public Works Projects Occurring in the Same Vicinity

There will only be short-term traffic impacts during the construction phase of this project and proper traffic control measures will be followed.

7 Mitigation

7.1 Short-Term, Construction Related Mitigation

Environmental disruption will occur during construction. Guidelines will be established for cover vegetation removal, dust control, traffic control, and accident prevention. Once construction is completed those short-term effects will stop and the area will be returned to the original conditions.

The soil erosion impact would be mitigated through the contractor's required compliance with a program for control of soil erosion and sedimentation as specified in Part 91 of Michigan Act 451, P.A. of 1994. The use of soil erosion and sedimentation controls (i.e., straw bales, sedimentation basins, catch basin inserts, silt fencing, etc.) will protect the Boardman River, Boardman Lake, Kids Creek, and the Grand Traverse Bay.

Careful considerations will be taken during the construction planning process to ensure that the plant remains in service while the improvements are underway. Construction equipment will be maintained in good condition to decrease noise. All access roads will be swept as necessary to avoid tracking sediment onto public roads.

7.2 Mitigation of Long-Term Impacts

General construction activities will prohibit the disposal of soil in wetlands, floodplains, or other sensitive areas. Catch basins will be protected where earthwork activities will take place.

7.3 Mitigation of Indirect Impacts

The current trend in Grand Traverse County and the City of Traverse City is that the land use is largely dominated by residential properties. According to the City of Traverse City's master planning for land use, this will not change. Considering that a vast majority of the residents within the City limits are connected to the wastewater system, a substantial increase in flow is not expected from within the City limits.

The City of Traverse City's Master Plan and ordinances can also be found on their websites.

8 Public Participation

8.1 General

The Project Plan was advertised in the local newspaper April 3, 2026 (refer to Appendix F for all public participation documentation.) A copy of the Project Plan was placed at the following location for review:

- City Hall
- Online at the City of Traverse City's Website

A formal public hearing was held on April 20, 2026, to review the work associated with the proposed Project Plan. The hearing reviewed the information presented in the Project Plan, including estimated user costs, and received comments and views of interested persons. Copies of correspondence related to agency notifications, as well as other relevant correspondence, will also be included in Appendix F.

8.2 Public Hearing

Appendix H includes a transcribed copy of the public hearing, commission members attendance list, the Project Plan resolution, and a photocopy of the slides presented at the hearing. No comments were received.

8.3 Resolution

The City Commission made a formal resolution regarding this Plan at a Commission meeting following the public hearing scheduled for April 20, 2026. The resolution is included in Appendix G.

APPENDIX A: AGENCY CORRESPONDANCE

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 16, 2026

NESHAP Asbestos Program
Department of Environment, Great Lakes & Energy – Air Quality Division
P.O. Box 30260
Lansing, MI 48909-7760

Attn: Mr. Shane Nixon, Program Manager

Re: Impact Review
Wastewater Improvements Program
City of Traverse City, Michigan

HRC Job No. 2060067

Dear Mr. Nixon:

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project plan requires a review to determine any potential impacts due to removal of building materials containing asbestos in the vicinity of the project.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

Since the proposed project does not plan for the removal of any building materials containing asbestos, no impacts are expected from the proposed project upon any NESHAP regulations. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause an impact to NESHAP regulations in the project vicinity.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines. If you have any questions or require any additional information, please contact the undersigned.

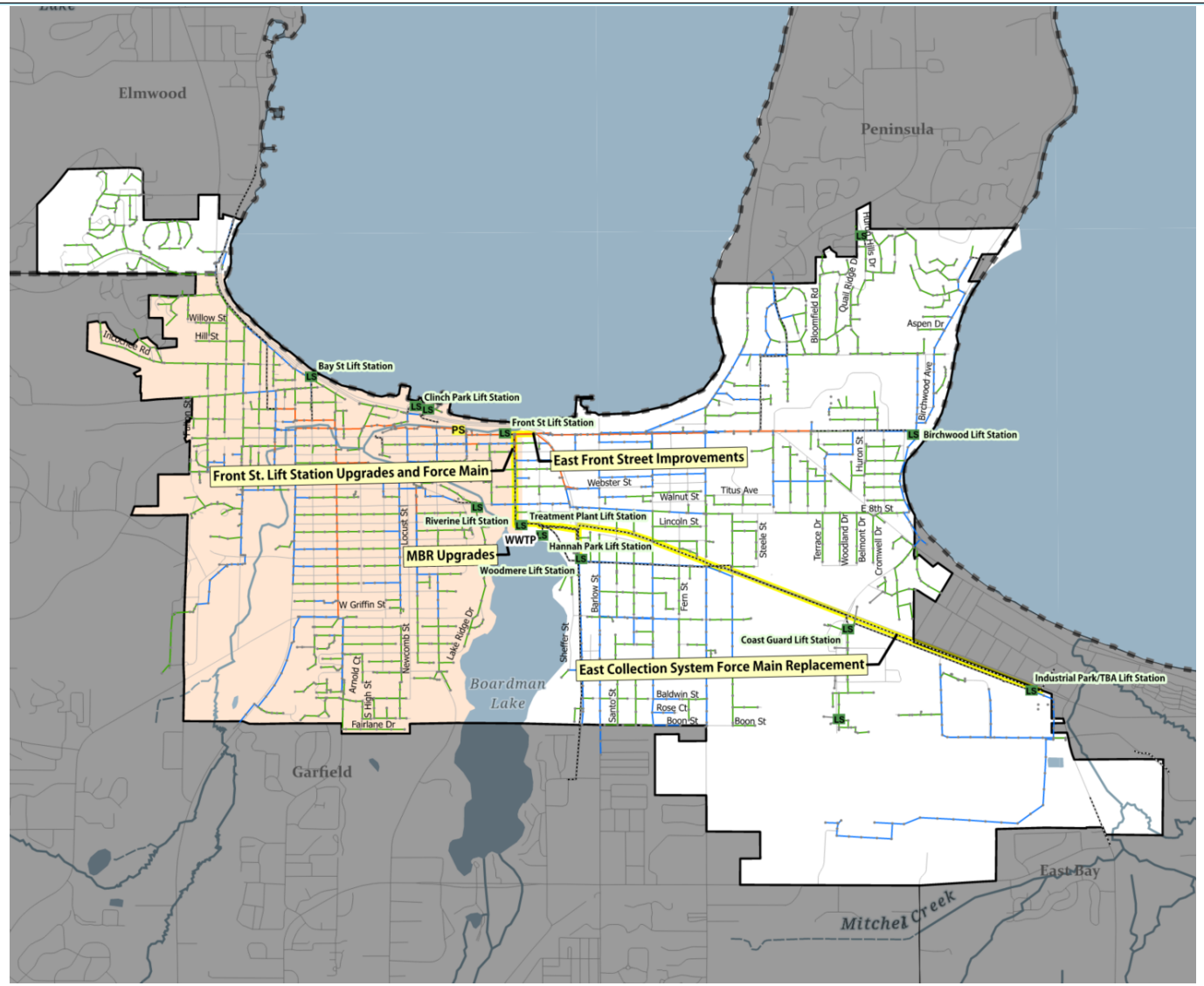
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachment
Project Map



HRC

Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 16, 2026

Michigan Department of Environment, Great Lakes, & Energy
Office of Waste Management and Radiological Protection Division
P.O. Box 30473
Lansing, MI 48909-7973

Re: Impact Review
Wastewater Improvements Program
City of Traverse City, Michigan

HRC Job No. 20260067

To Whom it May Concern:

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project plan requires a review to determine any potential impacts due to the disposal of waste materials in accordance with Michigan's Natural Resources and Environmental Protection Act (NREPA) as a result of the project.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

The proposed project involves replacement of existing facilities. No removal or disposal of building materials which contain lead, mercury, PCBs, or similar contaminants is expected. There may be existing facilities that were constructed during a period when lead paint was being used. However, in any case contaminants are discovered on the premises during construction, precaution and proper disposal will be implemented to follow regulations. We are requesting a review to confirm that the above referenced project will not impact Part 111, Part 115, or Part 121 of the NREPA.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines. If you have any questions or require any additional information, please contact the undersigned.

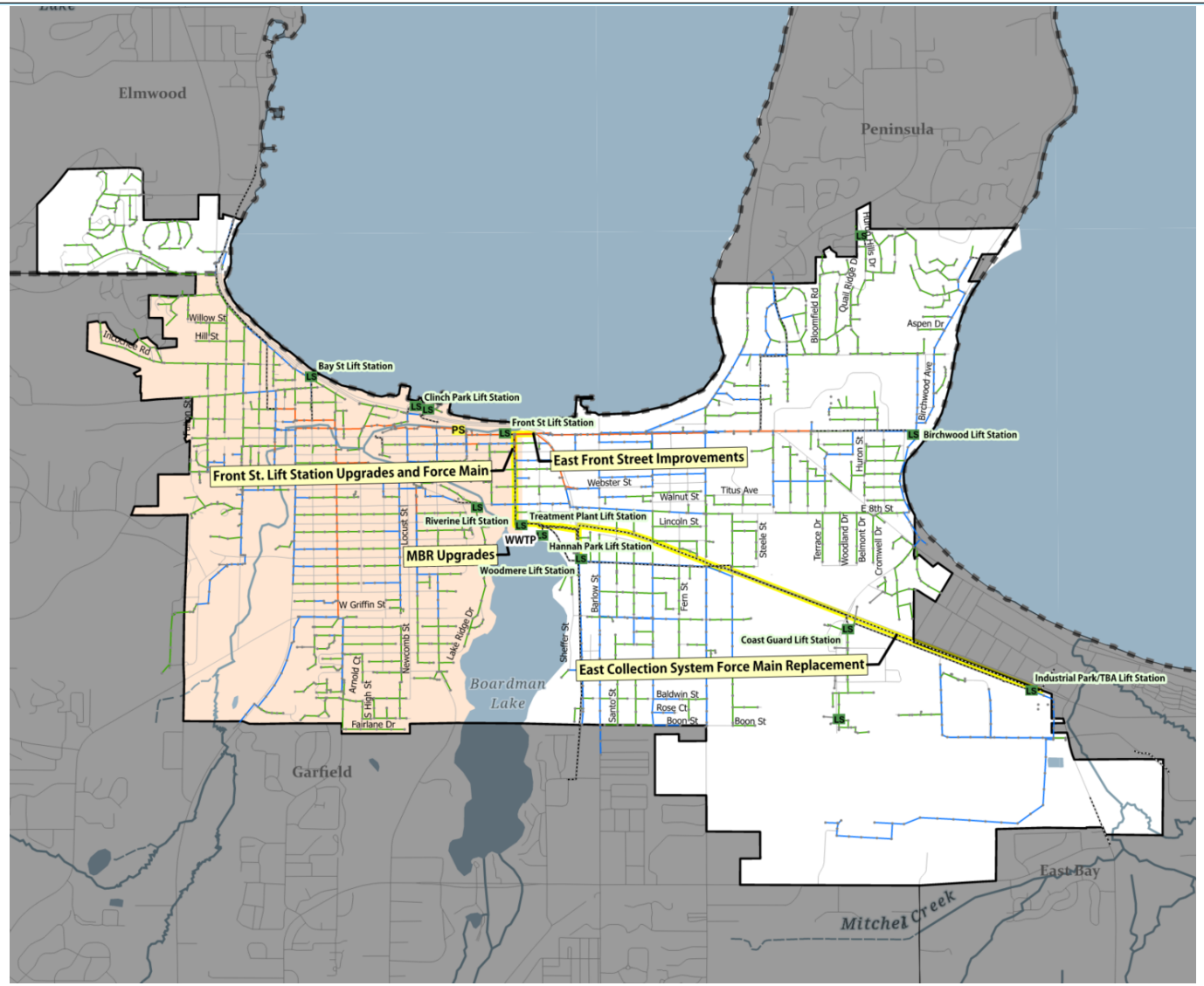
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachment
Project Map
EGLE RRD Listed Facilities Map



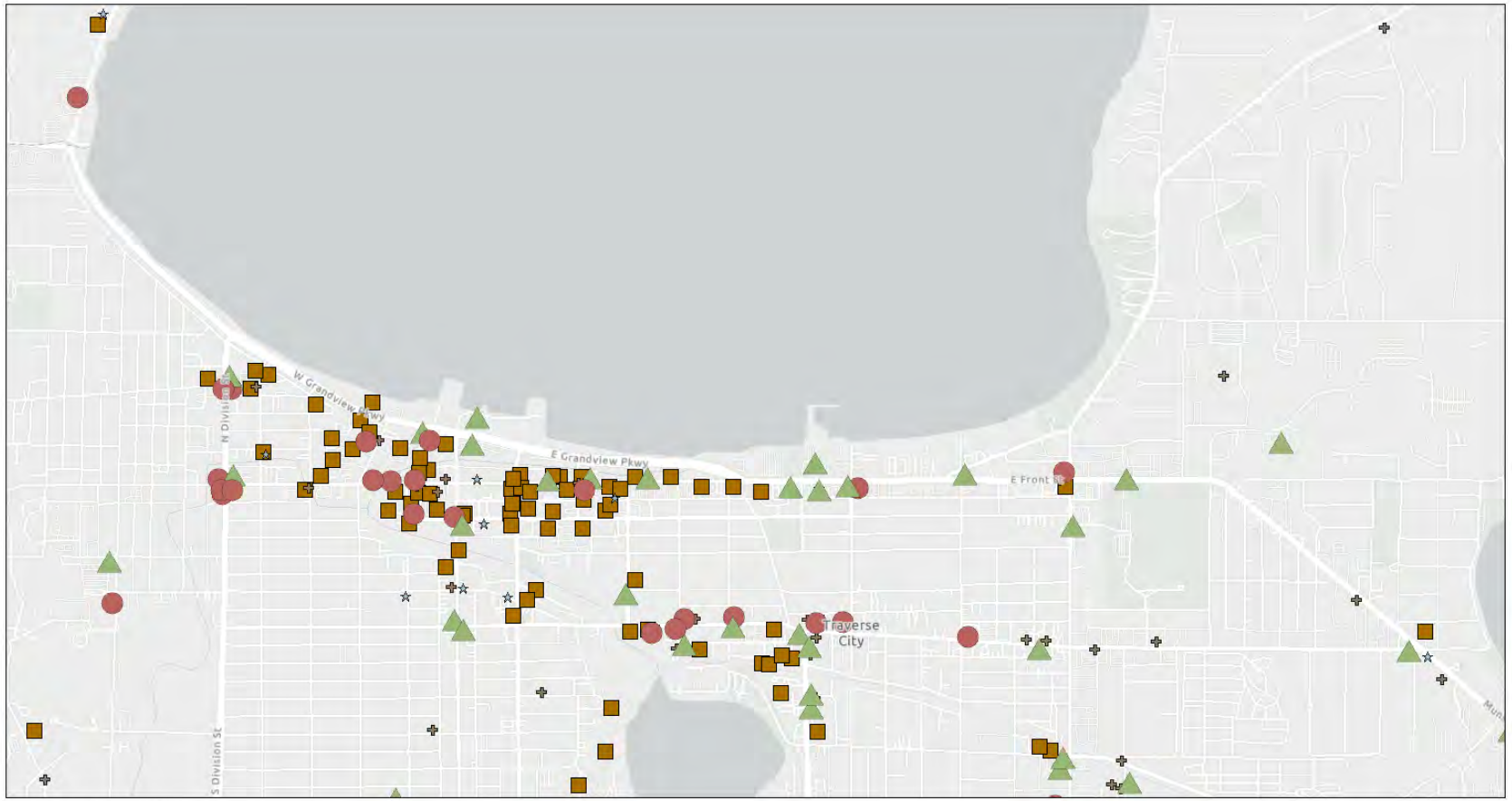
HRC

Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1



HRC

Traverse City Wastewater Improvements

EGLE RRD Listed Facilities Map

Date
3/6/2026

Figure No.
2

Covault, Brittany R.

From: Bott, Kevin (EGLE) <BottK@michigan.gov>
Sent: Tuesday, March 24, 2026 8:34 AM
To: Covault, Brittany R.
Cc: Tyson, Kimberly (EGLE); Vincent, Nicole (EGLE); Nixon, Shane (EGLE); Bragg, Justin (EGLE)
Subject: FW: City of Traverse City - CWSRF
Attachments: HazardousWaste_CoverLetter.pdf

Brittany,

Thank you for reaching out regarding the City of Traverse City CWSRF work (attached). Based on the information you provided, our records indicate that the area does not appear to be a facility or part of a facility subject to cleanup requirements under Part 111 and the Part 111 rules. Please note, we cannot confirm the project will not impact Part 111, Part 115, or Part 121 as during work and digging, if any historical waste or material is discovered, it is the generator's responsibility to appropriately characterize the waste to determine the appropriate subsequent management of that waste.

Please contact EGLE's Air Quality Division (AQD) regarding how the work may impact NESHAP regulations. Shane Nixon, Supervisor for AQD's Cadillac District Office, is copied on this email, and may be able to provide additional information.

Additionally, please contact EGLE's Water Resources Division (WRD) regarding the proposed work related to the wastewater treatment plant and collection systems. Justin Bragg, Supervisor for WRD's Cadillac District Office, is also copied on this email and may be able to provide additional information .

Thank you again for reaching out. If you have any additional questions, please let us know.

Kevin W. Bott, Supervisor
Permitting and Program Support Unit
Hazardous Waste Section
Materials Management Division
Michigan Department of Environment, Great Lakes, and Energy
517-614-4079 | BottK@Michigan.gov
Michigan.gov/EGLE

From: Covault, Brittany R. <BCovault@hrcengr.com>
Sent: Monday, March 16, 2026 3:33 PM
To: Vincent, Nicole (EGLE) <VincentN1@michigan.gov>
Subject: City of Traverse City - CWSRF

CAUTION: This is an External email. Please report suspicious emails via the "Report to Abuse" button in Outlook

Good afternoon, Nicole,

Attached is a letter on behalf of the City of Traverse City requesting information regarding the impacts of the Clean Water Improvement Projects proposed for Traverse City to determine any potential impacts due to the disposal of waste materials in accordance with Michigan's Natural Resources and Environmental Protection Act (NREPA). We appreciate your review and would be grateful for a response by Monday, April 6, 2026, so that we may meet program deadlines.

Thanks,

Brittany R. Covault, E.I.T. | Senior Project Analyst
HUBBELL, ROTH & CLARK, INC
2101 Aurelius Road, Suite 2, Holt, MI 48842
O: 517-292-1936 | M: 574-520-3788

**This email originated from outside the company. Please be sure to check the sending email address and report any suspicious emails using the Phish Tool.

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 16, 2026

Networks Northwest
600 East Front Street, Suite 205
PO Box 506
Traverse City, MI 49685-0506

Re: Regional Environmental Planning Review
Wastewater Improvements Project
City of Traverse City, Michigan

HRC Job No. 20260067

To Whom It May Concern:

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project Plan requires a review to determine any potential impacts on any local development plans, area wide waste treatment management plans and/or regional water quality management plans.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

All population figures and projections referenced in the project plan will be collected from the Networks Northwest Website.

We request, on behalf of the City of Traverse City, notification if an alternative source for the population data is recommended.

Since the proposed project involves improvements to existing facilities, no impacts are expected from the proposed project upon local development plans, area wide waste treatment management plans and/or regional water quality management plans. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause an impact to any local development plans, area wide waste treatment management plans and/or regional water quality management plans.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines. If you have any questions or require any additional information, please contact the undersigned.

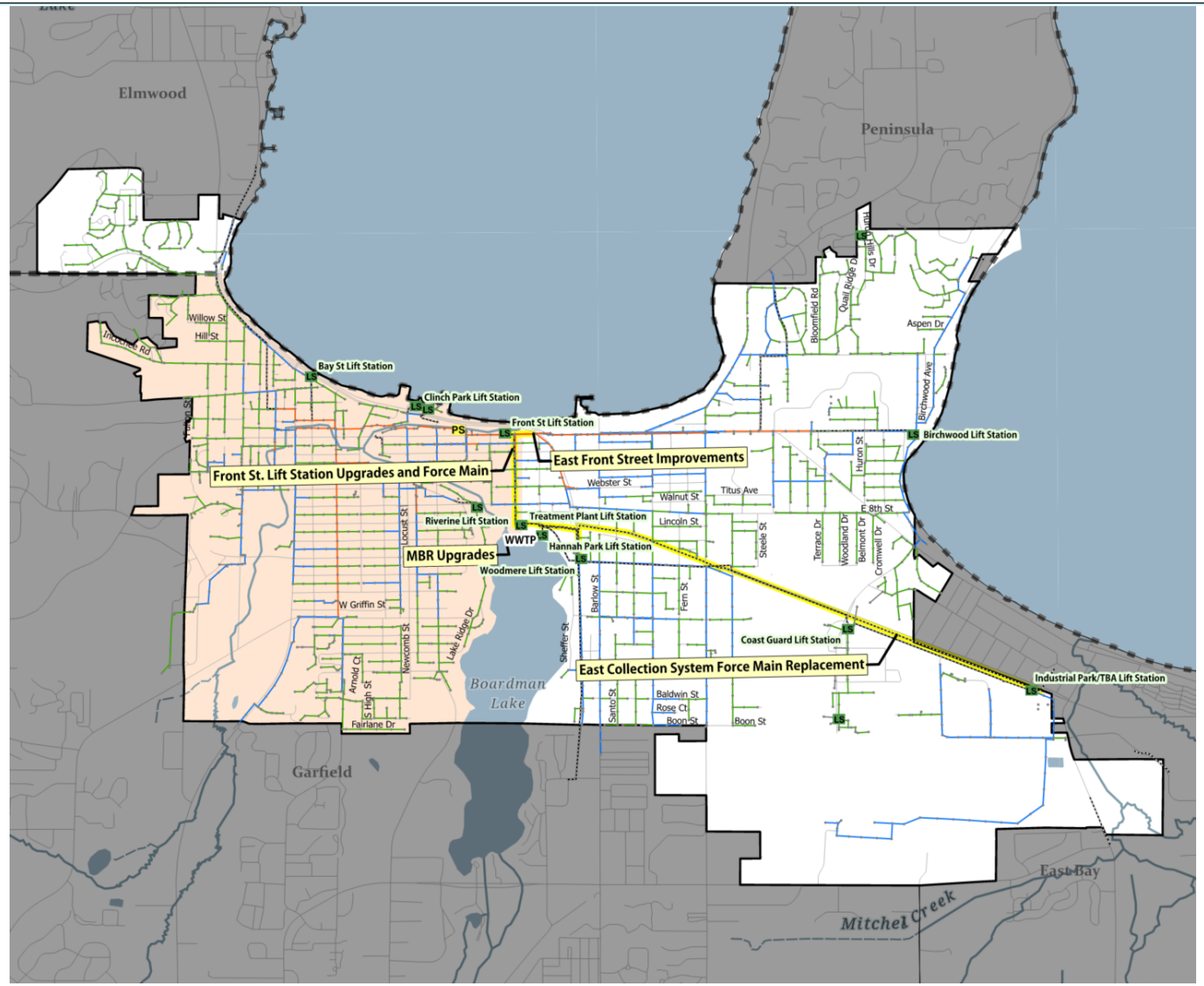
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachment
Project Map



HRC

Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1

3/20/2026

Re: Application for Traverse City, Grand Traverse County, Michigan; to the EGLE Clean Water State Revolving Fund Loan Program for Waste Water System Improvements

Michigan EGLE Application Review,

The Northwest Michigan Council of Governments (dba. Networks Northwest) has performed a review of the Project Plan by the City of Traverse City for improvements to the City's waste water system. The review has made a determination of no negative impacts on local and regional development plans, area wide waste treatment management plans and regional water quality management plans. Additionally, no impacts are anticipated above the regulatory requirements of the National Emission Standards for Hazardous Air Pollutants regulations.

The project aligns with the strategies of regional and local plans which support the maintenance and sound function of community waste water systems

All data utilized for population figures and projections as referenced for obtainment from the Networks Northwest website is supported as the best available data for our region. The data sources through our website integrated Data API and Benchmarks documents are sourced to the US Census Bureau and the Bureau of Labor Statistics.

Please reach out if there are any questions in regard to this letter of consistency.

Respectfully,

Rob Carson, A.I.C.P.
Director of Community Development
Networks Northwest
600 E. Front St., Suite 104
Traverse City, MI 49686
rob.carson@networksnorthwest.org
Cell: 231-342-1198

CC:
Brittany R. Covault, E.I.T.

Networks Northwest and Northwest Michigan Works! are supported by the State of Michigan and are proud partners of the American Job Center Network. Projects may be funded with the authorized and appropriate use of federal funds. Contact Networks Northwest for additional information. Equal opportunity employer/program. Auxiliary aids and service are available upon request to individuals with disabilities. Individuals with speech or hearing impairments may call the Michigan Relay Center by dialing 711.

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 16, 2026

Farmland Preservation Program
USDA Natural Resources Conversation Service
3001 Coolidge Road, Suite 250
East Lansing, MI 48823-6362

Re: Impact Review
Wastewater Improvements Project
City of Traverse City, Michigan

HRC Job No. 20260067

To Whom it May Concern:

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project Plan requires a review to determine any potential impacts on prime and unique farmland in the vicinity of the project.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

The proposed project site covers only urban areas, mainly zoned as single family residential or commercial. All excavated land will be restored to pre-construction condition. Since the proposed project involves improvements to existing facilities, no conversions of farmland to nonagricultural uses are expected. Please see attached map which shows a lack of existing significant farmlands in the project area. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause an impact to any significant farmland or agricultural lands in the project vicinity.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines. If you have any questions or require any additional information, please contact the undersigned.

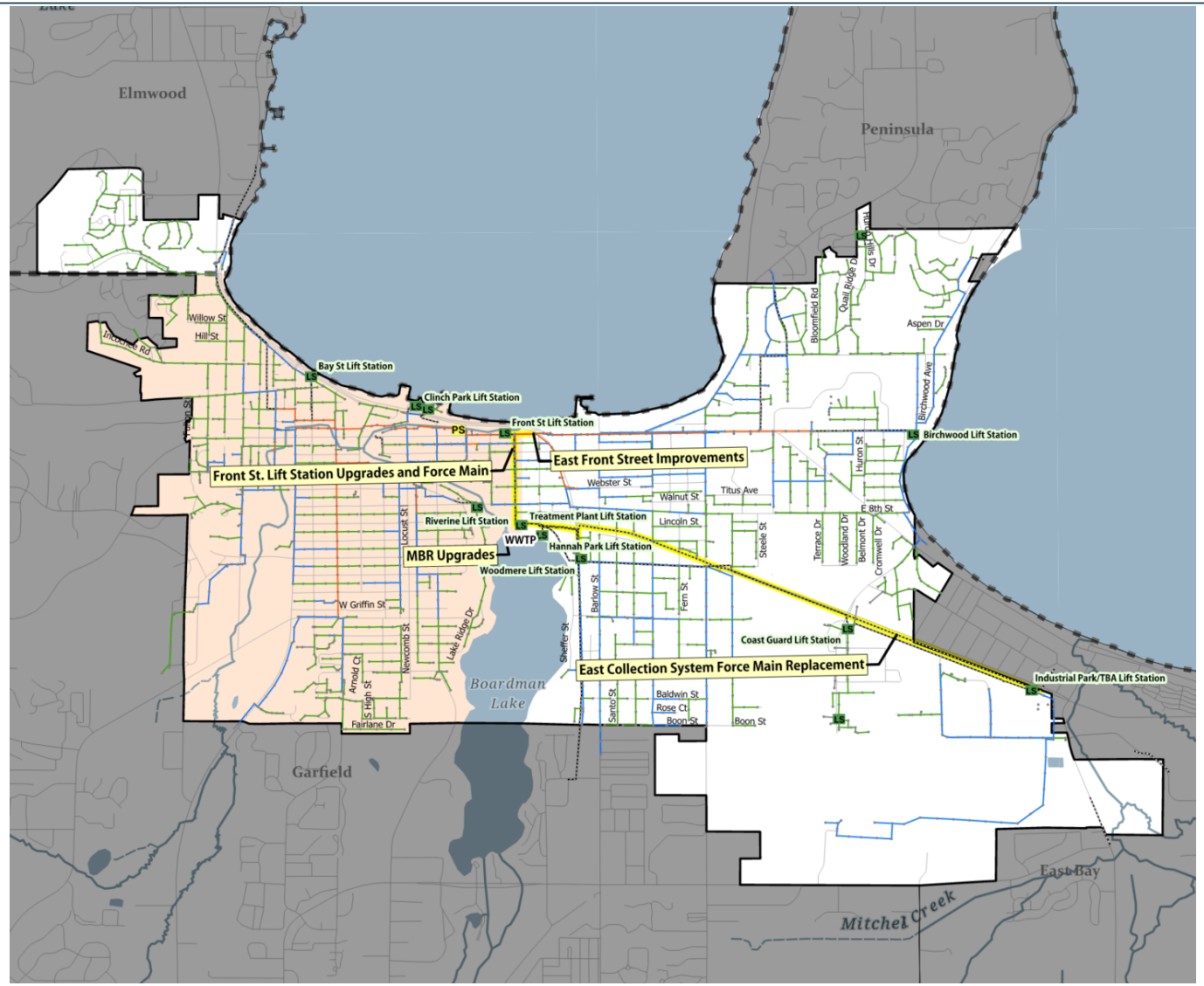
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachment
Project Map



HRC

Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 12, 2026

Michigan Department of Environment, Great Lakes, and Energy (EGLE)
Cadillac District Office
120 West Chapin Street
Cadillac, MI 49601-2158

Re: Regional Environmental Planning Review
Wastewater Improvements Program
City of Traverse City, Michigan

HRC Job No. 20260067

To Whom it May Concern:

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project plan requires a review to determine any potential impacts on land-water interfaces, including Inland Lakes and Streams, Floodplains, Wetlands, Great Lakes Shorelands, Navigable Waters and Army Corps of Engineers (ACE) Regulated Activities.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

The proposed project plan site encompasses pre-existing sewer pipeline beneath paved roadways or along bridges, as well as a brief segment through a wooded area near a residential area. In addition to this, construction will take place within the existing Wastewater Treatment Plant.

Based on the attached FEMA Floodplain Maps, it can be concluded that the portion of construction crossing the Lower Boardman River will be within the 100-year Floodplain. Because the construction will take place along the existing bridge, it is expected that the construction will not have any effect on the floodplain. All proper permits and precautions will be implemented during this construction. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause any long-term impacts to any floodplains in the project vicinity.

The proposed project locations are mainly within previously attained easements. Since the work will be primarily within existing structures in these easements, no impacts to any existing wetland areas are expected. However, if project work is required within an existing wetland, necessary mitigation measures will be undertaken to protect the wetlands influenced by the project. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause an impact to any wetlands in the project vicinity.

Since the proposed project involves improvements to existing facilities located along a shoreline or within navigable waters of the United States, no impacts are expected from the proposed project upon Great Lakes Shorelands, Navigable Waters or ACE Regulated Activities. On behalf of the City of Traverse City, we are requesting a review to confirm that the above referenced project will not cause an impact to any Great Lakes Shorelands, Navigable Waters or ACE Regulated Activities.

If not already obtained, the appropriate joint permit applications will be completed, and the necessary permits obtained prior to any construction activities in this project area.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines. If you have any questions or require any additional information, please contact the undersigned.

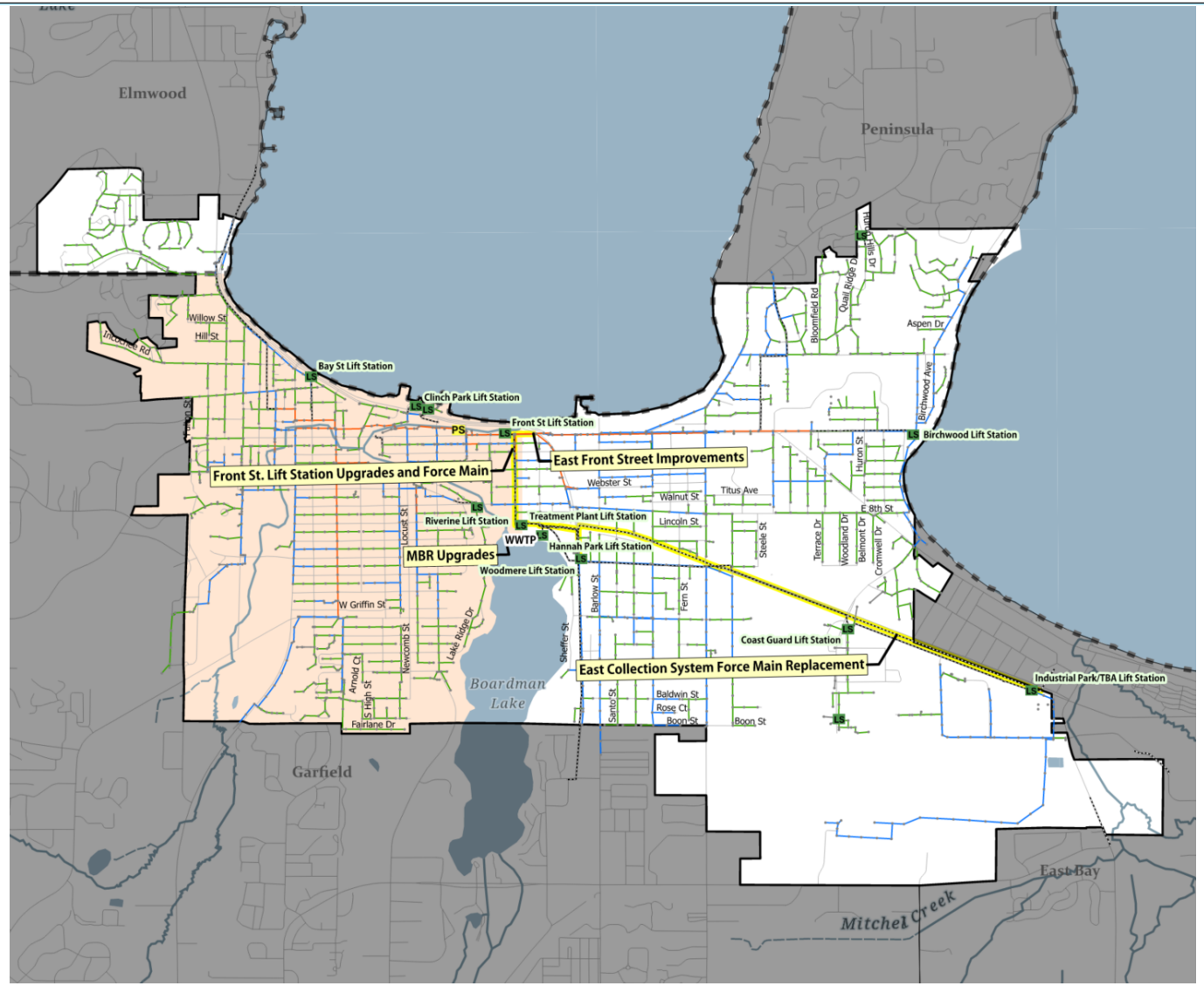
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachment
Project Map
FEMA Floodplain



HRC

Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the National Agricultural Imagery Program (NAIP). This information was photogrammetrically compiled at a scale of 1:12,000 from aerial photography dated 2007 or later.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Figure 2-6 FEMA Floodplain Map

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% Annual Chance Floodplain Boundary
	0.2% Annual Chance Floodplain Boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 — 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000mN	1000-meter Universal Transverse Mercator grid values, zone 16
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 28, 2018

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0113C

FIRM

FLOOD INSURANCE RATE MAP

GRAND TRAVERSE COUNTY, MICHIGAN (ALL JURISDICTIONS)

PANEL 113 OF 425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PENINSULA, TOWNSHIP OF	260747	0113	C
TRAVERSE CITY, CITY OF	260082	0113	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
26055C0113C
EFFECTIVE DATE
AUGUST 28, 2018

Federal Emergency Management Agency

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

1925 Breton Road SE, Suite 100
Grand Rapids, MI 49506

616-454-4286

www.hrcengr.com

March 12, 2026

Natural River Administrator
DNR Fisheries Division
PO Box 30446
Lansing, MI 48909-7946

Re: Wild and Scenic Rivers Review
Wastewater Improvements Project
City of Traverse City, Michigan

HRC Job No. 20260067

To Whom It May Concern,

The City of Traverse City is submitting a Project Plan to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for acceptance into the Clean Water State Revolving Fund (CWSRF) Loan Program. The Project Plan requires a review to determine any potential impacts on state or federally designated wild, scenic, or natural rivers or tributaries in the vicinity of the project.

On behalf of the City of Traverse City, we are requesting information regarding the impacts of the above referenced proposed project upon National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. The project work will involve the following:

- Front Street Lift Station and Forcemain Upgrades
- Sewer Rehabilitation and Replacement
- East Front Street Sewer Improvements
- East Collection System Force Main Replacement
- WWTP Membrane Upgrades

Conveyance of wastewater to the TCRWWTP is accomplished by a sanitary sewer collection system with nine lift stations. The network of collection and transmission infrastructure collects and treats wastewater from the City of Traverse City, Garfield Township, Acme Township, Blair Township, East Bay Township, Peninsula Township in Grand Traverse County and Elmwood Township in Leelanau County. The City owns and maintains its sanitary sewer collection system, which is comprised of approximately 1,902 manholes, 81 miles of sanitary sewer pipeline, 4.7 miles of public force mains, and 9 lift stations. The service area location of the WWTP that will be impacted is provided in the attached figures.

The proposed project site covers primarily commercial and residential areas. Excavations will be made in paved areas, primarily where sewer mains are preexisting. All land will be returned to pre-construction conditions.

Although the projects span the Lower Boardman River, it is not designated by any state or federally as a wild, scenic, or natural river. Additionally, any construction spanning this river will take place on the pre-existing bridge. Therefore, we are requesting on behalf of the City of Traverse City a review to confirm that the above referenced project will not cause an impact to any state or federally designated wild, scenic, or natural rivers or tributaries.

We request, on behalf of the City of Traverse City, your concurrence with this determination. We appreciate your review and would be grateful for a response as soon as possible so that we may meet program deadlines.

If you have any questions or require any additional information, please contact the undersigned.

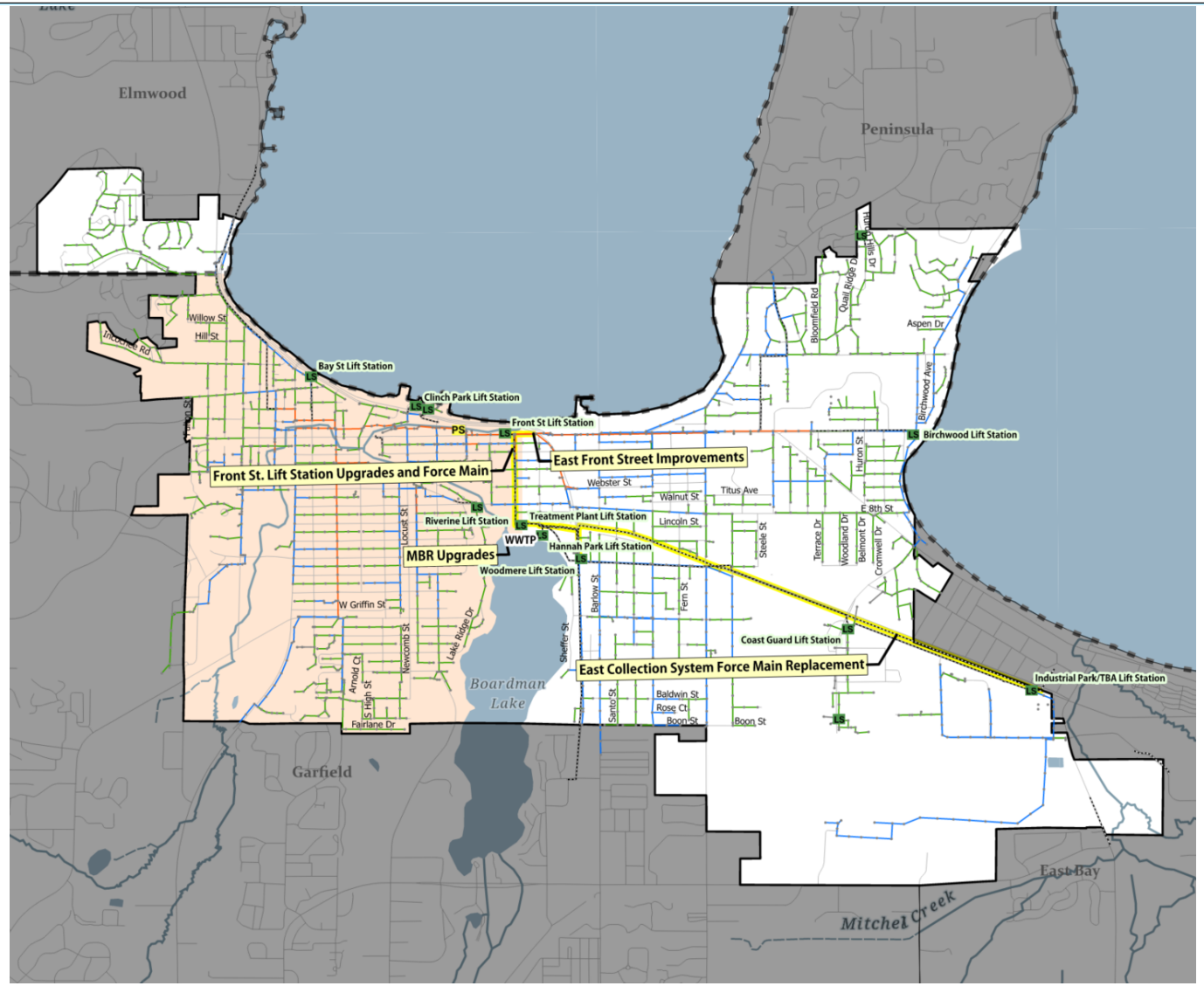
Very truly yours,

HUBBELL, ROTH & CLARK, INC.

Brittany R. Covault

Brittany R. Covault, E.I.T.
Senior Project Analyst

Attachments:
Project Map
National Wild and Scenic Rivers System with Project Location
Nationwide Rivers Inventory with Site Location



HRC

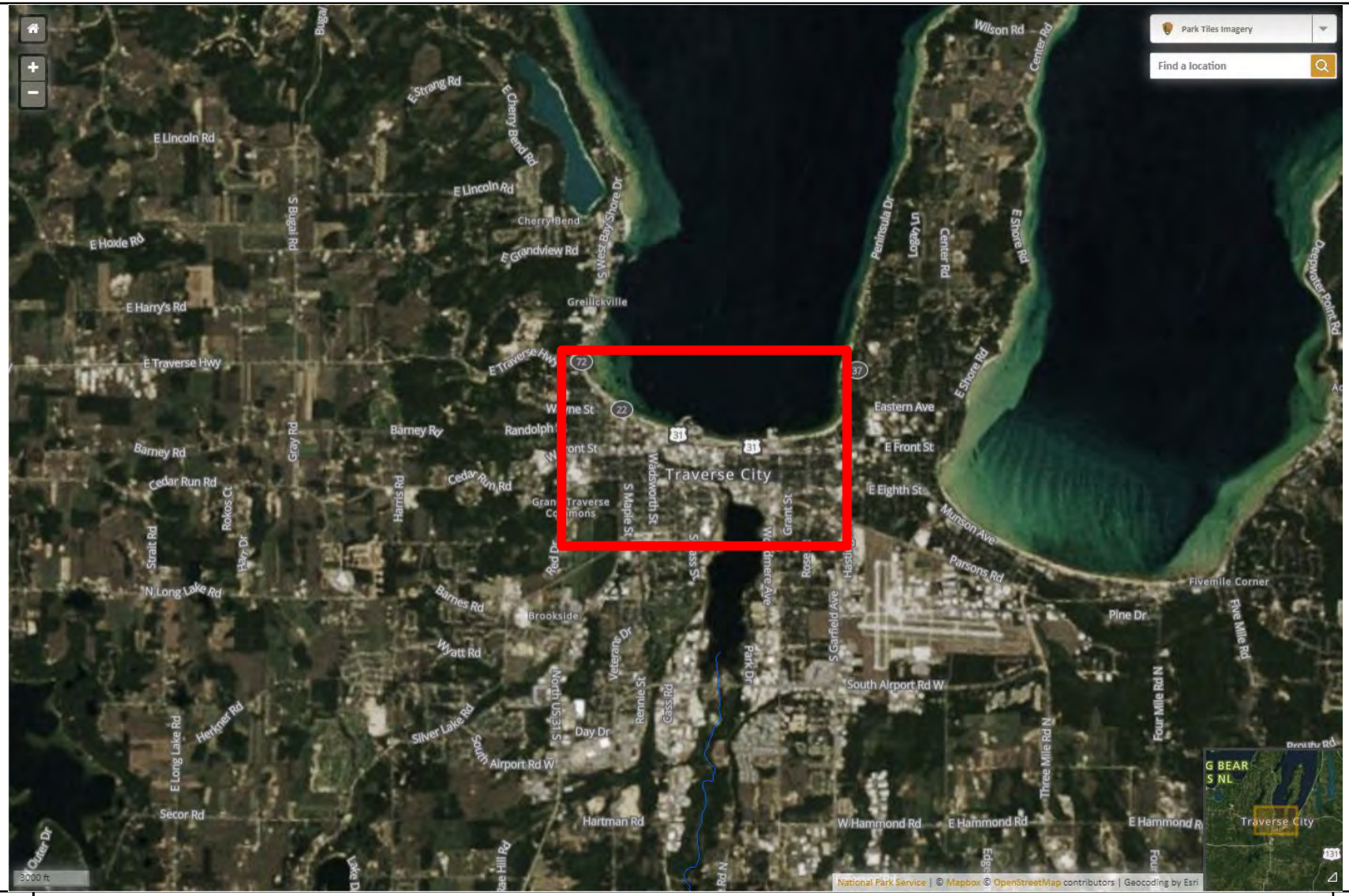
Traverse City Wastewater Improvements

Project Map

Date
3/6/2026

Figure No.
1

HRC	Wild and Scenic Rivers Review: Traverse City Sanitary Sewer Rehabilitation	
	National Wild and Scenic Rivers System with Project Location	Date 3/6/2026 Figure No. 2



Wild and Scenic Rivers Review: Traverse City Sanitary Sewer Rehabilitation

Nationwide Rivers Inventory with Site Location

Date
3/6/2026

Figure No.
3

Covault, Brittany R.

From: Heintzelman, Scott (DNR) <HeintzelmanS@michigan.gov>
Sent: Tuesday, March 17, 2026 10:51 AM
To: Covault, Brittany R.
Cc: Hettinger, Heather (DNR)
Subject: RE: City of Traverse City - CWSRF

Hello Brittany,
I have reviewed the proposed project and consulted with our local management biologist Heather Hettinger, and we concur the project will not cause an
impact to state or federally designated wild, scenic, or natural rivers or tributaries.
Thank you, and have a great day,

Scott Heintzelman
MDNR Fisheries Division
Central Lake Michigan Unit Manager
Ph. 231-433-9782 or heintzelmans@michigan.gov

From: Covault, Brittany R. <BCovault@hrcengr.com>
Sent: Thursday, March 12, 2026 3:24 PM
To: Heintzelman, Scott (DNR) <HeintzelmanS@michigan.gov>
Subject: City of Traverse City - CWSRF

CAUTION: This is an External email. Please report suspicious emails via the "Report to Abuse" button in Outlook

Good afternoon, Scott,

Attached is a letter on behalf of the City of Traverse City requesting information regarding the impacts of the Clean Water Improvement Projects proposed for Traverse City upon state or federally-designated wild, scenic, or natural rivers or tributaries. We appreciate your review and would be grateful for a response by Monday, April 6, 2026, so that we may meet program deadlines.

Thanks,

Brittany R. Covault, E.I.T. | Senior Project Analyst
HUBBELL, ROTH & CLARK, INC
2101 Aurelius Road, Suite 2, Holt, MI 48842
O: 517-292-1936 | M: 574-520-3788

**This email originated from outside the company. Please be sure to check the sending email address and report any suspicious emails using the Phish Tool.

APPENDIX B: WEB SOILS SURVEY RESULTS

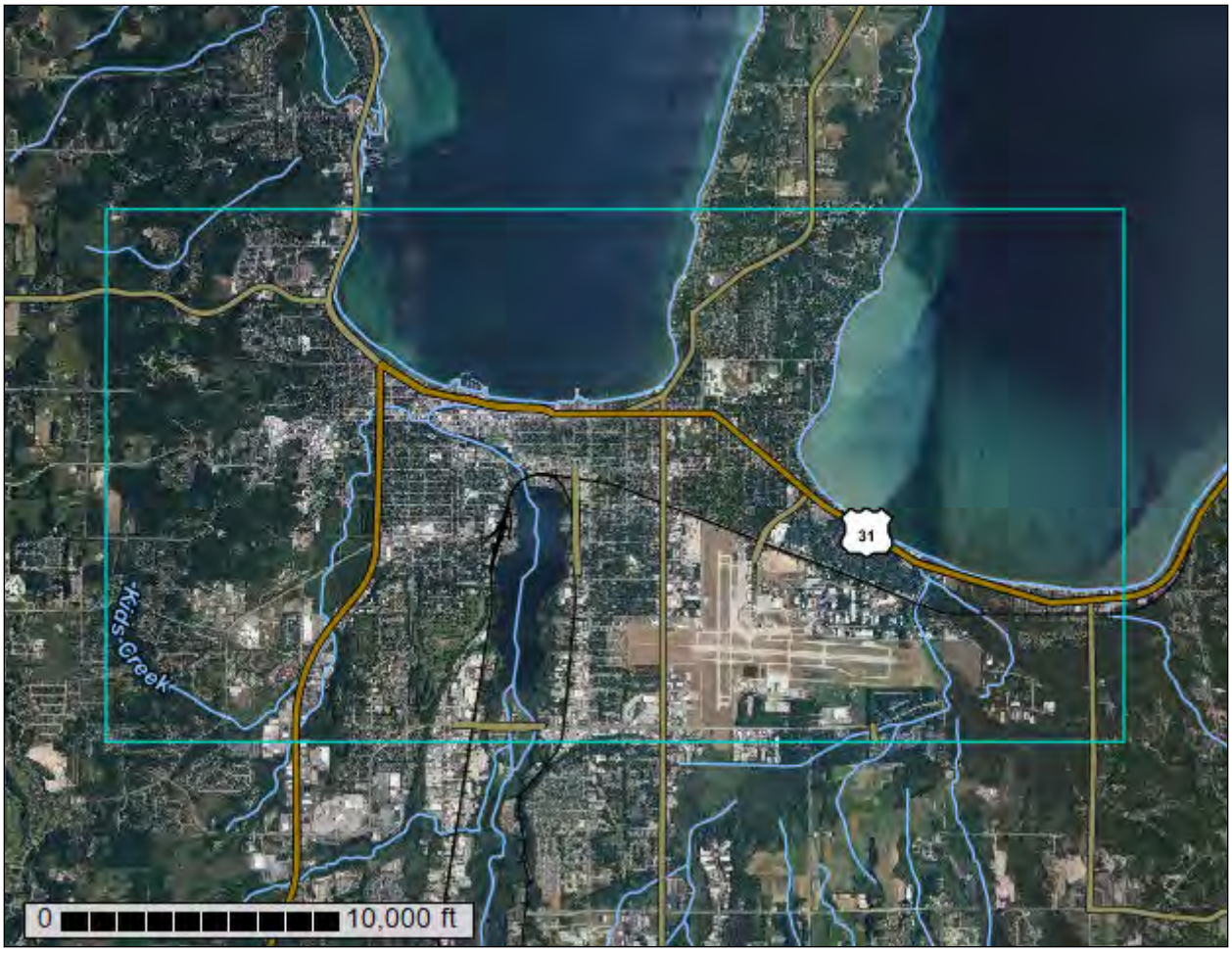
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Grand Traverse County, Michigan, and Leelanau County, Michigan



February 17, 2026

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....8
Soil Map.....11
Soil Map.....12
Legend.....13
Map Unit Legend.....15
Map Unit Descriptions.....21
Grand Traverse County, Michigan.....23
AdracA—Adrian muck, lake moderated snowy, 0 to 1 percent slopes.....23
AeA—Alpena-East Lake gravelly loamy sands, 0 to 2 percent slopes.....25
AeB—Alpena-East Lake gravelly loamy sands, 2 to 6 percent slopes.....26
AeC—Alpena-East Lake gravelly loamy sands, 6 to 12 percent slopes.....28
AsA—Au Gres-Saugatuck sands, 0 to 2 percent slopes.....30
CaraeA—Carlisle muck, lake moderated snowy, 0 to 2 percent slopes.....31
CoA—Croswell loamy sands, 0 to 2 percent slopes, overwash.....33
CoB—Croswell loamy sands, 2 to 6 percent slopes, overwash.....34
CpA—Croswell loamy sands, 0 to 2 percent slopes.....35
CpB—Croswell loamy sands, 2 to 6 percent slopes.....36
CrA—Croswell-Rubicon sands, 0 to 2 percent slopes.....37
EdwaaA—Edwards muck, lake moderated snowy, 0 to 1 percent slopes.....39
EmA—East Lake-Mancelona loamy sands, 0 to 2 percent slopes.....41
EmB—East Lake-Mancelona loamy sands, 2 to 6 percent slopes.....43
EmC—East Lake-Mancelona loamy sands, 6 to 12 percent slopes.....44
EmE—East Lake-Mancelona loamy sands, 18 to 25 percent slopes.....46
ErA—Eastport-Roscommon sands, 0 to 2 percent slopes.....48
ExA—Emmet gravelly sandy loam, 0 to 2 percent slopes.....50
ExB—Emmet gravelly sandy loam, 2 to 6 percent slopes.....51
ExC—Emmet gravelly sandy loam, 6 to 12 percent slopes.....52
ExD—Emmet gravelly sandy loam, 12 to 18 percent slopes.....53
ExD2—Emmet gravelly sandy loam, 12 to 18 percent slopes, moderately eroded.....55
ExE—Emmet gravelly sandy loam, 18 to 25 percent slopes.....56
ExE2—Emmet gravelly sandy loam, 18 to 25 percent slopes, moderately eroded.....57
ExF—Emmet gravelly sandy loam, 25 to 45 percent slopes.....58
ExF2—Emmet gravelly sandy loam, 25 to 45 percent slopes, moderately eroded.....59
EyA—Emmet sandy loam, 0 to 2 percent slopes.....60
EyB—Emmet sandy loam, 2 to 6 percent slopes.....62
EyC—Emmet sandy loam, 6 to 12 percent slopes.....63
EyC2—Emmet sandy loam, 6 to 12 percent slopes, moderately eroded.....64
EyD—Emmet sandy loam, 12 to 18 percent slopes.....65
EyD2—Emmet sandy loam, 12 to 18 percent slopes, moderately eroded.....67
EyE—Emmet sandy loam, 18 to 25 percent slopes.....68

EyE2—Emmet sandy loam, 18 to 25 percent slopes, moderately eroded.. 70
EyF—Emmet sandy loam, 25 to 45 percent slopes..... 71
EyF2—Emmet sandy loam, 25 to 45 percent slopes, moderately eroded.. 73
Fm—Fresh water marsh.....74
GrA—Gladwin-Richter gravelly sandy loams, 0 to 2 percent slopes.....75
GrB—Gladwin-Richter gravelly sandy loams, 2 to 6 percent slopes.....76
GsE—Gravelly land, moderately steep..... 78
GsF—Gravelly land, steep..... 78
Gt—Gravel pits.....78
GxA—Guelph-Nester loams, 0 to 2 percent slopes..... 78
GxB2—Guelph-Nester loams, 2 to 6 percent slopes, moderately eroded.. 80
GxC2—Guelph-Nester loams, 6 to 12 percent slopes, moderately eroded.....82
GxD2—Guelph-Nester loams, 12 to 18 percent slopes, moderately eroded.....83
GxE2—Guelph-Nester loams, 18 to 25 percent slopes, moderately eroded.....85
GxF2—Guelph-Nester loams, 25 to 35 percent slopes, moderately eroded.....87
Gy—Gullied land..... 89
HgtaaA—Houghton muck, lake moderated snowy, 0 to 1 percent slopes.. 90
IlB—Iosco loamy sand, 2 to 6 percent slopes..... 92
IlC—Iosco loamy sand, 6 to 12 percent slopes..... 93
IsA—Iosco-Ogemaw loamy sands, 0 to 2 percent slopes.....94
IsB—Iosco-Ogemaw loamy sands, 2 to 6 percent slopes.....96
KaA—Kalkaska loamy sand, 0 to 2 percent slopes.....97
KaB—Kalkaska loamy sand, 2 to 6 percent slopes.....99
KaC—Kalkaska loamy sand, 6 to 12 percent slopes..... 100
KaD—Kalkaska loamy sand, 12 to 18 percent slopes..... 101
KaE—Kalkaska loamy sand, 18 to 25 percent slopes.....102
KaE2—Kalkaska loamy sand, 18 to 25 percent slopes, moderately eroded.....104
KaF—Kalkaska loamy sand, 25 to 45 percent slopes.....105
KaF2—Kalkaska loamy sand, 25 to 45 percent slopes, moderately eroded.....106
KbB—Kalkaska sand, 0 to 6 percent slopes..... 108
KbD—Kalkaska sand, 6 to 18 percent slopes..... 109
KbF—Kalkaska sand, 35 to 60 percent slopes..... 111
KlC—Karlin loamy sand, 6 to 12 percent slopes..... 112
KlF—Karlin loamy sand, 25 to 45 percent slopes.....114
Kt—Kerston muck.....115
LeB—Lake beach and Eastport sand, 0 to 6 percent slopes..... 116
LkA—Leelanau-Kalkaska loamy sands, 0 to 2 percent slopes.....118
LkB—Leelanau-Kalkaska loamy sands, 2 to 6 percent slopes..... 120
LkC—Leelanau-Kalkaska loamy sands, 6 to 12 percent slopes..... 122
LkD—Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes..... 124
LkD2—Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes, moderately eroded.....126
LkE—Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes..... 128
LkE2—Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes, moderately eroded.....130
LkF—Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes.....132
LkF2—Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes, moderately eroded.....134

MaA—Mancelona gravelly sandy loam, 0 to 2 percent slopes....136
MaC—Mancelona gravelly sandy loam, 6 to 12 percent slopes.... 138
MaC2—Mancelona gravelly sandy loam, 6 to 12 percent slopes, moderately eroded....139
MaD—Mancelona gravelly sandy loam, 12 to 18 percent slopes.... 140
MeA—Mancelona-East Lake loamy sands, 0 to 2 percent slopes....142
MeB—Mancelona-East Lake loamy sands, 2 to 6 percent slopes....144
MeE—Mancelona-East Lake loamy sands, 18 to 25 percent slopes....146
RcA—Richter loams, 0 to 2 percent slopes, overwash.... 148
RcB—Richter loams, 2 to 6 percent slopes, overwash.... 149
RhA—Richter loams, 0 to 2 percent slopes.... 150
RpA—Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes, overwash....151
RrA—Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes.... 153
RrC—Richter, Tonkey, and Pinconning loams, 6 to 12 percent slopes.... 155
Rs—Rifle peat.... 157
Ru—Roscommon mucky loamy sand.... 159
RwA—Rubicon sand, 0 to 2 percent slopes....160
RwB—Rubicon sand, 0 to 6 percent slopes....161
SrB—Sanilac-Richter loams, 0 to 6 percent slopes.... 163
Ta—Tawas-Roscommon complex....164
Tm—Tonkey mucky sandy loam.... 167
Tn—Tonkey sandy loam, overwash.... 168
To—Tonkey sandy loam.... 169
Tp—Tonkey-Hettinger-Pickford loams, overwash.... 170
Tr—Tonkey-Hettinger-Pickford loams....173
UnA—Ubly-Nester complex, 0 to 2 percent slopes....175
UnB—Ubly-Nester complex, 2 to 6 percent slopes....177
UnD2—Ubly-Nester complex, 12 to 18 percent slopes, moderately eroded....179
UnE—Ubly-Nester complex, 18 to 25 percent slopes....181
UnE2—Ubly-Nester complex, 18 to 25 percent slopes, moderately eroded....183
UnF—Ubly-Nester complex, 25 to 35 percent slopes.... 185
W—Water....188
WdD—Wind eroded land, strongly sloping....188
Leelanau County, Michigan....189
ArA—Alcona-Richter sandy loams, 0 to 2 percent slopes....189
ArB—Alcona-Richter sandy loams, 2 to 6 percent slopes....190
EdB—Eastport sand, 0 to 6 percent slopes.... 192
EnB—Emmet-Leelanau complex, 2 to 6 percent slopes....194
EnC—Emmet-Leelanau complex, 6 to 12 percent slopes....196
EnD—Emmet-Leelanau complex, 12 to 18 percent slopes....198
EnE—Emmet-Leelanau complex, 18 to 25 percent slopes....201
EnF—Emmet-Leelanau complex, 25 to 50 percent slopes....203
EoC—Emmet-Mancelona gravelly sandy loams, 4 to 12 percent slopes..205
EoE—Emmet-Mancelona gravelly sandy loams, 18 to 35 percent slopes 207
Hm—Hettinger-Muck complex.... 210
KaB—Kaleva sand, 0 to 6 percent slopes....213
KaC—Kaleva sand, 6 to 12 percent slopes....214
KeB—Kalkaska-East Lake loamy sands, 0 to 6 percent slopes, lake moderated....216
LlB—Leelanau-East Lake loamy sands, 0 to 6 percent slopes....218
LlC—Leelanau-East Lake loamy sands, 6 to 12 percent slopes....220

LID—Leelanau-East Lake loamy sands, 12 to 18 percent slopes, lake moderated....223
LIE—Leelanau-East Lake loamy sands, 18 to 25 percent slopes, lake moderated....226
LIF—Leelanau-East Lake loamy sands, 25 to 45 percent slopes....228
Lm—Lupton-Markey mucks....231
MrB—Mancelona-Richter gravelly sandy loams, 0 to 6 percent slopes....233
NtF3—Nester silty clay loam, 20 to 50 percent slopes, severely eroded....235
PpskaB—Pipestone-Kaleva sands, 0 to 4 percent slopes....237
Pt—Pits, gravel....239
TmA—Tonkey-Munuscong-Iosco sandy loams, 0 to 2 percent slopes....239
TmB—Tonkey-Munuscong-Iosco sandy loams, 2 to 6 percent slopes....242
WlD—Wind eroded land, steep....245
References....246

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

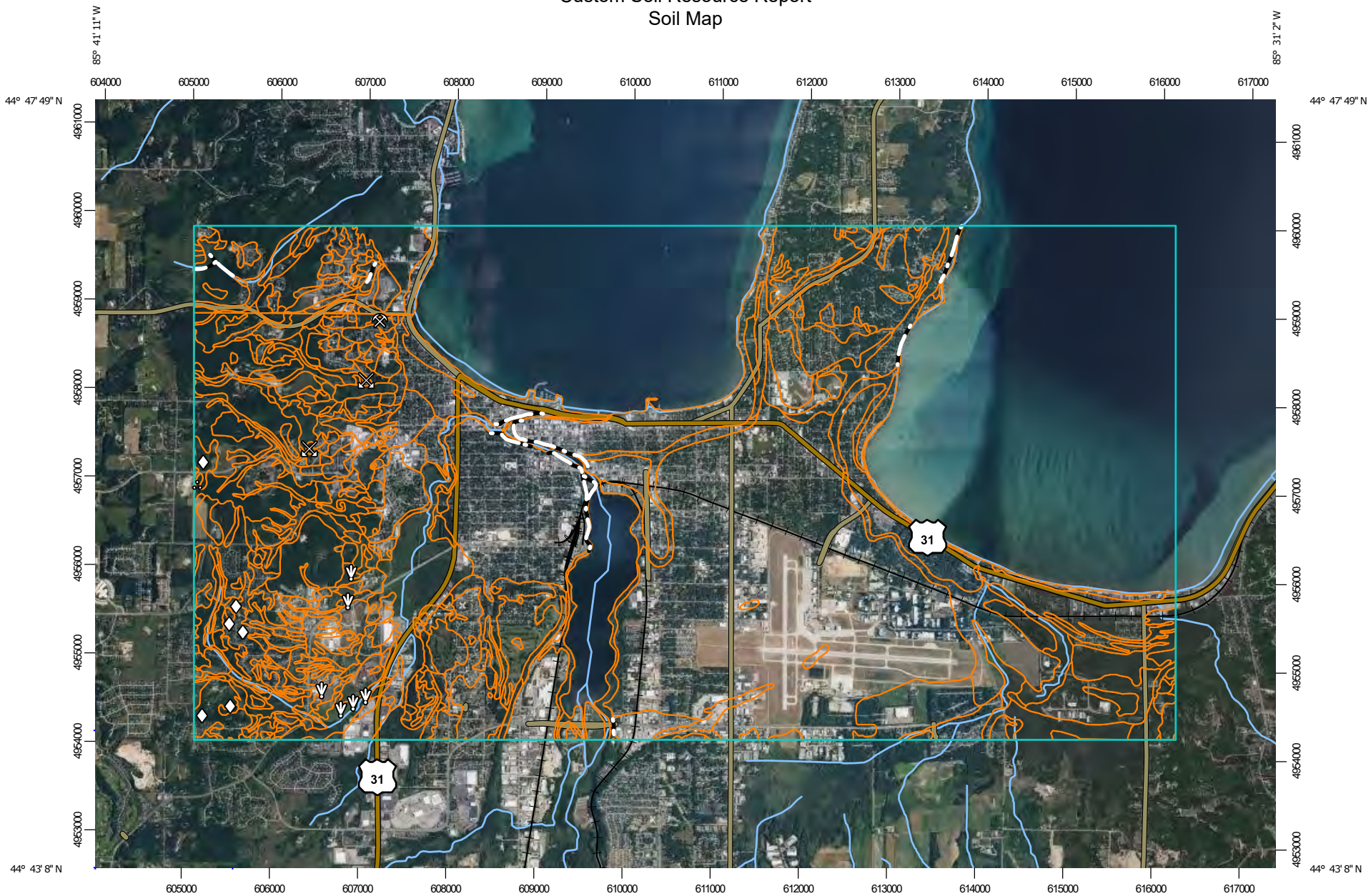
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.



Map Scale: 1:61,200 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 500 1000 2000 3000

Feet
0 2500 5000 10000 15000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Grand Traverse County, Michigan
Survey Area Data: Version 19, Sep 3, 2025

Soil Survey Area: Leelanau County, Michigan
Survey Area Data: Version 19, Sep 4, 2025

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 2, 2020—May 28, 2023

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AdracA	Adrian muck, lake moderated snowy, 0 to 1 percent slopes	1.7	0.0%
AeA	Alpena-East Lake gravelly loamy sands, 0 to 2 percent slopes	2.7	0.0%
AeB	Alpena-East Lake gravelly loamy sands, 2 to 6 percent slopes	15.7	0.1%
AeC	Alpena-East Lake gravelly loamy sands, 6 to 12 percent slopes	3.9	0.0%
AsA	Au Gres-Saugatuck sands, 0 to 2 percent slopes	18.2	0.1%
CaraeA	Carlisle muck, lake moderated snowy, 0 to 2 percent slopes	273.7	1.7%
CoA	Croswell loamy sands, 0 to 2 percent slopes, overwash	86.0	0.5%
CoB	Croswell loamy sands, 2 to 6 percent slopes, overwash	12.0	0.1%
CpA	Croswell loamy sands, 0 to 2 percent slopes	61.0	0.4%
CpB	Croswell loamy sands, 2 to 6 percent slopes	6.9	0.0%
CrA	Croswell-Rubicon sands, 0 to 2 percent slopes	598.2	3.7%
EdwaaA	Edwards muck, lake moderated snowy, 0 to 1 percent slopes	285.3	1.8%
EmA	East Lake-Mancelona loamy sands, 0 to 2 percent slopes	701.8	4.4%
EmB	East Lake-Mancelona loamy sands, 2 to 6 percent slopes	327.0	2.0%
EmC	East Lake-Mancelona loamy sands, 6 to 12 percent slopes	46.9	0.3%
EmE	East Lake-Mancelona loamy sands, 18 to 25 percent slopes	28.7	0.2%
ErA	Eastport-Roscommon sands, 0 to 2 percent slopes	219.7	1.4%
ExA	Emmet gravelly sandy loam, 0 to 2 percent slopes	28.8	0.2%
ExB	Emmet gravelly sandy loam, 2 to 6 percent slopes	175.5	1.1%
ExC	Emmet gravelly sandy loam, 6 to 12 percent slopes	144.8	0.9%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ExD	Emmet gravelly sandy loam, 12 to 18 percent slopes	64.2	0.4%
ExD2	Emmet gravelly sandy loam, 12 to 18 percent slopes, moderately eroded	31.4	0.2%
ExE	Emmet gravelly sandy loam, 18 to 25 percent slopes	71.3	0.4%
ExE2	Emmet gravelly sandy loam, 18 to 25 percent slopes, moderately eroded	17.1	0.1%
ExF	Emmet gravelly sandy loam, 25 to 45 percent slopes	266.5	1.7%
ExF2	Emmet gravelly sandy loam, 25 to 45 percent slopes, moderately eroded	265.5	1.7%
EyA	Emmet sandy loam, 0 to 2 percent slopes	7.5	0.0%
EyB	Emmet sandy loam, 2 to 6 percent slopes	55.5	0.3%
EyC	Emmet sandy loam, 6 to 12 percent slopes	95.7	0.6%
EyC2	Emmet sandy loam, 6 to 12 percent slopes, moderately eroded	21.0	0.1%
EyD	Emmet sandy loam, 12 to 18 percent slopes	17.7	0.1%
EyD2	Emmet sandy loam, 12 to 18 percent slopes, moderately eroded	3.6	0.0%
EyE	Emmet sandy loam, 18 to 25 percent slopes	11.6	0.1%
EyE2	Emmet sandy loam, 18 to 25 percent slopes, moderately eroded	36.2	0.2%
EyF	Emmet sandy loam, 25 to 45 percent slopes	44.9	0.3%
EyF2	Emmet sandy loam, 25 to 45 percent slopes, moderately eroded	53.1	0.3%
Fm	Fresh water marsh	7.3	0.0%
GrA	Gladwin-Richter gravelly sandy loams, 0 to 2 percent slopes	8.0	0.0%
GrB	Gladwin-Richter gravelly sandy loams, 2 to 6 percent slopes	26.3	0.2%
GsE	Gravelly land, moderately steep	7.4	0.0%
GsF	Gravelly land, steep	11.1	0.1%
Gt	Gravel pits	15.0	0.1%
GxA	Guelph-Nester loams, 0 to 2 percent slopes	2.5	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GxB2	Guelph-Nester loams, 2 to 6 percent slopes, moderately eroded	3.3	0.0%
GxC2	Guelph-Nester loams, 6 to 12 percent slopes, moderately eroded	7.3	0.0%
GxD2	Guelph-Nester loams, 12 to 18 percent slopes, moderately eroded	6.2	0.0%
GxE2	Guelph-Nester loams, 18 to 25 percent slopes, moderately eroded	4.8	0.0%
GxF2	Guelph-Nester loams, 25 to 35 percent slopes, moderately eroded	4.3	0.0%
Gy	Gullied land	0.7	0.0%
HgtaaA	Houghton muck, lake moderated snowy, 0 to 1 percent slopes	33.5	0.2%
IIB	Iosco loamy sand, 2 to 6 percent slopes	19.0	0.1%
IIC	Iosco loamy sand, 6 to 12 percent slopes	7.6	0.0%
IsA	Iosco-Ogemaw loamy sands, 0 to 2 percent slopes	44.1	0.3%
IsB	Iosco-Ogemaw loamy sands, 2 to 6 percent slopes	10.6	0.1%
KaA	Kalkaska loamy sand, 0 to 2 percent slopes	371.0	2.3%
KaB	Kalkaska loamy sand, 2 to 6 percent slopes	90.8	0.6%
KaC	Kalkaska loamy sand, 6 to 12 percent slopes	107.7	0.7%
KaD	Kalkaska loamy sand, 12 to 18 percent slopes	16.7	0.1%
KaE	Kalkaska loamy sand, 18 to 25 percent slopes	74.8	0.5%
KaE2	Kalkaska loamy sand, 18 to 25 percent slopes, moderately eroded	59.1	0.4%
KaF	Kalkaska loamy sand, 25 to 45 percent slopes	37.9	0.2%
KaF2	Kalkaska loamy sand, 25 to 45 percent slopes, moderately eroded	11.6	0.1%
KbB	Kalkaska sand, 0 to 6 percent slopes	34.8	0.2%
KbD	Kalkaska sand, 6 to 18 percent slopes	3.4	0.0%
KbF	Kalkaska sand, 35 to 60 percent slopes	157.3	1.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
KlC	Karlin loamy sand, 6 to 12 percent slopes	0.0	0.0%
KlF	Karlin loamy sand, 25 to 45 percent slopes	31.8	0.2%
Kt	Kerston muck	169.8	1.1%
LeB	Lake beach and Eastport sand, 0 to 6 percent slopes	534.9	3.3%
LkA	Leelanau-Kalkaska loamy sands, 0 to 2 percent slopes	1.5	0.0%
LkB	Leelanau-Kalkaska loamy sands, 2 to 6 percent slopes	60.5	0.4%
LkC	Leelanau-Kalkaska loamy sands, 6 to 12 percent slopes	131.5	0.8%
LkD	Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes	24.9	0.2%
LkD2	Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes, moderately eroded	0.7	0.0%
LkE	Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes	238.7	1.5%
LkE2	Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes, moderately eroded	39.1	0.2%
LkF	Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes	140.6	0.9%
LkF2	Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes, moderately eroded	96.9	0.6%
MaA	Mancelona gravelly sandy loam, 0 to 2 percent slopes	1.0	0.0%
MaC	Mancelona gravelly sandy loam, 6 to 12 percent slopes	2.9	0.0%
MaC2	Mancelona gravelly sandy loam, 6 to 12 percent slopes, moderately eroded	3.1	0.0%
MaD	Mancelona gravelly sandy loam, 12 to 18 percent slopes	1.0	0.0%
MeA	Mancelona-East Lake loamy sands, 0 to 2 percent slopes	90.4	0.6%
MeB	Mancelona-East Lake loamy sands, 2 to 6 percent slopes	0.4	0.0%
MeE	Mancelona-East Lake loamy sands, 18 to 25 percent slopes	19.2	0.1%
RcA	Richter loams, 0 to 2 percent slopes, overwash	75.7	0.5%
RcB	Richter loams, 2 to 6 percent slopes, overwash	33.5	0.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
RhA	Richter loams, 0 to 2 percent slopes	82.7	0.5%
RpA	Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes, overwash	18.9	0.1%
RrA	Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes	145.6	0.9%
RrC	Richter, Tonkey, and Pinconning loams, 6 to 12 percent slopes	5.0	0.0%
Rs	Rifle peat	99.0	0.6%
Ru	Roscommon mucky loamy sand	129.7	0.8%
RwA	Rubicon sand, 0 to 2 percent slopes	2,431.5	15.2%
RwB	Rubicon sand, 0 to 6 percent slopes	222.9	1.4%
SrB	Sanilac-Richter loams, 0 to 6 percent slopes	1.5	0.0%
Ta	Tawas-Roscommon complex	33.2	0.2%
Tm	Tonkey mucky sandy loam	6.9	0.0%
Tn	Tonkey sandy loam, overwash	7.9	0.0%
To	Tonkey sandy loam	38.8	0.2%
Tp	Tonkey-Hettinger-Pickford loams, overwash	15.9	0.1%
Tr	Tonkey-Hettinger-Pickford loams	6.1	0.0%
UnA	Ubly-Nester complex, 0 to 2 percent slopes	0.8	0.0%
UnB	Ubly-Nester complex, 2 to 6 percent slopes	9.1	0.1%
UnD2	Ubly-Nester complex, 12 to 18 percent slopes, moderately eroded	3.1	0.0%
UnE	Ubly-Nester complex, 18 to 25 percent slopes	3.9	0.0%
UnE2	Ubly-Nester complex, 18 to 25 percent slopes, moderately eroded	0.0	0.0%
UnF	Ubly-Nester complex, 25 to 35 percent slopes	0.1	0.0%
W	Water	347.7	2.2%
WdD	Wind eroded land, strongly sloping	77.8	0.5%
Subtotals for Soil Survey Area		**10,672.1**	**66.5%**
Totals for Area of Interest		**16,048.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ArA	Alcona-Richter sandy loams, 0 to 2 percent slopes	13.1	0.1%
ArB	Alcona-Richter sandy loams, 2 to 6 percent slopes	1.6	0.0%
EdB	Eastport sand, 0 to 6 percent slopes	30.6	0.2%
EnB	Emmet-Leelanau complex, 2 to 6 percent slopes	6.0	0.0%
EnC	Emmet-Leelanau complex, 6 to 12 percent slopes	2.1	0.0%
EnD	Emmet-Leelanau complex, 12 to 18 percent slopes	1.6	0.0%
EnE	Emmet-Leelanau complex, 18 to 25 percent slopes	2.4	0.0%
EnF	Emmet-Leelanau complex, 25 to 50 percent slopes	11.3	0.1%
EoC	Emmet-Mancelona gravelly sandy loams, 4 to 12 percent slopes	19.8	0.1%
EoE	Emmet-Mancelona gravelly sandy loams, 18 to 35 percent slopes	2.5	0.0%
Hm	Hettinger-Muck complex	1.3	0.0%
KaB	Kaleva sand, 0 to 6 percent slopes	20.5	0.1%
KaC	Kaleva sand, 6 to 12 percent slopes	10.6	0.1%
KeB	Kalkaska-East Lake loamy sands, 0 to 6 percent slopes, lake moderated	0.2	0.0%
LlB	Leelanau-East Lake loamy sands, 0 to 6 percent slopes	23.5	0.1%
LlC	Leelanau-East Lake loamy sands, 6 to 12 percent slopes	45.1	0.3%
LlD	Leelanau-East Lake loamy sands, 12 to 18 percent slopes, lake moderated	24.4	0.2%
LlE	Leelanau-East Lake loamy sands, 18 to 25 percent slopes, lake moderated	25.9	0.2%
LlF	Leelanau-East Lake loamy sands, 25 to 45 percent slopes	230.5	1.4%
Lm	Lupton-Markey mucks	128.1	0.8%
MrB	Mancelona-Richter gravelly sandy loams, 0 to 6 percent slopes	6.8	0.0%
NtF3	Nester silty clay loam, 20 to 50 percent slopes, severely eroded	3.6	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
PpskaB	Pipestone-Kaleva sands, 0 to 4 percent slopes	10.1	0.1%
Pt	Pits, gravel	1.5	0.0%
TmA	Tonkey-Munuscong-Iosco sandy loams, 0 to 2 percent slopes	2.6	0.0%
TmB	Tonkey-Munuscong-Iosco sandy loams, 2 to 6 percent slopes	5.3	0.0%
WID	Wind eroded land, steep	19.0	0.1%
Subtotals for Soil Survey Area		**650.1**	**4.1%**
Totals for Area of Interest		**16,048.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Grand Traverse County, Michigan

AdracA—Adrian muck, lake moderated snowy, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2zdlg
Landscape: Till plains
Elevation: 610 to 760 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 45 to 46 degrees F
Frost-free period: 110 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Adrian and similar soils: 92 percent
Minor components: 8 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Adrian

Setting

Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Herbaceous organic material over sandy glaciofluvial deposits

Typical profile

Oa1 - 0 to 12 inches: muck
Oa2 - 12 to 34 inches: muck
Cg - 34 to 80 inches: sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.3 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 0.2
Available water supply, 0 to 60 inches: Very high (about 15.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression

Hydric soil rating: Yes

Minor Components

Kingsville

Percent of map unit: 3 percent
Landscape: Outwash plains, lake plains
Landform: Outwash plains, Nearshore zones (relict)
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Edwards

Percent of map unit: 2 percent
Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Houghton

Percent of map unit: 2 percent
Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Gilford, gravelly subsoil

Percent of map unit: 1 percent
Landscape: Outwash plains, till plains
Landform: Glacial drainage channels, Glacial drainage channels
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

AeA—Alpena-East Lake gravelly loamy sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c25
Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 120 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Alpena and similar soils: 60 percent
East lake and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alpena

Setting

Landform: Outwash plains, Glacial lakeshores, Kames
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 4 to 10 inches of sandy and loamy material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 12 inches: gravelly loamy sand
H2 - 12 to 60 inches: very gravelly sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.98 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

AeB—Alpena-East Lake gravelly loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c26
Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 120 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Alpena and similar soils: 60 percent
East lake and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alpena

Setting

Landform: Outwash plains, Glacial lakeshores, Kames
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 4 to 10 inches of sandy and loamy material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 12 inches: gravelly loamy sand
H2 - 12 to 60 inches: very gravelly sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.98 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

AeC—Alpena-East Lake gravelly loamy sands, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c27
Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 120 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Alpena and similar soils: 60 percent
East lake and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alpena

Setting

Landform: Outwash plains, Kames, Glacial lakeshores
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex, linear
Parent material: 4 to 10 inches of sandy and loamy material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 12 inches: gravelly loamy sand
H2 - 12 to 60 inches: very gravelly sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.98 to 19.98 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

AsA—Au Gres-Saugatuck sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c2b
Elevation: 600 to 1,800 feet
Mean annual precipitation: 22 to 40 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Au gres and similar soils: 55 percent
Saugatuck and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Au Gres

Setting

Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 4 inches: sand
H2 - 4 to 22 inches: sand
H3 - 22 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: A/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Saugatuck

Setting

Landform: Till plains, Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits cemented with ortstein

Typical profile

H1 - 0 to 2 inches: sand
H2 - 2 to 12 inches: sand
H3 - 12 to 26 inches: sand
H4 - 26 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 0.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Minor Components

Roscommon

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

CaraeA—Carlisle muck, lake moderated snowy, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 30n5c

Landscape: Till plains
Elevation: 580 to 1,000 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 45 to 46 degrees F
Frost-free period: 110 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Carlisle and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Carlisle

Setting

Landscape: Till plains
Landform: Depressions on moraines, Depressions on glacial drainage channels, Depressions on outwash plains, Depressions on till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Parent material: Woody organic material

Typical profile

Oa1 - 0 to 13 inches: muck
Oa2 - 13 to 37 inches: muck
Oa3 - 37 to 80 inches: muck

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 0.6
Available water supply, 0 to 60 inches: Very high (about 23.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Minor Components

Adrian

Percent of map unit: 5 percent
Landscape: Till plains, ice-margin complexes
Landform: Drainageways on moraines, Depressions on moraines, Drainageways on moraines, Drainageways on glacial drainage channels, Drainageways on

outwash plains, Depressions on outwash plains, Depressions on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Kingsville
Percent of map unit: 3 percent
Landscape: Outwash plains, lake plains
Landform: Outwash plains, Nearshore zones (relict)
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Wallkill
Percent of map unit: 2 percent
Landscape: Till plains
Landform: Depressions on glacial drainage channels, Depressions on moraines, Depressions on till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

CoA—Croswell loamy sands, 0 to 2 percent slopes, overwash

Map Unit Setting
National map unit symbol: 6c2h
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Croswell and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Croswell

Setting
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 5 inches: loamy sand
H2 - 5 to 12 inches: sand
H3 - 12 to 30 inches: sand
H4 - 30 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

CoB—Croswell loamy sands, 2 to 6 percent slopes, overwash

Map Unit Setting

National map unit symbol: 6c2j
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Croswell and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Croswell

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 5 inches: loamy sand
H2 - 5 to 12 inches: sand
H3 - 12 to 30 inches: sand
H4 - 30 to 60 inches: sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

CpA—Croswell loamy sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c2k
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Croswell and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Croswell

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 5 inches: loamy sand
H2 - 5 to 12 inches: sand
H3 - 12 to 30 inches: sand

H4 - 30 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

CpB—Croswell loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c2m
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Croswell and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Croswell

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 5 inches: loamy sand
H2 - 5 to 12 inches: sand
H3 - 12 to 30 inches: sand
H4 - 30 to 60 inches: sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

CrA—Croswell-Rubicon sands, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c2p
Elevation: 600 to 1,800 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 80 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Croswell and similar soils: 50 percent
Rubicon and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Croswell

Setting
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile
H1 - 0 to 5 inches: sand
H2 - 5 to 12 inches: sand
H3 - 12 to 30 inches: sand
H4 - 30 to 60 inches: sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained

Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Rubicon

Setting
Landform: Beach ridges, Moraines, Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile
H1 - 0 to 5 inches: sand
H2 - 5 to 34 inches: sand
H3 - 34 to 60 inches: sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Eastport
Percent of map unit: 5 percent
Landform: Beach ridges, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Au gres

Percent of map unit: 5 percent
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EdwaaA—Edwards muck, lake moderated snowy, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2zdl4
Landscape: Till plains
Elevation: 590 to 760 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 45 to 46 degrees F
Frost-free period: 110 to 160 days
Farmland classification: Farmland of local importance

Map Unit Composition

Edwards and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Edwards

Setting

Landscape: Till plains
Landform: Lakebeds (relict) on glacial drainage channels, Lakebeds (relict) on outwash plains, Lakebeds (relict) on moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Herbaceous organic material over marl

Typical profile

Oa1 - 0 to 9 inches: muck
Oa2 - 9 to 26 inches: muck
Lma - 26 to 80 inches: marly silt loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 100 percent
Gypsum, maximum content: 4 percent
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Very high (about 20.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Minor Components

Adrian

Percent of map unit: 3 percent
Landscape: Till plains
Landform: Lakebeds (relict) on moraines, Lakebeds (relict) on glacial drainage channels, Lakebeds (relict) on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Houghton

Percent of map unit: 3 percent
Landscape: Till plains, outwash plains
Landform: Lakebeds (relict) on glacial drainage channels, Lakebeds (relict) on outwash plains, Lakebeds (relict) on moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Gilford

Percent of map unit: 2 percent
Landscape: Till plains, outwash plains
Landform: Lakebeds (relict) on moraines, Lakebeds (relict) on glacial drainage channels, Lakebeds (relict) on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, talf

Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Palms

Percent of map unit: 2 percent
Landscape: Till plains, ice-margin complexes, outwash plains
Landform: Drainageways on moraines, Depressions on moraines, Drainageways on glacial drainage channels, Drainageways on outwash plains, Depressions on outwash plains, Depressions on outwash plains, Drainageways on moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

EmA—East Lake-Mancelona loamy sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c2s
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

East lake and similar soils: 55 percent
Mancelona and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Beach ridges, Outwash plains, Moraines, Kames, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Croswell

Percent of map unit: 5 percent
Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EmB—East Lake-Mancelona loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c2t
Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

East lake and similar soils: 60 percent
Mancelona and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Beach ridges, Outwash plains, Moraines, Kames, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

EmC—East Lake-Mancelona loamy sands, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c2v

Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

East lake and similar soils: 60 percent
Mancelona and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Beach ridges, Outwash plains, Moraines, Kames, Lake plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest

Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

EmE—East Lake-Mancelona loamy sands, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c2y
Elevation: 600 to 1,000 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

East lake and similar soils: 60 percent
Mancelona and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces

Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Beach ridges, Outwash plains, Moraines, Kames, Lake plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

ErA—Eastport-Roscommon sands, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c31
Elevation: 600 to 1,800 feet
Mean annual precipitation: 22 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Eastport and similar soils: 50 percent
Roscommon and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eastport

Setting
Landform: Dunes, Beach ridges
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy eolian deposits

Typical profile
H1 - 0 to 5 inches: sand
H2 - 5 to 26 inches: sand
H3 - 26 to 60 inches: sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Roscommon

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 3 inches: sand
H2 - 3 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Minor Components

Au gres

Percent of map unit: 5 percent
Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Croswell

Percent of map unit: 5 percent
Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

ExA—Emmet gravelly sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c33
Elevation: 600 to 1,200 feet
Mean annual precipitation: 28 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 100 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Emmet and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

ExB—Emmet gravelly sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c34
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mancelona
Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

ExC—Emmet gravelly sandy loam, 6 to 12 percent slopes

Map Unit Setting
National map unit symbol: 6c35
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition
Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile
H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities
Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

ExD—Emmet gravelly sandy loam, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6c36
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines

Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

ExD2—Emmet gravelly sandy loam, 12 to 18 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c37
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

ExE—Emmet gravelly sandy loam, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c38
Elevation: 600 to 1,200 feet
Mean annual precipitation: 28 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 18 to 25 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

ExE2—Emmet gravelly sandy loam, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c39
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

ExF—Emmet gravelly sandy loam, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: 6c3b
Elevation: 600 to 1,200 feet
Mean annual precipitation: 28 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

ExF2—Emmet gravelly sandy loam, 25 to 45 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c3c
Elevation: 600 to 1,200 feet
Mean annual precipitation: 28 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet, moderately eroded, and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

EyA—Emmet sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c3d
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Emmet and similar soils: 90 percent

Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 10 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EyB—Emmet sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c3f
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 10 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EyC—Emmet sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c3h
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 10 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

EyC2—Emmet sandy loam, 6 to 12 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c3j
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear

Across-slope shape: Convex, linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 10 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

EyD—Emmet sandy loam, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6c3k
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EyD2—Emmet sandy loam, 12 to 18 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c3l
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EyE—Emmet sandy loam, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c3m
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EyE2—Emmet sandy loam, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c3n
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EyF—Emmet sandy loam, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: 6c3q
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EyF2—Emmet sandy loam, 25 to 45 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c3r
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 38 inches: sandy clay loam
H4 - 38 to 60 inches: sandy loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Leelanau

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Fm—Fresh water marsh

Map Unit Composition

Fresh water marsh: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fresh Water Marsh

Interpretive groups

Land capability classification (irrigated): None specified
Ecological site: R096XY002MI - Great Lakes Marsh
Hydric soil rating: Unranked

GrA—Gladwin-Richter gravelly sandy loams, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c3v
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 160 days
Farmland classification: Farmland of local importance

Map Unit Composition

Gladwin and similar soils: 60 percent
Richter and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gladwin

Setting

Landform: Beach ridges, Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 14 inches: loamy sand
H3 - 14 to 20 inches: sandy loam
H4 - 20 to 60 inches: gravelly sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Richter

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 39 inches: very fine sandy loam
H3 - 39 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

GrB—Gladwin-Richter gravelly sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c3w
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 160 days
Farmland classification: Farmland of local importance

Map Unit Composition

Gladwin and similar soils: 60 percent
Richter and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gladwin

Setting

Landform: Beach ridges, Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 14 inches: loamy sand
H3 - 14 to 20 inches: sandy loam
H4 - 20 to 60 inches: gravelly sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Richter

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 39 inches: very fine sandy loam
H3 - 39 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

GsE—Gravelly land, moderately steep

Map Unit Composition
Gravelly land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

GsF—Gravelly land, steep

Map Unit Composition
Gravelly land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Gt—Gravel pits

Map Unit Composition
Gravel pits: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

GxA—Guelph-Nester loams, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c43
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Guelph and similar soils: 60 percent

Nester and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

GxB2—Guelph-Nester loams, 2 to 6 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c45
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Guelph, moderately eroded, and similar soils: 60 percent
Nester, moderately eroded, and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

GxC2—Guelph-Nester loams, 6 to 12 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c46
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Guelph, moderately eroded, and similar soils: 60 percent
Nester, moderately eroded, and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till

Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

GxD2—Guelph-Nester loams, 12 to 18 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c48
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Guelph, moderately eroded, and similar soils: 60 percent
Nester, moderately eroded, and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

GxE2—Guelph-Nester loams, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c49
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Guelph, moderately eroded, and similar soils: 50 percent
Nester, moderately eroded, and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Iosco

Percent of map unit: 5 percent
Landform: Outwash plains, Till plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ubly

Percent of map unit: 5 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

GxF2—Guelph-Nester loams, 25 to 35 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c4b
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Guelph, moderately eroded, and similar soils: 50 percent

Nester, moderately eroded, and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guelph, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Loamy till

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 21 inches: clay loam
H3 - 21 to 60 inches: silt loam

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 14 inches: silty clay loam

H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Iosco

Percent of map unit: 5 percent
Landform: Outwash plains, Till plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ubly

Percent of map unit: 5 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Gy—Gullied land

Map Unit Composition

Gullied land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

HgtaaA—Houghton muck, lake moderated snowy, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2zdlb
Landscape: Till plains
Elevation: 710 to 960 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 45 to 46 degrees F
Frost-free period: 110 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Houghton and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Houghton

Setting

Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Herbaceous organic material

Typical profile

Oa1 - 0 to 12 inches: muck
Oa2 - 12 to 35 inches: muck
Oa3 - 35 to 80 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline to very slightly saline (0.4 to 2.7 mmhos/cm)
Sodium adsorption ratio, maximum: 0.8
Available water supply, 0 to 60 inches: Very high (about 23.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression

Hydric soil rating: Yes

Minor Components

Adrian

Percent of map unit: 4 percent
Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Edwards

Percent of map unit: 3 percent
Landscape: Till plains
Landform: Depressions on outwash plains, Depressions on moraines on outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Palms

Percent of map unit: 2 percent
Landscape: Till plains, outwash plains
Landform: Drainageways on moraines, Drainageways on outwash plains, Depressions on outwash plains, Depressions on till plains, Swamps on outwash plains, Swamps on till plains, Depressions on moraines, Swamps on moraines, Drainageways on till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Gilford, gravelly subsoil

Percent of map unit: 1 percent
Landscape: Outwash plains, till plains
Landform: Glacial drainage channels, Glacial drainage channels
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

IIB—Iosco loamy sand, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c4h
Elevation: 600 to 1,400 feet
Mean annual precipitation: 28 to 32 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Iosco and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iosco

Setting

Landform: Till plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 37 inches: sandy clay loam
H4 - 37 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

IIC—Iosco loamy sand, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c4j
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Iosco and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iosco

Setting

Landform: Till plains, Outwash plains
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 37 inches: sandy clay loam
H4 - 37 to 60 inches: silty clay loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A

Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Minor Components

Montcalm
Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Ubly
Percent of map unit: 5 percent
Landform: Moraines, Till plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

IsA—Iosco-Ogemaw loamy sands, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c4l
Elevation: 600 to 1,500 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 80 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Iosco and similar soils: 60 percent
Ogemaw and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iosco

Setting
Landform: Outwash plains, Till plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 37 inches: sandy clay loam
H4 - 37 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression, F094AA007MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Ogemaw

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material with ortstein over loamy till

Typical profile

H1 - 0 to 10 inches: loamy sand
H2 - 10 to 20 inches: loamy sand
H3 - 20 to 26 inches: loamy sand
H4 - 26 to 60 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Very low (about 1.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

IsB—Iosco-Ogemaw loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c4m
Elevation: 600 to 1,500 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 80 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Iosco and similar soils: 60 percent
Ogemaw and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iosco

Setting

Landform: Till plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 37 inches: sandy clay loam
H4 - 37 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent

Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Ogemaw

Setting

Landform: Lake plains, Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material with ortstein over loamy till

Typical profile

H1 - 0 to 10 inches: loamy sand
H2 - 10 to 20 inches: loamy sand
H3 - 20 to 26 inches: loamy sand
H4 - 26 to 60 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Very low (about 1.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression, F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

KaA—Kalkaska loamy sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c4n
Elevation: 600 to 1,900 feet

Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

KaB—Kalkaska loamy sand, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c4q
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

KaC—Kalkaska loamy sand, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c4s
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

KaD—Kalkaska loamy sand, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6c4w
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

KaE—Kalkaska loamy sand, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c4y
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

KaE2—Kalkaska loamy sand, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c4z
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska, moderately eroded, and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska, Moderately Eroded

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake
Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

KaF—Kalkaska loamy sand, 25 to 45 percent slopes

Map Unit Setting
National map unit symbol: 6c50
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting
Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile
H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities
Slope: 25 to 45 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F094AA005MI - Snowy Rich Sandy Drift, F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

KaF2—Kalkaska loamy sand, 25 to 45 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c51
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska, moderately eroded, and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska, Moderately Eroded

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

KbB—Kalkaska sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2zgp3
Landscape: Outwash plains, till plains, ice-margin complexes
Elevation: 580 to 1,680 feet
Mean annual precipitation: 28 to 36 inches
Mean annual air temperature: 41 to 48 degrees F
Frost-free period: 90 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landscape: Outwash plains, till plains, ice-margin complexes
Landform: Flats, Moraines, Lake plains, Valley trains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Sandy outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: sand
E - 2 to 9 inches: sand
Bhs - 9 to 15 inches: sand
Bs - 15 to 31 inches: sand
BC - 31 to 56 inches: sand
C - 56 to 80 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F094AA005MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Blue lake

Percent of map unit: 3 percent
Landscape: Outwash plains, till plains, ice-margin complexes
Landform: Moraines, Lake plains, Flats, Valley trains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Ecological site: F094AA006MI - Snowy Sandy Drift
Hydric soil rating: No

Au gres

Percent of map unit: 1 percent
Landscape: Outwash plains, till plains, ice-margin complexes
Landform: Flats, Moraines, Lake plains, Valley trains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Halfaday

Percent of map unit: 1 percent
Landscape: Outwash plains, till plains, ice-margin complexes
Landform: Moraines, Lake plains, Flats, Valley trains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F094AA007MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

KbD—Kalkaska sand, 6 to 18 percent slopes

Map Unit Setting

National map unit symbol: 2zgp4
Landscape: Till plains, ice-margin complexes, outwash plains
Elevation: 580 to 1,710 feet
Mean annual precipitation: 28 to 36 inches
Mean annual air temperature: 41 to 48 degrees F

Frost-free period: 90 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landscape: Till plains, ice-margin complexes, outwash plains
Landform: Moraines, Valley trains, Rises
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Sandy drift

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: sand
E - 2 to 9 inches: sand
Bhs - 9 to 15 inches: sand
Bs - 15 to 31 inches: sand
BC - 31 to 56 inches: sand
C - 56 to 80 inches: sand

Properties and qualities

Slope: 6 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F094AA005MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Blue lake

Percent of map unit: 2 percent
Landscape: Till plains, ice-margin complexes, outwash plains
Landform: Moraines, Valley trains, Rises
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope

Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Ecological site: F094AA006MI - Snowy Sandy Drift
Hydric soil rating: No

KbF—Kalkaska sand, 35 to 60 percent slopes

Map Unit Setting

National map unit symbol: 2zgp6
Landscape: Ice-margin complexes
Elevation: 580 to 1,690 feet
Mean annual precipitation: 28 to 36 inches
Mean annual air temperature: 41 to 48 degrees F
Frost-free period: 90 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Kalkaska and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landscape: Ice-margin complexes
Landform: Moraines, Glacial drainage channels
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Sandy drift

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: sand
E - 2 to 9 inches: sand
Bhs - 9 to 15 inches: sand
Bs - 15 to 31 inches: sand
BC - 31 to 56 inches: sand
C - 56 to 80 inches: sand

Properties and qualities

Slope: 35 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F094AA005MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Blue lake

Percent of map unit: 5 percent
Landscape: Ice-margin complexes
Landform: Glacial drainage channels on moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Ecological site: F094AA006MI - Snowy Sandy Drift
Hydric soil rating: No

KIC—Karlin loamy sand, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c5g
Elevation: 600 to 1,950 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 36 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Karlin and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Karlin

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear

Parent material: Loamy and/or sandy surface over sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 32 inches: loamy fine sand
H3 - 32 to 60 inches: sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Mancelona

Percent of map unit: 5 percent
Landform: Beach ridges, Lake plains, Outwash plains, Moraines, Kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

KlF—Karlin loamy sand, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: 6c5n
Elevation: 600 to 1,950 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 36 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Karlin and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Karlin

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Loamy and/or sandy surface over sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 32 inches: loamy fine sand
H3 - 32 to 60 inches: sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift

Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Newaygo

Percent of map unit: 5 percent
Landform: Outwash plains, Lake terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Mancelona

Percent of map unit: 3 percent
Landform: Beach ridges, Lake plains, Outwash plains, Moraines, Kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Coventry

Percent of map unit: 2 percent
Landform: Outwash plains, Lake terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Kt—Kerston muck

Map Unit Setting

National map unit symbol: 6c5t
Elevation: 670 to 1,600 feet

Mean annual precipitation: 22 to 33 inches
Mean annual air temperature: 36 to 45 degrees F
Frost-free period: 88 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Kerston and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kerston

Setting

Landform: Flood plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 16 to 40 inches of organic deposits over stratified mineral alluvium

Typical profile

Oa - 0 to 5 inches: muck
C - 5 to 10 inches: stratified sand to fine sandy loam
O'a - 10 to 21 inches: muck
C' - 21 to 60 inches: stratified sand to muck

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA013MI - Snowy Wet Floodplain
Hydric soil rating: Yes

LeB—Lake beach and Eastport sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c5v
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F

Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Eastport and similar soils: 50 percent
Lake beach: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eastport

Setting

Landform: Beach ridges, Dunes
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy eolian deposits

Typical profile

H1 - 0 to 5 inches: sand
H2 - 5 to 26 inches: sand
H3 - 26 to 60 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Lake Beach

Interpretive groups

Land capability classification (irrigated): None specified
Ecological site: R096XY001MI - Coastal Dune Complex
Hydric soil rating: Unranked

Minor Components

Alpena

Percent of map unit: 5 percent
Landform: Outwash plains, Kames, Glacial lakeshores
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Hydric soil rating: No

Kalkaska

Percent of map unit: 5 percent
Landform: Moraines, Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

LkA—Leelanau-Kalkaska loamy sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c5w
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Leelanau and similar soils: 55 percent
Kalkaska and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

LkB—Leelanau-Kalkaska loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c5y
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Leelanau and similar soils: 55 percent
Kalkaska and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

LkC—Leelanau-Kalkaska loamy sands, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c60
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Leelanau and similar soils: 55 percent
Kalkaska and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 5 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

LkD—Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6c62
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau and similar soils: 50 percent
Kalkaska and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LkD2—Leelanau-Kalkaska loamy sands, 12 to 18 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c63
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau, moderately eroded, and similar soils: 50 percent
Kalkaska, moderately eroded, and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 10 percent
Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LkE—Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c64
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau and similar soils: 55 percent
Kalkaska and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LkE2—Leelanau-Kalkaska loamy sands, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c65
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau, moderately eroded, and similar soils: 55 percent
Kalkaska, moderately eroded, and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LkF—Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: 6c66
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Leelanau and similar soils: 55 percent
Kalkaska and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 25 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LkF2—Leelanau-Kalkaska loamy sands, 25 to 45 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c67
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Leelanau, moderately eroded, and similar soils: 55 percent
Kalkaska, moderately eroded, and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 25 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of Kalkaska, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 8 inches: sand
H3 - 8 to 36 inches: sand
H4 - 36 to 60 inches: sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Beach ridges, Lake terraces, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

MaA—Mancelona gravelly sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c69
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Mancelona and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Outwash plains, Kames, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: gravelly sandy loam
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Newaygo

Percent of map unit: 5 percent
Landform: Outwash plains, Lake terraces, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

MaC—Mancelona gravelly sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c6c
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Mancelona and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Moraines, Kames, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: gravelly sandy loam
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Newaygo
Percent of map unit: 5 percent
Landform: Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

MaC2—Mancelona gravelly sandy loam, 6 to 12 percent slopes, moderately eroded

Map Unit Setting
National map unit symbol: 6c6d
Elevation: 600 to 1,200 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition
Mancelona, moderately eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona, Moderately Eroded

Setting
Landform: Beach ridges, Lake plains, Moraines, Kames, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile
H1 - 0 to 6 inches: gravelly sandy loam
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam

H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Newaygo

Percent of map unit: 5 percent
Landform: Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Alpena

Percent of map unit: 5 percent
Landform: Kames, Glacial lakeshores, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

MaD—Mancelona gravelly sandy loam, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6c6f
Elevation: 600 to 1,200 feet

Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Mancelona and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Moraines, Kames, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: gravelly sandy loam
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Newaygo

Percent of map unit: 5 percent
Landform: Lake terraces, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

MeA—Mancelona-East Lake loamy sands, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c6l
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Mancelona and similar soils: 55 percent
East lake and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Moraines, Kames, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Beach ridges, Lake terraces, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 5 percent
Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

MeB—Mancelona-East Lake loamy sands, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c6m
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Mancelona and similar soils: 55 percent
East lake and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Outwash plains, Moraines, Kames
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 5 percent
Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

MeE—Mancelona-East Lake loamy sands, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c6r
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Mancelona and similar soils: 55 percent
East lake and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Outwash plains, Moraines, Kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 13 inches: loamy sand
H3 - 13 to 20 inches: sandy clay loam
H4 - 20 to 60 inches: Error

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Beach ridges, Lake terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: stratified gravelly sand to sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest

Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

RcA—Richter loams, 0 to 2 percent slopes, overwash

Map Unit Setting

National map unit symbol: 6c7k
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Richter and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D

Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

RcB—Richter loams, 2 to 6 percent slopes, overwash

Map Unit Setting

National map unit symbol: 6c7l
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Richter and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

RhA—Richter loams, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6c7m
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Richter and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting

Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

RpA—Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes, overwash

Map Unit Setting

National map unit symbol: 6c7p
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Richter and similar soils: 40 percent
Tonkey and similar soils: 30 percent
Pinconning and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Pinconning

Setting

Landform: Depressions on lake plains, Depressions on moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous clayey lacustrine deposits

Typical profile

H1 - 0 to 6 inches: sandy loam
H2 - 6 to 26 inches: loamy sand
H3 - 26 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches

Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 26 percent
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

RrA—Richter, Tonkey, and Pinconning loams, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c7q
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Richter and similar soils: 40 percent
Tonkey and similar soils: 30 percent
Pinconning and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting
Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile
H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F094AA003MI - Snowy Loamy Depression, F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F094AA004MI - Snowy Wet Loamy Depression, F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Pinconning

Setting

Landform: Depressions on lake plains, Depressions on moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: 20 to 40 inches of sandy material over calcareous clayey lacustrine deposits

Typical profile

H1 - 0 to 6 inches: sandy loam
H2 - 6 to 26 inches: loamy sand
H3 - 26 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 26 percent
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F094AA004MI - Snowy Wet Loamy Depression, F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

RrC—Richter, Tonkey, and Pinconning loams, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6c7s
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Richter and similar soils: 40 percent
Tonkey and similar soils: 30 percent
Pinconning and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Richter

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Pinconning

Setting

Landform: Depressions on lake plains, Depressions on moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous clayey lacustrine deposits

Typical profile

H1 - 0 to 6 inches: sandy loam
H2 - 6 to 26 inches: loamy sand
H3 - 26 to 60 inches: silty clay

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 26 percent
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Rs—Rifle peat

Map Unit Setting

National map unit symbol: 6c7t
Elevation: 600 to 1,500 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 39 to 46 degrees F

Frost-free period: 60 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition

Rifle and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rifle

Setting

Landform: Depressions on moraines, Depressions on outwash plains, Depressions on lake plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: > 51 inches of organic material

Typical profile

Oi - 0 to 2 inches: peat
Oe - 2 to 60 inches: mucky peat

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 24.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F094AA013MI - Snowy Mucky Depression, F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Minor Components

Roscommon

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Tawas

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip

Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Lupton

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on outwash plains, Depressions on till plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Ru—Roscommon mucky loamy sand

Map Unit Setting

National map unit symbol: 6c7w
Elevation: 600 to 1,500 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Roscommon and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Roscommon

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 3 inches: mucky loamy sand
H2 - 3 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent

Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 4.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Minor Components

Tawas
Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

RwA—Rubicon sand, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c7y
Elevation: 600 to 1,800 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 80 to 140 days
Farmland classification: Not prime farmland

Map Unit Composition
Rubicon and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rubicon

Setting
Landform: Beach ridges, Moraines, Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile
H1 - 0 to 5 inches: sand
H2 - 5 to 34 inches: sand
H3 - 34 to 60 inches: sand

Properties and qualities
Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

RwB—Rubicon sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2qz6l
Landscape: Till plains, outwash plains
Elevation: 580 to 1,500 feet
Mean annual precipitation: 28 to 36 inches
Mean annual air temperature: 41 to 48 degrees F
Frost-free period: 90 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Rubicon and similar soils: 93 percent
Minor components: 7 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rubicon

Setting

Landscape: Till plains, outwash plains
Landform: Moraines, Broad flats, Low knolls, Large heads-of-outwash, Glacial drainageways
Landform position (two-dimensional): Summit, footslope, backslope, toeslope
Landform position (three-dimensional): Interfluve, base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, convex
Parent material: Sandy glaciofluvial deposits

Typical profile

A - 0 to 1 inches: sand
E - 1 to 6 inches: sand
Bs - 6 to 18 inches: sand
C - 18 to 80 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (1.56 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.1 mmhos/cm)
Sodium adsorption ratio, maximum: 0.1
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F094AA006MI - Snowy Sandy Drift, F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Croswell

Percent of map unit: 4 percent
Landscape: Lake plains, till plains
Landform: Sandy till-floored lake plains, Deltas, Glacial drainageways, Moraines
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Base slope, interfluve
Down-slope shape: Linear, concave
Across-slope shape: Linear
Hydric soil rating: No

Au gres

Percent of map unit: 2 percent
Landscape: Outwash plains
Landform: Broad flats, Glacial drainageways
Microfeatures of landform position: Swales
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: No

Kinross

Percent of map unit: 1 percent
Landscape: Outwash plains
Landform: Broad flats, Glacial drainageways
Microfeatures of landform position: Closed depressions
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear
Hydric soil rating: Yes

SrB—Sanilac-Richter loams, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c8f
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Sanilac and similar soils: 50 percent
Richter and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sanilac

Setting

Landform: Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous silty lacustrine deposits and/or eolian deposits

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 42 inches: silt loam
H3 - 42 to 60 inches: stratified very fine sand to silt loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Description of Richter

Setting

Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 35 inches: very fine sandy loam
H3 - 35 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Minor Components

Alpena

Percent of map unit: 10 percent
Landform: Outwash plains, Kames, Glacial lakeshores
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ta—Tawas-Roscommon complex

Map Unit Setting

National map unit symbol: 6c8g

Elevation: 600 to 1,800 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 60 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Tawas and similar soils: 50 percent
Roscommon and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tawas

Setting
Landform: Depressions on lake plains, Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 16 to 51 inches of organic material over sandy glaciofluvial deposits

Typical profile
Oa - 0 to 24 inches: muck
H2 - 24 to 60 inches: sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 12.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Description of Roscommon

Setting
Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile
H1 - 0 to 3 inches: mucky sand

H2 - 3 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Minor Components

Croswell

Percent of map unit: 5 percent
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Au gres

Percent of map unit: 5 percent
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Lupton

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on outwash plains, Depressions on till plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Tm—Tonkey mucky sandy loam

Map Unit Setting

National map unit symbol: 6c8h
Elevation: 600 to 1,600 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: mucky sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Minor Components

Roscommon

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Tawas

Percent of map unit: 5 percent
Landform: Depressions on lake plains, Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Richter

Percent of map unit: 5 percent
Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Tn—Tonkey sandy loam, overwash

Map Unit Setting

National map unit symbol: 6c8j
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

To—Tonkey sandy loam

Map Unit Setting

National map unit symbol: 6c8k
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy loam

H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Minor Components

Richter

Percent of map unit: 5 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Tp—Tonkey-Hettinger-Pickford loams, overwash

Map Unit Setting

National map unit symbol: 6c8l
Elevation: 600 to 1,600 feet
Mean annual precipitation: 26 to 34 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 70 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 45 percent
Hettinger and similar soils: 30 percent
Pickford and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: stratified sand to loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression, F094AA004MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Hettinger

Setting

Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 12 to 36 inches of fine-loamy material over stratified, calcareous silty and clayey glaciolacustrine deposits

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 12 inches: clay loam
H3 - 12 to 20 inches: clay loam
H4 - 20 to 60 inches: stratified clay loam to silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 35 percent
Available water supply, 0 to 60 inches: High (about 9.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F094AA004MI - Snowy Wet Loamy Depression, F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Pickford

Setting

Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 14 to 30 inches of loamy and clayey material over calcareous clayey lacustrine deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 20 inches: silty clay
H3 - 20 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: F094AA004MI - Snowy Wet Loamy Depression, F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Tr—Tonkey-Hettinger-Pickford loams

Map Unit Setting

National map unit symbol: 6c8m
Elevation: 600 to 1,600 feet
Mean annual precipitation: 26 to 34 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 70 to 140 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 45 percent
Hettinger and similar soils: 30 percent
Pickford and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 30 inches: very fine sandy loam
H3 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Hettinger

Setting

Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 12 to 36 inches of fine-loamy material over stratified, calcareous silty and clayey glaciolacustrine deposits

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 12 inches: clay loam
H3 - 12 to 20 inches: clay loam
H4 - 20 to 60 inches: stratified clay loam to silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 35 percent
Available water supply, 0 to 60 inches: High (about 9.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Pickford

Setting

Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 14 to 30 inches of loamy and clayey material over calcareous clayey lacustrine deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 20 inches: silty clay
H3 - 20 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

UnA—Ubly-Nester complex, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 6c91
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Ubly and similar soils: 55 percent
Nester and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly

Setting
Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile
H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (three-dimensional): Rise

Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

UnB—Ubly-Nester complex, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6c92
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ubly and similar soils: 55 percent
Nester and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly

Setting

Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e

Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till, F094AA002MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F094AA002MI - Snowy Loamy Till, F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

UnD2—Ubly-Nester complex, 12 to 18 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c95
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Ubly, moderately eroded, and similar soils: 50 percent
Nester, moderately eroded, and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Montcalm

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear

Across-slope shape: Concave, convex
Hydric soil rating: No

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

UnE—Ubly-Nester complex, 18 to 25 percent slopes

Map Unit Setting

National map unit symbol: 6c96
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Ubly and similar soils: 50 percent
Nester and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Montcalm

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

UnE2—Ubly-Nester complex, 18 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: 6c97
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Ubly, moderately eroded, and similar soils: 50 percent
Nester, moderately eroded, and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly, Moderately Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile
H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities
Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester, Moderately Eroded

Setting
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile
H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam
H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities
Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Montcalm

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

UnF—Ubly-Nester complex, 25 to 35 percent slopes

Map Unit Setting

National map unit symbol: 6c98
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 33 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Ubly and similar soils: 50 percent

Nester and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ubly

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 30 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 24 inches: loamy sand
H3 - 24 to 60 inches: clay loam

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Nester

Setting

Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 14 inches: silty clay loam

H3 - 14 to 28 inches: clay loam
H4 - 28 to 60 inches: clay loam

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Montcalm

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Mcbride

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

WdD—Wind eroded land, strongly sloping

Map Unit Composition

Wind eroded land: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Leelanau County, Michigan

ArA—Alcona-Richter sandy loams, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6dj3
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Alcona and similar soils: 55 percent
Richter and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alcona

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified sandy and loamy glaciofluvial deposits and/or glaciolacustrine deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 12 inches: loamy fine sand
H3 - 12 to 18 inches: loamy sand
H4 - 18 to 24 inches: sandy loam
H5 - 24 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 30 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Richter

Setting

Landform: Lake plains, Glacial drainageways, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 27 inches: fine sandy loam
H3 - 27 to 60 inches: stratified loamy fine sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Minor Components

Hettinger

Percent of map unit: 15 percent
Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

ArB—Alcona-Richter sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6dj4

Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Alcona and similar soils: 65 percent
Richter and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alcona

Setting

Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified sandy and loamy glaciofluvial deposits and/or glaciolacustrine deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 12 inches: loamy fine sand
H3 - 12 to 18 inches: loamy sand
H4 - 18 to 24 inches: sandy loam
H5 - 24 to 60 inches: stratified loamy sand to sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 30 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Richter

Setting

Landform: Lake plains, Glacial drainageways, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 27 inches: fine sandy loam
H3 - 27 to 60 inches: stratified loamy fine sand to sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 5 percent
Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EdB—Eastport sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6djk
Elevation: 600 to 700 feet
Mean annual precipitation: 27 to 31 inches

Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 130 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Eastport and similar soils: 93 percent
Minor components: 7 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eastport

Setting

Landform: Beach ridges, Dunes, Lake terraces
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy eolian deposits

Typical profile

H1 - 0 to 3 inches: sand
H2 - 3 to 26 inches: sand
H3 - 26 to 60 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Alpena

Percent of map unit: 7 percent
Landform: Lake terraces, Beach ridges, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

EnB—Emmet-Leelanau complex, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6djn
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Emmet and similar soils: 60 percent
Leelanau and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Drumlins, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 4 percent
Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Alcona

Percent of map unit: 3 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Nester

Percent of map unit: 3 percent
Landform: Till plains, Moraines

Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EnC—Emmet-Leelanau complex, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6djp
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 60 percent
Leelanau and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Drumlins, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Nester

Percent of map unit: 5 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

East lake

Percent of map unit: 5 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

EnD—Emmet-Leelanau complex, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: 6djq
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 50 percent
Leelanau and similar soils: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Drumlins, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam

H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake
Percent of map unit: 5 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Kalkaska
Percent of map unit: 5 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Nester
Percent of map unit: 3 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Wallace
Percent of map unit: 3 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Alcona
Percent of map unit: 2 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope
Down-slope shape: Linear

Across-slope shape: Convex, linear
Hydric soil rating: No

Richter
Percent of map unit: 2 percent
Landform: Moraines, Glacial drainageways, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

EnE—Emmet-Leelanau complex, 18 to 25 percent slopes

Map Unit Setting
National map unit symbol: 6djr
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition
Emmet and similar soils: 50 percent
Leelanau and similar soils: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting
Landform: Moraines, Drumlins, Till plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile
H1 - 0 to 8 inches: sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities
Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Leelanau

Setting

Landform: Moraines, Till plains, Drumlins
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 10 percent
Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Nester

Percent of map unit: 10 percent
Landform: Moraines, Till plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EnF—Emmet-Leelanau complex, 25 to 50 percent slopes

Map Unit Setting

National map unit symbol: 6djt
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Emmet and similar soils: 45 percent
Leelanau and similar soils: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Drumlins, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest

Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 25 to 50 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 25 to 50 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

East lake

Percent of map unit: 13 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Nester

Percent of map unit: 12 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

EoC—Emmet-Mancelona gravelly sandy loams, 4 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6djw
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Emmet and similar soils: 70 percent
Mancelona and similar soils: 25 percent

Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Till plains, Drumlins, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 4 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 25 inches: loamy sand

H3 - 25 to 30 inches: gravelly sandy loam
H4 - 30 to 60 inches: very gravelly coarse sand

Properties and qualities

Slope: 4 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Nester

Percent of map unit: 3 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Kiva

Percent of map unit: 2 percent
Landform: Moraines, Lake plains, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

EoE—Emmet-Mancelona gravelly sandy loams, 18 to 35 percent slopes

Map Unit Setting

National map unit symbol: 6djy

Elevation: 600 to 1,400 feet
Mean annual precipitation: 22 to 44 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 60 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Emmet and similar soils: 60 percent
Mancelona and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Emmet

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 24 to 50 inches of loamy material over calcareous loamy till

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 26 inches: sandy loam
H3 - 26 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy loam

Properties and qualities

Slope: 18 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Description of Mancelona

Setting

Landform: Moraines, Outwash plains, Valley trains, Lake plains, Beach ridges
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 25 inches: loamy sand
H3 - 25 to 30 inches: gravelly sandy loam
H4 - 30 to 60 inches: very gravelly coarse sand

Properties and qualities

Slope: 18 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Lupton

Percent of map unit: 2 percent
Landform: Moraines, Depressions, Depressions, Depressions, Till plains, Lake terraces
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Markey

Percent of map unit: 2 percent
Landform: Depressions on moraines, Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Nester

Percent of map unit: 2 percent
Landform: Moraines, Till plains

Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Alpena

Percent of map unit: 2 percent
Landform: Moraines, Lake terraces, Beach ridges
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Kiva

Percent of map unit: 2 percent
Landform: Moraines, Lake plains, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Hm—Hettinger-Muck complex

Map Unit Setting

National map unit symbol: 6dk6
Elevation: 600 to 1,600 feet
Mean annual precipitation: 19 to 44 inches
Mean annual air temperature: 36 to 46 degrees F
Frost-free period: 60 to 172 days
Farmland classification: Not prime farmland

Map Unit Composition

Hettinger and similar soils: 45 percent
Muck: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hettinger

Setting

Landform: Depressions on lake plains
Landform position (three-dimensional): Talf

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 12 to 36 inches of fine-loamy material over stratified, calcareous silty and clayey glaciolacustrine deposits

Typical profile
H1 - 0 to 8 inches: loam
H2 - 8 to 23 inches: silty clay loam
H3 - 23 to 60 inches: stratified clay loam to silty clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 10.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Muck

Setting
Landform: Depressions
Parent material: Organic material

Typical profile
Oa1 - 0 to 11 inches: muck
Oa2 - 11 to 23 inches: muck
2C - 23 to 60 inches: loam

Properties and qualities
Slope: 0 to 2 percent
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 inches
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Very high (about 15.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Minor Components

Lupton

Percent of map unit: 5 percent
Landform: Lake terraces, Moraines, Till plains, Depressions, Depressions, Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Kiva

Percent of map unit: 5 percent
Landform: Lake plains, Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mancelona

Percent of map unit: 5 percent
Landform: Moraines, Beach ridges, Valley trains, Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Markey

Percent of map unit: 3 percent
Landform: Depressions on outwash plains, Depressions on lake plains, Depressions on moraines
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Tonkey

Percent of map unit: 3 percent
Landform: Depressions on depressions on lake plains, Depressions on glacial drainageways, Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Edwards

Percent of map unit: 2 percent
Landform: Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Roscommon

Percent of map unit: 2 percent
Landform: Depressions on outwash plains, Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear

Across-slope shape: Linear
Hydric soil rating: Yes

KaB—Kaleva sand, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2w5mq
Landscape: Till plains, lake plains, ice-margin complexes, outwash plains
Elevation: 580 to 1,110 feet
Mean annual precipitation: 30 to 41 inches
Mean annual air temperature: 41 to 52 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Kaleva and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kaleva

Setting

Landscape: Till plains, lake plains, ice-margin complexes, outwash plains
Landform: Moraines, Lake plains, Outwash plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy outwash

Typical profile

A - 0 to 3 inches: sand
E - 3 to 9 inches: sand
Bhs - 9 to 12 inches: sand
Bs1 - 12 to 19 inches: sand
Bs2 - 19 to 30 inches: sand
BC - 30 to 35 inches: sand
C - 35 to 80 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.1 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Pipestone

Percent of map unit: 5 percent
Landscape: Lake plains, ice-margin complexes, till plains, outwash plains
Landform: Lake plains, Moraines, Outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear
Hydric soil rating: No

Nessen

Percent of map unit: 3 percent
Landscape: Till plains, lake plains, ice-margin complexes, outwash plains
Landform: Lake plains, Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Fern

Percent of map unit: 2 percent
Landscape: Till plains
Landform: Moraines, Till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

KaC—Kaleva sand, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2w5mr
Landscape: Till plains, outwash plains, ice-margin complexes, lake plains

Elevation: 590 to 1,330 feet
Mean annual precipitation: 30 to 41 inches
Mean annual air temperature: 41 to 52 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Kaleva and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kaleva

Setting

Landscape: Till plains, outwash plains, ice-margin complexes, lake plains
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Sandy drift

Typical profile

A - 0 to 3 inches: sand
E - 3 to 9 inches: sand
Bhs - 9 to 12 inches: sand
Bs1 - 12 to 19 inches: sand
Bs2 - 19 to 30 inches: sand
BC - 30 to 35 inches: sand
C - 35 to 80 inches: sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.1 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F094AA005MI - Snowy Rich Sandy Drift, F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Nessen

Percent of map unit: 5 percent

Landscape: Till plains, outwash plains, ice-margin complexes, lake plains
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

KeB—Kalkaska-East Lake loamy sands, 0 to 6 percent slopes, lake moderated

Map Unit Setting

National map unit symbol: 6dkg
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Kalkaska and similar soils: 55 percent
East lake and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kalkaska

Setting

Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 15 inches: sand
H3 - 15 to 32 inches: sand
H4 - 32 to 60 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Moraines, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Leelanau

Percent of map unit: 2 percent
Landform: Drumlins, Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Leelanau

Percent of map unit: 2 percent
Landform: Moraines, Drumlins, Till plains
Landform position (three-dimensional): Rise

Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mancelona

Percent of map unit: 2 percent
Landform: Moraines, Outwash plains, Valley trains, Lake plains, Beach ridges
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Alcona

Percent of map unit: 2 percent
Landform: Moraines, Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Richter

Percent of map unit: 2 percent
Landform: Moraines, Glacial drainageways, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

LIB—Leelanau-East Lake loamy sands, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6dkp
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Leelanau and similar soils: 60 percent
East lake and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile
H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities
Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting
Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile
H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities
Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Alcona

Percent of map unit: 4 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Kalkaska

Percent of map unit: 3 percent
Landform: Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mancelona

Percent of map unit: 3 percent
Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

LIC—Leelanau-East Lake loamy sands, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 6dkq
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Leelanau and similar soils: 65 percent
East lake and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 3 percent
Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Kalkaska

Percent of map unit: 2 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Alcona

Percent of map unit: 2 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Tonkey

Percent of map unit: 1 percent
Landform: Depressions on depressions on lake plains, Depressions on glacial drainageways, Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Richter

Percent of map unit: 1 percent
Landform: Moraines, Glacial drainageways, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Nester

Percent of map unit: 1 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

LID—Leelanau-East Lake loamy sands, 12 to 18 percent slopes, lake moderated

Map Unit Setting

National map unit symbol: 6dkr
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau and similar soils: 65 percent
East lake and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines

Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained

Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Alcona
Percent of map unit: 3 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Kalkaska
Percent of map unit: 3 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Mancelona
Percent of map unit: 2 percent
Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Nester
Percent of map unit: 2 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest

Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

LIE—Leelanau-East Lake loamy sands, 18 to 25 percent slopes, lake moderated

Map Unit Setting

National map unit symbol: 6dks
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Leelanau and similar soils: 50 percent
East lake and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 18 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Mancelona

Percent of map unit: 4 percent
Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Nester

Percent of map unit: 4 percent
Landform: Moraines, Till plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Kalkaska

Percent of map unit: 4 percent
Landform: Moraines, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Alcona

Percent of map unit: 3 percent
Landform: Moraines, Outwash plains, Lake plains
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Hydric soil rating: No

LIF—Leelanau-East Lake loamy sands, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: 6dkt
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 36 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 70 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Leelanau and similar soils: 50 percent
East lake and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leelanau

Setting

Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 52 inches of sandy and loamy material over calcareous sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 28 inches: loamy sand
H3 - 28 to 36 inches: sandy loam
H4 - 36 to 60 inches: loamy sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Description of East Lake

Setting

Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Parent material: 20 to 40 inches of sandy material over calcareous, sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 26 inches: loamy sand
H3 - 26 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Minor Components

Kalkaska

Percent of map unit: 3 percent
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Mancelona

Percent of map unit: 3 percent
Landform: Beach ridges, Lake plains, Valley trains, Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Alcona

Percent of map unit: 3 percent
Landform: Lake plains, Outwash plains, Moraines
Landform position (two-dimensional): Backslope, footslope, toeslope

Landform position (three-dimensional): Interfluve, nose slope, side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Nester

Percent of map unit: 3 percent
Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Wind eroded land

Percent of map unit: 3 percent
Hydric soil rating: Unranked

Lm—Lupton-Markey mucks

Map Unit Setting

National map unit symbol: 6dkv
Elevation: 600 to 1,500 feet
Mean annual precipitation: 19 to 44 inches
Mean annual air temperature: 36 to 46 degrees F
Frost-free period: 60 to 172 days
Farmland classification: Not prime farmland

Map Unit Composition

Lupton and similar soils: 60 percent
Markey and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lupton

Setting

Landform: Lake terraces, Moraines, Till plains, Depressions, Depressions, Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Greater than 51 inches of organic material

Typical profile

Oa1 - 0 to 10 inches: muck
Oa2 - 10 to 60 inches: muck

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 23.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Description of Markey

Setting

Landform: Depressions on outwash plains, Depressions on lake plains, Depressions on moraines
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 16 to 51 inches of organic material over sandy glaciofluvial deposits

Typical profile

Oa - 0 to 20 inches: muck
2C - 20 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Minor Components

Roscommon

Percent of map unit: 5 percent
Landform: Depressions on outwash plains, Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Edwards

Percent of map unit: 5 percent
Landform: Depressions on moraines, Depressions on outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

MrB—Mancelona-Richter gravelly sandy loams, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6dl3
Elevation: 600 to 1,600 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Farmland of local importance

Map Unit Composition

Mancelona and similar soils: 70 percent
Richter and similar soils: 25 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mancelona

Setting

Landform: Moraines, Beach ridges, Valley trains, Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 18 to 40 inches of sandy and/or gravelly material over calcareous sandy and gravelly glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam
H2 - 8 to 25 inches: loamy sand
H3 - 25 to 30 inches: gravelly sandy loam
H4 - 30 to 60 inches: very gravelly coarse sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Hydrologic Soil Group: A
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: No

Description of Richter

Setting

Landform: Valley trains, Glacial drainageways, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 25 to 40 inches of sandy and/or loamy material over stratified, calcareous sandy and silty glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 27 inches: fine sandy loam
H3 - 27 to 60 inches: stratified loamy fine sand to sandy loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Ecological site: F096XA004MI - Snowy Loamy Depression
Hydric soil rating: No

Minor Components

Tonkey

Percent of map unit: 2 percent
Landform: Depressions on depressions on lake plains, Depressions on glacial drainageways, Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Epoufette

Percent of map unit: 2 percent
Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Wallace

Percent of map unit: 1 percent
Landform: Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

NtF3—Nester silty clay loam, 20 to 50 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 6dl9
Elevation: 600 to 1,400 feet
Mean annual precipitation: 27 to 32 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 90 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Nester, severely eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nester, Severely Eroded

Setting

Landform: Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest

Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: 20 to 36 inches of loamy and clayey material over calcareous loamy and clayey till

Typical profile

H1 - 0 to 6 inches: silty clay loam
H2 - 6 to 28 inches: silty clay loam
H3 - 28 to 60 inches: silty clay loam

Properties and qualities

Slope: 20 to 50 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F096XA003MI - Snowy Loamy Till
Hydric soil rating: No

Minor Components

Emmet

Percent of map unit: 4 percent
Landform: Till plains, Drumlins, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Leelanau

Percent of map unit: 3 percent
Landform: Drumlins, Till plains, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Omena

Percent of map unit: 3 percent
Landform: Drumlins, Moraines

Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Hydric soil rating: No

PpskaB—Pipestone-Kaleva sands, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 31gtn
Landscape: Lake plains, ice-margin complexes
Elevation: 580 to 720 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 45 to 46 degrees F
Frost-free period: 110 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Pipestone and similar soils: 45 percent
Kaleva and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pipestone

Setting

Landscape: Lake plains, ice-margin complexes
Landform: Lakebeds (relict), Drumlins
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, talf
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Typical profile

A - 0 to 4 inches: sand
E - 4 to 9 inches: sand
Bhs - 9 to 17 inches: sand
Bs - 17 to 31 inches: sand
C - 31 to 79 inches: sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)

Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water supply, 0 to 60 inches: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: A/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Description of Kaleva

Setting

Landscape: Outwash plains, ice-margin complexes, lake plains
Landform: Depressions, Drumlins, Lakebeds (relict)
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, nose slope, side slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Sandy outwash

Typical profile

A - 0 to 3 inches: sand
E - 3 to 9 inches: sand
Bhs - 9 to 12 inches: sand
Bs1 - 12 to 19 inches: sand
Bs2 - 19 to 30 inches: sand
BC - 30 to 35 inches: sand
C - 35 to 79 inches: sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.1 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F096XA006MI - Snowy Rich Sandy Drift
Hydric soil rating: No

Minor Components

Adrian

Percent of map unit: 10 percent
Landscape: Ice-margin complexes, lake plains
Landform: Drumlins, Lakebeds (relict)
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: F096XA014MI - Snowy Mucky Depression
Hydric soil rating: Yes

Kingsville

Percent of map unit: 10 percent
Landscape: Ice-margin complexes, lake plains
Landform: Drumlins, Lakebeds (relict)
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: F096XA011MI - Snowy Wet Sandy Depression
Hydric soil rating: Yes

Pt—Pits, gravel

Map Unit Composition

Pits, gravel: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

TmA—Tonkey-Munuscong-Iosco sandy loams, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 6dlh
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 40 percent
Iosco and similar soils: 25 percent
Munuscong and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on depressions on lake plains, Depressions on glacial drainageways, Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 20 inches: fine sandy loam
H3 - 20 to 60 inches: stratified sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Munuscong

Setting

Landform: Depressions on lake plains, Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of loamy material over clayey lacustrine deposits

Typical profile

H1 - 0 to 10 inches: sandy loam
H2 - 10 to 24 inches: fine sandy loam
H3 - 24 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None

Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Iosco

Setting

Landform: Lake plains, Outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 27 inches: sand
H3 - 27 to 34 inches: silty clay loam
H4 - 34 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Minor Components

Au gres

Percent of map unit: 4 percent
Landform: Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Nester

Percent of map unit: 3 percent
Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Kalkaska

Percent of map unit: 3 percent
Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

TmB—Tonkey-Munuscong-Iosco sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 6dlj
Elevation: 600 to 1,900 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 70 to 150 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonkey and similar soils: 35 percent
Munuscong and similar soils: 30 percent
Iosco and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonkey

Setting

Landform: Depressions on depressions on lake plains, Depressions on glacial drainageways, Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified loamy and sandy glaciofluvial deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 20 inches: fine sandy loam
H3 - 20 to 60 inches: stratified sand to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Munuscong

Setting

Landform: Depressions on outwash plains, Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of loamy material over clayey lacustrine deposits

Typical profile

H1 - 0 to 10 inches: sandy loam
H2 - 10 to 24 inches: fine sandy loam
H3 - 24 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F096XA005MI - Snowy Wet Loamy Depression
Hydric soil rating: Yes

Description of Iosco

Setting

Landform: Outwash plains, Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: 20 to 40 inches of sandy glaciofluvial deposits over loamy till or glacialacustrine deposits

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 27 inches: sand
H3 - 27 to 34 inches: silty clay loam
H4 - 34 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: F096XA008MI - Snowy Acidic Sandy Depression
Hydric soil rating: No

Minor Components

Au gres

Percent of map unit: 4 percent
Landform: Lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Nester

Percent of map unit: 4 percent
Landform: Till plains, Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Kalkaska

Percent of map unit: 4 percent
Landform: Outwash plains, Lake plains

Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Hettinger

Percent of map unit: 3 percent
Landform: Depressions on lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

WID—Wind eroded land, steep

Map Unit Setting

National map unit symbol: 6dln
Elevation: 600 to 1,000 feet
Mean annual precipitation: 28 to 36 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 100 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Wind eroded land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wind Eroded Land

Typical profile

H1 - 0 to 60 inches: sand

Interpretive groups

Land capability classification (irrigated): None specified
Ecological site: F096XA007MI - Snowy Sandy Drift
Hydric soil rating: Unranked

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX C: CITY OF TRAVERSE CITY CURRENT NPDES PERMIT

PERMIT NO. MI0027481

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the federal Clean Water Act (federal Water Pollution Control Act, 33 U.S.C., Section 1251 *et seq*., as amended); Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA); Part 41, Sewerage Systems, of the NREPA; and Michigan Executive Order 2019-06,

City of Traverse City
400 Boardman Avenue
Traverse City, MI 49684

is authorized to discharge from the **Traverse City Regional Wastewater Treatment Plant, l**ocated at

606 Hannah Avenue
Traverse City, MI 49686

designated as **Traverse City WWTP**

to the receiving water named the Boardman River in accordance with effluent limitations, monitoring requirements, and other conditions set forth in this permit.

This permit is based on an application received on March 25, 2024, and completed on May 29, 2024.

This permit takes effect on September 1, 2025. The provisions of this permit are severable. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term in accordance with applicable laws and rules. On its effective date, this permit shall supersede National Pollutant Discharge Elimination System (NPDES) Permit No. MI0027481 (expiring October 1, 2024).

This permit and the authorization to discharge shall expire at midnight on **October 1, 2029**. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit an application that contains such information, forms, and fees as are required by the Michigan Department of Environment, Great Lakes, and Energy (Department) by **April 4, 2029**.

Issued: August 27, 2025.

Original signed by Christine Alexander
Christine Alexander, Manager
Permits Section
Water Resources Division

PERMIT FEE REQUIREMENTS

In accordance with Section 324.3120 of the NREPA, the permittee shall make payment of an annual permit fee to the Department for each October 1 the permit is in effect regardless of occurrence of discharge. The permittee shall submit the fee in response to the Department's annual notice. Payment may be made electronically via the Department's MiEnviro Portal system. The MiEnviro Portal website is located at https://mienviro.michigan.gov/ncore/. Payment shall be submitted or postmarked by January 15 for notices mailed by December 1. Payment shall be submitted or postmarked no later than 45 days after receiving the notice for notices mailed after December 1.

Annual Permit Fee Classification: Municipal Major, less than 10 MGD (Individual Permit)

In accordance with Section 324.3132 of the NREPA, the permittee shall make payment of an annual biosolids land application fee to the Department if the permittee land applies biosolids. The permittee shall submit the fee in response to the Department's annual notice. Payment may be made electronically via the Department's MiEnviro Portal system. The MiEnviro Portal website is located at https://mienviro.michigan.gov/ncore/. Payment shall be submitted or postmarked no later than January 31 of each year for notices mailed by December 15. Payment shall be submitted or postmarked no later than 45 days after receiving the notice for notices mailed after December 15.

CONTACT INFORMATION

Unless specified otherwise, all contact with the Department required by this permit shall be made to the Cadillac District Office of the Water Resources Division. The Cadillac District Office is located at 120 West Chapin Street, Cadillac, MI 49601-2158, Telephone: 231-775-3960, Fax: 231-775-1511.

CONTESTED CASE INFORMATION

Any person who is aggrieved by this permit may file a sworn petition with the Michigan Administrative Hearing System within the Michigan Department of Licensing and Regulatory Affairs, c/o the Michigan Department of Environment, Great Lakes, and Energy, setting forth the conditions of the permit which are being challenged and specifying the grounds for the challenge. The Department of Licensing and Regulatory Affairs may reject any petition filed more than 60 days after issuance as being untimely.

CYBERSECURITY INFORMATION

Cybersecurity is becoming increasingly important as cyberattacks present an imminent and substantial risk to wastewater systems. Many wastewater systems have gaps in their existing cybersecurity practices that leave them vulnerable to potentially disabling attacks. The Department encourages the permittee to identify cybersecurity gaps in their wastewater system (e.g., changing default passwords in operational technology) and eliminate those vulnerabilities. The United States Environmental Protection Agency, the Cybersecurity and Infrastructure Security Agency, and the state of Michigan offer guidance and technical assistance for conducting cybersecurity risk assessments, developing and implementing a risk mitigation plan, and implementing cybersecurity controls. Applicable resources can be located at https://www.epa.gov/waterresilience/epa-cybersecurity-water-sector, https://www.cisa.gov/resources-tools/resources/top-cyber-actions-securing-water-systems, and https://www.michigan.gov/dtmb/services/cybersecurity.

PART I

Section A. Limitations and Monitoring Requirements

1. Final Effluent Limitations, Monitoring Point 001A

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge treated municipal wastewater from Monitoring Point 001A through Outfall 001. Outfall 001 discharges to the Boardman River at Latitude 44.75724, Longitude -85.61441. Such discharge shall be limited and monitored by the permittee as specified below.

Parameter	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD5)	1800	2800	(report)	lbs/day	25	40	(report)	mg/l	3xWeekly	24-Hr Composite
Total Suspended Solids (TSS)	2100	3200	(report)	lbs/day	30	45	(report)	mg/l	3xWeekly	24-Hr Composite
Ammonia Nitrogen (as N)										
Through August 31, 2028										
May – September	780	---	(report)	lbs/day	11	---	(report)	mg/l	3xWeekly	24-Hr Composite
Beginning September 1, 2028 (three years from effective date of permit)										
May	780	---	(report)	lbs/day	11	---	(report)	mg/l	3xWeekly	24-Hr Composite
June – August	695	---	(report)	lbs/day	9.8	---	(report)	mg/l	3xWeekly	24-Hr Composite
September	780	---	(report)	lbs/day	11	---	(report)	mg/l	3xWeekly	24-Hr Composite
October – November	1,100	---	(report)	lbs/day	16	---	(report)	mg/l	3x Weekly	24-Hr Composite
Total Phosphorus (as P)	35	---	(report)	lbs/day	0.5	---	(report)	mg/l	5xWeekly	24-Hr Composite
Chloride	---	---	---	---	---	---	(report)	mg/l	Monthly	24-Hr Composite
Sulfate	---	---	---	---	---	---	(report)	mg/l	Monthly	24-Hr Composite
Fecal Coliform Bacteria	---	---	---	---	200	400	(report)	cts/ 100 ml	3xWeekly	Grab
Perfluorooctanesulfonic Acid (PFOS)	---	---	---	---	---	---	(report)	ng/l	Quarterly	Grab
Total Mercury										
Corrected	(report)	---	(report)	lbs/day	(report)	---	(report)	ng/l	Quarterly	Calculation
Uncorrected	---	---	---	---	---	---	(report)	ng/l	Quarterly	Grab
Field Duplicate	---	---	---	---	---	---	(report)	ng/l	Quarterly	Grab
Field Blank	---	---	---	---	---	---	(report)	ng/l	Quarterly	Preparation
Laboratory Method Blank	---	---	---	---	---	---	(report)	ng/l	Quarterly	Preparation

PART I

Section A. Limitations and Monitoring Requirements

Parameter	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		
					Minimum % Monthly		Minimum % Daily			
CBOD5 Minimum % Removal	---	---	---	---	85	---	(report)	%	Monthly	Calculation
TSS Minimum % Removal	---	---	---	---	85	---	(report)	%	Monthly	Calculation
					Minimum Daily		Maximum Daily			
pH	---	---	---	---	6.5	---	9.0	S.U.	3xWeekly	Grab
Dissolved Oxygen										
June - August	---	---	---	---	6.0	---	---	mg/l	3xWeekly	Grab
September - May	---	---	---	---	4.0	---	---	mg/l	3xWeekly	Grab

The following design flow was used in determining the above limitations, but is not to be considered a limitation or actual capacity: 8.5 MGD

a. Narrative Standard
The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.

b. Sampling Locations
Samples for CBOD5, Total Suspended Solids, Ammonia Nitrogen, Total Phosphorus, Total mercury, Chloride, and Sulfate shall be taken prior to disinfection. Samples for Dissolved Oxygen, Fecal Coliform Bacteria, and pH shall be taken after disinfection. The Department may approve alternate sampling locations that are demonstrated by the permittee to be representative of the effluent.

c. Quarterly Monitoring
Quarterly samples shall be taken during the months of January, April, July, and October. If the facility does not discharge during these months, the permittee shall sample the next discharge occurring during the period in question. If the facility does not discharge during the period in question, a sample is not required for that period. For any month in which a sample is not taken, the permittee shall enter "*G" on the Discharge Monitoring Report (DMR). (For purposes of reporting on the Daily tab of the DMR, the permittee shall enter “*G” on the first day of the month only).

d. Ultraviolet Disinfection
It is understood that ultraviolet light will be used to achieve compliance with the fecal coliform limitations. If disinfection other than ultraviolet light will be used, the permittee shall notify the Department in accordance with Part II.C.12. of this permit.

e. Percent Removal Requirements
Monthly percent removal shall be calculated based on the monthly average effluent CBOD5 and TSS concentrations and the monthly average influent concentrations for approximately the same period. Daily percent removal shall be calculated based on the daily effluent CBOD5 and TSS concentrations and the daily influent concentrations for the same day. Reporting of Daily percent removal is only required on days on which an influent sample is obtained. The calculation shall be made as follows for each parameter: Percent removal = (influent concentration - effluent concentration) / influent concentration x 100.

PART I

Section A. Limitations and Monitoring Requirements

f. Monitoring Frequency Reduction for Perfluorooctanesulfonic Acid (PFOS).
After the submittal of at least 10 equally spaced sample results obtained over a minimum of three (3) months, the permittee may request, in writing, Department approval of a reduction in monitoring frequency for PFOS. This request shall contain an explanation as to why the reduced monitoring is appropriate. Upon receipt of written approval and consistent with such approval, the permittee may reduce the monitoring frequency indicated in Part I.A.1. of this permit. The monitoring frequency for PFOS, shall not be reduced to less than annually. The Department may revoke the approval for reduced monitoring at any time upon notification to the permittee.

g. Ongoing IPP Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Status Reporting Requirements
On or before **August 1 of each year**, the permittee shall complete and submit via MiEnviro Portal the Ongoing IPP PFAS Status Report form to report on progress made to reduce and/or eliminate sources of PFAS to the facility. This report shall include the results of all industrial user PFAS sampling obtained during the prior period. The permittee shall continue submitting these reports annually unless/until notification is received from the Department that this reporting may cease.

h. Total Mercury Testing and Additional Reporting Requirements
The analytical protocol for total mercury shall be in accordance with EPA Method 1631, Revision E, "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry," EPA-821-R-02-019, August 2002. The quantification level for total mercury shall be 0.5 ng/l, unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department **within 30 days** of such determination.

The use of clean technique sampling procedures is required unless the permittee can demonstrate to the Department that an alternate sampling procedure is representative of the discharge. Guidance for clean technique sampling is contained in EPA Method 1669, “Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (Sampling Guidance),” EPA-821-R96-001, July 1996. Information and data documenting the permittee's sampling and analytical protocols and data acceptability shall be submitted to the Department upon request.

In order to demonstrate compliance with EPA Method 1631E and EPA Method 1669, the permittee shall report, on the daily sheet, the analytical results of all field blanks and field duplicates collected in conjunction with each sampling event, as well as laboratory method blanks when used for blank correction. The permittee shall collect at least one (1) field blank and at least one (1) field duplicate per sampling event. If more than 10 samples are collected during a sampling event, the permittee shall collect at least one (1) additional field blank AND field duplicate for every 10 samples collected. A “sampling event” shall be defined herein as all sampling for total mercury conducted on the same day, provided the same sampling team collected all samples using the same sampling methods, procedures, and equipment on that day. Only field blanks or laboratory method blanks may be used to calculate a concentration lower than the actual sample analytical results (i.e., a blank correction). Only one (1) blank (field OR laboratory method) may be used for blank correction of a given sample result, and only if the blank meets the quality control acceptance criteria. If blank correction is not performed on a given sample analytical result, the permittee shall report under "Total Mercury – Corrected" the same value reported under "Total Mercury – Uncorrected." The field duplicate is for quality control purposes only; its analytical result shall not be averaged with the sample result.

i. Ammonia Nitrogen Certification
On or before **September 1, 2027**, the permittee shall submit to the Department for review and approval written certification that the facility will be able to meet the Ammonia Nitrogen (as N) effluent limits effective **September 1, 2028**, as set forth in Part I.A.1. of this permit, at the facility’s annual average design flow. Submittal of this certification shall include a supporting evaluation that considers, at a minimum, the facility design flow and other factors affecting nitrification at the facility. If the permittee is unable to certify that it will be able to meet the Ammonia Nitrogen (as N) limits effective **September 1, 2028**, then by the date specified herein, the permittee shall submit a negative certification including a

PART I

Section A. Limitations and Monitoring Requirements

supporting evaluation, and following Department review of that evaluation, this permit may be modified by the Department in accordance with applicable laws and rules.

PART I

Section A. Limitations and Monitoring Requirements

2. Quantification Levels and Analytical Methods for Selected Parameters

Maximum acceptable quantification levels (QLs) are specified for selected parameters in the table below. These QLs apply to all monitoring conducted in compliance with this permit if and when the parameters specified herein are monitored. This includes monitoring conducted to meet the requirements of the application for permit reissuance. These QLs shall be considered the maximum acceptable unless a higher QL is appropriate because of sample matrix interference. Justification for higher QLs shall be submitted to the Department **within 30 days** of such determination.

Where necessary to help ensure that the QLs specified herein can be achieved, analytical methods may also be specified in the table below. The sampling procedures, preservation and handling, and analytical protocol for all monitoring conducted in compliance with this permit, including monitoring conducted to meet the requirements of the application for permit reissuance, shall be in accordance with the methods specified herein, or in accordance with Part II.B.2. of this permit if no method is specified herein, unless an alternate method is approved by the Department. The Department will consider only alternate methods that meet the requirements of Part II.B.2. and whose QLs are at least as sensitive (i.e., low) as those specified herein. **Not all QLs are expressed in the same units in the table below**. The table is continued on the following page:

Parameter	QL	Units	Analytical Method
1,2-Diphenylhydrazine (as Azobenzene)	3.0	ug/l	
2,4,6-Trichlorophenol	5.0	ug/l	
2,4-Dinitrophenol	19	ug/l	
3,3'-Dichlorobenzidine	1.5	ug/l	
4-Chloro-3-Methylphenol	7.0	ug/l	
4,4'-DDD	0.01	ug/l	
4,4'-DDE	0.01	ug/l	
4,4'-DDT	0.01	ug/l	
Acrylonitrile	1.0	ug/l	
Aldrin	0.01	ug/l	
Alpha-Endosulfan	0.01	ug/l	
Alpha-Hexachlorocyclohexane	0.01	ug/l	
Antimony, Total	1	ug/l	
Arsenic, Total	1	ug/l	
Barium, Total	5	ug/l	
Benzidine	0.1	ug/l	
Beryllium, Total	1	ug/l	
Beta-Endosulfan	0.01	ug/l	
Beta-Hexachlorocyclohexane	0.01	ug/l	
Bis (2-Chloroethyl) Ether	1.0	ug/l	
Bis (2-Ethylhexyl) Phthalate	5.0	ug/l	
Boron, Total	20	ug/l	
Cadmium, Total	0.2	ug/l	
Chlordane	0.01	ug/l	
Chloride	1.0	mg/l	
Chromium, Hexavalent	5	ug/l	
Chromium, Total	10	ug/l	
Copper, Total	1	ug/l	
Cyanide, Available	2	ug/l	EPA Method OIA 1677
Cyanide, Total	5	ug/l	
Delta-Hexachlorocyclohexane	0.01	ug/l	

PART I

Section A. Limitations and Monitoring Requirements

Parameter	QL	Units	Analytical Method
Dieldrin	0.01	ug/l	
Di-N-Butyl Phthalate	9.0	ug/l	
Endosulfan Sulfate	0.01	ug/l	
Endrin	0.01	ug/l	
Endrin Aldehyde	0.01	ug/l	
Fluoranthene	1.0	ug/l	
Heptachlor	0.01	ug/l	
Heptachlor Epoxide	0.01	ug/l	
Hexachlorobenzene	0.01	ug/l	
Hexachlorobutadiene	0.01	ug/l	
Hexachlorocyclopentadiene	0.01	ug/l	
Hexachloroethane	5.0	ug/l	
Lead, Total	1	ug/l	
Lindane	0.01	ug/l	
Lithium, Total	10	ug/l	
Mercury, Total	0.5	ng/l	EPA Method 1631E
Nickel, Total	5	ug/l	
PCB-1016	0.1	ug/l	
PCB-1221	0.1	ug/l	
PCB-1232	0.1	ug/l	
PCB-1242	0.1	ug/l	
PCB-1248	0.1	ug/l	
PCB-1254	0.1	ug/l	
PCB-1260	0.1	ug/l	
Pentachlorophenol	1.8	ug/l	
Perfluorooctanesulfonic acid (PFOS)	2.0	ng/l	Analyses may be performed using EPA Method 1633A, ASTM D7979, or an isotope dilution method (sometimes referred to as Method 537 modified) until one or more analytical methods are promulgated at which time only promulgated methods may be used.
Perfluorooctanoic acid (PFOA)			
Perfluorobutanesulfonic acid (PFBS)			
Perfluorononanoic acid (PFNA)			
Perfluorohexanesulfonic acid (PFHxS)			
Phenanthrene	1.0	ug/l	
Selenium, Total	1.0	ug/l	
Silver, Total	0.5	ug/l	
Strontium, Total	1000	ug/l	
Sulfate	2.0	mg/l	
Sulfide, Total	20	ug/l	
Thallium, Total	1	ug/l	
Toxaphene	0.1	ug/l	
Vinyl Chloride	1.0	ug/l	
Zinc, Total	10	ug/l	

PART I

Section A. Limitations and Monitoring Requirements

3. Additional Monitoring Requirements

As a condition of this permit, the permittee shall annually monitor the discharge from monitoring point 001 for the constituents identified below in accordance with the schedule specified herein. This monitoring is an application requirement of 40 CFR 122.21(j), effective December 2, 1999. Testing shall be conducted in **October 2025**, **May 2026, March 2027**, and **August 2028**. Grab samples shall be collected for available cyanide, total phenols, and Volatile Organic Compounds identified below. For all other parameters, 24-hour composite samples shall be collected.

Test species for whole effluent toxicity monitoring shall include fathead minnow **and** *Ceriodaphnia dubia,* for a total of four (4) tests on each species. Testing and reporting procedures shall follow procedures contained in EPA-821-R-02-013, "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (Fourth Edition). When the effluent ammonia nitrogen (as N) concentration is greater than 3 mg/l, the pH of the toxicity test shall be maintained at a pH of 8 Standard Units. Acute and chronic toxicity data shall be included in the reporting for the toxicity test results. Toxicity test data acceptability is contingent upon the validation of the test method by the testing laboratory. Such validation shall be submitted to the Department upon request. The permittee shall report to the Department any whole effluent toxicity test results greater than 1.0 TU_A or 1.0 TU_C **within five (5) days** of becoming aware of the result.

The results of such additional monitoring shall be submitted with the application for reissuance (see the cover page of this permit for the application due date). The permittee shall notify the Department **within 14 days** of completing the monitoring for each month specified above in accordance with Part II.C.5. Additional reporting requirements are specified in Part II.C.11. If, upon review of the analysis, it is determined that additional requirements are needed to protect the receiving waters in accordance with applicable water quality standards, the permit may then be modified by the Department in accordance with applicable laws and rules.

Whole Effluent Toxicity

acute toxicity	chronic toxicity

Hardness

calcium carbonate

Metals (Total Recoverable), Cyanide and Total Phenols

antimony	arsenic	available cyanide	nickel
beryllium	cadmium	chromium	zinc
copper	lead	thallium	
selenium	silver	total phenols	

Volatile Organic Compounds

acrolein	acrylonitrile	benzene	bromoform
carbon tetrachloride	chlorobenzene	chlorodibromomethane	chloroethane
2-chloroethylvinyl ether	chloroform	dichlorobromomethane	1,1-dichloroethane
1,2-dichloroethane	trans-1,2-dichloroethylene	1,1-dichloroethylene	1,2-dichloropropane
1,3-dichloropropylene	ethylbenzene	methyl bromide	methyl chloride
methylene chloride	1,1,2,2-tetrachloroethane	tetrachloroethylene	toluene
1,1,1-trichloroethane	1,1,2-trichloroethane	trichloroethylene	vinyl chloride

Acid-Extractable Compounds

4-chloro-3-methylphenol	2-chlorophenol	2,4-dichlorophenol	2,4-dimethylphenol
4,6-dinitro-o-cresol	2,4-dinitrophenol	2-nitrophenol	4-nitrophenol
pentachlorophenol	phenol	2,4,6-trichlorophenol	

PART I

Section A. Limitations and Monitoring Requirements

Base/Neutral Compounds

acenaphthene	acenaphthylene	anthracene	benzidine
benzo(a)anthracene	benzo(a)pyrene	3,4-benzofluoranthene	benzo(ghi)perylene
benzo(k)fluoranthene	bis(2-chloroethoxy)methane	bis(2-chloroethyl)ether	bis(2-chloroisopropyl)ether
bis(2-ethylhexyl)phthalate	4-bromophenyl phenyl ether	butylbenzyl phthalate	2-chloronaphthalene
4-chlorophenyl phenyl ether	chrysene	di-n-butyl phthalate	di-n-octyl phthalate
dibenzo(a,h)anthracene	1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene
3,3'-dichlorobenzidine	diethyl phthalate	dimethyl phthalate	2,4-dinitrotoluene
2,6-dinitrotoluene	1,2-diphenylhydrazine	fluoranthene	fluorene
hexachlorobenzene	hexachlorobutadiene	hexachlorocyclopentadiene	hexachloroethane
indeno(1,2,3-cd)pyrene	isophorone	naphthalene	nitrobenzene
n-nitrosodi-n-propylamine	n-nitrosodimethylamine	n-nitrosodiphenylamine	phenanthrene
pyrene	1,2,4-trichlorobenzene		

4. Pollutant Minimization Program for Total Mercury

This condition is required, upon written notification by the Department or if the permittee notifies the Department that the final effluent concentration of total mercury has exceeded 5 ng/l, as specified in Part I.A.1. The goal of the Pollutant Minimization Program is to maintain the effluent concentration of total mercury at or below 1.3 ng/l. **Within 90 days** of written notification by the Department **or after the permittee notifies the Department** that the final effluent concentration of total mercury has exceeded 5 ng/l, the permittee shall submit to the Department an approvable Pollutant Minimization Program for mercury designed to proceed toward the goal.

The Pollutant Minimization Program shall include the following:

a. an annual review and semi-annual monitoring of potential sources of mercury entering the wastewater collection system;

b. a program for quarterly monitoring of influent and periodic monitoring of sludge for mercury; and

c. implementation of reasonable, cost-effective control measures when sources of mercury are discovered. Factors to be considered include significance of sources, economic considerations, and technical and treatability considerations.

On or before **March 31 of each year**, the permittee shall submit a status report for the previous calendar year to the Department that includes 1) the monitoring results for the previous year, 2) an updated list of potential mercury sources, and 3) a summary of all actions taken to reduce or eliminate identified sources of mercury.

Any information generated as a result of the Pollutant Minimization Program set forth in this permit may be used to support a request to modify the approved program or to demonstrate that the Pollutant Minimization Program requirement has been completed satisfactorily.

A request for modification of the approved program and supporting documentation shall be submitted in writing to the Department for review and approval. The Department may approve modifications to the approved program (approval of a program modification does not require a permit modification), including a reduction in the frequency of the requirements under items a. and b. above.

This permit may be modified in accordance with applicable laws and rules to include additional mercury conditions and/or limitations as necessary.

PART I

Section A. Limitations and Monitoring Requirements

5. Pollutant Minimization and Source Evaluation Program for Perfluorooctanesulfonic Acid (PFOS), Perfluorooctanoic Acid (PFOA), Perfluorobutanesulfonic Acid (PFBS), Perfluorononanoic Acid (PFNA), and Perfluorohexanesulfonic Acid (PFHxS)

The goal of the Pollutant Minimization and Source Evaluation Program is to identify and address sources of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), to reduce and maintain the effluent concentrations of PFOS, PFOA, PFBS, PFNA, and PFHxS at or below the water quality-based effluent limitations (WQBELs), and to reduce or maintain biosolids concentrations of PFOS and PFOA at or below the mitigation criteria defined in the Land Application of Biosolids Containing PFAS Interim Strategy. The WQBELs are 12 ng/l for PFOS; 1,000 ng/l for PFOA; 4,100,000 ng/l for PFBS; 180 ng/l for PFNA; and 1,300 ng/l for PFHxS.

a. **Within 90 days** of written notification by the Department, or after the permittee notifies the Department that the effluent concentration of an applicable PFAS has exceeded the WQBEL or the biosolids concentrations of an applicable PFAS has exceeded the mitigation criteria, the permittee shall submit to the Department for review and approval a Pollutant Minimization and Source Evaluation Program. The Pollutant Minimization and Source Evaluation Program shall be submitted in MiEnviro Portal via the "Pollutant Minimization and Source Evaluation Program for PFAS" schedule and include the following requirements.

1) the results of a survey of potential nondomestic sources of PFAS, including but not limited to commercial operations (e.g. laundries, dry cleaners, car washes, schools, and carpet cleaners), fire stations, and nondomestic users that are known or suspected to discharge PFAS. The survey shall include the following information:

a) the user's name and mailing address which shall include both the local facility address and the main office address, if different;

b) the principal enterprise(s) of the user; the product(s) produced and raw material(s) processed; the facility's production rate(s); and the Standard Industrial Classification (SIC) code(s);

c) the quantity and quality, if known, of process wastewater discharged (in gallons per day) and an indication of whether the discharge is continuous or batch; and

d) a description of any pretreatment provided prior to discharge to the wastewater collection system.

2) the results of a survey of contaminated sites and potential inflow and infiltration and/or collection system contamination from current and/or historical activities.

3) an evaluation of the results of the surveys conducted under items 1) and 2) above to determine probable sources of PFAS to the facility. The evaluation shall identify probable nondomestic sources, nondomestic users that are known or suspected to discharge PFAS, and contaminated sites with probable inflow and infiltration and/or collection system contamination from current and/or historical activities.

4) a monitoring plan, which shall include the following, at a minimum:

a) monitoring of wastewater from nondomestic sources known or suspected to discharge PFAS based on the survey conducted under item 1) above. Existing sample results may be submitted to the Department in lieu of collecting new samples for those pollutants;

PART I

Section A. Limitations and Monitoring Requirements

b) if applicable, a plan to collect and analyze wastewater samples from each contributing municipality, measure or estimate the volumes discharged, and calculate PFAS loadings;

c) a plan to collect and analyze samples from residential footing drains, sewer leads, the wastewater collection system, source water, and sewer contamination, as applicable, based on the survey conducted under item 2) above;

d) a plan for PFAS monitoring within the various facility operations to determine if contamination exists within the facility. This plan shall include establishing flows and loadings of PFOS within the facility. Alternatively, if existing data indicates that the facility is not a source of contamination, provide a written evaluation of the findings demonstrating this conclusion;

e) a schedule for conducting the monitoring outlined in items a) - d) above.

The monitoring plan submitted as part of the Pollutant Minimization and Source Evaluation Program shall be implemented upon approval by the Department in accordance with the approved schedule.

b. Based on the information generated by the Pollutant Minimization and Source Evaluation Program outlined above, the permittee may be required to undertake the following actions to address the source(s) of PFAS, as appropriate:

1) establish the legal authority necessary to control nondomestic users discharging PFAS;

2) develop an Industrial Pretreatment Program if Significant Industrial Users are identified;

3) conduct an inflow and infiltration study if contaminated groundwater and/or surface water entering the collection system is identified as a potential source; and

4) additional sampling within the collection system and/or facility to further identify source of PFAS.

c. On or before **August 1 of each year** following Department approval of the Pollutant Minimization and Source Evaluation Program, the permittee shall submit to the Department a status report for the period since the previous status report was submitted. Status reports shall be submitted in MiEnviro Portal via the “Pollutant Minimization and Source Evaluation Program for PFAS Status Report.” Status reports shall include, as applicable:

1) a complete list of known and potential sources;

2) a summary of monitoring data, including flow, from known and/or potential sources;

3) the compliance status of sources;

4) implemented measures to eliminate, reduce, or control sources, (prioritizing highest loadings and concentrations), and an assessment of the degree of success and the strategies used to measure success;

5) an evaluation of the facility’s influent, effluent, biosolids, and collection system PFAS data;

6) proposed measures and schedules for elimination, control, or reduction of any newly identified PFAS sources (prioritizing highest loadings and concentrations), and the strategies that will be used to measure success;

7) barriers to implementation and revisions to the implementation schedule; and

PART I

Section A. Limitations and Monitoring Requirements

8) laboratory reports, if not previously supplied.

Any information generated as a result of the Pollutant Minimization and Source Evaluation Program set forth in this permit may be used to support a request to modify the Pollutant Minimization and Source Evaluation Program or to demonstrate that the requirement has been completed satisfactorily.

A request for modification of the approved Pollutant Minimization and Source Evaluation Program shall be submitted in writing to the Department along with supporting documentation for review and approval. The Department may approve modifications to the approved Pollutant Minimization and Source Evaluation Program, including a reduction in the frequency of the influent and known or potential source monitoring requirements. Approval of a Pollutant Minimization and Source Evaluation Program modification does not require a permit modification.

This permit may be modified in accordance with applicable laws and rules to include additional PFAS conditions and/or limitations as necessary.

6. Untreated or Partially Treated Sewage Discharge Reporting and Testing Requirements

In accordance with Section 324.3112a of the NREPA, if untreated or partially treated sewage is directly or indirectly discharged from a sewer system onto land or into the waters of the state, the permittee shall immediately, but not more than 24 hours after the discharge begins, notify local health departments, a daily newspaper of general circulation in the county in which the permittee is located, and a daily newspaper of general circulation in the county or counties in which the municipalities whose waters may be affected by the discharge are located, that the discharge is occurring. The permittee shall also notify the Department via its MiEnviro Portal system on the form entitled “Report of Discharge (CSO/SSO/RTB).” The MiEnviro Portal website is located at https://mienviro.michigan.gov/ncore/. At the conclusion of the discharge, the permittee shall make all such notifications specified in, and in accordance with, Section 324.3112a of the NREPA, and shall notify the Department via its MiEnviro Portal system on the form entitled “Report of Discharge (CSO/SSO/RTB).”

The permittee shall also annually contact municipalities, including the superintendent of a public drinking water supply with potentially affected intakes, whose waters may be affected by the permittee's discharge of untreated or partially treated sewage, and if those municipalities wish to be notified in the same manner as specified above, the permittee shall provide such notification.

Additionally, in accordance with Section 324.3112a of the NREPA, each time a discharge of untreated or partially treated sewage occurs, the permittee shall test the affected waters for *Escherichia coli* to assess the risk to the public health as a result of the discharge and shall provide the test results to the affected local county health departments and to the Department. The results of this testing shall be submitted to the Department via MiEnviro Portal as part of the notification specified above, or, if the results are not yet available, submitted as soon as they become available. This testing is not required if it has been waived by the local health department, or if the discharge(s) did not affect surface waters. The testing shall be done at locations specified by each affected local county health department but shall not exceed 10 tests for each separate discharge event. The affected local county health department may waive this testing requirement if it determines that such testing is not needed to assess the risk to the public health as a result of the discharge event.

Permittees accepting sanitary or municipal sewage from other sewage collection systems are encouraged to notify the owners of those systems of the above reporting and testing requirements.

PART I

Section A. Limitations and Monitoring Requirements

7. Facility Contact

The "Facility Contact" was specified in the application. The permittee may replace the facility contact at any time, and shall notify the Department in writing **within 10 days** after replacement (including the name, address and telephone number of the new facility contact).

a. The facility contact shall be (or a duly authorized representative of this person):
- for a corporation, a principal executive officer of at least the level of vice president; or a designated representative if the representative is responsible for the overall operation of the facility from which the discharge originates, as described in the permit application or other NPDES form,
- for a partnership, a general partner,
- for a sole proprietorship, the proprietor, or
- for a municipal, state, or other public facility, either a principal executive officer, the mayor, village president, city or village manager or other duly authorized employee.

b. A person is a duly authorized representative only if:
- the authorization is made in writing to the Department by a person described in paragraph a. of this section; and
- the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the facility (a duly authorized representative may thus be either a named individual or any individual occupying a named position).

Nothing in this section releases the permittee from properly submitting reports and forms as required by law.

8. Monthly Operating Reports

Part 41 of Act 451 of 1994 as amended, specifically Section 324.4106 and associated R 299.2953, requires that the permittee file with the Department, on forms prescribed by the Department, operating reports showing the effectiveness of the treatment facility operation and the quantity and quality of liquid wastes discharged into waters of the state. Applicable forms and guidance are available on the Department's web site at https://www.michigan.gov/egle/about/Organization/Water-Resources/wastewater-construction. The permittee may use alternate forms if they are consistent with the approved treatment facility monitoring program. Unless the Department provides written notification to the permittee that monthly submittal of operating reports is required, operating reports that result from implementation of the approved treatment facility monitoring program shall be maintained on site for a minimum of three (3) years and shall be made available to the Department for review upon request.

Within 30 days of the effective date of this permit, the permittee shall submit to the Department either a revised treatment facility monitoring program to address monitoring requirement changes reflected in this permit, or justification explaining why monitoring requirement changes reflected in this permit do not necessitate revisions to the treatment facility monitoring program. Upon receipt of approval from the Department and consistent with such approval, the permittee shall implement the approved revised treatment facility monitoring program.

9. Asset Management

The permittee shall at all times properly operate and maintain all facilities (i.e., the sewer system and treatment works as defined in Part 41 of the NREPA), and control systems installed or used by the permittee to operate the sewer system and treatment works and achieve and maintain compliance with the conditions of this permit (also see Part II.D.3 of this permit). The requirements of an Asset Management Program function to achieve the goals of effective performance, adequate funding, and adequate operator staffing and training. Asset management is a planning process for ensuring that optimum value is gained for each asset and that financial resources are available to rehabilitate and replace those assets when necessary. Asset management is centered on a framework of five (5) core elements: the current state of the assets; the required sustainable level of service; the assets critical to sustained performance; the minimum life-cycle costs; and the best long-term funding strategy.

PART I

Section A. Limitations and Monitoring Requirements

a. Asset Management Program Requirements

The permittee shall continue to implement the Asset Management Plan approved on February 8, 2019, and approved modifications thereto. The Asset Management Plan contains a schedule for the development and implementation of an Asset Management Program that meets the requirements outlined below in 1) – 4):

1) *Maintenance Staff.* The permittee shall provide an adequate staff to carry out the operation, maintenance, repair, and testing functions required to ensure compliance with the terms and conditions of this permit. The level of staffing needed shall be determined by taking into account the work involved in operating the sewer system and treatment works, planning for and conducting maintenance, and complying with this permit.

2) *Collection System Map.* The permittee shall complete a map of the sewer collection system it owns and operates. The map shall be of sufficient detail and at a scale to allow easy interpretation. The collection system information shown on the map shall be based on current conditions and shall be kept up-to-date and available for review by the Department. **Note: Items below referencing combined sewer systems are not applicable to separate sewer systems.** Such map(s) shall include but not be limited to the following:

a) all sanitary sewer lines and related manholes;

b) all combined sewer lines, related manholes, catch basins and CSO regulators;

c) all known or suspected connections between the sanitary sewer or combined sewer and storm drain systems;

d) all outfalls, including the treatment plant outfall(s), combined sewer treatment facility outfalls, untreated CSOs, and any known SSOs;

e) all pump stations and force mains;

f) the wastewater treatment facility(ies), including all treatment processes;

g) all surface waters (labeled);

h) other major appurtenances such as inverted siphons and air release valves;

i) a numbering system which uniquely identifies manholes, catch basins, overflow points, regulators and outfalls;

j) the scale and a north arrow;

k) the pipe diameter, date of installation, type of material, distance between manholes, and the direction of flow; and

l) the manhole interior material, rim elevation (optional), and invert elevations.

PART I

Section A. Limitations and Monitoring Requirements

3) *Inventory and assessment of fixed assets.* The permittee shall complete an inventory and assessment of operations-related fixed assets including portions of the collection system owned and operated by the permittee. Fixed assets are assets that are normally stationary (e.g., pumps, blowers, buildings, manholes, and sewer lines). The inventory and assessment shall be based on current conditions and shall be kept up-to-date and available for review by the Department.

a) The fixed asset inventory shall include the following:

(1) a brief description of the fixed asset, its design capacity (e.g., pump: 120 gallons per minute), its level of redundancy, and its tag number if applicable;

(2) the location of the fixed asset;

(3) the year the fixed asset was installed;

(4) the present condition of the fixed asset (e.g., excellent, good, fair, poor); and

(5) the current fixed asset (replacement) cost in dollars for year specified in accordance with approved schedules;

b) The fixed asset assessment shall include a “Business Risk Evaluation” that combines the probability of failure of the fixed asset and the criticality of the fixed asset, as follows:

(1) Rate the probability of failure of the fixed asset on a scale of 1-5 (low to high) using criteria such as maintenance history, failure history, and remaining percentage of useful life (or years remaining);

(2) Rate the criticality of the fixed asset on a scale of 1-5 (low to high) based on the consequence of failure versus the desired level of service for the facility; and

(3) Compute the Business Risk Factor of the fixed asset by multiplying the failure rating from (1) by the criticality rating from (2).

4) *Operation, Maintenance & Replacement (OM&R) Budget and Rate Sufficiency for the Sewer System and Treatment Works.* The permittee shall complete an assessment of its user rates and replacement fund, including the following:

a) beginning and end dates of fiscal year;

b) name of the department, committee, board, or other organization that sets rates for the operation of the sewer system and treatment works;

c) amount in the permittee’s replacement fund in dollars for year specified in accordance with approved schedules;

d) replacement fund strategy of all assets with a useful life of 20 years or less;

e) expenditures for maintenance, corrective action and capital improvement taken during the fiscal year;

f) OM&R budget for the fiscal year; and

g) rate calculation demonstrating sufficient revenues to cover OM&R expenses. If the rate calculation shows there are insufficient revenues to cover OM&R expenses, the

PART I

Section A. Limitations and Monitoring Requirements

permittee shall document, within three (3) fiscal years after submittal of the Asset Management Plan, that there is at least one rate adjustment that reduces the revenue gap by at least 10 percent. The permittee may prepare and submit an alternate plan, subject to Department approval, for addressing the revenue gap. The ultimate goal of the Asset Management Program is to ensure sufficient revenues to cover OM&R expenses.

b. Annual Reporting

The permittee shall develop a written report that summarizes asset management activities completed during the previous year and planned for the upcoming year. The written report shall be submitted to the Department on or before **July 30th of each year**. The written report shall include:

1) a description of the staffing levels maintained during the year;

2) a description of inspections and maintenance activities conducted and corrective actions taken during the previous year;

3) expenditures for collection system maintenance activities, treatment works maintenance activities, corrective actions, and capital improvement during the previous year;

4) a summary of assets/areas identified for inspection/action (including capital improvement) in the upcoming year based on the five (5) core elements and the Business Risk Factors computed in accordance with condition a.3)b)(3) above;

5) a maintenance budget and capital improvement budget for the upcoming year that take into account implementation of an effective Asset Management Program that meets the five (5) core elements;

6) an updated asset inventory based on the original submission; and

7) an updated OM&R budget with an updated rate schedule that includes the amount of insufficient revenues, if any.

PART I

Section A. Limitations and Monitoring Requirements

10. Discharge Monitoring Report – Quality Assurance Study Program

The permittee shall participate in the Discharge Monitoring Report – Quality Assurance (DMR-QA) Study Program. The purpose of the DMR-QA Study Program is to annually evaluate the proficiency of all in-house and/or contract laboratory(ies) that perform, on behalf of the facility authorized to discharge under this permit, the analytical testing required under this permit. In accordance with Section 308 of the Clean Water Act (33 U.S.C. § 1318); and R 323.2138 and R 323.2154 of Part 21, Wastewater Discharge Permits, promulgated under Part 31 of the NREPA, participation in the DMR-QA Study Program is required for all major facilities, and for minor facilities selected for participation by the Department.

Annually and in accordance with DMR-QA Study Program requirements and submittal due dates, the permittee shall submit to the Michigan DMR-QA Study Program state coordinator all documentation required by the DMR-QA Study. DMR-QA Study Program participation is required only for the analytes required under this permit and only when those analytes are also identified in the DMR-QA Study.

If the permitted facility's status as a major facility should change, participation in the DMR-QA Study Program may be reevaluated. Questions concerning participation in the DMR-QA Study Program should be directed to the Michigan DMR-QA Study Program state coordinator.

All forms and instructions required for participation in the DMR-QA Study Program, including submittal due dates and state coordinator contact information, can be found at https://www.epa.gov/compliance/discharge-monitoring-report-quality-assurance-study-program.

11. Continuous Monitoring

If continuous monitoring equipment is used and becomes temporarily inoperable, the permittee shall manually obtain a minimum of three (3) equally spaced grab samples/readings within each 24-hour period for the affected parameter(s). On such days, in the comment field on the Daily tab of the DMR, the permittee shall indicate "continuous monitoring system inoperable," the date on which the system is expected to become operable again, and the number of samples/readings obtained during each 24-hour period.

12. PFAS Data Reporting Requirements

On or before **the 20th day of the month** following each month in which PFAS sampling is required, the permittee shall submit the complete laboratory analysis of each PFAS sample. This may be in addition to required DMR reporting. Submittals shall be made via MiEnviro Portal using the PFAS POTW Effluent Monitoring Report form. Until one or more analytical methods for PFAS are promulgated by EPA, the complete laboratory analysis of each PFAS sample shall constitute the first 28 analytes identified on the PFAS POTW Effluent Monitoring Report form. Following promulgation of one or more analytical methods for PFAS, the complete laboratory analysis of each PFAS sample shall constitute all analytes targeted by the method.

PART I

Section B. Stormwater Pollution Prevention

Section B. Stormwater Pollution Prevention is not required for this permit.

PART I

Section C. Industrial Waste Pretreatment Program

1. Federal Industrial Pretreatment Program

a. The permittee shall continue to implement the Federal Industrial Pretreatment Program (FIPP) approved on July 23, 1985, and any subsequent modifications approved up to the issuance of this permit. Approval of substantial program modifications after the issuance of this permit shall be incorporated into this permit by minor modification in accordance with 40 CFR 122.63.

b. The permittee shall comply with R 323.2301 through R 323.2317 of the Michigan Administrative Code (Part 23 Rules), the General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403), and the approved FIPP.

c. The permittee shall have the legal authority and necessary interjurisdictional agreements that provide the basis for the implementation and enforcement of the approved FIPP throughout the service area. The legal authority and necessary interjurisdictional agreements shall include, at a minimum, the authority to carry out the activities specified in R 323.2306(a).

d. The permittee shall develop procedures which describe, in sufficient detail, program commitments which enable implementation of the approved FIPP, 40 CFR Part 403, and the Part 23 Rules in accordance with R 323.2306(c).

e. The permittee shall establish an interjurisdictional agreement (or comparable document) with all tributary governmental jurisdictions. Each interjurisdictional agreement shall contain, at a minimum, the following:

1) identification of the agency responsible for the implementation and enforcement of the approved FIPP within the tributary governmental jurisdiction's boundaries; and

2) the provision of the legal authority which provides the basis for the implementation and enforcement of the approved FIPP within the tributary governmental jurisdiction's boundaries.

f. The permittee shall prohibit discharges that:

1) cause, in whole or in part, the permittee's failure to comply with any condition of this permit or the NREPA;

2) restrict, in whole or in part, the permittee's management of biosolids;

3) cause, in whole or in part, operational problems at the treatment facility or in its collection system;

4) violate any of the general or specific prohibitions identified in R 323.2303(1) and (2);

5) violate categorical standards identified in R 323.2311; and

6) violate local limits established in accordance with R 323.2303(4).

g. The permittee shall maintain a list of its nondomestic users that meet the criteria of a significant industrial user as identified in R 323.2302(cc).

h. The permittee shall develop an enforcement response plan which describes, in sufficient detail, program commitments which will enable the enforcement of the approved FIPP, 40 CFR Part 403, and the Part 23 Rules in accordance with R 323.2306(g).

i. The Department may require modifications to the approved FIPP which are necessary to ensure compliance with 40 CFR Part 403 and the Part 23 Rules in accordance with R 323.2309.

PART I

Section C. Industrial Waste Pretreatment Program

j. The permittee shall not implement changes or modifications to the approved FIPP without notification to the Department. Any substantial modification shall be subject to Department public noticing and approval in accordance with R 323.2309.

k. The permittee shall maintain an adequate revenue structure and staffing level for effective implementation of the approved FIPP.

l. The permittee shall develop and maintain, for a minimum of three (3) years, all records and information necessary to determine nondomestic user compliance with 40 CFR Part 403, Part 23 Rules and the approved FIPP. This period of retention shall be extended during the course of any unresolved enforcement action or litigation regarding a nondomestic user or when requested by the Department or the United States Environmental Protection Agency. All of the aforementioned records and information shall be made available upon request for inspection and copying by the Department and the United States Environmental Protection Agency.

m. The permittee shall evaluate the approved FIPP for compliance with the 40 CFR Part 403, Part 23 Rules and the prohibitions stated in item f. above. Based upon this evaluation, the permittee shall propose to the Department all necessary changes or modifications to the approved FIPP no later than the next Industrial Pretreatment Program Annual Report due date (see item p. below).

n. The permittee shall develop and enforce local limits to implement the prohibitions listed in item f above. Local limits shall be based upon data representative of actual conditions demonstrated in a maximum allowable headworks loading analysis. An evaluation of whether the existing local limits need to be revised shall be submitted to the Department by **September 1, 2026**. The submittal shall provide a technical evaluation of the basis upon which this determination was made which includes information regarding the maximum allowable headworks loading, collection system protection criteria, and worker health and safety, based upon data collected since the last local limits review.

The following pollutants shall be evaluated:

1) Arsenic, Cadmium, Chromium, Copper, Cyanide, Lead, Mercury, Nickel, Silver, and Zinc;

2) Pollutants that are subject to limits or monitoring in this permit;

3) Pollutants that have an existing local limit; and,

4) Other pollutants of concern which would reasonably be expected to be discharged or transported by truck or rail or otherwise introduced into the POTW.

o. The permittee is required under this permit and R 323.2303(4) of the Michigan Administrative Code to review and update their local limits when:

1) new pollutants are introduced;

2) new pollutants that were previously unevaluated are identified;

3) new water quality or biosolids standards are established or additional information becomes available about the nature of pollutants, such as removal rates and accumulation in biosolids; or

4) substantial increases of pollutants are proposed as required in the notification of new or increased uses in accordance with the provisions of 40 CFR 122.42.

p. On or before **April 1 of each year**, the permittee shall submit to the Department, as required by R 323.2310(8), an Industrial Pretreatment Program Annual Report on the status of program

PART I

Section C. Industrial Waste Pretreatment Program

implementation and enforcement activities. The reporting period shall begin on January 1 and end on December 31. At a minimum, the Industrial Pretreatment Program Annual Report shall include:

1) the Pretreatment Program Reports data identified in Appendix A to 40 CFR Part 127 – NPDES Electronic Reporting;

2) a summary of changes to the approved FIPP that have not been previously reported to the Department;

3) a summary of results of all the sampling and analyses performed of the wastewater treatment plant's influent, effluent, and biosolids conducted in accordance with approved methods during the reporting period. The summary shall include the monthly average, daily maximum, quantification level, and number of samples analyzed for each pollutant. At a minimum, the results of analyses for all locally limited parameters for at least one monitoring event that tests influent, effluent and biosolids during the reporting period shall be submitted with each report, unless otherwise required by the Department. Sample collection shall be at intervals sufficient to provide pollutant removal rates, unless the pollutant is not measurable; and

4) any other relevant information requested by the Department.

PART I

Section D. Residuals Management Program

1. Residuals Management Program for Land Application of Biosolids

The permittee is authorized to land-apply bulk biosolids or prepare bulk biosolids for land application in accordance with the permittee's approved Residuals Management Program (RMP) approved on June 18, 2001, and approved modifications thereto, and the requirements established in R 323.2401 through R 323.2418 of the Michigan Administrative Code (Part 24 Rules). The approved RMP, and any approved modifications thereto, are enforceable requirements of this permit. Incineration, landfilling and other residual disposal activities shall be conducted in accordance with Part II.D.7. of this permit. The Part 24 Rules can be obtained via the internet at https://www.michigan.gov/egle/about/organization/water-resources/biosolids/laws-and-rules.

a. Annual Report
On or before **October 30 of each year**, the permittee shall submit an annual report to the Department for the previous fiscal year of October 1 through September 30. The report shall be submitted electronically via the Department's MiEnviro Portal system at https://mienviro.michigan.gov/ncore/. At a minimum, the report shall contain:

1) a certification that current residuals management practices are in accordance with the approved RMP, or a proposal for modification to the approved RMP; and

2) a completed Annual Report Form for Reporting Biosolids, available at https://mienviro.michigan.gov/ncore/.

b. Modifications to the Approved RMP
Prior to implementation of modifications to the RMP, the permittee shall submit proposed modifications to the Department for approval. The approved modification shall become effective upon the date of approval. Upon written notification, the Department may impose additional requirements and/or limitations to the approved RMP as necessary to protect public health and the environment from any adverse effect of a pollutant in the biosolids.

c. Record Keeping
Records required by the Part 24 Rules shall be kept for a minimum of five (5) years. However, the records documenting cumulative loading for sites subject to cumulative pollutant loading rates shall be kept as long as the site receives biosolids.

d. Contact Information
RMP-related submittals shall be made to the Department.

PART II

Section A. Definitions

Part II may include terms and /or conditions not applicable to discharges covered under this permit.

Acute toxic unit (TUA) means 100/LC50 where the LC50 is determined from a whole effluent toxicity (WET) test which produces a result that is statistically or graphically estimated to be lethal to 50% of the test organisms.

Annual monitoring frequency refers to a calendar year beginning on January 1 and ending on December 31. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Authorized public agency means a state, local, or county agency that is designated pursuant to the provisions of Section 9110 of Part 91, Soil and Sedimentation Control, of the NREPA, to implement soil erosion and sedimentation control requirements with regard to construction activities undertaken by that agency.

Best management practices (BMPs) means structural devices or nonstructural practices that are designed to prevent pollutants from entering into stormwater, to direct the flow of stormwater, or to treat polluted stormwater.

Bioaccumulative chemical of concern (BCC) means a chemical which, upon entering the surface waters, by itself or as its toxic transformation product, accumulates in aquatic organisms by a human health bioaccumulation factor of more than 1000 after considering metabolism and other physiochemical properties that might enhance or inhibit bioaccumulation. The human health bioaccumulation factor shall be derived according to R 323.1057(5). Chemicals with half-lives of less than 8 weeks in the water column, sediment, and biota are not BCCs. The minimum bioaccumulation concentration factor (BAF) information needed to define an organic chemical as a BCC is either a field-measured BAF or a BAF derived using the biota-sediment accumulation factor (BSAF) methodology. The minimum BAF information needed to define an inorganic chemical as a BCC, including an organometal, is either a field-measured BAF or a laboratory-measured bioconcentration factor (BCF). The BCCs to which these rules apply are identified in Table 5 of R 323.1057 of the Water Quality Standards.

Biosolids are the solid, semisolid, or liquid residues generated during the treatment of sanitary sewage or domestic sewage in a treatment works. This includes, but is not limited to, scum or solids removed in primary, secondary, or advanced wastewater treatment processes and a derivative of the removed scum or solids.

Bulk biosolids means biosolids that are not sold or given away in a bag or other container for application to a lawn or home garden.

CAFO means concentrated animal feeding operation.

Certificate of Coverage (COC) is a document, issued by the Department, which authorizes a discharge under a general permit.

Chronic toxic unit (TUC) means 100/MATC or 100/IC25, where the maximum acceptable toxicant concentration (MATC) and IC25 are expressed as a percent effluent in the test medium.

Class B biosolids refers to material that has met the Class B pathogen reduction requirements or equivalent treatment by a Process to Significantly Reduce Pathogens (PSRP) in accordance with the Part 24 Rules, Land Application of Biosolids, promulgated under Part 31 of the NREPA. Processes include aerobic digestion, composting, anaerobic digestion, lime stabilization and air drying.

Combined sewer system is a sewer system in which stormwater runoff is combined with sanitary wastes.

Composite sample is a sample collected over time, either by continuous sampling or by mixing discrete samples. A composite sample represents the average wastewater characteristics present during the compositing period. Various methods for compositing are available and are based on either time or flow-proportioning, the choice of which will depend on the permit requirements.

PART II

Section A. Definitions

Continuous monitoring refers to sampling/readings that occur at regular and consistent intervals throughout a 24-hour period and at a frequency sufficient to capture data that are representative of the discharge. The maximum acceptable interval between samples/readings shall be one (1) hour.

Daily concentration
FOR PARAMETERS OTHER THAN pH, DISSOLVED OXYGEN, TEMPERATURE, AND CONDUCTIVITY – Daily concentration is the sum of the concentrations of the individual samples of a parameter taken within a calendar day divided by the number of samples taken within that calendar day. The daily concentration will be used to determine compliance with any maximum and minimum daily concentration limitations. For guidance and examples showing how to report and perform calculations using results below quantification levels, see the document entitled "Reporting Results Below Quantification," available at https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/MiEnviro/results-below-quantification.pdf.

FOR pH, DISSOLVED OXYGEN, TEMPERATURE, AND CONDUCTIVITY – The daily concentration used to determine compliance with maximum daily pH, temperature, and conductivity limitations is the highest pH, temperature, and conductivity readings obtained within a calendar day. The daily concentration used to determine compliance with minimum daily pH and dissolved oxygen limitations is the lowest pH and dissolved oxygen readings obtained within a calendar day.

Daily loading is the total discharge by weight of a parameter discharged during any calendar day. This value is calculated by multiplying the daily concentration by the total daily flow and by the appropriate conversion factor. The daily loading will be used to determine compliance with any maximum daily loading limitations. When required by the permit, report the maximum calculated daily loading for the month in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMRs.

Daily monitoring frequency refers to a 24-hour day. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Department means the Michigan Department of Environment, Great Lakes, and Energy.

Detection level means the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability.

Discharge means the addition of any waste, waste effluent, wastewater, pollutant, or any combination thereof to any surface water of the state.

EC_{50} means a statistically or graphically estimated concentration that is expected to cause 1 or more specified effects in 50% of a group of organisms under specified conditions.

Fecal coliform bacteria monthly
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a discharge event. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR. If the period in which the discharge event occurred was partially in each of two months, the calculated monthly value shall be reported on the DMR of the month in which the last day of discharge occurred.

PART II

Section A. Definitions

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a reporting month. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR.

Fecal coliform bacteria 7-day
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days of discharge during a discharge event. If the number of daily concentrations determined during the discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean value for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs. If the 7-day period was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days in a reporting month. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs. The first calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

Flow-proportioned composite sample is a composite sample in which either a) the volume of each portion of the composite is proportional to the effluent flow rate at the time that portion is obtained; or b) a constant sample volume is obtained at varying time intervals proportional to the effluent flow rate.

General permit means an NPDES permit authorizing a category of similar discharges.

Geometric mean is the average of the logarithmic values of a base 10 data set, converted back to a base 10 number.

Grab sample is a single sample taken at neither a set time nor flow.

IC_{25} means the toxicant concentration that would cause a 25% reduction in a nonquantal biological measurement for the test population.

Illicit connection means a physical connection to a municipal separate storm sewer system that primarily conveys non-stormwater discharges other than uncontaminated groundwater into the storm sewer; or a physical connection not authorized or permitted by the local authority, where a local authority requires authorization or a permit for physical connections.

Illicit discharge means any discharge to, or seepage into, a municipal separate storm sewer system that is not composed entirely of stormwater or uncontaminated groundwater. Illicit discharges include non-stormwater discharges through pipes or other physical connections; dumping of motor vehicle fluids, household hazardous wastes, domestic animal wastes, or litter; collection and intentional dumping of grass clippings or leaf litter; or unauthorized discharges of sewage, industrial waste, restaurant wastes, or any other non-stormwater waste directly into a separate storm sewer.

Individual permit means a site-specific NPDES permit.

PART II

Section A. Definitions

Inlet means a catch basin, roof drain, conduit, drain tile, retention pond riser pipe, sump pump, or other point where stormwater or wastewater enters into a closed conveyance system prior to discharge off site or into waters of the state.

Interference is a discharge which, alone or in conjunction with a discharge or discharges from other sources, both: 1) inhibits or disrupts a POTW, its treatment processes or operations, or its sludge processes, use or disposal; and 2) therefore, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or, of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent state or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including Title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including state regulations contained in any state sludge management plan prepared pursuant to Subtitle D of the SWDA), the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act. [This definition does not apply to sample matrix interference].

Land application means spraying or spreading biosolids or a biosolids derivative onto the land surface, injecting below the land surface, or incorporating into the soil so that the biosolids or biosolids derivative can either condition the soil or fertilize crops or vegetation grown in the soil.

LC_{50} means a statistically or graphically estimated concentration that is expected to be lethal to 50% of a group of organisms under specified conditions.

Maximum acceptable toxicant concentration (MATC) means the concentration obtained by calculating the geometric mean of the lower and upper chronic limits from a chronic test. A lower chronic limit is the highest tested concentration that did not cause the occurrence of a specific adverse effect. An upper chronic limit is the lowest tested concentration which did cause the occurrence of a specific adverse effect and above which all tested concentrations caused such an occurrence.

Maximum extent practicable means implementation of best management practices by a public body to comply with an approved stormwater management program as required by a national permit for a municipal separate storm sewer system, in a manner that is environmentally beneficial, technically feasible, and within the public body's legal authority.

MBTU/hr means million British Thermal Units per hour.

MGD means million gallons per day.

Monthly concentration is the sum of the daily concentrations determined during a reporting period divided by the number of daily concentrations determined. The calculated monthly concentration will be used to determine compliance with any maximum monthly concentration limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly concentration in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR. For guidance and examples showing how to report and perform calculations using results below quantification levels, see the document entitled "Reporting Results Below Quantification," available at https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/MiEnviro/results-below-quantification.pdf.

For minimum percent removal requirements, the monthly influent concentration and the monthly effluent concentration shall be determined. The calculated monthly percent removal, which is equal to 100 times the quantity [1 minus the quantity (monthly effluent concentration divided by the monthly influent concentration)], shall be reported in the "MINIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs.

PART II

Section A. Definitions

Monthly loading is the sum of the daily loadings of a parameter divided by the number of daily loadings determined during a reporting period. The calculated monthly loading will be used to determine compliance with any maximum monthly loading limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly loading in the "AVERAGE" column under "QUANTITY OR LOADING" on the DMR.

Monthly monitoring frequency refers to a calendar month. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Municipal separate storm sewer means a conveyance or system of conveyances designed or used for collecting or conveying stormwater which is not a combined sewer and which is not part of a POTW as defined in the Code of Federal Regulations at 40 CFR 122.2.

Municipal separate storm sewer system (MS4) means all separate storm sewers that are owned or operated by the United States, a state, city, village, township, county, district, association, or other public body created by or pursuant to state law, having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under state law, such as a sewer district, flood control district, or drainage district, or similar entity, or a designated or approved management agency under Section 208 of the Clean Water Act that discharges to the waters of the state. This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings.

National Pretreatment Standards are the regulations promulgated by or to be promulgated by the Federal Environmental Protection Agency pursuant to Section 307(b) and (c) of the Clean Water Act. The standards establish nationwide limits for specific industrial categories for discharge to a POTW.

No observed adverse effect level (NOAEL) means the highest tested dose or concentration of a substance which results in no observed adverse effect in exposed test organisms where higher doses or concentrations result in an adverse effect.

Noncontact cooling water is water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product or finished product.

Nondomestic user is any discharger to a POTW that discharges wastes other than or in addition to water-carried wastes from toilet, kitchen, laundry, bathing or other facilities used for household purposes.

Nonstructural controls are practices or procedures implemented by employees at a facility to manage stormwater or to prevent contamination of stormwater.

NPDES means National Pollutant Discharge Elimination System.

Outfall is the location at which a point source discharge first enters a surface water of the state.

Part 91 agency means an agency that is designated by a county board of commissioners pursuant to the provisions of Section 9105 of Part 91 of the NREPA; an agency that is designated by a city, village, or township in accordance with the provisions of Section 9106 of Part 91 of the NREPA; or the Department for soil erosion and sedimentation control activities under Part 615, Supervisor of Wells; Part 631, Reclamation of Mining Lands; or Part 632, Nonferrous Metallic Mineral Mining, of the NREPA, pursuant to the provisions of Section 9115 of Part 91 of the NREPA.

Part 91 permit means a soil erosion and sedimentation control permit issued by a Part 91 agency pursuant to the provisions of Part 91 of the NREPA.

PART II

Section A. Definitions

Partially treated sewage is any sewage, sewage and stormwater, or sewage and wastewater, from domestic or industrial sources that is treated to a level less than that required by the permittee's NPDES permit, or that is not treated to national secondary treatment standards for wastewater, including discharges to surface waters from retention treatment facilities.

PFAS means perfluoroalkyl and polyfluoroalkyl substances.

Point of discharge is the location of a point source discharge where stormwater is discharged directly into a separate storm sewer system.

Point source discharge means a discharge from any discernible, confined, discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, or rolling stock. Changing the surface of land or establishing grading patterns on land will result in a point source discharge where the runoff from the site is ultimately discharged to waters of the state.

Polluting material means any material, in solid or liquid form, identified as a polluting material under the Part 5 Rules, Spillage of Oil and Polluting Materials, promulgated under Part 31 of the NREPA (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

POTW is a publicly owned treatment work.

Predevelopment is the last land use prior to the planned new development or redevelopment.

Pretreatment is reducing the amount of pollutants, eliminating pollutants, or altering the nature of pollutant properties to a less harmful state prior to discharge into a public sewer. The reduction or alteration can be by physical, chemical, or biological processes, process changes, or by other means. Dilution is not considered pretreatment unless expressly authorized by an applicable National Pretreatment Standard for a particular industrial category.

Public (as used in the MS4 individual permit) means all persons who potentially could affect the authorized stormwater discharges, including, but not limited to, residents, visitors to the area, public employees, businesses, industries, and construction contractors and developers.

Public body means the United States; the state of Michigan; a city, village, township, county, school district, public college or university, or single-purpose governmental agency; or any other body which is created by federal or state statute or law.

Qualified Personnel means an individual who meets qualifications acceptable to the Department and who is authorized by an Industrial Stormwater Certified Operator to collect the stormwater sample.

Qualifying storm event means a precipitation event that results in a measurable amount of precipitation (i.e., a storm event that results in an actual discharge), and that follows the preceding storm event by at least 72 hours (i.e., three days). The 72-hour storm interval does not apply if documentation is provided showing that less than a 72-hour interval is representative for local storm events.

Quantification level means the measurement of the concentration of a contaminant obtained by using a specified laboratory procedure calculated at a specified concentration above the detection level. It is considered the lowest concentration at which a particular contaminant can be quantitatively measured using a specified laboratory procedure for monitoring of the contaminant.

Quarterly monitoring frequency refers to a three-month period, defined as January through March, April through June, July through September, and October through December (or otherwise defined in the permit). When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

PART II

Section A. Definitions

Regional Administrator is the Region 5 Administrator, U.S. EPA, located at R-19J, 77 W. Jackson Blvd., Chicago, Illinois 60604.

Regulated area means the permittee's urbanized area, where urbanized area is defined as a place and its adjacent densely populated territory that together have a minimum population of 50,000 people as defined by the United States Bureau of the Census and as determined by the latest available decennial census.

Secondary containment structure means a unit, other than the primary container, in which significant materials are packaged or held, which is required by state or federal law to prevent the escape of significant materials by gravity into sewers, drains, or otherwise directly or indirectly into any sewer system or to the surface waters or groundwaters of the state.

Separate storm sewer system means a system of drainage, including, but not limited to, roads, catch basins, curbs, gutters, parking lots, ditches, conduits, pumping devices, or man-made channels, which is not a combined sewer where stormwater mixes with sanitary wastes, and is not part of a POTW.

Significant industrial user is a nondomestic user that: 1) is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; or 2) discharges an average of 25,000 gallons per day or more of process wastewater to a POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewater); contributes a process waste stream which makes up five (5) percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the permittee as defined in 40 CFR 403.12(a) on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's treatment plant operation or violating any pretreatment standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

Significant materials means any material which could degrade or impair water quality, including but not limited to: raw materials; fuels; solvents, detergents, and plastic pellets; finished materials such as metallic products; hazardous substances designated under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (see 40 CFR 372.65); any chemical the facility is required to report pursuant to Section 313 of Emergency Planning and Community Right-to-Know Act (EPCRA); polluting materials as identified under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code); Hazardous Wastes as defined in Part 111, Hazardous Waste Management, of the NREPA; fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with stormwater discharges.

Significant spills and significant leaks means any release of a polluting material reportable under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

Special-use area means stormwater discharges for which the Department has determined that additional monitoring is needed from: secondary containment structures required by state or federal law; lands on Michigan's List of Sites of Environmental Contamination pursuant to Part 201, Environmental Remediation, of the NREPA; and/or areas with other activities that may contribute pollutants to the stormwater.

Stoichiometric means the quantity of a reagent calculated to be necessary and sufficient for a given chemical reaction.

Stormwater means stormwater runoff, snowmelt runoff, surface runoff and drainage, and non-stormwater included under the conditions of this permit.

Stormwater discharge point is the location where the point source discharge of stormwater is directed to surface waters of the state or to a separate storm sewer. It includes the location of all point source discharges where stormwater exits the facility, including outfalls which discharge directly to surface waters of the state, and points of discharge which discharge directly into separate storm sewer systems.

Structural controls are physical features or structures used at a facility to manage or treat stormwater.

PART II

Section A. Definitions

SWPPP means the Stormwater Pollution Prevention Plan prepared in accordance with this permit.

Tier I value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier I toxicity database.

Tier II value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier II toxicity database.

Total maximum daily loads (TMDLs) are required by the Clean Water Act for waterbodies that do not meet water quality standards. TMDLs represent the maximum daily load of a pollutant that a waterbody can assimilate and meet water quality standards, and an allocation of that load among point sources, nonpoint sources, and a margin of safety.

Toxicity reduction evaluation (TRE) means a site-specific study conducted in a stepwise process designed to identify the causative agents of effluent toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in effluent toxicity.

Water Quality Standards means the Part 4 Water Quality Standards promulgated pursuant to Part 31 of the NREPA, being R 323.1041 through R 323.1117 of the Michigan Administrative Code.

Weekly monitoring frequency refers to a calendar week which begins on Sunday and ends on Saturday. When required by this permit, an analytical result, reading, value, or observation shall be reported for that period if a discharge occurs during that period. If the calendar week begins in one month and ends in the following month, the analytical result, reading, value, or observation shall be reported in the month in which monitoring was conducted.

WWSL is a wastewater stabilization lagoon.

WWSL discharge event is a discrete occurrence during which effluent is discharged to the surface water up to 10 days of a consecutive 14-day period.

3-portion composite sample is a sample consisting of three equal-volume grab samples collected at equal intervals over an 8-hour period.

7-day concentration
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily concentrations determined. If the number of daily concentrations determined during the WWSL discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations. When required by the permit, report the maximum calculated 7-day concentration for the WWSL discharge event in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days in a reporting month divided by the number of daily concentrations determined. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations in the reporting month. When required by the permit, report the maximum calculated 7-day concentration for the month in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

PART II

Section A. Definitions

7-day loading
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily loadings determined. If the number of daily loadings determined during the WWSL discharge event is less than 7 days, the number of actual daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations. When required by the permit, report the maximum calculated 7-day loading for the WWSL discharge event in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days in a reporting month divided by the number of daily loadings determined. If the number of daily loadings determined is less than 7, the actual number of daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations in the reporting month. When required by the permit, report the maximum calculated 7-day loading for the month in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

12-month rolling average
When required by the permit, the 12-month rolling average is determined by adding the present monthly average result to the preceding 11 monthly average results and dividing the sum by 12. If sufficient data needed to calculate the 12-month rolling average is not yet available, enter "***E**" on the monthly DMR until 12 months, or the equivalent of 12 months, of monthly monitoring data have been obtained, then begin reporting the calculated 12-month rolling average as required. If quarterly monitoring requirements apply, quarterly monitoring shall be equivalent to three (3) months of monitoring in calculating the 12-month rolling average. If monitoring more frequent than monthly applies, determine the monthly average result by summing the results of all data obtained in a given month and dividing that sum by the total number of samples taken in that month.

24-hour composite sample is a flow-proportioned composite sample consisting of hourly or more frequent portions that are taken over a 24-hour period and in which the volume of each portion is proportional to the discharge flow rate at the time that portion is taken. A time-proportioned composite sample may be used upon approval from the Department if the permittee demonstrates it is representative of the discharge.

PART II

Section B. Monitoring Procedures

1. Representative Samples

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations promulgated pursuant to Section 304(h) of the Clean Water Act (40 CFR Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants), unless specified otherwise in this permit. **Test procedures used shall be sufficiently sensitive to determine compliance with applicable effluent limitations**. For lists of approved test methods, go to https://www.epa.gov/cwa-methods. Requests to use test procedures not promulgated under 40 CFR Part 136 for pollutant monitoring required by this permit shall be made in accordance with the Alternate Test Procedures regulations specified in 40 CFR Part 136.4. These requests shall be submitted to the Manager of the Permits Section, Water Resources Division, Michigan Department of Environment, Great Lakes, and Energy, P.O. Box 30458, Lansing, Michigan, 48909-7958. The permittee may use such procedures upon approval.

The permittee shall periodically calibrate and perform maintenance procedures on all analytical instrumentation at intervals to ensure accuracy of measurements. The calibration and maintenance shall be performed as part of the permittee's laboratory Quality Assurance/Quality Control program.

3. Instrumentation

The permittee shall periodically calibrate and perform maintenance procedures on all monitoring instrumentation at intervals to ensure accuracy of measurements.

4. Recording Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information: 1) the exact place, date, and time of measurement or sampling; 2) the person(s) who performed the measurement or sample collection; 3) the dates the analyses were performed; 4) the person(s) who performed the analyses; 5) the analytical techniques or methods used; 6) the date of and person responsible for equipment calibration; and 7) the results of all required analyses.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit, including all records of analyses performed, calibration and maintenance of instrumentation, and recordings from continuous monitoring instrumentation, shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the Department.

PART II

Section C. Reporting Requirements

1. Start-Up Notification

The permittee shall notify the Department of start-up if one of the following conditions applies and in accordance with the applicable condition:

a. Non-CAFOs

1) **If this is an individual permit** and the permittee will not discharge during the first 60 days following the effective date of this permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of this permit, and then again **60 days prior** to commencement of the discharge.

2) **If this is a general permit** and the permittee will not discharge during the first 60 days following the effective date of the Certificate of Coverage (COC) issued under this general permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of the COC, and then again **60 days prior** to commencement of the discharge.

b. CAFOs

1) **If this is an individual permit** and the permittee will not populate with animals during the first 60 days following the effective date of this permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of this permit, and then again **60 days prior** to populating with animals.

2) **If this is a general permit** and the permittee will not populate with animals during 60 days following the effective date of the Certificate of Coverage (COC) issued under this general permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of the COC, and then again **60 days prior** to populating with animals.

2. Submittal Requirements for Self-Monitoring Data

Part 31 of the NREPA (specifically Section 324.3110(7)); and R 323.2155(2) of Part 21, Wastewater Discharge Permits, promulgated under Part 31 of the NREPA, allow the Department to specify the forms to be utilized for reporting the required self-monitoring data. Unless instructed on the effluent limitations page to conduct "Retained Self-Monitoring," the permittee shall submit self-monitoring data via the Department's MiEnviro Portal system.

The permittee shall utilize the information provided on the MiEnviro Portal website, located at https://mienviro.michigan.gov/ncore/, to access and submit the electronic forms. Both monthly summary and daily data shall be submitted to the Department no later than the **20th day of the month** following each month of the authorized discharge period(s). The permittee may be allowed to submit the electronic forms after this date if the Department has granted an extension to the submittal date.

3. Retained Self-Monitoring Requirements

If instructed on the effluent limits page (or otherwise authorized by the Department in accordance with the provisions of this permit) to conduct retained self-monitoring, the permittee shall maintain a year-to-date log of retained self-monitoring results and, upon request, provide such log for inspection to the staff of the Department. Retained self-monitoring results are public information and shall be promptly provided to the public upon request.

PART II

Section C. Reporting Requirements

The permittee shall certify, in writing, to the Department, on or before **January 10 (April 1 for animal feeding operation facilities) of each year**, that: 1) all retained self-monitoring requirements have been complied with and a year-to-date log has been maintained; and 2) the application on which this permit is based still accurately describes the discharge. With this annual certification, the permittee shall submit a summary of the previous year's monitoring data. The summary shall include maximum values for samples to be reported as daily maximums and/or monthly maximums and minimum values for any daily minimum samples.

Retained self-monitoring may be denied to a permittee by notification in writing from the Department. In such cases, the permittee shall submit self-monitoring data in accordance with Part II.C.2., above. Such a denial may be rescinded by the Department upon written notification to the permittee. Reissuance or modification of this permit or reissuance or modification of an individual permittee's authorization to discharge shall not affect previous approval or denial for retained self-monitoring unless the Department provides notification in writing to the permittee.

4. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report. Such increased frequency shall also be indicated.

Monitoring required pursuant to Part 41 of the NREPA or Rule 35 of the Mobile Home Park Commission Act, 1987 PA 96, as amended, for assurance of proper facility operation, shall be submitted as required by the Department.

5. Compliance Dates Notification

Within 14 days of every compliance date specified in this permit, the permittee shall submit a written notification to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) indicating whether or not the particular requirement was accomplished. If the requirement was not accomplished, the notification shall include an explanation of the failure to accomplish the requirement, actions taken or planned by the permittee to correct the situation, and an estimate of when the requirement will be accomplished. If a written report is required to be submitted by a specified date and the permittee accomplishes this, a separate written notification is not required.

6. Noncompliance Notification

Compliance with all applicable requirements set forth in the Clean Water Act, Parts 31 and 41 of the NREPA, and related regulations and rules is required. All instances of noncompliance shall be reported as follows:

a. 24-Hour Reporting
Any noncompliance which may endanger health or the environment (including maximum and/or minimum daily concentration discharge limitation exceedances) shall be reported, verbally, **within 24 hours** from the time the permittee becomes aware of the noncompliance by calling the Department at the number indicated on the second page of this permit (or, if this is a general permit, on the COC). A written submission shall also be provided via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) **within five (5) days**.

b. Other Reporting
The permittee shall report, in writing via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), all other instances of noncompliance not described in a. above **at the time monitoring reports are submitted**; or, in the case of retained self-monitoring, **within five (5) days** from the time the permittee becomes aware of the noncompliance.

PART II

Section C. Reporting Requirements

Reporting shall include: 1) a description of the discharge and cause of noncompliance; and 2) the period of noncompliance, including exact dates and times, or, if not yet corrected, the anticipated time the noncompliance is expected to continue, and the steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

7. Spill Notification

The permittee shall immediately report any release of any polluting material which occurs to the surface waters or groundwaters of the state, unless the permittee has determined that the release is not in excess of the threshold reporting quantities specified in the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code), by calling the Department at the number indicated on the second page of this permit (or, if this is a general permit, on the COC); or, if the notice is provided after regular working hours, by calling the Department's 24-hour Pollution Emergency Alerting System telephone number, 1-800-292-4706.

Within 10 days of the release, the permittee shall submit to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) a full written explanation as to the cause of the release, the discovery of the release, response measures (clean-up and/or recovery) taken, and preventive measures taken or a schedule for completion of measures to be taken to prevent reoccurrence of similar releases.

8. Upset Noncompliance Notification

If a process "upset" (defined as an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee) has occurred, the permittee who wishes to establish the affirmative defense of upset shall notify the Department by telephone **within 24 hours** of becoming aware of such conditions; and **within five (5) days**, provide in writing, the following information:

a. that an upset occurred and that the permittee can identify the specific cause(s) of the upset;

b. that the permitted wastewater treatment facility was, at the time, being properly operated and maintained (note that an upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation); and

c. that the permittee has specified and taken action on all responsible steps to minimize or correct any adverse impact in the environment resulting from noncompliance with this permit.

No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

In any enforcement proceedings, the permittee, seeking to establish the occurrence of an upset, has the burden of proof.

9. Bypass Prohibition and Notification

a. Bypass Prohibition
Bypass is prohibited, and the Department may take an enforcement action, unless:

1) bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

PART II

Section C. Reporting Requirements

2) there were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass; and

3) the permittee submitted notices as required under 9.b. or 9.c. below.

b. Notice of Anticipated Bypass
If the permittee knows in advance of the need for a bypass, the permittee shall submit written notification to the Department before the anticipated date of the bypass. This notification shall be submitted **at least 10 days before** the date of the bypass; however, the Department will accept fewer than 10 days advance notice if adequate explanation for this is provided. The notification shall provide information about the anticipated bypass as required by the Department. The Department may approve an anticipated bypass, after considering its adverse effects, if it will meet the three (3) conditions specified in a. above.

c. Notice of Unanticipated Bypass
As soon as possible but no later than 24 hours from the time the permittee becomes aware of the unanticipated bypass, the permittee shall notify the Department by calling the number indicated on the second page of this permit (or, if this is a general permit, on the COC); or, if notification is provided after regular working hours, call the Department's 24-hour Pollution Emergency Alerting System telephone number, 1-800-292-4706.

d. Written Report of Bypass
A written submission shall be provided within five (5) working days of commencing any bypass to the Department, and at additional times as directed by the Department. The written submission shall contain a description of the bypass and its cause; the period of bypass, including exact dates and times, and if the bypass has not been corrected, the anticipated time it is expected to continue; steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass; and other information as required by the Department.

e. Bypass Not Exceeding Limitations
The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to ensure efficient operation. These bypasses are not subject to the provisions of 9.a., 9.b., 9.c., and 9.d., above. This provision does not relieve the permittee of any notification responsibilities under Part II.C.11. of this permit.

f. Definitions

1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

10. Bioaccumulative Chemicals of Concern (BCC)

Consistent with the requirements of R 323.1098 and R 323.1215 of the Michigan Administrative Code, the permittee is prohibited from undertaking any action that would result in a lowering of water quality from an increased loading of a BCC unless an increased use request and antidegradation demonstration have been submitted and approved by the Department.

PART II

Section C. Reporting Requirements

11. Notification of Changes in Discharge

The permittee shall notify the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), as soon as possible but **within no more than 10 days** of knowing, or having reason to believe, that any activity or change has occurred or will occur which would result in the discharge of: 1) detectable levels of chemicals on the current Michigan Critical Materials Register, priority pollutants or hazardous substances set forth in 40 CFR 122.21, Appendix D, or the Pollutants of Initial Focus in the Great Lakes Water Quality Initiative specified in 40 CFR 132.6, Table 6, which were not acknowledged in the application or listed in the application at less than detectable levels; 2) detectable levels of any other chemical not listed in the application or listed at less than detection, for which the application specifically requested information; or 3) any chemical at levels greater than five times the average level reported in the complete application (see the first page of this permit, for the date(s) the complete application was submitted). Any other monitoring results obtained as a requirement of this permit shall be reported in accordance with the compliance schedules.

12. Changes in Facility Operations

Any anticipated action or activity, including but not limited to facility expansion, production increases, or process modification, which will result in new or increased loadings of pollutants to the receiving waters must be reported to the Department a) by submission of an increased use request (application) and all information required under R 323.1098 (Antidegradation) of the Water Quality Standards or b) by written notice if the following conditions are met: 1) the action or activity will not result in a change in the types of wastewater discharged or result in a greater quantity of wastewater than currently authorized by this permit; 2) the action or activity will not result in violations of the effluent limitations specified in this permit; 3) the action or activity is not prohibited by the requirements of Part II.C.10.; and 4) the action or activity will not require notification pursuant to Part II.C.11. Following such written notice, the permit or, if applicable, the facility's COC, may be modified according to applicable laws and rules to specify and limit any pollutant not previously limited.

13. Transfer of Ownership or Control

In the event of any change in ownership or control of facilities from which the authorized discharge emanates, the following requirements apply: Not less than **30 days prior** to the actual transfer of ownership or control – for non-CAFOs, or **within 30 days** of the actual transfer of ownership or control – for CAFOs, the permittee shall submit to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) a written agreement between the current permittee and the new permittee containing: 1) the legal name and address of the new owner; 2) a specific date for the effective transfer of permit responsibility, coverage and liability; and 3) a certification of the continuity of or any changes in operations, wastewater discharge, or wastewater treatment.

If the new permittee is proposing changes in operations, wastewater discharge, or wastewater treatment, the Department may propose modification of this permit in accordance with applicable laws and rules.

14. Operations and Maintenance Manual

For wastewater treatment facilities that serve the public (and are thus subject to Part 41 of the NREPA), Section 4104 of Part 41 and associated Rule 2957 of the Michigan Administrative Code allow the Department to require an Operations and Maintenance (O&M) Manual from the facility. An up-to-date copy of the O&M Manual shall be kept at the facility and shall be provided to the Department upon request. The Department may review the O&M Manual in whole or in part at its discretion and require modifications to it if portions are determined to be inadequate.

At a minimum, the O&M Manual shall include the following information: permit standards; descriptions and operation information for all equipment; staffing information; laboratory requirements; record keeping requirements; a maintenance plan for equipment; an emergency operating plan; safety program information; and copies of all pertinent forms, as-built plans, and manufacturer's manuals.

PART II

Section C. Reporting Requirements

Certification of the existence and accuracy of the O&M Manual shall be submitted to the Department at least 60 days prior to start-up of a new wastewater treatment facility. Recertification shall be submitted **60 days prior to start-up** of any substantial improvements or modifications made to an existing wastewater treatment facility.

15. Signatory Requirements

All applications, reports, or information submitted to the Department in accordance with the conditions of this permit and that require a signature shall be signed and certified as described in the Clean Water Act and the NREPA.

The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six (6) months per violation, or by both.

The NREPA (Section 3115(2)) provides that a person who at the time of the violation knew or should have known that he or she discharged a substance contrary to this part, or contrary to a permit, COC, or order issued or rule promulgated under this part, or who intentionally makes a false statement, representation, or certification in an application for or form pertaining to a permit or COC or in a notice or report required by the terms and conditions of an issued permit or COC, or who intentionally renders inaccurate a monitoring device or record required to be maintained by the Department, is guilty of a felony and shall be fined not less than $2,500.00 or more than $25,000.00 for each violation. The court may impose an additional fine of not more than $25,000.00 for each day during which the unlawful discharge occurred. If the conviction is for a violation committed after a first conviction of the person under this subsection, the court shall impose a fine of not less than $25,000.00 per day and not more than $50,000.00 per day of violation. Upon conviction, in addition to a fine, the court in its discretion may sentence the defendant to imprisonment for not more than two (2) years or impose probation upon a person for a violation of this part. With the exception of the issuance of criminal complaints, issuance of warrants, and the holding of an arraignment, the circuit court for the county in which the violation occurred has exclusive jurisdiction. However, the person shall not be subject to the penalties of this subsection if the discharge of the effluent is in conformance with and obedient to a rule, order, permit, or COC of the Department. In addition to a fine, the attorney general may file a civil suit in a court of competent jurisdiction to recover the full value of the injuries done to the natural resources of the state and the costs of surveillance and enforcement by the state resulting from the violation.

16. Electronic Reporting

Upon notice by the Department that electronic reporting tools are available for specific reports or notifications, the permittee shall submit electronically via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) all such reports or notifications as required by this permit, on forms provided by the Department.

PART II

Section D. Management Responsibilities

1. Duty to Comply

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit, more frequently than, or at a level in excess of, that authorized, shall constitute a violation of the permit.

It is the duty of the permittee to comply with all the terms and conditions of this permit. Any noncompliance with the Effluent Limitations, Special Conditions, or terms of this permit constitutes a violation of the NREPA and/or the Clean Water Act and constitutes grounds for enforcement action; for permit or COC termination, revocation and reissuance, or modification; or denial of an application for permit or COC renewal.

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2. Operator Certification

The permittee shall have the waste treatment facilities under direct supervision of an operator certified at the appropriate level for the facility certification by the Department, as required by Sections 3110 and 4104 of the NREPA. Permittees authorized to discharge stormwater shall have the stormwater treatment and/or control measures under direct supervision of a stormwater operator certified by the Department, as required by Section 3110 of the NREPA.

3. Facilities Operation

The permittee shall, at all times, properly operate and maintain all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures.

4. Power Failures

In order to maintain compliance with the effluent limitations of this permit and prevent unauthorized discharges, the permittee shall either:

a. provide an alternative power source sufficient to operate facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit; or

b. upon the reduction, loss, or failure of one or more of the primary sources of power to facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit, the permittee shall halt, reduce or otherwise control production and/or all discharge in order to maintain compliance with the effluent limitations and conditions of this permit.

5. Adverse Impact

The permittee shall take all reasonable steps to minimize or prevent any adverse impact to the surface waters or groundwaters of the state resulting from noncompliance with any effluent limitation specified in this permit including, but not limited to, such accelerated or additional monitoring as necessary to determine the nature and impact of the discharge in noncompliance.

6. Containment Facilities

The permittee shall provide facilities for containment of any accidental losses of polluting materials in accordance with the requirements of the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code). For a POTW, these facilities shall be approved under Part 41 of the NREPA.

PART II

Section D. Management Responsibilities

7. Waste Treatment Residues

Residuals (i.e., solids, sludges, biosolids, filter backwash, scrubber water, ash, grit, or other pollutants or wastes) removed from or resulting from treatment or control of wastewaters, including those that are generated during treatment or left over after treatment or control has ceased, shall be disposed of in an environmentally compatible manner and according to applicable laws and rules. These laws may include, but are not limited to, the NREPA, Part 31 for protection of water resources, Part 55 for air pollution control, Part 111 for hazardous waste management, Part 115 for solid waste management, Part 121 for liquid industrial wastes, Part 301 for protection of inland lakes and streams, and Part 303 for wetlands protection. Such disposal shall not result in any unlawful pollution of the air, surface waters or groundwaters of the state.

8. Right of Entry

The permittee shall allow the Department, any agent appointed by the Department, or the Regional Administrator, upon the presentation of credentials and, for animal feeding operation facilities, following appropriate biosecurity protocols:

a. to enter upon the permittee's premises where an effluent source is located or any place in which records are required to be kept under the terms and conditions of this permit; and

b. at reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect process facilities, treatment works, monitoring methods and equipment regulated or required under this permit; and to sample any discharge of pollutants.

9. Availability of Reports

Except for data determined to be confidential under Section 308 of the Clean Water Act and Rule 2128 (R 323.2128 of the Michigan Administrative Code), all reports prepared in accordance with the terms of this permit and required to be submitted to the Department shall be available for public inspection via MiEnviro Portal (https://mienviro.michigan.gov/ncore/). As required by the Clean Water Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Clean Water Act and Sections 3112, 3115, 4106 and 4110 of the NREPA.

10. Duty to Provide Information

The permittee shall furnish to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), **within a reasonable time**, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or the facility's COC, or to determine compliance with this permit. The permittee shall also furnish to the Department, upon request, copies of records required to be kept by this permit.

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information.

PART II

Section E. Activities Not Authorized by This Permit

1. Discharge to the Groundwaters

This permit does not authorize any discharge to the groundwaters. Such discharge may be authorized by a groundwater discharge permit issued pursuant to the NREPA.

2. POTW Construction

This permit does not authorize or approve the construction or modification of any physical structures or facilities at a POTW. Approval for the construction or modification of any physical structures or facilities at a POTW shall be by permit issued under Part 41 of the NREPA.

3. Civil and Criminal Liability

Except as provided in permit conditions on "Bypass" (Part II.C.9. pursuant to 40 CFR 122.41(m)), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond the permittee's control, such as accidents, equipment breakdowns, or labor disputes.

4. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee may be subject under Section 311 of the Clean Water Act except as are exempted by federal regulations.

5. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 510 of the Clean Water Act.

6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize violation of any federal, state or local laws or regulations, nor does it obviate the necessity of obtaining such permits, including any other Department of Environment, Great Lakes, and Energy permits, or approvals from other units of government as may be required by law.

APPENDIX D: COST ESTIMATES

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506

Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**

LOCATION: **Traverse City, Michigan**

WORK: **Sanitary Sewer and Manhole Rehabilitation**

DATE: **3/26/2026**

PROJECT NO. **20260067**

ESTIMATOR:

CHECKED BY:

ENR CCI#:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Mobilization	3	EA	$50,000	$150,000
2	8-inch to 15-inch CIPP	4,000	LF	$150	$600,000
3	18-inch CIPP Lining	2,100	LF	$180	$378,000
4	24-inch CIPP Lining	1,600	LF	$200	$320,000
5	Manhole Rehabilitation	1,600	VLF	$1,000	$1,600,000
6					
7	**Construction Subtotal**				**$3,048,000**
8	Contingencies	20	%		$610,000
9	Engineering, Legal, and Administrative	10	%		$305,000
10	**TOTAL PROJECT COST**				**$3,963,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506
Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**
LOCATION: **Traverse City, Michigan**
WORK: **Front Street LS and Force Main**

DATE: **3/25/2021**
PROJECT NO. **20260067**
ESTIMATOR: **DIU**
CHECKED BY:
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Traffic Control (5% of Force Main Construction)	1	LS	$137,250	$137,250
2	20-inch DIP Force Main	2,500	LF	$750	$1,875,000
3	Flow Meter and Vault	1	LS	$70,000	$70,000
4	Bypass and Connections	1	LS	$250,000	$250,000
5	Cleanup and Restoration	1	LS	$50,000	$50,000
6	16-inch FM Rehabilitation/Lining	2,500	LF	$200	$500,000
7	Additional Wet Well Volume	1	LS	$500,000	$500,000
8	20-inch Pipe and Fittings	20	LF	$2,000	$40,000
9	Pump Replacement	3	EA	$75,000	$225,000
10	Odor Control System	1	LS	$75,000	$75,000
11	Jack and Bore 20-inch DIP under Railroad	150	LF	$1,500	$225,000
12					
13	**Construction Subtotal**				**$3,948,000**
14	General Conditions/Mobilization (10% of Construction Cost)	1	LS	$394,800	$394,800
15					
16	Contingencies	20	%		$790,000
17	Engineering, Legal, and Administrative	20	%		$790,000
	TOTAL PROJECT COST				**$5,930,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506

Telephone: (616) 454-4286

PROJECT:	**Traverse City CWSRF**	DATE:	**3/25/2021**
LOCATION:	**Traverse City, Michigan**	PROJECT NO.	**20260067**
		ESTIMATOR:	**DIU**
WORK:	**WWTP MBR Enclosure**	CHECKED BY:	
		CURRENT ENR:	

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	MBR Enclosure (105' x 55')	5775	SF	$300	$1,732,500
2	HVAC and Plumbing	1	LS	$125,000	$125,000
3	Structural Columns	16	EA	$25,000	$400,000
4	New 3T Hoist	1	LS	$500,000	$500,000
5					
6	**Construction Subtotal**				**$2,760,000**
7	General Conditions/Mobilization (10% of Construction Cost)	1	LS	$276,000	$276,000
8					
9	Contingencies	20	%		$552,000
10	Engineering, Legal, and Administrative	20	%		$552,000
	TOTAL PROJECT COST				**$4,140,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506
Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**
LOCATION: **Traverse City, Michigan**
WORK: **East Collection System Force Main Replacements**

DATE: **3/26/2026**
PROJECT NO. **20260067**
ESTIMATOR: **DIU**
CHECKED BY:
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Mobilization	1	LS	$75,000	$75,000
2	Traffic Control	1	LS	$20,000	$20,000
3	Bypass Pumping	1	LS	$75,000	$75,000
4	New Manholes	5	EA	$20,000	$100,000
5	Connect to Existing FM	4	EA	$10,000	$40,000
6	12-inch DIP Coast Guard LS Force Main	7,500	LF	$500	$3,750,000
7					
8	**Construction Subtotal**				**$4,060,000**
9					
10	Contingencies	20	%		$812,000
11	Engineering, Legal, and Administrative	20	%		$812,000
	TOTAL PROJECT COST				**$5,690,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506
Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**
LOCATION: **Traverse City, Michigan**
WORK: **WWTP Odor Control Improvements**

DATE: **3/25/2021**
PROJECT NO. **20260067**
ESTIMATOR: **DIU**
CHECKED BY:
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Mobilization (5% of Construction)	1	LS	$81,000	$81,000
2	Concrete Pad	50	CY	$1,200	$60,000
3	Odor Control Ducting	200	LF	$250	$50,000
4	Odor Control Package System	1	LS	$500,000	$500,000
5	Control Panel and Integration	1	LS	$150,000	$150,000
6	Electrical Installation	15	%	$841,000	$126,150
7	Mechanical Installation	20	%	$886,150	$177,230
8					
9	**Construction Subtotal**				**$1,150,000**
10	General Conditions/Mobilization (10% of Construction Cost)	1	LS	$115,000	$115,000
11					
12	Contingencies	20	%		$230,000
13	Engineering, Legal, and Administrative	20	%		$230,000
	TOTAL PROJECT COST				**$1,730,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506
Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**
LOCATION: **Traverse City, Michigan**
WORK: **East Front Sewer Improvements**

DATE: **3/26/2026**
PROJECT NO. **20260067**
ESTIMATOR: **DIU**
CHECKED BY:
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Mobilization	1	LS	$75,000	$75,000
2	Traffic Control	1	LS	$20,000	$20,000
3	Bypass Pumping	1	LS	$75,000	$75,000
4	Sewer Cleaning (Pre-lining), 24-inch Pipe	720	LF	$10.00	$7,200
5	Abandon 24-inch Sewer (Southern Sewer on East Front)	527	LF	$25	$13,175
6	CCTV Inspection (Pre-&-Post Lining) incl. Sewer to Abandon	1,250	LF	$7.0	$8,750
7	24-inch Cured-In-Place Pipe Lining	720	LF	$200	$144,000
8	Replace Sewer Leads on East Front	20	EA	$10,000	$200,000
9	New Manholes	1	EA	$20,000	$20,000
10	Connect to Existing Manhole	2	EA	$10,000	$20,000
11	24-inch Sewer	100	LF	$400	$40,000
12					
13	**Construction Subtotal**				**$624,000**
14					
15	Contingencies	20	%		$125,000
16	Engineering, Legal, and Administrative	20	%		$125,000
	TOTAL PROJECT COST				**$874,000**

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Engineering. Environment. Excellence.

1925 Breton Road SE, Suite 100; Grand Rapids, MI 49506
Telephone: (616) 454-4286

PROJECT: **Traverse City CWSRF**
LOCATION: **Traverse City, Michigan**
WORK: **WWTP Anaerobic Digester 4 Improvements**

DATE: **3/26/2026**
PROJECT NO. **20260067**
ESTIMATOR: **DIU**
CHECKED BY:
CURRENT ENR:

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Demolition of Existing Cover and Equipment	1	LS	$75,000	$75,000
2	Tank Cleaning	1	LS	$50,000	$50,000
3	Rehabilitation of Digester Walls	1,000	SF	$75	$75,000
4	Crack Repair of Digester Walls	500	LF	$50	$25,000
5	Digester Wall Lining	3,925	SF	$50	$196,250
6	Digester Gas Piping Replacement	100	LF	$250	$25,000
7	Waste Sludge Piping	100	LF	$250	$25,000
8	Replacement of 50-ft Digester Gas Holding Cover w/ Installation	1	EA	$975,000	$975,000
9	Digester Gas Handling Equipment	1	LS	$150,000	$150,000
10	Gas Mixing Equipment w/Installation	1	LS	$500,000	$500,000
11	Site Restoration	1	LS	$100,000	$100,000
12	Electrical Installation	15	%	$2,121,250	$318,188
13	Mechanical Installation	20	%	$2,196,250	$439,250
14	Misc. Painting	1	%	$2,196,250	$21,963
15					
16	**Construction Subtotal**				**$3,196,000**
17	General Conditions/Mobilization (10% of Construction Cost)	1	LS	$297,565	$297,565
18					
19	Contingencies	20	%		$640,000
20	Engineering, Legal, and Administrative	20	%		$640,000
	TOTAL PROJECT COST				**$4,480,000**

APPENDIX E: WASTEWATER ASSET MANAGEMENT PLAN

TRAVERSE CITY

Sanitary Sewer System
Asset Management Plan

May 2017

OHM Advisors®

Table of Contents

Acronyms iv

EXECUTIVE SUMMARY 1

I. Introduction 8

A. Mission Statement 8

B. Team 8

II. Inventory and Condition Assessment 9

A. NASSCO Rating System 9

B. Manholes 11

C. Sanitary Sewer 14

D. Force Mains 20

E. Pump Stations 20

III. Deterioration Forecasting 23

IV. Hydrologic and Hydraulic Modeling 26

A. Metering 26

B. Antecedent Moisture Model 26

C. Hydraulic Numeric Model 27

D. Recommendations 28

V. Level of Service 29

VI. Critical Assets 30

VII. Revenue Analysis 33

A. Capital Improvement Plan 33

B. O&M Strategies 33

VIII. On-Going Data Management 36

Figures

Figure 1 : Asset Management Team....2
Figure 2 : Portion of Sewer System Assessed....3
Figure 3 : Risk Equation....4
Figure 4 : Asset Management Team....8
Figure 5: NASSCO Metrics....10
Figure 6: Distribution of Wastewater Manholes Based on Installation Decade....11
Figure 7: Wastewater Manhole O&M Ratings....12
Figure 8: Wastewater Manhole Structural Ratings....12
Figure 9: Average Wastewater Manhole Condition Ratings Indices by Installation Decade....12
Figure 10: Wastewater Manhole Structural Ratings Indices by Decade....13
Figure 11: Wastewater Manhole O&M Ratings Indices by Decade....13
Figure 12: Manhole Defects....14
Figure 13: Wastewater Sewer Installation Inventory....15
Figure 14: Wastewater Sewer Diameter Inventory....15
Figure 15: Wastewater Sewer Material Inventory....16
Figure 16: Wastewater Sewer Structural Ratings....16
Figure 17: Wastewater Sewer O&M Ratings....16
Figure 18: Average Wastewater Sewer Condition Rating Indices by Installation Decade....17
Figure 19: Breakdown of Wastewater Sewer Pipe Structural Scores by Decade....17
Figure 20: Breakdown of Wastewater Sewer Pipe O&M Scores by Decade....18
Figure 21: Wastewater Sewer Defects....19
Figure 22: System Deterioration....24
Figure 23: System Deterioration Under Current Funding Level....25
Figure 24: System Deterioration Under Proposed Funding Level....25
Figure 25: Benchmarked Meter District Wetness....27
Figure 26: BRE Equation....30
Figure 27 : BRE Matrix....31
Figure 28: CIP and Risk Flow Chart....32
Figure 29: Data Management Process Diagram....36

Tables

Table 1: Summary of Level of Service Criteria 5
Table 2: Condition Rating Index 11
Table 3: Highest Rated Sewer System Structural Defects Extrapolation 18
Table 4: Highest Rated Sewer System Structural Defects by Diameter 19
Table 5: Prioritized Force Mains 20
Table 6: Pump Station Asset Probability of Failure 21
Table 7: Pump Station Issues 22
Table 8: Modeling Recommendations 28
Table 9: Level of Service Criteria, Performance Indicator, and Level 29
Table 10: Probability of Failure 30
Table 11: Consequence of Failure 31
Table 12: Estimated Cleaning and Inspection Costs for Pipes 34
Table 13 : Estimated Manhole Inspection Costs 34

Appendices

Appendix A: Condition Maps
Appendix B: Data Management and Editing
Appendix C: Force Main Inventory and Assessment Technical Memorandum
Appendix D: Pump Station Inventory and Assessment Technical Memorandum
Appendix E: Hydrologic and Hydraulic Technical Memorandum
Appendix F: Collection System Criticality and Capital Improvement Plan
Appendix G: CH2M WWTP CIP and O&M Strategies
Appendix H: Capital Improvement and Revenue Analysis

Acronyms

AMP – Asset Management Plan or Program

BRE – Business Risk Exposure

CIP – Capital Improvement Plan

CIPP – Cured-in-Place Pipe

CMMS – Computerized Management and Maintenance System

CoF – Consequence of Failure

GIS – Geographic Information Systems

I/I – Inflow and Infiltration

MACP – Manhole Assessment Certification Program

MDEQ – Michigan Department of Environmental Quality

NASSCO – National Association of Sewer Service Companies

O&M – Operations and Maintenance

PACP – Pipeline Assessment Certification Program

PoF – Probability of Failure

SAW – Wastewater Asset Management and Wastewater Grant

WWTP – Wastewater Treatment Plant

EXECUTIVE SUMMARY

The wastewater infrastructure system of Traverse City provides a critical service to its residents and businesses, providing for the collection and treatment of wastewater and protecting Grand Traverse Bay by discharging clean water through an advanced treatment process. Recognizing the importance of this wastewater system, Traverse City initiated a comprehensive assessment of its wastewater infrastructure.

This Asset Management Plan summarizes this assessment and includes key recommendations for future funding levels. This document was prepared using grant funding from the State of Michigan Stormwater, Asset Management and Wastewater (SAW) Grant Program and is intended to accomplish the following key goals:

- Provide the City with a new framework for collecting, organizing, and storing data for their wastewater collection system using the latest available hardware and software.
- Survey key system components to augment the City's existing Geographic Information System (GIS) database and to make it easier for future generations to access infrastructure data with greater ease.
- Add information for sewer material type, size, age, and depth to the GIS database.
- Physically evaluate the structural condition of all publicly-owned system components, including sanitary sewer pipes, manholes, pump stations, and force mains. Store the data in the City's GIS database.
- Analyze the flow capacity of the City's sanitary sewer pipes and identify where pipes should be enlarged to minimize overflow potential.
- Identify long-term operations and maintenance strategies to maintain a reasonable structural condition into perpetuity, including:
    - Regularly-scheduled sewer inspection (televising)
    - Repair and rehabilitation to address structural problems resulting from aging infrastructure
- Provide recommendations for developing a prioritized Capital Improvement Plan to be funded through the City's wastewater enterprise fund.

Mission Statement

One important element to an asset management program is a mission statement, which identifies the overarching purpose of the City's asset management program. The purpose of the City's asset management program is summarized by the following mission statement:

Enhance the safety, health, and quality of life for the people of Traverse City through the effective management and maintenance of its wastewater infrastructure.

Asset Management Team Leaders

The team leaders listed in Figure 1 are committed to the asset management mission statement and were instrumental in the progress made and findings outlined in this report. Further questions on the City's asset management program can be directed to these team members.

Larry LaCross

- GIS Coordinator
- llacross@traversecitymi.gov
- 231.922.4900 ext 130

Dave Green

- Director of Public Services
- dgreen@traversecitymi.gov
- 231.922.4900

Timothy Lodge, PE

- City Engineer
- tlodge@traversecitymi.gov
- 231.922.4455

Christine Black

- Asset Management/GIS Analyst
- cblack@traversecitymi.gov
- 231.922.4900 ext 131

John Travis

- Asset Management Technician
- jtravis@traversecitymi.gov
- 231.922.4900 ext 127

Figure 1 : Asset Management Team

Infrastructure Technology & Know-How

The City has made investments in updating their existing GIS database to make it easier for future generations to access infrastructure knowledge. These upgrades include the following:

- Surveyed key system components to augment the City's existing GIS database
- Procured and implemented Lucity, a computerized maintenance management system (CMMS), to not only house work order and call request information but also infrastructure condition information
- Added information for sewer material type, size, age, and depth to the GIS database
- Purchased tablets and mobile devices to improve access to real-time asset information and enhance field data collection
- Provide staff training on new hardware and software

Asset Inventory

An asset inventory is a list of the City's assets and their attributes. The City inventoried and digitized the majority of its sanitary sewer infrastructure, including manholes, sanitary sewers, force mains,

and pumping stations. The City is continuing to populate the attributes of the inventory using observations in the field while performing condition assessment. This inventory resides in the City's GIS and CMMS systems. The GIS framework was enhanced as part of this effort, making it easier for the City to store critical data for the location, size, material, install date, and condition of each wastewater asset.

Condition Assessment

Through a methodical sampling procedure, a representative sample of the City's sanitary sewer infrastructure (sanitary sewer pipes and manholes) has been assessed. The condition of the infrastructure is based on the National Association of Sewer Service Companies (NASSCO) condition grading system, which uses a scale of zero to five. Zero indicates the infrastructure is in very good condition, while five indicates the infrastructure is in very poor condition or has already failed. About 42% of the approximately 1,902-structure manhole network and about 47%[1] of the approximately 69 miles[2] of sanitary sewer pipe infrastructure has been condition assessed. City staff indicates that there are 81 miles of sanitary sewer in Traverse City; this difference is due to OHM identifying only those sewer segments noted as Traverse City-owned assets instead of including all public assets from the geodatabase provided to OHM in April 2017, and it does not impact the findings of this Asset Management Plan. The assets within the City's nine pumping stations were also inventoried and assessed. The major components inventoried within each station include but are not limited to pumps, check/control valves, motors, level control systems, backup power, structure, wet well, valve vault, and telemetry. An analysis of force main age, material, and break history determined the likelihood of failure for force main segments, which were not physically assessed due to concerns about removing and repairing force main segments.

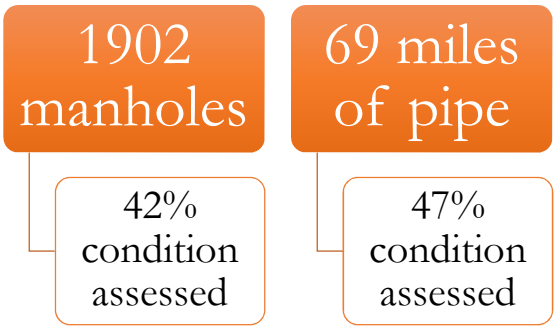


Figure 2 : Portion of Sewer System Assessed

It was also observed that:

- Manhole infrastructure exhibits age-appropriate wear with an average structural rating of approximately 1.75 and average O&M rating of 1.96. Structural manhole defects were predominately related to brickwork. O&M manhole issues were driven by deposits, roots, obstructions, and infiltration.

[1] The percent of pipes assessed is based on the March 2017 data deliverable from the city and their corresponding GIS pipe lengths.
[2] Traverse City Owned pipes as defined in the provided April 2017 Geodatabase (*SSGravityMain* Layer) were used for analysis.

- Sewer infrastructure has an average structural rating 1.82 and average O&M rating of 1.98. The predominant structural defects as observed in the wastewater system are cracks or fractures and pipe failures; the most common O&M defects in the surveyed system are soil/dirt/rock deposits and roots.
- The infrastructure will continue to degrade over time, for example, even though the average condition of the manhole infrastructure is between a score of 1 (minimal wear and good working) and 2 (moderate wear but still functional) per the 2016 assessment data, a small percent of the infrastructure has a condition rating of 5; this percentage will grow over time.

Criticality and Risk

The investigation leading to the identification of critical sewer infrastructure involved the determination of business risk, which is identified as the combination of the probability of the infrastructure failing as well as the consequence of its failure as shown in Figure 3.

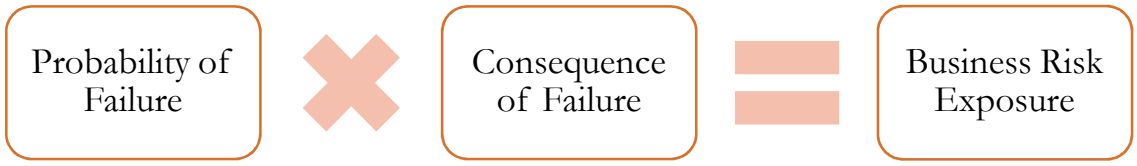


Figure 3 : Risk Equation

The probability of failure is related to the physical condition of an asset. The consequence of failure focuses on the economic losses and impacts to society due to an asset's failure. The following factors were combined to determine the consequence of failure for manholes, sanitary sewer and force mains:

- Network Position – the sum of upstream sewers discharging to a structure
- Diameter/Size – the relative size of the asset with respect to the rest of the system
- Restoration Type/Accessibility – refers to the cost to restore the surface above the asset and if traffic control is needed
- Environment – proximity to sensitive environmental features like Boardman River, Kid's Creek, Grand Traverse Bay, etc.
- Critical Users – important system users (Munson Hospital)

For pumping station assets, probability of failure was based on the condition and the consequence of failure was determined by the effect of an individual asset failure on system operations.

Level of Service

The City, in line with its mission statement outlined earlier, adopted level of service criteria's, which it plans on using as guidelines to manage the sanitary sewer system. These level of service criteria's are summarized in Table 1.

Table 1: Summary of Level of Service Criteria

Key Service Criteria	Performance Indicator	Target Level of Service
Asset Condition Assessment	PACP & MACP Inspections per Year*	• MACP inspect a minimum of 380 manholes per year, approximately 20% of the system • PACP inspect a minimum of 14 miles of sewer per year, approximately 20 % of the system
Meter Updates and Radio Reads	Replace existing meters with the new sensus meters and install radio reads for higher accuracy of reads.	**
Regulatory Compliance	Compliance with MDEQ Sanitary Sewer Overflow (SSO) Policy and the Clean Water Act	Continue to comply with the MDEQ SSO policy and The Clean Water Act
Service Delivery and Customer Communication	Utilize Lucity Software to aid in utility management and promote customer communication, increase effort to reduce number of sewer calls and response time	Respond to customer complaints and requests within one hour
O&M Optimization	Regular cleaning and maintenance of the collection system	Clean and maintain 20% of the system per year

* Pipe Assessment Certification Program (PACP), to assess sanitary sewer condition
  Manhole Assessment Certification Program (MACP), to assess manhole condition

** City to review and provide input. Information pulled from City's 2016-2017 Annual Budget Report.

Revenue Structure and Capital Improvement Plan

The condition assessment helped identify capital improvements that will allow the City to operate at its maximum potential. Additional long-term operations and maintenance strategies will provide the means to maintain a sound structural condition into perpetuity, including:

- Regularly-scheduled sewer, manhole, and pump station inspection
- Repair and rehabilitation to address structural problems resulting from aging infrastructure
- Upgrades to the City's wastewater treatment facilities, many of which have aged beyond their useful service lives

As communities like Traverse City have developed and aged, the buried infrastructure is deteriorating. Unless the City begins to systematically repair, rehabilitate, and/or replace these aging components, City residents and businesses will experience a decreased level of service. The increased level of investment is significant, and will require increased revenues.

Although the City currently has an annual budget of approximately $6 million for its wastewater collection and treatment system, the recommendations in this Asset Management Plan would result in a new annual budget of approximately $9 million. The primary reasons for this increase are:

1. Increased investment in sewer/manhole rehabilitation, repair, and/or replacement for the City's aging infrastructure.
2. Systematic replacement of older force mains, which have aged well beyond their typical service lives.
3. Additional investment at the Wastewater Treatment Plant, with multiple projects to be identified in the upcoming Facility Plan.
4. Upgrades to pump stations that will require higher flow capacities to serve growing areas.
5. Targeted replacement of undersized sanitary sewers, as identified in this report.
6. Increased attention to sewer/manhole inspections and ongoing updates to this Asset Management Plan.

The City Treasurer has reviewed the proposed level of investment for the collection system, pump stations, and the WWTP and has provided the following recommendations for rate increases to address the increased investment need:

- 2017-2018 Budget Year: Increase the base rate from $36.00 per the first 600 cubic feet to $37.00 per the first 600 cubic feet, and increase the next tier from $42.00 per 1,000 cubic feet to $43.00 per 1,000 cubic feet.

- 2018-2019 Budget Year: Increase the base rate from $37.00 per the first 600 cubic feet to $47.00 per the first 600 cubic feet, and increase the next tier from $43.00 per 1,000 cubic feet to $53.00 per 1,000 cubic feet

The recommended rate increases for the 2018-2019 Budget year are relatively large, and should be revisited as the WWTP Facility Plan is developed. Depending on the speed at which the City is able to mobilize the increased investment in the collection and treatment systems, the rate increases may be adjusted or delayed to subsequent years.

See Appendix H for a comprehensive table of proposed investments during the next ten years. This table combines the recommendations from this Asset Management Plan with the cost projections from CH2M on the pumping and treatment facilities they manage.

I. Introduction

In December 2013, the Traverse City applied for and received a Stormwater, Asset Management, and Wastewater (SAW) grant from the Michigan Department of Environmental Quality (MDEQ) (which required a City matching contribution) in order to develop an Asset Management Program or Plan (AMP) for the City's wastewater system. This report summarizes the progress and findings of that program.

The International Infrastructure Management Manual defines the goal of an asset management program as meeting a required level of service in the most cost-effective way through the creation, acquisition, operation, maintenance, rehabilitation, and disposal of assets to provide for present and future customers. Such a program entails several components, which are detailed in this report, along with the means by which the City addressed these components.

A. Mission Statement

The purpose of the City's asset management program is summarized by the following mission statement:

Enhance the safety, health, and quality of life for the people of Traverse City through the effective management and maintenance of its wastewater infrastructure.

B. Team

The team leaders listed in Figure 4 are committed to the asset management mission statement and were instrumental in the progress made and findings outlined in this report. Further questions on the City's asset management program can be directed to these team members.

Larry LaCross
- GIS Coordinator
- llacross@traversecitymi.gov
- 231.922.4900 ext 130

Dave Green
- Director of Public Services
- dgreen@traversecitymi.gov
- 231.922.4900 ext. 116

Timothy Lodge, PE
- City Engineer
- tlodge@traversecitymi.gov
- 231.922.4455

Christine Black
- Asset Management/GIS Analyst
- cblack@traversecitymi.gov
- 231.922.4900 ext 131

John Travis
- Asset Management Technician
- jtravis@traversecitymi.gov
- 231.922.4900 ext 127

Figure 4 : Asset Management Team

II. Inventory and Condition Assessment

An asset inventory is a list of the city's assets and their attributes, e.g. unique identifier, location, size, material, etc. This inventory resides in the City Geographic Information System (GIS) and is also connected to the City's Computerized Maintenance and Management System (CMMS) program which houses infrastructure condition inspection information as well as work orders associated with individual assets, such as manholes, and sewer pipes. The City is continuing to edit and update the attributes of the inventory using both as-built data as well as observations in the field while performing maintenance and condition assessment.

The condition assessment of the existing infrastructure was designed to survey a representative portion of the system. Assessing every asset in the system would be cost-prohibitive, time consuming, and unnecessary to determine the overall system condition for the purposes of this project. Therefore, a method was used to physically evaluate a representative sample of the system in order to better understand the overall condition of the entire system. Throughout the AMP, condition is shown as a percent of the total. Because the inspected sample was representative of the system, the results can represent the entire system. The procedure for identifying the appropriate infrastructure to sample was preceded by the following analyses:

The City's GIS framework was enhanced as part of this effort, making it easier for the City to store critical data for the location, size, material, and condition of each wastewater asset.

- Characteristics of the System: An age, material, and size distribution of the infrastructure was identified.
- Determination of Sampling Size: Statistical science was incorporated into the analysis in order to approximate the size of the sample so that the results would yield a margin of error no greater than 5%.
- Random Selection of Sample: Once system characteristics were assessed as well as sampling size, pockets of wastewater sewer and manhole infrastructure to be condition assessed were selected randomly in an effort to obtain unbiased condition data that would still be practical to collect.

A. NASSCO Rating System

The National Association of Sewer Service Companies (NASSCO) is a not-for-profit organization setting the industry standard for the rehabilitation of underground utilities. NASSCO's Manhole Assessment Certification Program (MACP) and Pipeline Assessment Certification Program (PACP) standardize identification of the type and severity of defects

found in manholes and pipelines. The MACP and PACP processes rate the overall, structural, and operations and maintenance (O&M) condition of the assets using a well-established and universal defect coding system. MACP and PACP use the same process with some minor adjustments to length-dependent defects since manholes are usually not as deep as sewer pipes are long. The results are in the industry standard format used by most municipalities and infrastructure assessment professionals.

The wastewater collection system was sampled to get a reliable assessment of the overall structural condition of the entire system. See Appendix A for illustrations of the City's wastewater system.

Individual defects were assigned a grade from one through five, with five being the most serious, based on the type and severity of the defect. These grades are predefined by NASSCO in their defect coding system. Because there were often multiple defects per asset, their associated grades were totaled and combined to generate several metrics that are representative of the condition of each pipe segment. An explanation of the metrics are included in Figure 5. The metrics are categorized as: Structural, Operation and Maintenance (O&M), and Overall. Structural condition is affected by defects like cracks, fractures, and surface or lining damage. O&M condition is affected by defects like soil/dirt/rock deposits, roots, infiltration, and obstructions. Overall condition metrics combine both Structural and O&M defects. Appendix A contains maps to illustrate the condition of the assets inspected as part of this AMP.

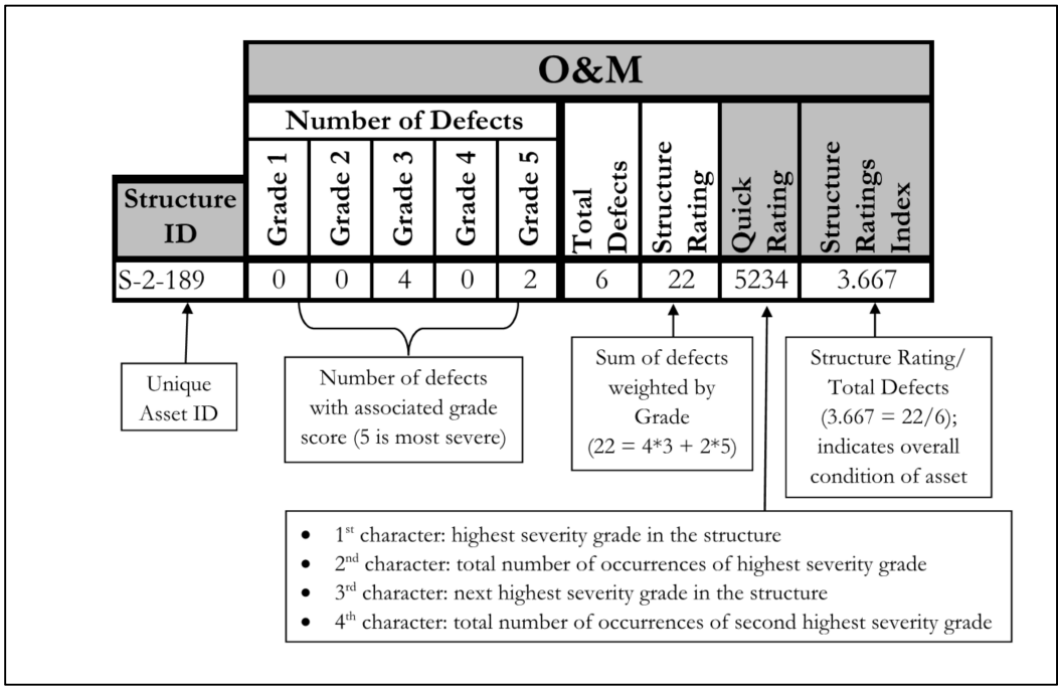


Figure 5: NASSCO Metrics

The Ratings Index indicates the general condition of each inspected asset. The Ratings Indices range from zero through five with zero being the best condition as shown in Table 2.

Table 2: Condition Rating Index

Ratings Index	Asset Condition
0	New or like new
1	Minimal wear and good working condition
2	Moderate wear but still functional
3	Failure unlikely in near future
4	Failure likely in the foreseeable future
5	Marginal functionality with failure imminent

*MACP and PACP Scores

B. Manholes

There are approximately 1,902 manhole structures in the City's wastewater collection system, as listed in the GIS. As part of the SAW effort, a detailed condition assessment was performed on about 807 manholes, or 42% of the total inventory. Figure 6 shows a distribution of the manhole infrastructure based on infrastructure age. The average age of the manholes in the system is nearly 57 years with approximately 66% of the system installed between 1930 and 1960.

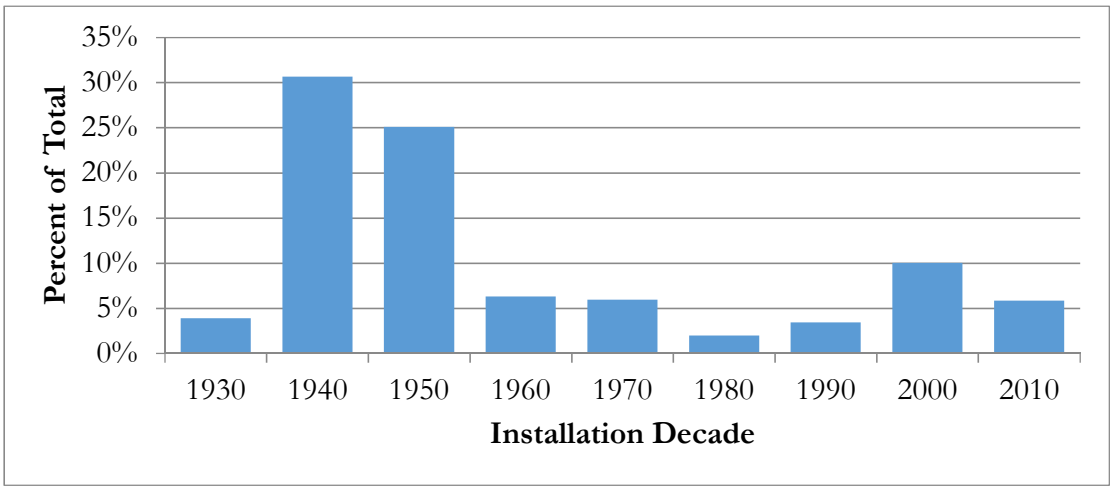


Figure 6: Distribution of Wastewater Manholes Based on Installation Decade

Figure 7 and Figure 8 summarize the average O&M and structural ratings of the surveyed manholes. Overall, the City infrastructure exhibits moderate wear with an average structural rating of approximately 1.75 and average O&M rating of 1.96. Figure 9 summarizes the distribution of MACP condition scores, by decade of installation, for the inspected manholes. This information was utilized in developing a structural deterioration curve for the City's manhole assets. In general, older manholes are in worse structural condition.

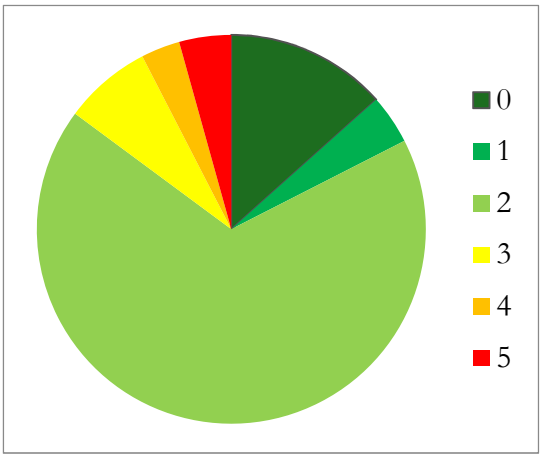


Figure 7: Wastewater Manhole O&M Ratings

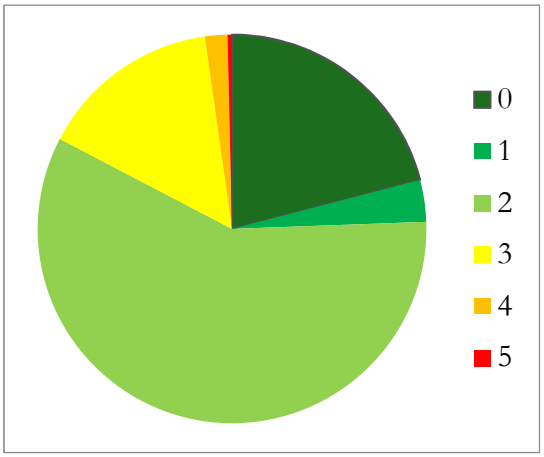


Figure 8: Wastewater Manhole Structural Ratings

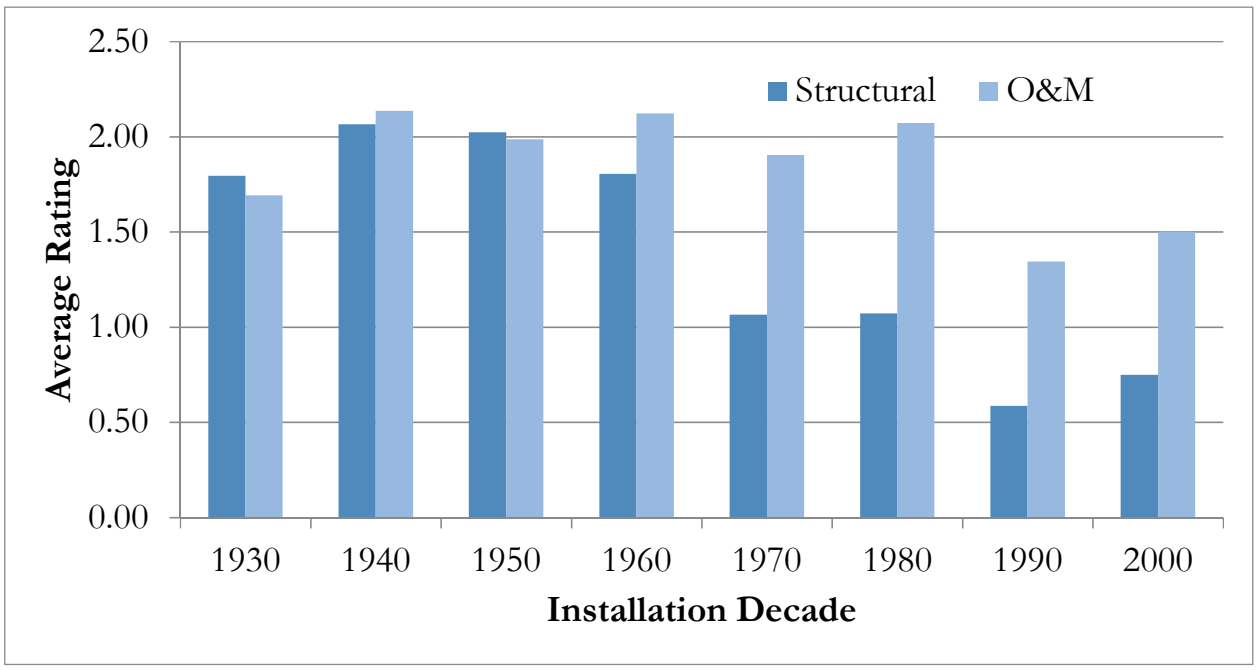


Figure 9: Average Wastewater Manhole Condition Ratings Indices by Installation Decade

* Some asset condition data (for components newer than 1993) were available from previous City inspections that were performed separate from the SAW Grant effort.

Figure 10 and Figure 11 provide additional details of the distribution of scores in each decade. Based on the inspection results, manholes that were installed in 1970's appear to be in the worst structural condition of the inspected manholes, while manholes installed in 1940's appear to be in the worst O&M condition of the inspected manholes. While a rating of 5 suggests imminent failure, a structural rating of 4 is defined as failure likely in the foreseeable future. Figure 10 below shows that pipes installed in the 1930's had the highest occurrences of a structural rating of 4.

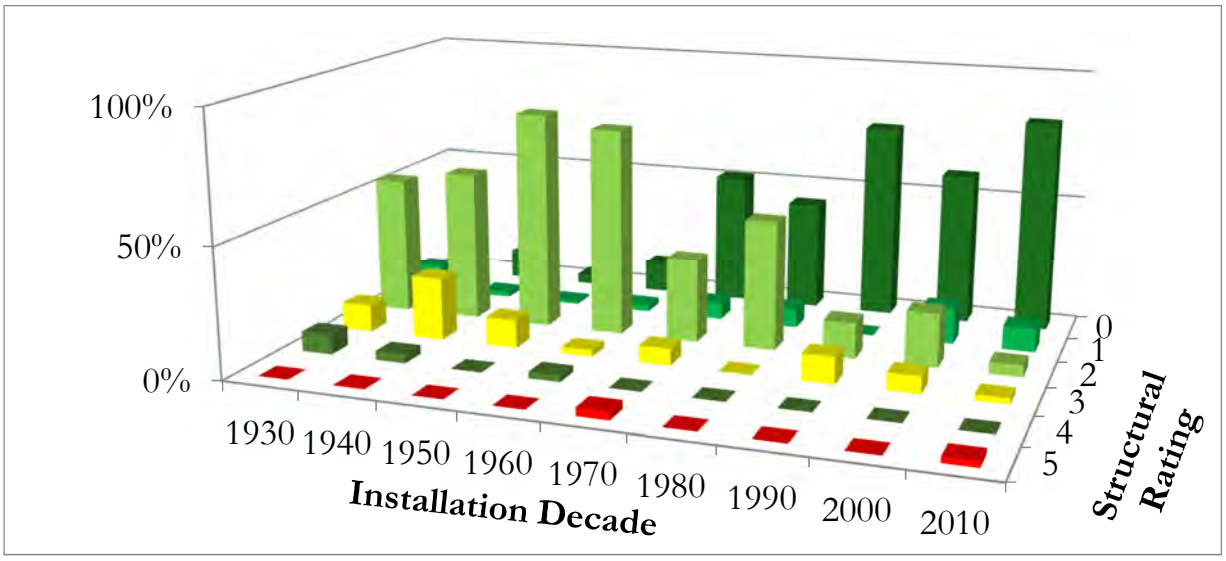


Figure 10: Wastewater Manhole Structural Ratings Indices by Decade

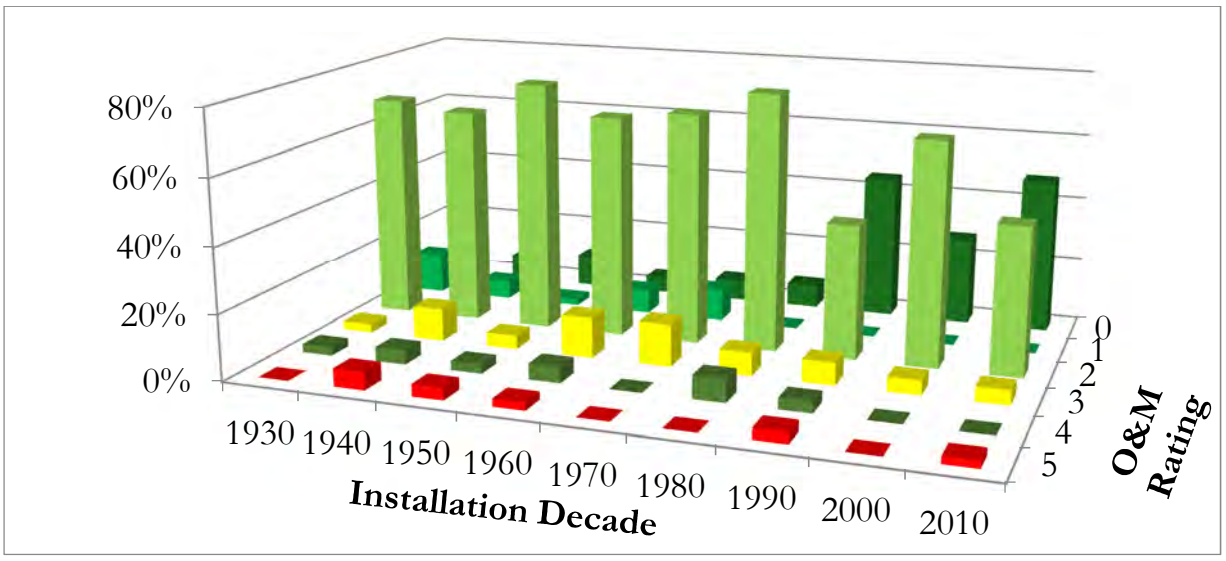


Figure 11: Wastewater Manhole O&M Ratings Indices by Decade

* Some asset condition data (for components newer than 1993) were available from previous City inspections that were performed separate from the SAW Grant effort.

A frequency analysis, represented in Figure 12, indicates the most common defects in the system. Overall, the following additional condition observations were made for the City's manholes:

- Structural manhole defects were predominately related to brickwork. Brickwork defects are assigned when displaced brick, missing brick, and missing mortar are identified in the manhole.
- O&M manhole issues were predominantly driven by deposits, roots, obstructions and infiltration. Infiltration is induced by cracks or fractures in the manhole, which provide inlets for rainwater and soil to infiltrate into the manholes. Deposits occur when soil and other debris build up in a structure without regular cleaning/flushing. Roots enter a manhole through defects such as cracks.

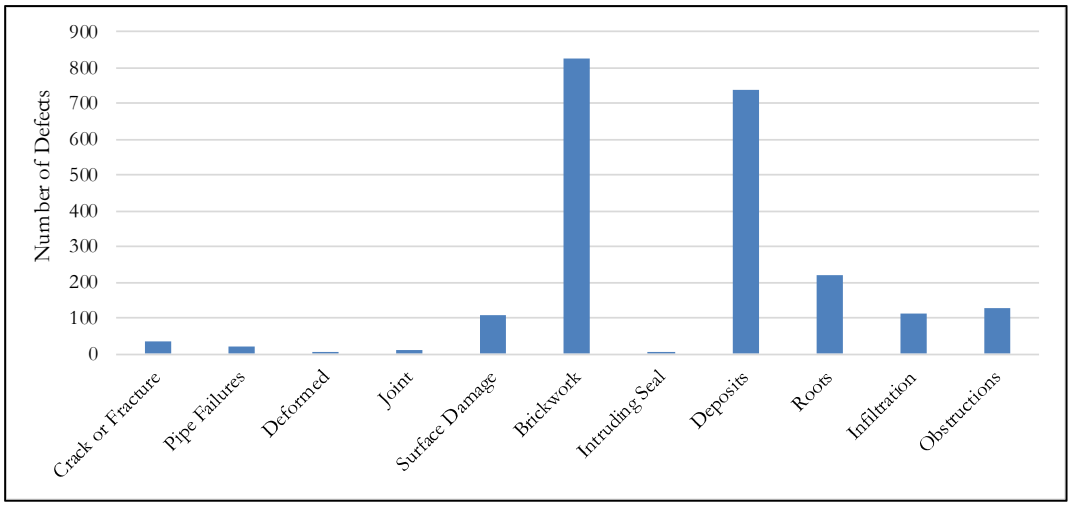


Figure 12: Manhole Defects

C. Sanitary Sewer

There are approximately 81 miles of sanitary sewer pipe in the City's wastewater collection system, as listed in the GIS; however, as stated in the Executive Summary, only 69 miles of sewer were used for the data analysis, as that was the quantity identified as Traverse City-owned assets in the GIS geodatabase received in April 2017. As the City continues to develop and refine its wastewater geodatabase, the sewer ownership attributes should be standardized so that City-owned assets can be grouped together in one ownership class.

The average age of the system is 59 years with nearly 70% of the system installed between 1930 and 1960. Figure 13, Figure 14, and Figure 15 summarize the sanitary sewer collection system

inventory in terms of age, diameter, and material. The majority of the system consists of clay and vitrified clay pipe.

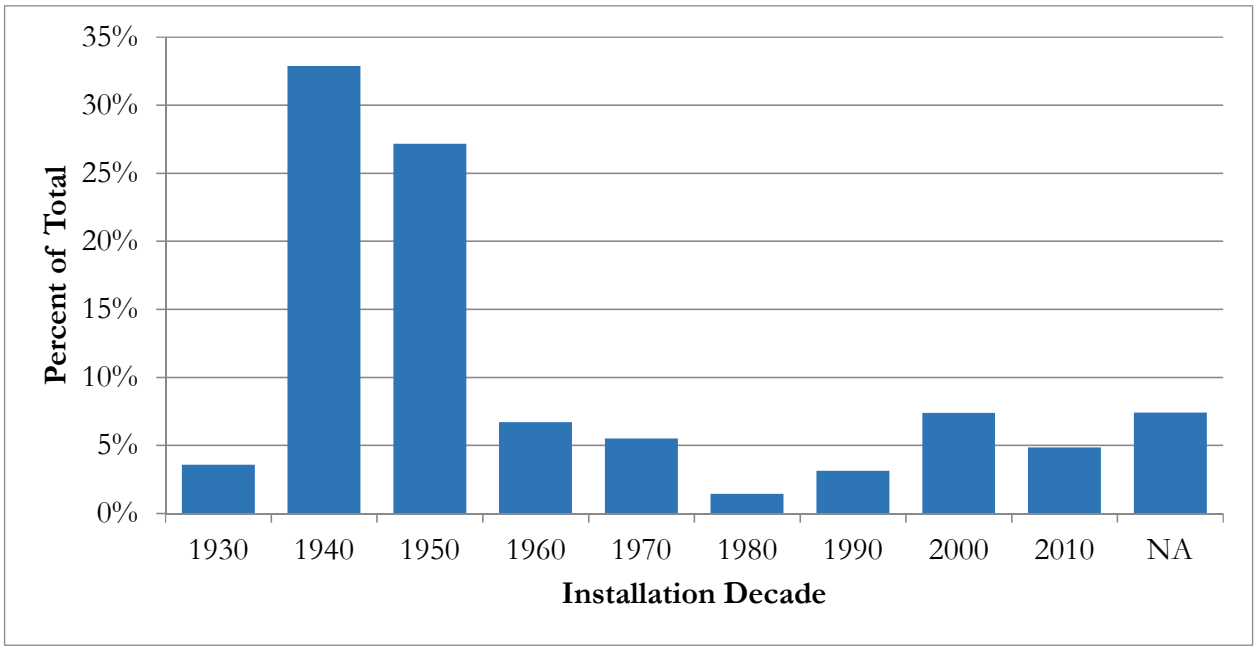


Figure 13: Wastewater Sewer Installation Inventory

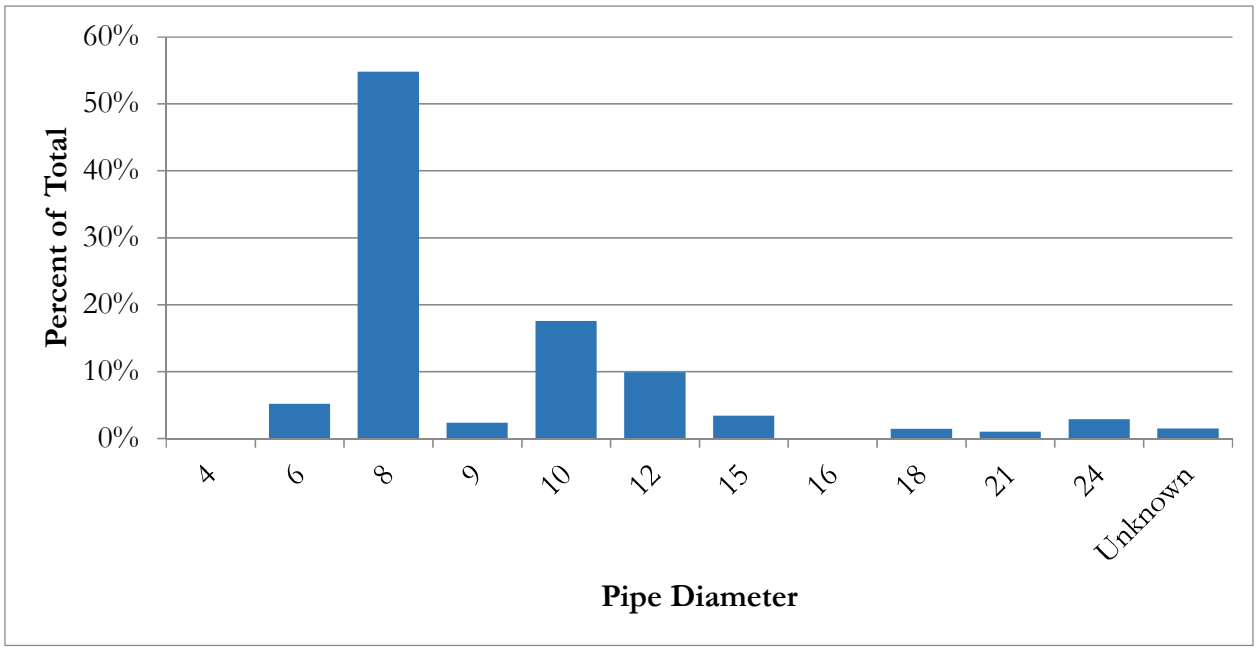


Figure 14: Wastewater Sewer Diameter Inventory

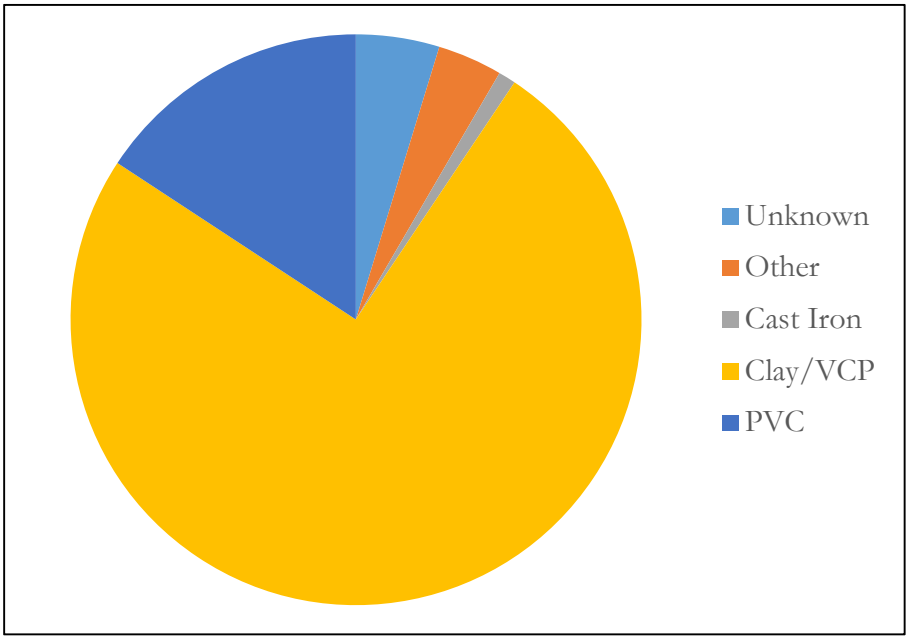


Figure 15: Wastewater Sewer Material Inventory

As part of the SAW effort, a condition assessment was performed on approximately 32 miles of pipe, or about 47% of the system. The inspected portion of the system had an average Overall (structural and O&M) rating of 2.04, indicating that the majority of the system is in good condition. The average structural rating is 1.82, and the overall O&M rating being 1.98. Figure 16 and Figure 17 show a breakdown of Overall PACP Ratings.

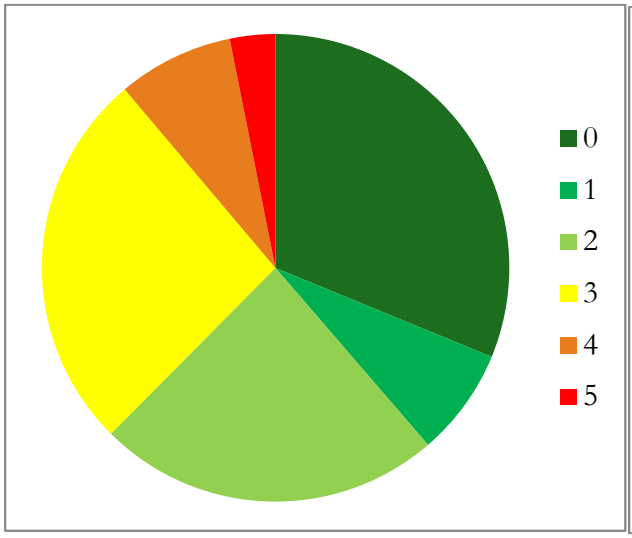


Figure 16: Wastewater Sewer Structural Ratings

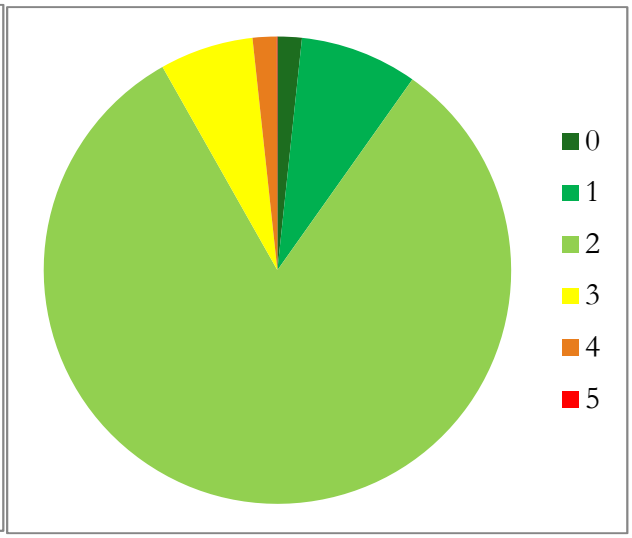


Figure 17: Wastewater Sewer O&M Ratings

Figure 18 shows a breakdown of the average wastewater sewer condition indices by installation decade.

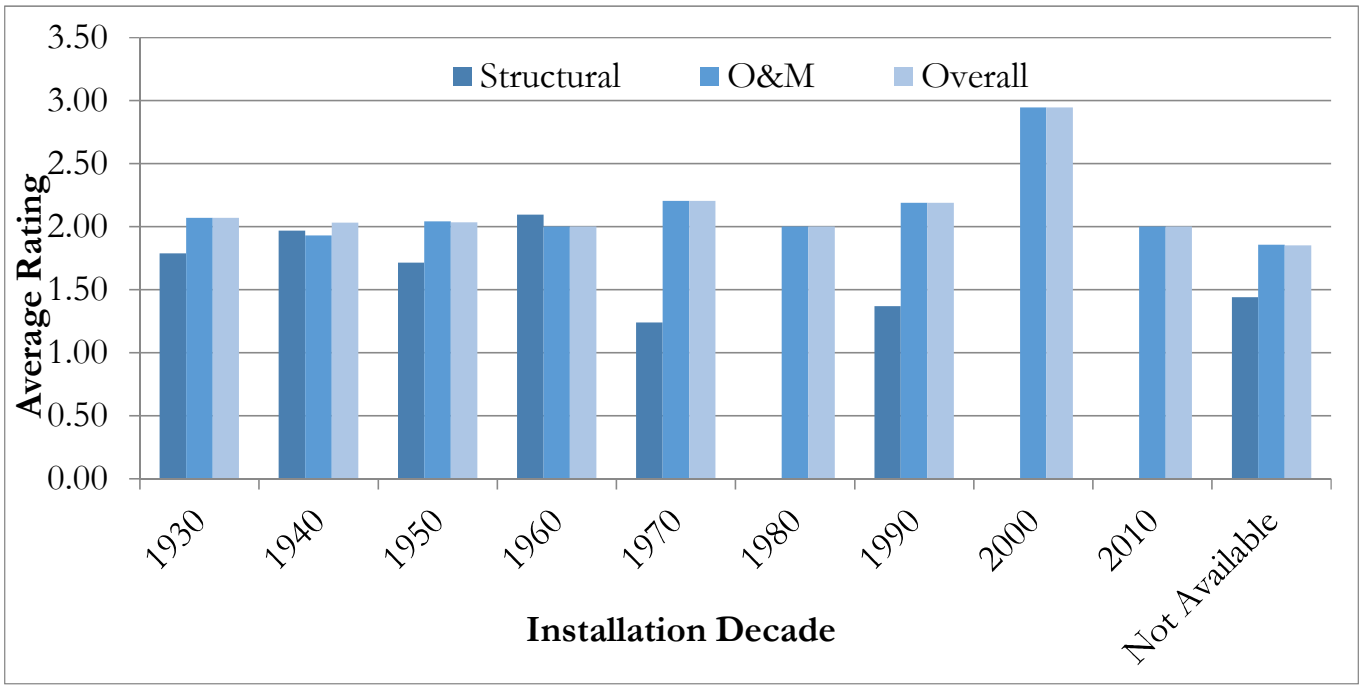


Figure 18: Average Wastewater Sewer Condition Rating Indices by Installation Decade

* Some asset condition data (for components newer than 1993) were available from previous City inspections that were performed separate from the SAW Grant effort.

Figure 19 and Figure 20 provide additional details of the distribution of scores in each decade. Based on the inspected pipes, pipes that were installed in 1960's appear to have the highest occurrences of a rating of 5. None of the inspected pipes returned an O&M rating of 5. In general, based on the structural ratings, pipes installed in 1970's and prior appear to be the worst off, structurally.

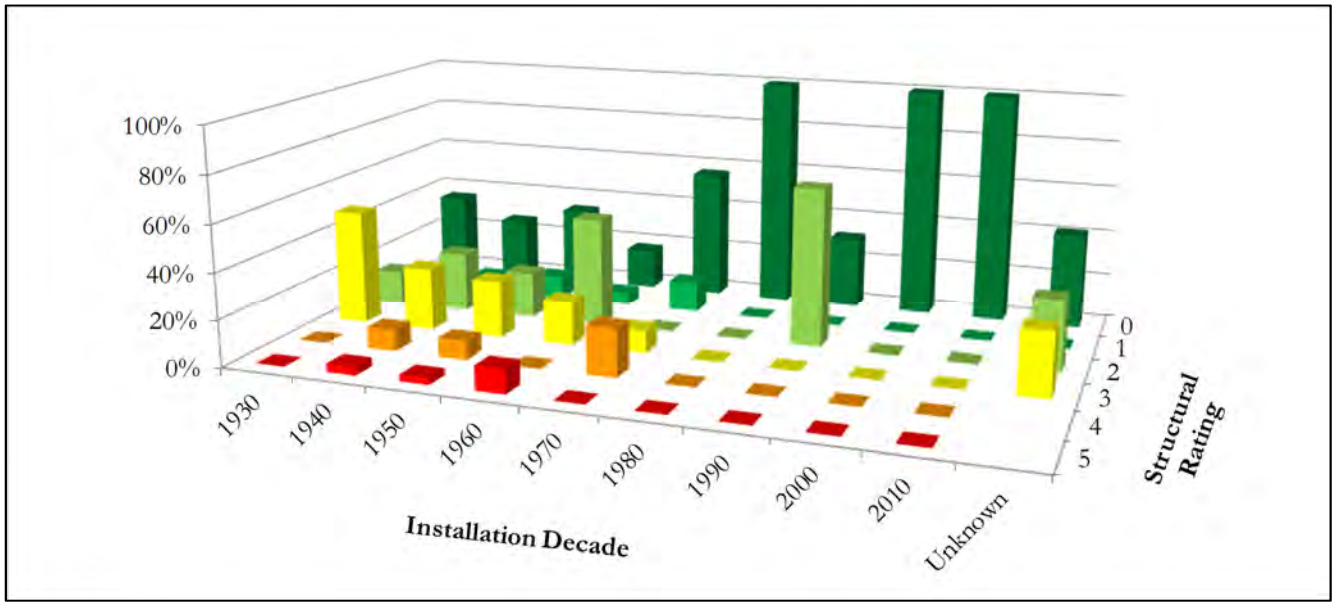


Figure 19: Breakdown of Wastewater Sewer Pipe Structural Scores by Decade

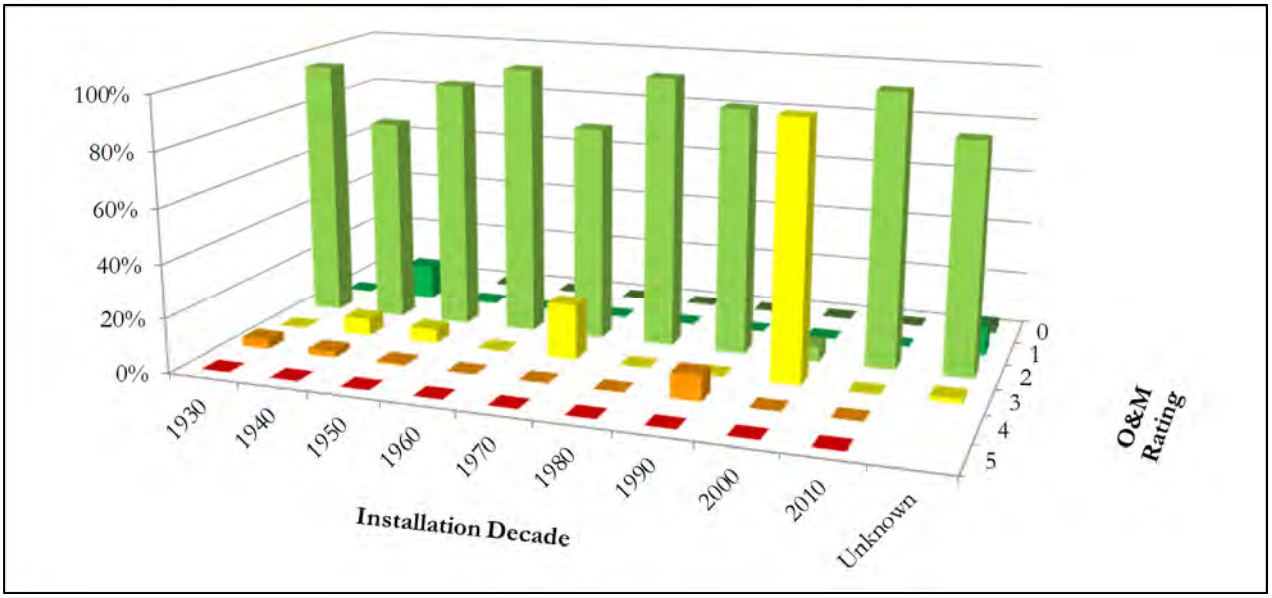


Figure 20: Breakdown of Wastewater Sewer Pipe O&M Scores by Decade

* Some asset condition data (for components newer than 1993) were available from previous City inspections that were performed separate from the SAW Grant effort.

Within the inspected portion of the sewer system, approximately 7 miles of pipe had one or more structural defects of grade 4 or 5 and is deemed to be in need of rehabilitation in order for the sewer to achieve its intended function. This reflects approximately 31% of the inspected system. Extrapolating this to the entire wastewater collection system yields roughly 21 miles of sanitary sewer pipe that is likely in need of rehabilitation. Details on the system extrapolation are available in Table 3.

Table 3: Highest Rated Sewer System Structural Defects Extrapolation

Highest Rated Defect	Inspected Length (mi)	Extrapolation to System (mi)	Percent of Total
0	6.7	21.5	31%
1	1.2	3.8	6%
2	3.1	10.1	15%
3	3.8	12.1	18%
4	2.6	8.3	12%
5	4.1	13.1	19%

Table 4 summarizes the highest rated structural defect by diameter for the inspected system. It appears that the majority of the 7 miles of pipe that had one or more structural defects of grade 4 or 5, are 12-inch in diameter.

Table 4: Highest Rated Sewer System Structural Defects by Diameter

Diameter (in)	0	1	2	3	4	5	Total
6	1918	696	1923	1283	1236	6368	13423
8	11471	2824	3758	3640	1744	5282	28720
9	1765	87	880	709	1831	1152	6424
10	5744	1387	2618	3130	1123	2434	16435
12	6858	175	4435	4022	3803	5565	24859
15	4116	452	1463	2693	2266	456	11445
18	1405	--	--	1091	502	250	3247
21	864	362	525	1475	--	--	3227
24	1171	286	940	1861	1069	17	5343
Total (ft)	35310	6269	16544	19907	13577	21529	113122
Total (mi)	7	1	3	4	3	4	21

The most predominant structural defects as observed in the sanitary system are cracks or fractures and pipe failures; the most common O&M defects in the surveyed system are soil/dirt/rock deposits and roots. Figure 21 depicts the type and number of defects reported in the inspected portion of the wastewater collection system.

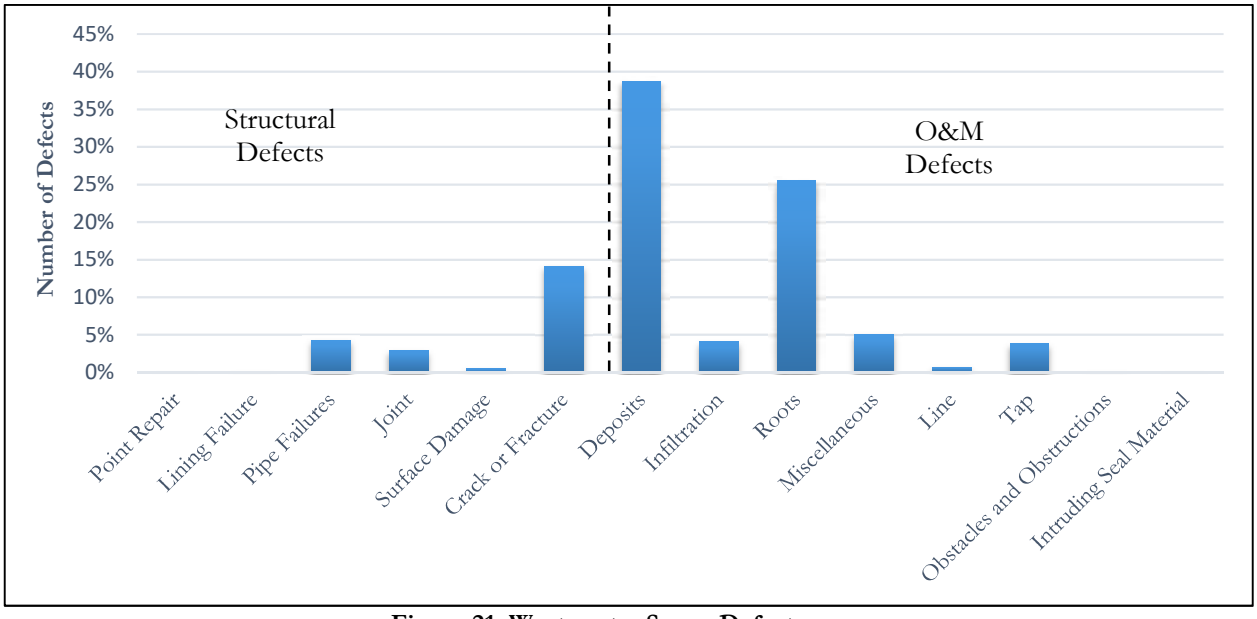


Figure 21: Wastewater Sewer Defects

D. Force Mains

There are approximately 4.7 miles of public force mains in the City's wastewater collection system. An inventory of the force mains was created using existing GIS and record drawings. A technical memorandum summarizing the force mains and their assessment is presented in Appendix C.

Assessing the condition of a force main is costly and often requires destructive or disruptive testing methods, thus no force mains were physically assessed as part of this AMP. However, the installation year, material type, history of breaks, associated pump stations, and location of the force mains were used as a proxy for condition. The CoF (1-5) was based on the associated pump station firm capacity and the location of the force main to roads, railroads, surface water, drinking water wells, other force mains, historic districts, and residential or commercial parcels. The PoF (1-5) was based on the force mains material, installation year, expected asset life, history of repair, crossing of a river or stream and number of junctions. A BRE (1-25) for each segment of force main was then calculated using the CoF and PoF.

Approximately 2.7 miles, or 60%, of the Traverse City's public force mains returned high PoF ratings indicating failure is likely in the foreseeable future or there is marginal functionality with failure being imminent. Table 5 summarizes these force mains ratings and their associated lengths.

Table 5: Prioritized Force Mains

Force Main Associated Pump Station	CoF	PoF	Maximum Segment BRE	Length (feet)
Front Street*	4.2	4.0	16.8	3,109
Coast Guard	3.0	4.2	14.3	7,316
Birchwood	3.1	4.0	13.6	2,583
WWTP	2.9	4.0	13.2	134
Bay	2.9	4.0	13.1	1,126

Includes 558 feet of force main that is also connected to the WWTP Pump Station

E. Pump Stations

There are nine pumping stations in Traverse City's collection system. The assets associated with each station were inventoried and evaluated for condition and criticality. The major components inventoried within each station include but are not limited to pumps, check/control valves, motors, level control systems, backup power, structure, wet well, valve vault, and telemetry. Details of the pump station assessment are available in Appendix D.

The current condition of the pump stations assets was assigned based on judgement of and experienced facility design engineers. The condition ratings range from 1 to 5 with 1 being the

best condition as shown in Table 6. The assets PoF was calculated based on the assets percentage of remaining useful life. Together, the assets CoF and PoF was used to determine the assets BRE.

Table 6: Pump Station Asset Probability of Failure

Ratings Index	Asset Condition
1	Excellent, appears new
2	Good, appropriate wear
3	Average, minor life cycle altering defects
4	Poor, significant wear but functional
5	Very poor, failure of intended function

Based on the inspections, Traverse City's pump stations are well maintained. Many assets are functioning past the manufacturer specified useful life. Table 7 below summarizes the pump stations approximate install year and the main issues encountered during inspection.

Table 7: Pump Station Issues

Station	Approx. Install Year	Issue
Riverine	1983	• Pumps, motors and check valves are nearing the end of the expected service life and should be monitored closely. • Heavy grease load at this station can adversely affect the pumps and check valves.
Coast Guard	1995	• Both submersible pumps are near the end of their expected service life. Although they are functioning, they should be closely monitored. • The chart recorder is not in service.
Hull Park	2001	• In 2015 it appeared that the pump was not properly seated causing recirculation in the wet well.
Clinch Park	2003	• No adverse comments.
Bay Street	1994	• Both submersible pumps are near the end of their expected service life. Although they are functioning, they should be closely monitored.
Birchwood	2002	• No adverse comments.
Front St	1930/1996	• Pumps need to be frequently unclogged due to rags and other debris. The result is high maintenance costs. In the future when the pumps need to be replaced, consider dry pit submersible pumps that have better solids handling ability.

A more detailed document describing the data collection and inventory, field investigations and findings, annual capital reserves and CIP, and recommendations for Traverse City's pumping stations is included in Appendix D.

III. Deterioration Forecasting

Forecasting of infrastructure deterioration was based on the system inventory, infrastructure age, historic data, and currently observed condition information. In general terms, the forecasting process included the following steps:

- Structural Deterioration Over Time:
  Infrastructure age and condition information was used to assess structural deterioration of the infrastructure. O&M deterioration is not forecasted, as this tends to be more random in nature and requires more detailed historic maintenance data. The deterioration information was converted to infrastructure structural deterioration curves that provided insights as to the anticipated infrastructure remaining life as well as rate of deterioration.
- Analysis of Entire System:
  The condition information collected through the sampling procedure outlined earlier yielded a structural condition rating distribution for the sampled infrastructure based on its age, size, and material. This information was projected out (extrapolated) to the rest of the system (the infrastructure which was not directly condition assessed) and the system as a whole was allowed to deteriorate over time within a deterioration forecast model.

The results of the forecasting process yielded information that was used to calculate the need for future investment in operation and maintenance of the wastewater infrastructure, which will be required for system components that are aging beyond their useful service lives.

Deterioration forecasting helps us determine what percentage of the City's assets must be rehabilitated each year in order to avoid unnecessary failures and more expensive emergency repairs.

Figure 22 shows the approximated structural deterioration curve for the City's wastewater infrastructure. The current average rating of the City's wastewater infrastructure is 1.82 and as suggested by the curve below, with an average system rating of 1.82, the system has approximately 42% of remaining useful life before reaching a rating of 5 (failure). In addition, the rate of deterioration of the existing infrastructure is likely going to increase, highlighting the importance of field inspection in the upcoming years.

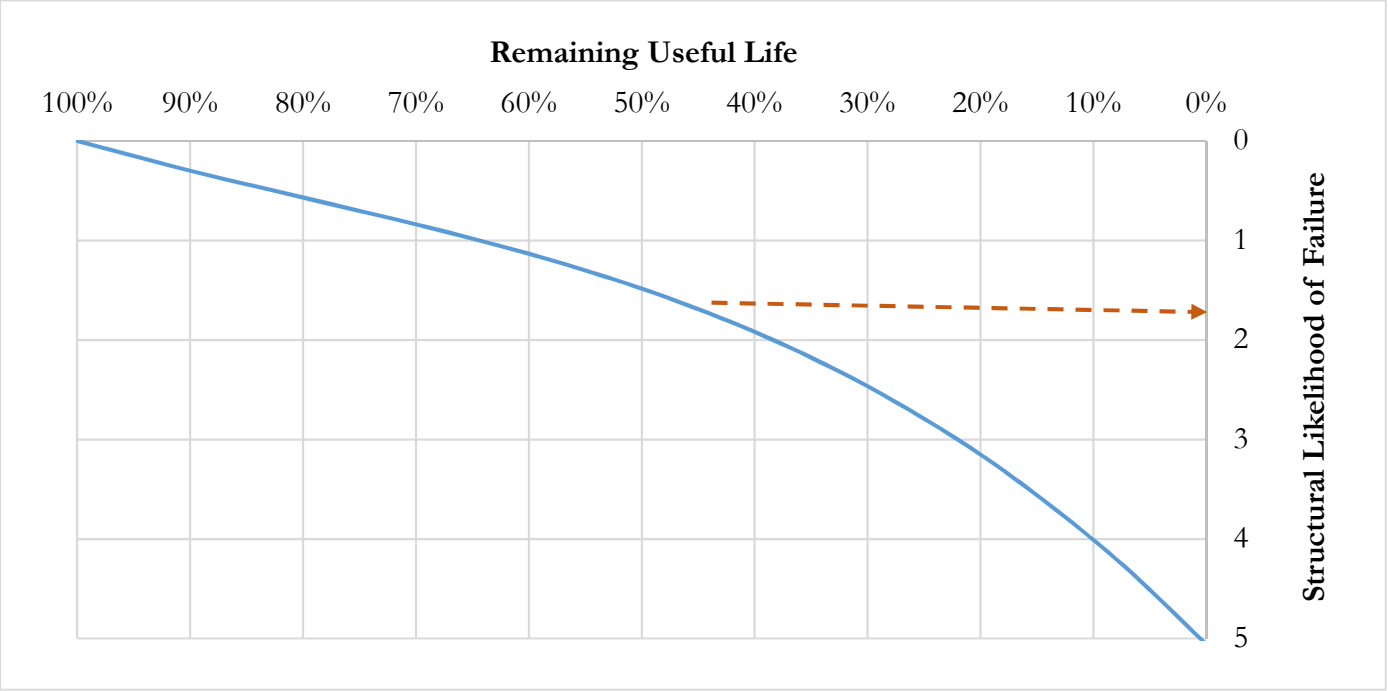


Figure 22: System Deterioration

The longevity of Traverse City's wastewater infrastructure was evaluated by combining data on average structural condition, remaining useful life, rehabilitation costs, and deterioration. Under the current funding structure, many assets are projected to fail as shown in Figure 23. This is indicted by the increasing percentage of red (PACP scores of 5) in the system. Deferred maintenance results in higher legacy costs when emergency repairs become necessary. In Figure 23 and Figure 24, both start with the currently-observed structural condition on the left side of the graph, with a deterioration rate that adjusts each component of the system based on typical annual deterioration for each asset. Traverse City's wastewater system is rapidly aging with some pipes and manholes installed as early as 1930.

With the proposed dedicated funding, Traverse City will be able to proactively maintain and rehabilitate the system, and improve their current level of service as shown in Figure 24.

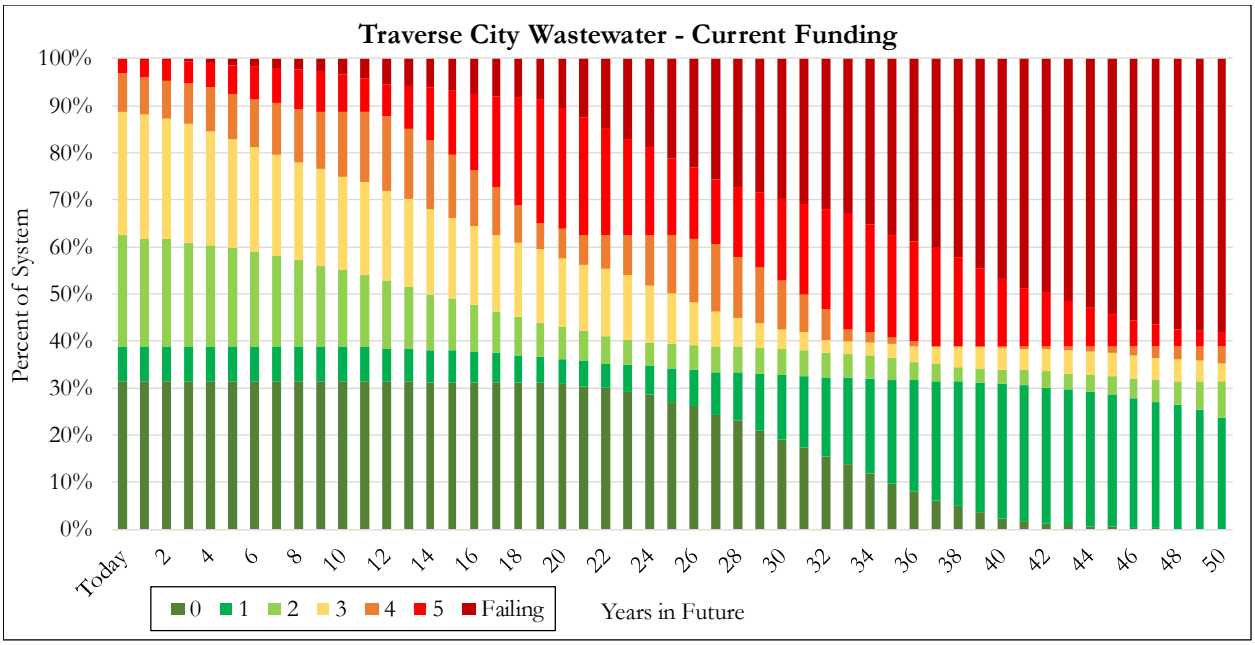


Figure 23: System Deterioration Under Current Funding Level

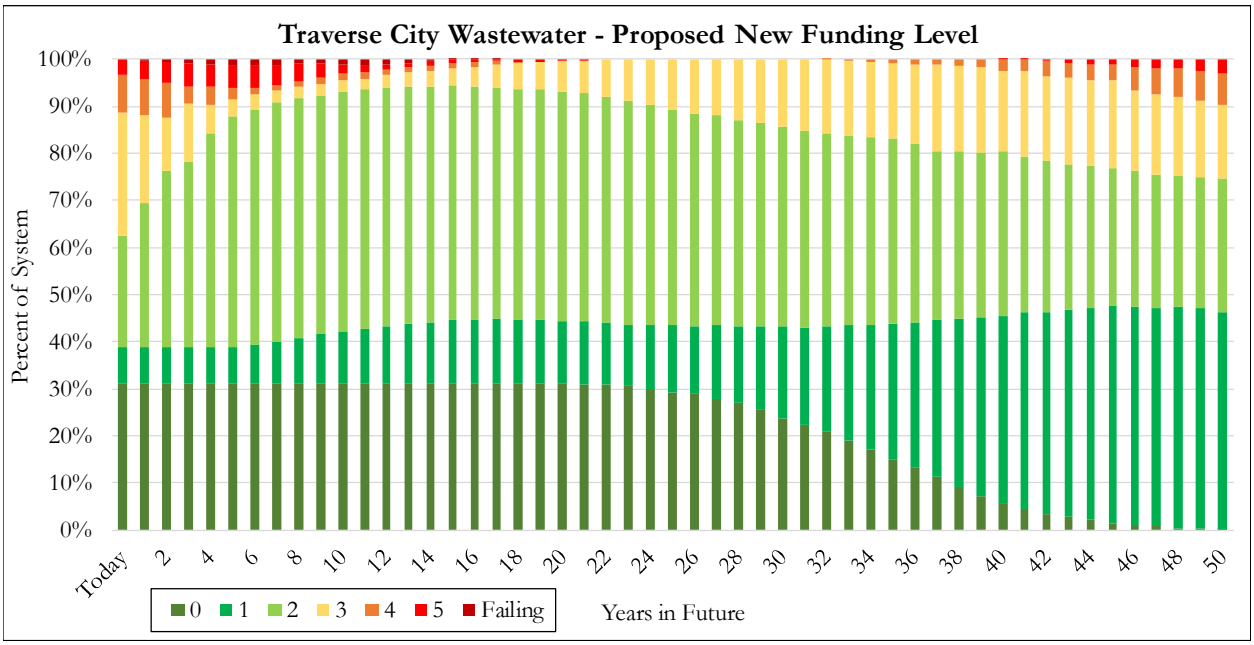


Figure 24: System Deterioration Under Proposed Funding Level

IV. Hydrologic and Hydraulic Modeling

As part of this AMP, the City wanted to assess and evaluate inflow and infiltration (I/I) concerns within the wastewater collection system. Appendix E contains the detailed results from the Antecedent Moisture Model (AMM) method to estimate peak flow rates, hydraulic modeling to evaluate conditions during peak flow rates, and a comparison of modeled peak flows to lift station capacities.

A. Metering

Nine (9) temporary sewer flow meters and one rain gauge were installed for a period of five months, from April - August 2015. The flow meters were used for many facets of this project: as a clue to suggest areas for future condition assessment, as a tool to create and calibrate the hydrologic and hydraulic models to assess the system capacity, as an indicator of current system function, and to help capture the amount of I/I in the system.

B. Antecedent Moisture Model

An AMM allows for development of a continuous hydrologic model of the system accounting for the variation in antecedent moisture conditions. Recent rainfall and soil moisture conditions significantly affect the system response to wet weather events. Two models were built utilizing flow metering and rain data. Other metered districts had wet weather flow responses that were too low to develop a reliable hydrologic model. Ten-year frequency flows were obtained from the AM Models for Meter District 3 and the WWTP. A ten-year frequency flow represents the amount of flow with a 10% chance of being exceeded in any given year. This is the MDEQ standard for evaluating sanitary sewer flow capacities.

Traverse City's Meter District 3 and the WWTP were benchmarked against over 100 other mid-western sewersheds. Benchmarking allows a direct comparison between sewer systems to quantify how tight or leaky the Traverse City system is relative to other systems. Based on this comparison, there is a wide range of wetness due to leaks observed in the City's system. As shown in Figure 25, Traverse Meter District 3 has a Peak I/I Flow per 1,000 acres on the high end of the spectrum and the Traverse City WWTP is on the low end of the spectrum. The antecedent moisture modeling highlighted that Traverse Meter District 3 has excess flow where wet weather flow removal may be especially advantageous.

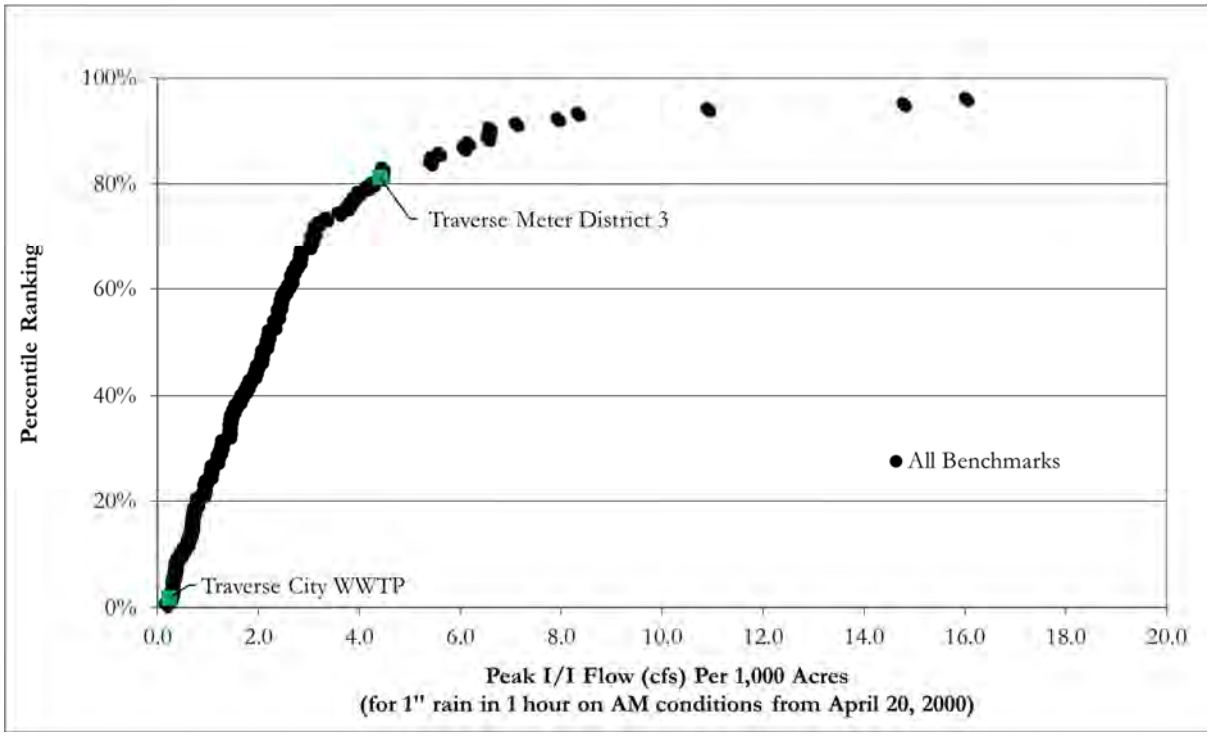


Figure 25: Benchmarked Meter District Wetness

C. Hydraulic Numeric Model

A hydraulic model was created using EPA-SWMM and Traverse City's exiting GIS data, LIDAR data, and additional information supplied by the City. The major trunks of the collection system that run east and west through downtown Traverse City were the focus of the hydraulic model, as these sewers convey the majority of flow in the City's collection system.

The model represents how the system functions, and is calibrated to real storms and the flow response in the sewer system. Using peak flow rates established with Ten State Standards, peaking factors, and results from the AMM, the EPA SWMM model was used to simulate hydraulic conditions during peak flows. The model demonstrated that the main trunk handling flows from the east side of the city has sufficient capacity to handle peak flows with no surcharging or sanitary sewer overflows (SSOs), while the main trunk handling flows on the west side of the city showed significant surcharging.

A more detailed document summarizing the hydrologic and hydraulic modeling completed as part of the SAW grant is included in Appendix E.

D. Recommendations

The recommendations for system upgrades resulting from the modeling study are shown in Table 8, below.

Table 8: Modeling Recommendations

	Task	Estimated Cost	Time Frame
1	Upgrade WWTP flow meter to one capable of recording flows up to 16-18 cfs.	$10,000	Year 1-2
2	Conduct Sanitary Sewer Evaluation Survey (SSES) with smoke testing in Meter District 3 to locate and remove inflow sources.	$30,000	Year 1-2
3	Conduct basement surveys along western trunk to identify allowable surcharging levels.	$12,000	Year 1-2
4	Clean and televise siphons. Based on the televising, plan for rehabilitation (regular cleaning) or replacement of siphon(s)	$25,000	Year 1-2
5	Perform additional metering in District 3 to evaluate new wet weather flows. Re-evaluate the recommended upgrades based on new flows.	$30,000	Year 3-5
6	Plan funding for recommended system upgrades.	-	Year 6-7
7	Perform recommended upgrades to the system. Current recommendations are to upgrade the 355 feet of 12-inch diameter sewer main along South Oak Street to 24-inch sewer, 695 feet of 21-inch diameter pipe downstream of the Oak Street Siphon to 30-inch, and 2,910 feet of 24-inch diameter pipe downstream of the Boardman River Siphon upgraded to 30-inch.	$2,705,000*	Year 8-10
8	Install larger capacity pumps (and, if necessary, force mains) for Bay and Woodmere during scheduled pump replacements	N/A**	During scheduled replacements

**Upgrade recommendations may change with completion of recommended surveys and metering. Construction method to be determined during preliminary design. Cost estimate assumes significant regulatory and geotechnical issues*

***Pump station upgrades are not included in this cost estimate, as they will occur as part of ongoing pump station operations and planned pump replacements as components age out. Pump station replacement costs and future force main rehabilitation and replacement costs are covered in separate technical memoranda.*

V. Level of Service

The City identified what are referred to as level of service measures that can be used to understand staff and resource priorities. Table 9 summarizes these measures for the City's asset management program.

Table 9: Level of Service Criteria, Performance Indicator, and Level

Key Service Criteria	Performance Indicator	Target Level of Service
Asset Condition Assessment	PACP & MACP Inspections Per Year*	• MACP inspect a minimum of 380 manholes per year, approximately 20% of the System • PACP inspect a minimum of 14 miles of sewer per year, approximately 20 % of the system
Meter Updates and Radio Reads	Replace existing meters with the new Sensus meters and install radio reads for higher accuracy of reads.	**
Regulatory Compliance	Compliance with MDEQ Sanitary Sewer Overflow (SSO) Policy and The Clean Water Act	Comply with the MDEQ SSO policy and The Clean Water Act
Service Delivery and Customer Communication	Utilize Lucity Software to Aide in Utility Management and Promote Customer Communication, Increase effort to reduce number of sewer calls	Respond to customer complaints and requests efficiently
O&M Optimization	Regular Cleaning and Maintenance of the Collection System	Clean and maintain 20% of the system per year

* Pipe Assessment Certification Program (PACP), to assess sanitary sewer condition
Manhole Assessment Certification Program (MACP), to assess manhole condition

** City to review and provide input. Information pulled from City's 2016-2017 Annual Budget Report.

VI. Critical Assets

Determining the assets most critical to system operation allows a community to manage risk, support Capital Improvement Plans (CIP), and efficiently allocate O&M funds. The two key factors used to determine criticality are Probability of Failure (PoF) and Consequence of Failure (CoF). PoF and CoF are multiplied to determine the Business Risk Exposure (BRE) as shown in Figure 26, below. Details and maps are available in Appendices F and H.

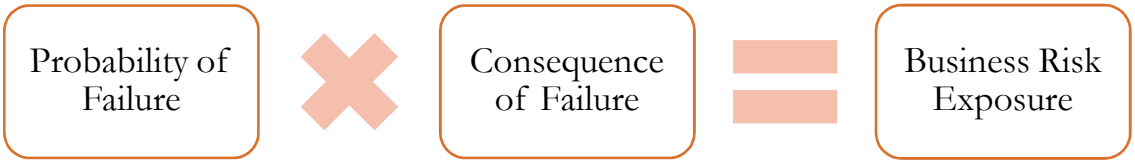


Figure 26: BRE Equation

PoF considers the physical condition or age of an asset and is often based on the Structural MACP or PACP Index Rating. If an asset was not inspected, remaining useful life can be used a proxy for condition. A standardized rating of one through five is assigned to each asset with a score of five indicating worst condition as shown in Table 10.

Table 10: Probability of Failure

Score	Description
1	Improbable
2	Remote, unlikely but possible
3	Possible
4	Probable, likely
5	Imminent, likely in near future

CoF encourages a focus on social, environmental, and economic cost impacts. The economic CoF encompasses the impacts of direct and indirect economic losses to the affected organization and third parties due to asset failure. The social consequence represents the impact of society due to asset failure and the environmental consequence of failure considers the impact to ecological conditions occurring as a result of asset failure.

The factors were rated on a one through five scale for each asset. If one factor is deemed more important, the weighting can be skewed to give that factor more influence. The final CoF incorporating all the factors is described in Table 11. Details in how the factors were scaled is available in Appendix F.

The following factors were combined to determine the final CoF:

- Relative Network Position – the sum of upstream sewers discharging to a structure
- Diameter/Size – the relative size of the asset with respect to the rest of the system
- Restoration Type/Accessibility – refers to the cost to restore the surface above the asset and if traffic control is needed
- Environment – proximity to sensitive environmental features like Boardman River, Kid's Creek, Grand Traverse Bay, etc.
- Critical Users – important system users (Munson Hospital)

Table 11: Consequence of Failure

Score	Description
1	Negligible, minor loss of function
2	Minimal or marginal
3	Noticeable, may suspend some operations
4	Critical, temporarily suspends operations
5	Catastrophic disruption

A CIP should incorporate BRE and institutional knowledge, as shown in the flow chart in Figure 28. Institutional knowledge can reveal known problem areas or areas already designated for upcoming projects. Assets are given high, medium, or low priority based on their BRE as shown in Figure 27. An additional measure confirms that any assets with an MACP or PACP Structural rating of five or with defects likely to cause failure in the near future are automatically given high priority status. Uninspected assets nearing the end of their useful life should be inspected and assessed before potentially unnecessary rehabilitation or replacement funding is allocated. These assets should be given medium priority.

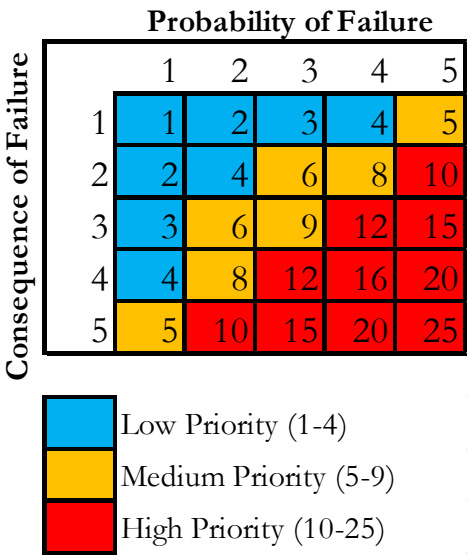


Figure 27 : BRE Matrix

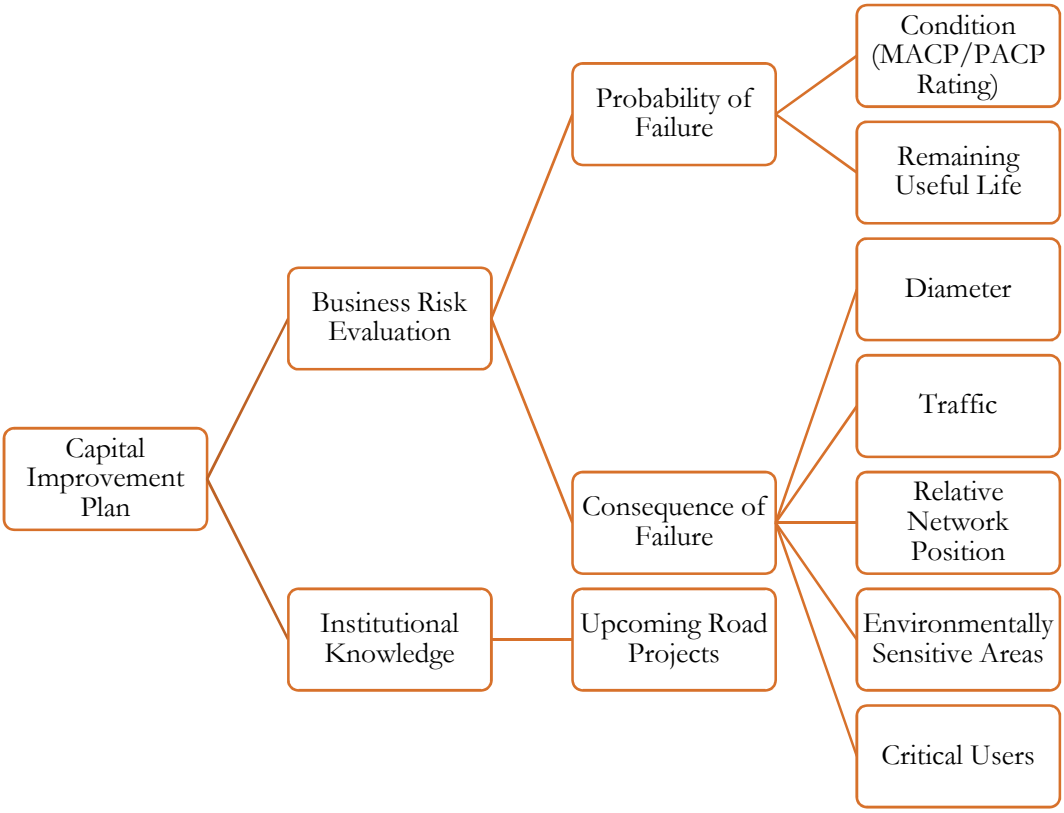


Figure 28: CIP and Risk Flow Chart

A more detailed document describing Traverse City's business risk exposure is included in Appendix F.

VII. Revenue Analysis

The condition assessment helped identify capital improvements that will allow the City to operate at its maximum potential. Additional long-term operations and maintenance strategies will provide the means to maintain a sound structural condition into perpetuity. The City Treasurer has reviewed the proposed level of investment for the collection system, pump stations, and the WWTP and has provided recommendations for rate increases to address the increased investment need. The rate recommendations are listed in the Executive Summary.

A summary table for all recommended investments over the next 10 years is included in Appendix H. This table includes costs identified in this Asset Management Plan as well as pumping/treatment facility costs as identified by CH2M. Appendix G includes CH2M's WWTP CIP and O&M Strategies.

Further refinement to the long-term revenue needs will be necessary when CH2M completes their Facility Plan process, which is expected to commence later in 2017.

A. Capital Improvement Plan

A Capital Improvement Plan (CIP) is a core component of an AMP and an essential planning tool that allows for a community to properly plan for high cost, non-recurring projects. A CIP should detail capital needs related to future/upcoming regulations, major asset replacements, system expansions, system consolidation or regionalization, and improved technology.

Traverse City's Capital Improvement Plan for its collection system is detailed in Appendix F and for its overall wastewater system is detailed in Appendix H. The Capital Improvement Plans will aide in identifying, prioritizing, and implementing capital projects within the City's wastewater collection system during the next 3-5 years.

B. O&M Strategies

Operation and Maintenance (O&M) strategies are an important component of an AMP. By having O&M strategies in-place, such as cleaning and inspecting assets, communicates can properly budget their funds while maintaining their assets.

O&M strategies directly tie into Traverse City's Level of Service (LOS) criteria. Below details the City's O&M strategies developed as part of this AMP.

- Pipes:
  There are approximately 69-miles of pipe in the Traverse City's sanitary system. This O&M strategy will focus on cleaning and inspecting approximately 20% of the systems pipes per year. Table 12 summarizes the estimated cleaning and inspection costs used to calculate the annual O&M cost.

Table 12: Estimated Cleaning and Inspection Costs for Pipes

Diameter (inches)	Cleaning Cost per Foot	Inspection Cost per Foot
4	$ 1.25	$1.08
6	$ 1.25	$1.08
8	$ 1.85	$1.08
9	$ 1.91	$1.09
11	$ 1.98	$1.10
12	$ 2.07	$1.11
15	$ 2.28	$1.22
16	$ 2.43	$1.23
18	$ 2.58	$1.24
21	$ 2.03	$2.30
24	$ 2.70	$2.30
Unknown	$ 2.03	$1.35

* The cleaning and inspection costs are estimated costs and reflective of public bid lists.

Using the cleaning and inspection costs detailed in Table 12 above, the annual O&M costs for pipes would be approximately $230,000 for 14-miles of pipe.

- Manholes:
  There are approximately 1902 manholes in Traverse City's wastewater system. This O&M strategy will focus on inspecting 20% of the systems manholes per year. The table below summarizes the estimate cost for manhole inspection, which was used to calculate the annual O&M cost

Table 13 : Estimated Manhole Inspection Costs

Manhole	Inspection Cost per Manhole
1	$ 100.00

Using the manhole O&M costs detailed in Table 13 above, the annual costs for manholes would be approximately $38,000, for 380 manholes.

Regular cleaning and maintenance of the collection system is necessary to prevent backups due to clogged or structurally-failing sewers. A "televise first" strategy is recommended when cleaning and televising sewers to optimize cleaning budgets. This is done by televising sewers ***before*** jetting/cleaning, and only cleaning when necessary. Based on our experience, most sanitary sewers are self-cleaning. We recommend that the City inspect and clean sanitary sewer collection systems on an "80/20" schedule. This schedule involves cleaning 80% of the system every 20 years and the most critical or high maintenance 20% of the system every five years. The 20% of the system to be

cleaned more frequently will be determined through the televising process and will generally consist of those sewers that are identified as those that are not self-cleaning. ***The baseline Level of Service for O&M purposes was a systematic wastewater televising (inspection) program and an annual repair and rehabilitation program to maintain an average structural condition equal to that observed in 2016.***

VIII. On-Going Data Management

A fully utilized AMP will improve the City's wastewater system for the City's future generations. Figure 29 shows that a healthy data management process is an ongoing cycle. The City's new asset management plan has essentially completed one cycle of the data management process. Even though that initial cycle is complete, it is essential that the City continue to collect data. Appendix B explains the lay out of the first cycle conducted by OHM. This data management process will aid in the tracking and use of data to cost-effectively manage the City's wastewater system.

1. Inventory

The City should continue to populate and complete missing or incorrect data in each asset's attributes. When assets are repaired or replaced and new assets are added, the BRE value can be updated. The City should assign new unique Facility IDs to new assets in accordance with their current naming convention.

2. Inspection Plan

Only a portion of the system was condition-assessed in the creation of this AMP, but it will be important to perform ongoing condition assessments of the rest of the system. Eventually you will come back to assets and assess them again. The AMP recommended an initial rate of condition assessment. The City should develop a plan to inspect assets at this rate. Whether the City performs the inspections internally or utilizes the help of a contractor, the City should specify a data format that will integrate with their existing GIS and CMMS software.

Figure 29: Data Management Process Diagram

3. **Quality Assurance**

   Data from the condition assessments will need to be checked for quality, either by the City or OHM Advisors' staff. The Quality Assurance process should occur throughout the Inventory and Inspection Plan steps, especially while condition assessment is taking place to ensure that the data is of satisfactory quality and in the correct format.

4. **Data Integration**

   After data is checked for quality, it will need to be integrated into the City's existing systems (e.g. GIS and Lucity). Significant data rectification and preparation work may need to be performed so that the collected information will transfer into the City's systems seamlessly. The amount of effort required will depend on the accuracy and format of the inspection data, as well as the status of the existing system database.

5. **Data Mining**

   Once the data is in the City's systems, OHM Advisors can perform data mining or train Traverse City staff on data mining. OHM Advisors analyzes the data to draw valuable insight from the incoming data. These insights include trends in pipes of certain material, size, age, and location.

6. **Immediate Needs Assessment**

   Use the inspection results to repair/replace assets that are failing and are in need of immediate attention, such as collapsing pipes or other imminent concerns.

7. **Long Term Planning**

   When a new batch of data is added, the City should check to see if the long term plan still aligns with the results of the updated system deterioration forecasting and O&M and budget optimizations. Long term budgeting and O&M planning should be updated as needed.

If these steps for a data management program are followed and continuously repeated and improved, the City will be well on its way to leveraging their asset management plan into a truly sustainable and cost-effective infrastructure management program.

Appendix A: Condition Maps

Figure A-1: Overall Wastewater System

Figure A-2: MACP Structural Index Ratings

Figure A-3: MACP Highest Rated Structural Defects

Figure A-4: MACP O&M Index Ratings

Figure A-5: MACP Highest Rated O&M Defects

Figure A-6: MACP Overall Index Ratings

Figure A-7: MACP Highest Rated Overall Defects

Figure A-8: PACP Structural Index Ratings

Figure A-9: PACP Highest Rated Structural Defects

Figure A-10: PACP O&M Index Ratings

Figure A-11: PACP Highest Rated O&M Defects

Figure A-12: PACP Overall Index Ratings

Figure A-13: PACP Highest Rated Overall Defects

Wastewater SAW
Overall System

Traverse City, MI

Figure A-1

N
W E
S

0 800 1,600 2,400
Feet
1" = 800'

- Sanitary Sewer Manholes
- LS Lift Station
- P Pump Station
- Treatment Plan

Sewer Gravity Mains
- Unknown

Diameter
- 4" - 8"
- 9" - 15"
- 16" - 24"
- Sewer Pressurized Mains

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: May 30, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advisors
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP Structural Index Ratings

Traverse City, MI

Figure A- 2

Sanitary Sewer Manholes

Structural Manhole Ratings Index

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP Highest Rated Structural Defects

Traverse City, MI

Figure A- 3

Sanitary Sewer Manholes

Structural Highest Rated Defect

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP O&M Index Ratings

Traverse City, MI

Figure A- 4

Sanitary Sewer Manholes

O&M Index Ratings

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP Highest Rated O&M Defects

Traverse City, MI

Figure A- 5

Sanitary Sewer Manholes

O&M Highest Rated Defects

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advisors
Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP Overall Index Ratings

Traverse City, MI

Figure A- 6

Sanitary Sewer Manholes

Overall Structure Ratings Index

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

MACP Highest Rated Overall Defects

Traverse City, MI

Figure A- 7

Sanitary Sewer Manholes

Overall Highest Rated Defect

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Rating

Sewer Gravity Mains

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

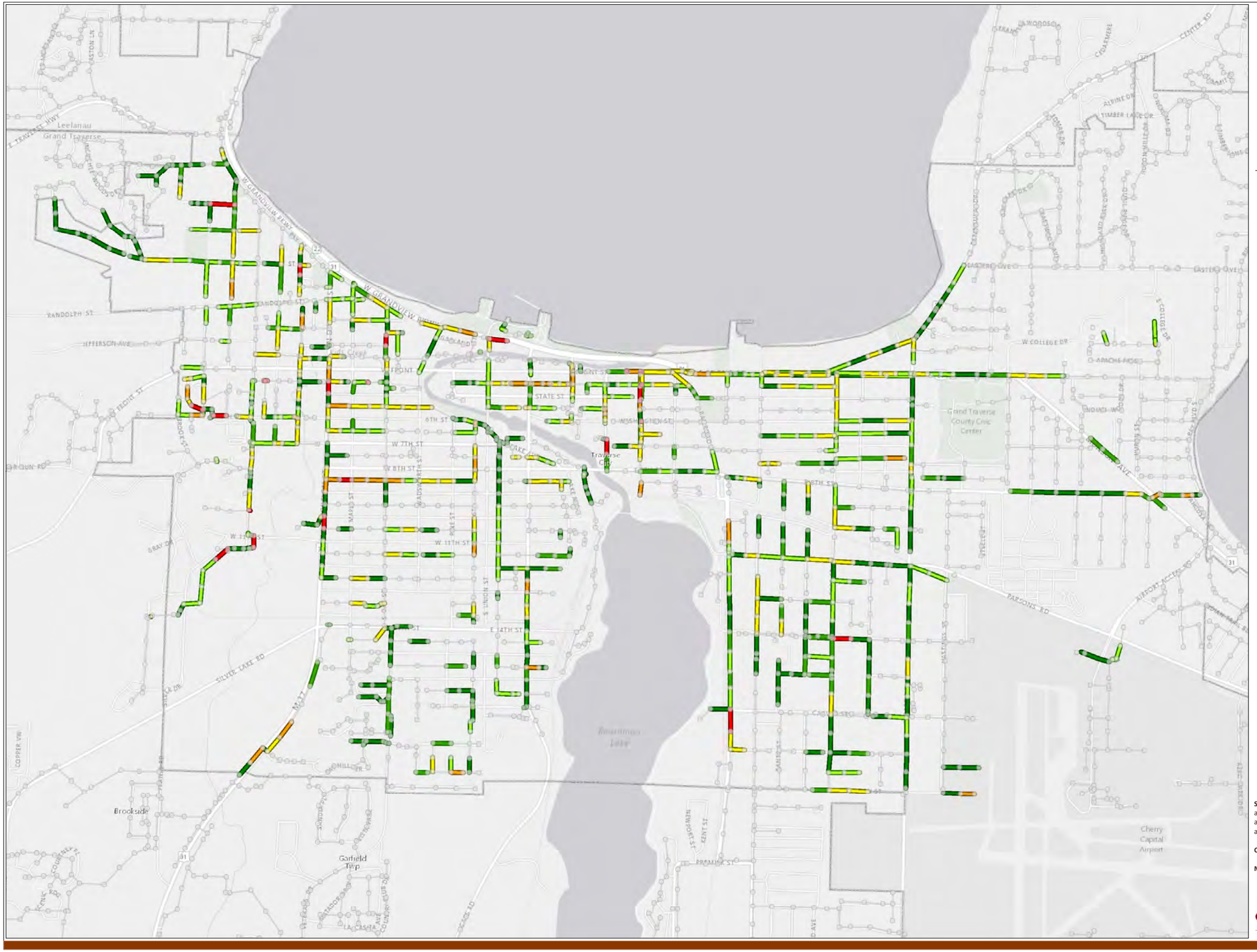
OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

PACP Structural Index Ratings

Traverse City, MI

Figure A- 8



Sanitary Sewer Manholes

Sewer Gravity Mains

Structural Pipe Ratings Index

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Value
- Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-7 PACP Structural Index Ratings.mxd

Traverse City SAW
PACP Highest Rated Structural Defects

Traverse City, MI

Figure A- 9

Sanitary Sewer Manholes

Sewer Gravity Mains

Structural Highest Rated Defect

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Value

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

PACP O&M Index Ratings

Traverse City, MI

Figure A- 10

Sanitary Sewer Manholes

Sewer Gravity Mains

O&M Pipe Ratings Index

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Value
- Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

PACP Highest Rated O&M Defects

Traverse City, MI

Figure A- 11

- Sanitary Sewer Manholes

Sewer Gravity Mains

O&M Highest Rated Defect

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Value
- Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

PACP Overall Index Ratings

Traverse City, MI

Figure A- 12

Sanitary Sewer Manholes

Sewer Gravity Mains

Overall Pipe Ratings Index

- 0 - 0.5
- 0.5 - 1.5
- 1.5 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5
- No Associated Value
- Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Traverse City SAW

PACP Highest Rated Overall Defects

Traverse City, MI

Figure A- 13

Sanitary Sewer Manholes

Sewer Gravity Mains

Overall Highest Rated Defect

- 0
- 1
- 2
- 3
- 4
- 5
- No Associated Value

Traverse City

0 1,600 3,200
Feet

1" = 1,600'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: April 27, 2017

OHM Advancing Communities
ARCHITECTS. ENGINEERS. PLANNERS.
888.522.6711 | ohm-advisors.com

Appendix B: Data Management and Editing

Appendix B: Data Management and Editing

Traverse City's wastewater asset inventory resides in the City's Geographic Information System (GIS) and is also connected to the City's Computerized Maintenance and Management System (CMMS) program which houses infrastructure condition inspection information as well as work orders associated with individual assets. The City is continuing to edit and update the attributes of the inventory. This document lays out edits made by the City and OHM Advisors during the completion of the Asset Management Plan (AMP).

A. Introduction

At the onset of this project, GIS was the repository for all of the City's digitally available asset data. The City shared the wastewater GIS database with OHM Advisors in early 2015. That database and a few subsequent updates served as the references for OHM throughout the course of the project. A screenshot of the database's most recent contents can be seen in Figure B-1.

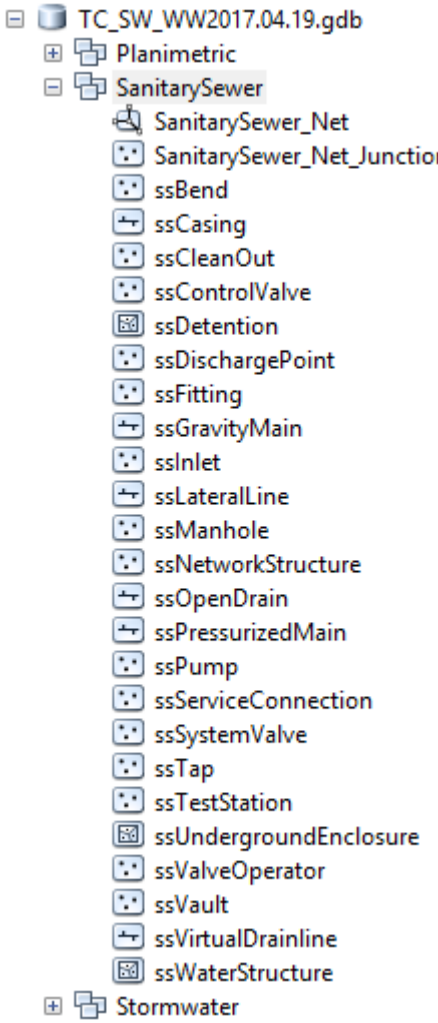


Figure B-1: Wastewater Geodatabase Contents

The City is maintaining the working database, which is constantly receiving updates and changes, some of which will be discussed later in this document. Although the work is ongoing, each asset has its own unique identifier and will be the key to incorporating all of the data collected during this project regardless of method, tool, or software used.

The City used a portion of the SAW grant funds to purchase and implement an asset management software called Lucity. CMMS software like Lucity is intended for integrating the types of data being collected with an existing GIS inventory. Lucity provides an efficient, user-friendly data management and work order platform that will benefit the City's wastewater system moving forward; especially if the City implements a funding source for the wastewater system that allows for systematic inspections, repairs, and rehabilitation.

B. Static Data vs. Dynamic Data

There are two types of data being collected during the inspections: Static and Dynamic. Dynamic data is any piece of information expected to continuously change over the lifespan of a particular asset like a condition rating. Information that isn't expected to change throughout the lifetime of an asset is considered to be static data. Just as the data types are different, the way each is stored should be different as well. Having two software applications as the City does in ArcGIS and Lucity, allows the data to be stored separately, yet remain connected. As long as the link is established between the two programs via the unique asset identifier, both datasets can be viewed from either program. Static data such as the upstream and downstream structures of a pipe, manhole wall material, spatial location, or invert elevations are best stored in a place that allows the data to be edited, exported, and manipulated to create maps or online modules. A GIS geodatabase is the perfect place to store this information, especially since a lot of the City's asset information already exists there. All of the static data can be kept in the attribute tables for each feature class such as manholes, pipes, etc. and only need to be changed if the asset undergoes a major change or replacement. An example of an attribute table for wastewater gravity mains is available in Figure B-2.

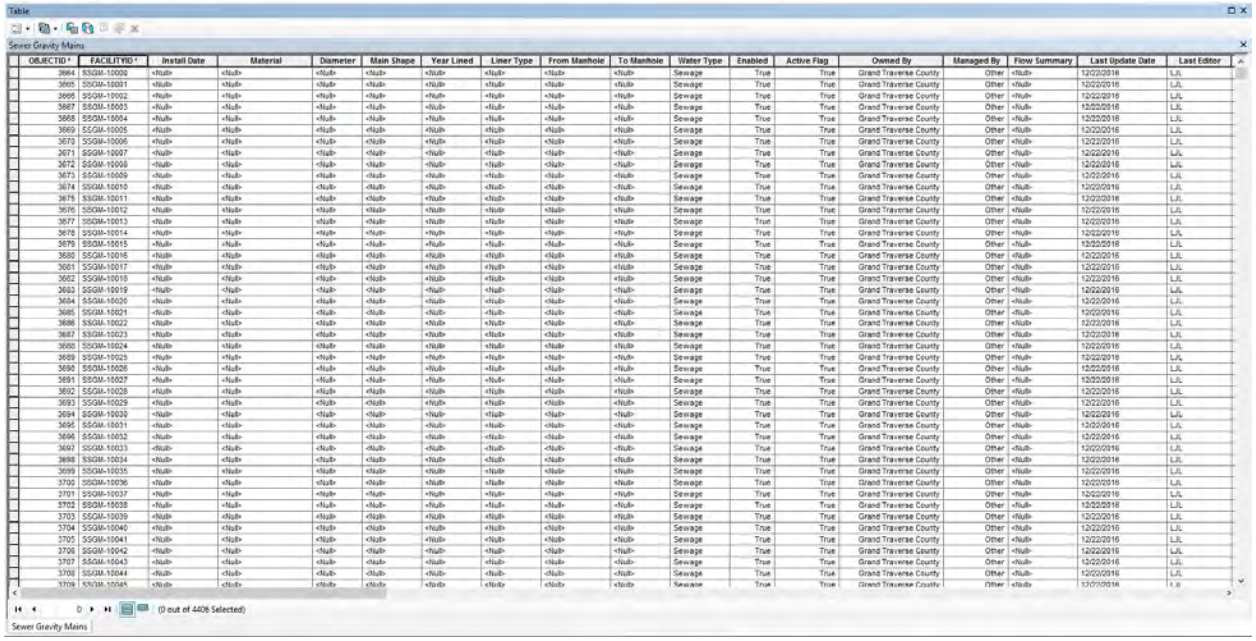


Figure B-2: Wastewater Gravity Main Attribute Table

Dynamic data can be effectively stored in Lucity, which allows multiple instances of the same piece of information to be kept for each asset. For example, condition ratings change over time. The condition of the asset is constantly changing and will typically yield a different rating each time it is inspected. In addition, the ratings are typically only valid for a short amount of time (most experts believe three to five years is appropriate) compared to the life of the asset. Therefore, the most recent rating is often the most important, but previous ratings can provide valuable information on an asset's history and deterioration rate. For example, the more ratings that exist for a particular asset over the course of its lifespan, the more accurate the deterioration forecast or remaining useful life estimation will be. By keeping dynamic data in a separate asset management software such as Lucity, the user has the flexibility to only show one or the most recent value in the ArcGIS program, while still having access to that particular asset's entire history of values in the asset management database.

C. Manhole Data

OHM Advisors performed manhole inspections in accordance with NASSCO's Manhole Assessment Certification Program (MACP). Due to NASSCO's Level 1 inspection being too basic and their Level 2 inspection being extremely detailed, OHM performed a hybrid Level 1.5 or 1+ inspection on 807 manholes. This hybrid level inspection contains all of the Level 1 data fields, some of the Level 2 data fields that OHM believes to be most important, defect coding, as well as an interior video of the manhole. Because the manhole inspection data was finalized prior to the City's shift to Lucity for the dynamic data storage, the information was delivered to the City on December 1, 2016 in a Microsoft Excel document named "Final Manhole Inspection Tables_WW.xlsx." This table can also can be found on the external hard drive associated with

the wastewater AMP. This file contains all of the manhole inspection information in a tabular format that is linked to the inspection videos and consistent with the rest of the condition data deliverables.

D. Sewer Data

Terra Contracting Services was hired to perform pipe inspections in accordance with NASSCO's Pipeline Assessment Certification Program (PACP). Terra inspected 25.4 miles of sewer, which is approximately 30% of the City's collection system. Terra provided the City with the inspection videos, reports, and two database files named "TRAVERSE CITY.mdb" (delivered to the City and shared with OHM shortly after) and "Traverse City.mdb" delivered directly to OHM on February 20, 2017. City staff also performed pipe inspections in accordance with NASSCO's Pipeline Assessment Certification Program (PACP) on 7.8 miles of sewer. This dataset was delivered to OHM on November 9, 2016.

OHM Advisors compiled the data from all database files and returned the finished product in an Excel file with multiple tables. This format provides the flexibility to integrate the data into Lucity and use the data for subsequent reporting and analysis. The Excel file contained the following five different tables:

1. "Inspection Data" – Table containing all of the header information, which would be considered the static data component of the inspection
2. "Media Links" – Table showing which media files pertain to which feature in GIS
3. "Structure Defect List" – Complete list of defects and their associated information
4. "Ratings" – NASSCO ratings table based on the defect coding
5. "Rehab Recommendation Summary" –Table containing all of the recommended rehabilitation that was identified during the review of the inspection videos

The sample final table file was sent to the City on September 12, 2016 and approved on November 21, 2016.

Several pipe inspections discovered discrepancies with the existing GIS mapping, such as buried manholes that needed to be added to the manhole features class or pipe segments that needed to be split at a structure connected to, but not located at the endpoint of the line segment. OHM Advisors provided the City with a list of the discrepancies and suggested corresponding GIS edits. The list became a working document between the City and OHM Advisors to track the collaboration and updates. All of the discrepancies were addressed and compiled into a final table. This final table documents all of the suggested changes, notes between OHM Advisors and the City, and geodatabase edits that were completed by the City. It is named "Final GIS Discrepancy List from Wastewater PACP Data.xlsx" and can be found on the external hard drive.

Upon completion of the edits, the PACP data fields were updated and compiled into the final data table format previously mentioned. This Excel file is named "Final Sewer Inspection Tables_WW.xlsx" and can be found on the external hard drive.

The external hard drive is a separate deliverable and will be submitted to the City on or before May 31, 2017.

E. Criticality Factors

The criticality factors were created using the "20160223_Storm_WatseWater.gdb" geodatabase. A new attribute field was created for each criticality factor, which was populated for all manhole and pipe segment features. Please refer to Appendix D for further details on factors and how the criticality matrix was developed. This table was not intended to be a working database. Instead, it is deliverable that will allow the City to join these new fields with their current working database based on the unique asset identifier. Once the new fields have been joined to the City's working database, they can be edited easily in the future as the condition of the assets change over time. The individual consequence of failure factors used to calculate the ratings will also delivered to the City on the external hard drive, so the City can re-evaluate risk as more inspections and rehabilitation projects are completed in the future.

F. Future Data Management Recommendations

The asset management plan is intended to be a working "document" that must be continuously edited to incorporate new information and update existing data. The deliverables produced during the SAW Grant project only pertain to a portion of the City's wastewater system, so the datasets are just the foundation of an ongoing effort to enhance the asset management plan. In addition, some of the data that was compiled during the project will need to be replaced with more current data as time goes on. For example, attribute fields such as condition ratings or risk factors will need to be adjusted in the event of any new inspections or changes to an asset's properties in the future.

Continued field data collection and database update efforts are crucial to an effective AMP.

Appendix C: Force Main Inventory and Assessment Technical Memorandum

Appendix C: Force Main Inventory and Assessment Technical Memorandum

A. Introduction

This memorandum summarizes the collection and assessment of data for the 4.7 miles of force main in Traverse City's wastewater conveyance system. The locations of these are shown in Figure C-A-1 in Appendix C-A. A force main's probability of failure was determined from age, pipe material, break history, presence of stream crossings, and number of junctions. Criticality was determined by associated pump station capacity, roadway traffic ratings, close proximity surface water, railroad crossings, close proximity drinking water wells, presence of redundant force mains, presence of historical districts, and the number of residential or commercial properties along the force main. A copy of the proposed methodology that was originally provided to Traverse City to describe these criticality ratings is provided in Appendix C-B. The rating scale and several other details have since been modified to better fit Traverse City's needs. The goal of this process is to provide an estimate of the needed annual reserves and capital improvement costs for force main maintenance and replacement.

B. Data Collection and Inventory

The 4.7 miles of force main that are maintained by Traverse City are shown in Figure C-A-1 in Appendix C-A. An inventory of the force mains was created using the existing GIS, record drawings, and operator input. Force mains were subdivided into shorter segments and inventoried separately when split by fittings or valves, for diameter changes, for material changes, and at major force main junction points. Segmentation allowed the risk potentials along the entire force main to be identified in more detail and helps prioritize areas of greater concern for future inspections. A unique facility identifier (ID) was assigned to each segment to link criticality ratings back to the existing GIS. Information collected for each segment is summarized in Table C-C-1 in Appendix C-C. Force main segments of an unknown material type or diameter were assumed to have the same properties as adjoining segments. Those with an unknown installation year were assumed to be installed at the same time as the associated pump station.

Assessing the condition of a force main is costly and often requires destructive or disruptive testing methods. In most cases bypass pumping would be required to prevent interruptions in flows and keep the system operating during testing. For these reasons, it was elected to forgo a condition assessment and use available information on each segment's expected useful life, history of repairs, presence of a stream or river crossing, and number of junctions as a surrogate for condition ratings.

A Probability of Failure (POF) rating predicts the likelihood of an asset to fail. Table C-1 provides a description of the POF score. The score was determined by taking a weighted average of several POF factors that were rated using the same scale. Remaining useful life was the highest weighted factor. As a force main deteriorates, and the remaining useful life decreases, the POF increases. Observations of the deterioration of sewer conduits suggest that deterioration in a new sewer starts slowly and occurs more rapidly as defects accumulate, thus fitting the shape of an exponential curve. The properties of a deterioration curve are unique to each system. However, with little information on the force main conditions in Traverse City to help fit the curve, a general exponential relationship was assumed by an experienced facilities design engineer. This relationship is characterized in Table C-2 and Figure C-1. As additional information on how the system is aging becomes available this curve should be updated. The history of repairs, presence of a stream crossing, and the number of additional junctions at the end of a force main segment are also assigned a 1 to 5 rating and are factored in the POF. A description of their individual ratings is provided in Table C-C-3 in Appendix C-C and rational for each item is further explained in the criticality document in Appendix C-D.

Table C-1: Probability of Failure Descriptions

Score	Description
1	Improbable
2	Remote, unlikely but possible
3	Possible
4	Probable, likely
5	Imminent, likely in near future

Table C-2: Probability of Failure Rating Compared to Force Main Remaining Useful Life

Remaining Useful Life	Probability of Failure
14%	4.0
22%	3.5
32%	3.0
43%	2.5
57%	2.0
75%	1.5
100%	1.0

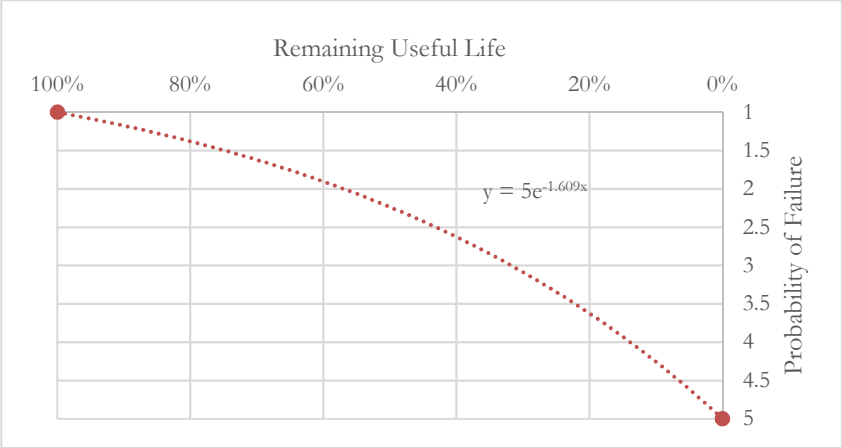


Figure C-1: Probability of Failure for Force Mains

The Consequence of Failure (COF) rating describes the effect of an individual asset's failure on system operations. This value corresponds to the descriptions in Table C-3. COF was determined by taking the weighted average of the following COF factors: the associated pump station capacity, roadway traffic ratings, proximity to surface water, railroad crossings, proximity to groundwater wells, presence of redundant force mains, presence of historical districts, and the number of residential or commercial properties along the force main segment. Each factor was assigned a 1 to 5 value with the higher values being used in conditions where failure of the force main would have a more catastrophic result. Table C-C-2 in Appendix C-C includes a breakdown of each factor, it's weighting, and how it is rated. Additional details for each factor are presented in the criticality methodology document in Appendix C-D.

Table C-3: Consequence of Failure

Score	Effect
1	Negligible, minor loss of function
2	Minimal or marginal disruption of operations
3	Noticeable, may suspend some operations
4	Critical, temporarily suspends operations
5	Catastrophic disruption

Traverse City expressed a desire for the POF to have greater significance than the COF when determining criticality. For this reason, a weighted average was calculated for the two factors with POF worth two-thirds of the average and COF worth the remaining one-third. The resulting average was squared to create the correct scale for the Business Risk Exposure (BRE) score. The BRE is used to determine the criticality of an asset to system operation and is helpful for prioritizing limited funding. BRE ranges from 1-25. Generally, assets with a BRE less than 8 are considered non-critical and greater than 16 are considered critical. Assets with higher BRE scores are more likely to need immediate attention. Assets with a lower BRE have longer remaining useful lives or a smaller consequence of failure, but still need to be maintained.

C. Force Main Assessment

Traverse City's force mains appear to be functioning as intended. Only five breaks have been recorded in the past 16 years. One of these breaks was a result of damage during construction while the remaining four were shear breaks. No single force main has had more than two recorded breaks.

Approximately 2.7 miles of force main has exceeded its material's expected useful life. Several of these force mains are more critical to the system and have been noted in Table C-4, along with the reasons for their BRE score. The life expectancy of ductile iron and cast iron force mains is 60-75 years. Some newer materials such as HDPE and PVC will last closer to 100 years. As the force mains continue to age, the risk of breaks and failures increases. It is recommended that force mains which are at or exceeding their maximum life expectancy be replaced as soon as possible to avoid a failure. The cost of force main replacement makes it difficult to replace all the aging force mains at the same time and so a recommended replacement schedule has been provided that spreads these out over the next fifteen years. Segments have been grouped by the upstream pump station and the most critical segments have been incorporated into the proposed 5-year Capital Improvement Plan budget.

Table C-4: High Business Risk Exposure Force Mains

Force Main Pump Station	BRE Explanation	Maximum Segment BRE	Length (feet)
Front Street and connection to WWTP	The 85-year-old cast iron and ductile iron force main has exceeded its expected life. There are no redundant force mains between the pump station and its connection to the WWTP. It is connected to a high capacity pump station and is located near some higher traffic roads and close to the Boardman River.	16.8	3,109
Coast Guard	Some 73-year-old ductile iron and cast iron segments between the Coast Guard Pump Station and Woodmere have exceeded their expected life. There have been two repairs, these segments are near a high traffic road, and they cross a railroad.	14.3	7,316
Birchwood	The 60-year-old cast iron force main is at the end of its expected life. It is connected to a decent capacity pump station, there is no redundant force main, and it is near multiple residential properties.	13.6	2,583
WWTP	The force mains that connect individual pump station force mains to the WWTP appear to be 85 years old and past or near their expected life depending on material. These force mains handle several pump stations and are higher capacity, have a few segments with no redundancy, and have many junctions.	13.2	134
Bay	This 85-year-old cast iron force main has exceeded its expected life. There is no redundancy, and it is near surface water and multiple commercial and residential properties.	13.1	1,126

D. Annual Capital Reserves and Capital Improvement Plan

This analysis provides an overview of the cost projections to manage Traverse City's force mains. The useful life of a force main is typically greater than 50 years. Capital assets with useful lives greater than 20 years are not funded annually by a replacement fund. The capital costs are substantial and should have some additional funding sources which may include bonds or other established accounts. Cost estimates are based on 2016 dollars. These values do not account for inflation.

Current technologies provide trenchless restoration options for force mains as an alternative to direct replacement. Costs for using one of these restoration options, a cured-in-place pipe (CIPP) lining system, were compared to the costs for a complete replacement. The cost

comparison showed that for some of the smaller diameter force mains CIPP could provide a cheaper option, but for 10-inch diameter and greater the savings were no longer significant and in some cases more expensive. Based on these cost considerations, all estimated costs for force mains 10-inches in diameter or greater were for the complete replacement of the force main. All smaller diameter force main costs are for CIPP, with the exclusion of 2-inch force mains which are too small for CIPP and must also be replaced.

Table 5 includes capital costs for force mains summed over the next 15 years. The critical force mains from Table C-4 that have exceeded their expected life are spread throughout this period order of their BRE rating. It may also be practical to consider prioritizing force mains that that are no longer appropriately sized. Figure C-2 graphically displays the annual capital cost for these replacements. A detailed list of these assets and any additional ones expected to fail over the next five years is available in Appendix C-D.

Table C-5: Annual Cash Reserves for Replacement and Repair

Force Main Pump Station	Capital Fund														
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bay	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$180,084	$0
Birchwood	$0	$0	$0	$0	$0	$0	$0	$568,278	$0	$0	$0	$0	$0	$0	$0
Coast Guard	$0	$0	$0	$0	$1,172,593	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Front Street	$0	$607,834	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Front Street – WWTP	$0	$148,531	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
WWTP	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$32,051	$0	$0	$0	$0
Grand Total	**$0**	**$756,365**	**$0**	**$0**	**$1,172,593**	**$0**	**$0**	**$568,278**	**$0**	**$0**	**$32,051**	**$0**	**$0**	**$180,084**	**$0**

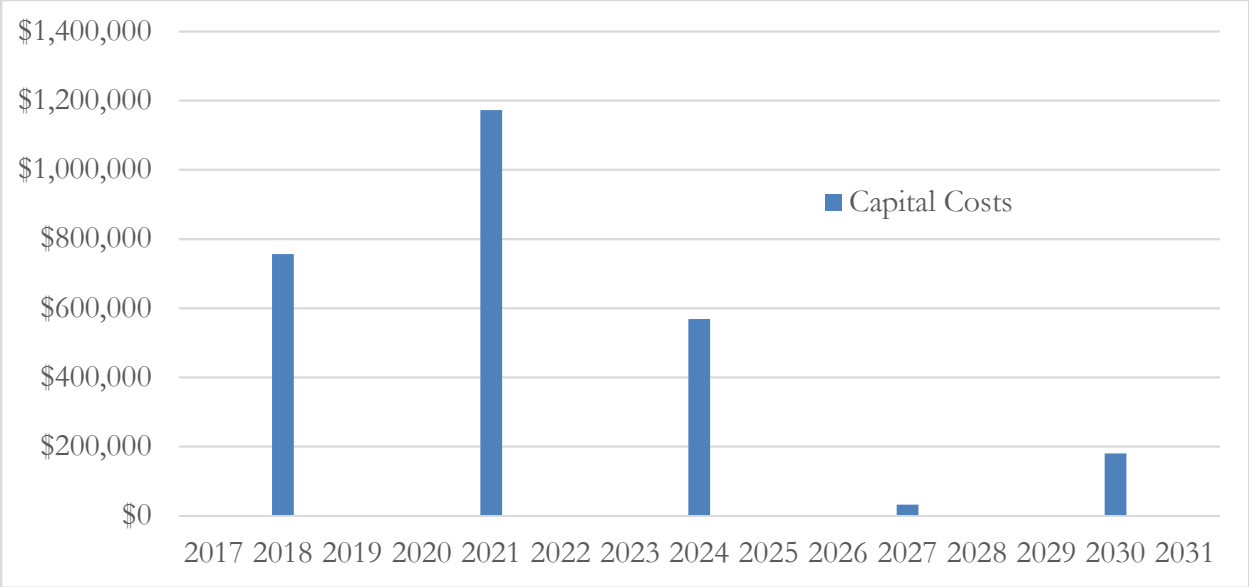


Figure C-2: Funding Necessary over Time at Recommended Replacement Years

In Figure C-3, costs were averaged over time to show typical annual expenses. All costs from the next five years were summed and divided by five to get an expected annual expense over those years. This provides a visualization of expected costs over time. The result is a capital cost of approximately $385,791 annually between 2017 and 2021 for a total of roughly $1,928,957. The following five years (2022-2026) decrease to an annual cost of $113,656 for a five year total of roughly $568,278. The last five years (2027-2031) continue to decrease with an annual cost of $42,427 and a total cost of $212,135.

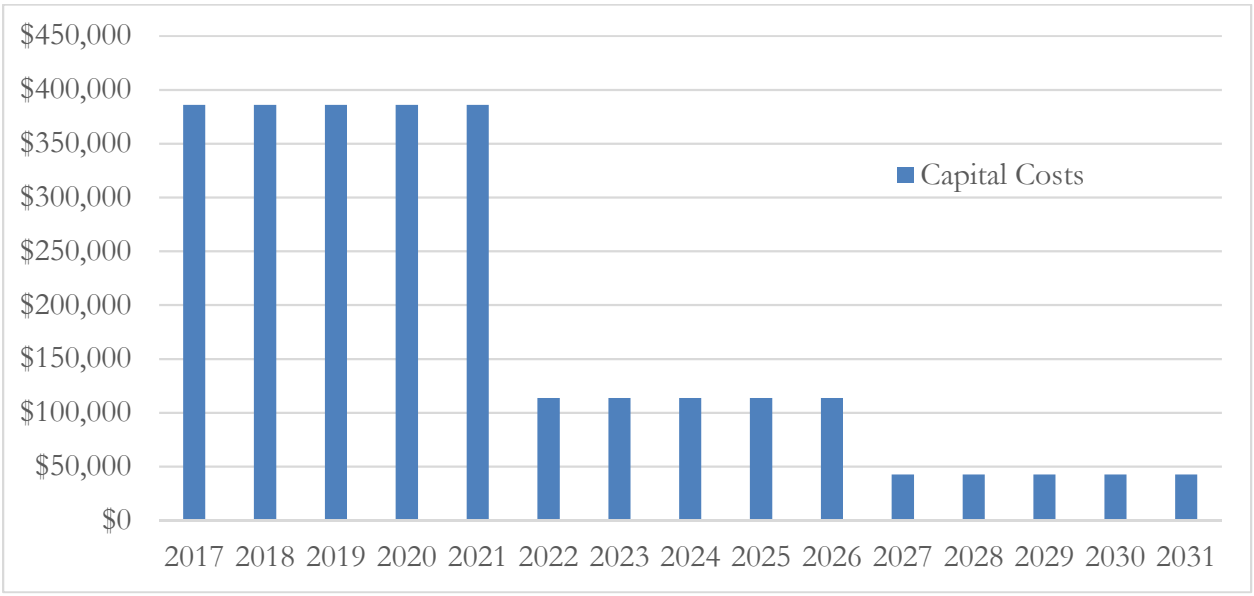


Figure C-3: Funding Spread Out Over Time for Recommended Replacements

E. Recommendations

The information gathered during the inventory and assessment will be compiled into an easily accessible and updatable database. The data presented in this memorandum provide an overview of the cost projections with the understanding that a combination of funding sources will be the best solution to manage Traverse City's force main assets. Future iterations will be documented with final agreed upon plan and funding mechanisms presented to the MDEQ in the rate analysis and Asset Management Plan (AMP).

Future work will include a comprehensive capital improvement plan for the system. A holistic approach to future improvements will incorporate results from assessments of the rest of the conveyance and treatment system.

In any AMP, it is vital to actively assess system components. As force mains age and are replaced, their probability of failure and system criticality change. These changes should be reflected in planning. As repairs and replacements occur it is recommended that the opportunity be taken to perform physical pipe inspections. Condition information from these inspections should be incorporated into an updated AMP.

Appendix C-A – Map of Traverse City's Force Mains

Traverse City

Figure C-A-1. Force Main Locations

Bay Lift Station

Clinch Park Lift Station

Front Street Lift Station

Birchwood Lift Station

Riverine Lift Station

Hull Lift Station

Woodmere Lift Station

Coast Guard Lift Station

TBA Lift Station

WWTP

Legend

- Lift Station
- Pump Station
- Force Mains Maintained by Others
- Traverse City Owned Force Mains
- Sanitary Gravity Main
- Railroads

0 1,500 3,000
Feet

1" = 1,500'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: June 5, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM
888.522.6711 | ohm-advisors.com

Appendix C-B – Original Proposed Assessment Methodology

PROPOSED METHODOLOGY – FM CRITICALITY ANALYSIS

To complete a conditional assessment and establish priorities for force main inspection and maintenance, TRAVERSE CITY proposes to perform a criticality analysis of their force main. A criticality analysis is a form of risk analysis that assigns priorities to individual force main segments for field inspection. Criticality scores are calculated values that use criteria to estimate, i.e., score, the likelihood (i.e. probability) of failure and consequence (i.e. impact) of failure for a given force main segment.

Prior to conducting the criticality analysis, TRAVERSE CITY will subdivide each force main into shorter segments (segmentation). The vertical and horizontal alignment of a force main, the environmental conditions that a force main travels through and the physical characteristics of the force main, are not typically uniform along its entire length. For example, a segment of force main that crosses a creek as a submerged section of pipe (or as an aerial crossing) represents a higher risk (i.e. criticality) condition than a segment of the same force main that travels along a 30-ft dedicated sewer utility easement. The primary purpose of segmentation is to disaggregate a force main into smaller, more discrete segments that can be scored differently to better reflect the different risk potential along the entire force main alignment.

TRAVERSE CITY will segment the force main system into multiple segments, and each segment will be assigned a unique asset ID number for use with TRAVERSE CITY's GIS system. The criteria used to perform the segmentation process are as follows:

1) Changes in force main diameter
2) Changes in force main material
3) Locations of force main junction points (e.g. tee fittings)
4) Intersections with mainline valves
5) 2,500 linear feet or less per segment

Weighting Factors

Recognizing that each criterion is not of equal importance in determining criticality, weighting factors are used to prioritize the degree of importance. A higher weighting factor indicates that the criterion is of greater importance in the decision-making process. For both likelihood of failure and consequence of failure criteria, weighting factors will be applied to the raw scores to arrive at a weighted score for each criterion.

TRAVERSE CITY expressed a desire to place more importance on likelihood of failure criteria. For the initial criticality analysis, therefore, likelihood of failure scores will be weighted with a factor ranging from 5 to 10, and consequence of failure scores will be weighted with a factor ranging from 1 to 6. By applying greater overall weighting to likelihood of failure criteria, the criticality analysis resulted in a prioritization that places a greater emphasis on identifying force main segments with a higher likelihood, or probability, of failure. While consequence of failure is also recognized as important, the objective of this approach is to identify the force main segments that represent the highest likelihood of failure so that corrective action can be implemented prior to a failure event occurring.

Likelihood of Failure Criteria

Likelihood of failure scores are intended to represent the probability that a force main will fail based on the environmental conditions of where the force main is located and the physical characteristics of the force main. Likelihood of failure criteria typically include age, material of construction, soil type where the force main is buried, flow and pressure on the force main, work order history for the force main, and actual pipe condition (as observed and recorded through field inspections). Following is a brief description

of the likelihood of failure criteria used by TRAVERSE CITY for the criticality analysis.

PIPE MATERIAL: Pipe material is a critical factor in determining the most typical failure modes for a given force main segment. Most ferrous and cement-based force main failures are attributed to corrosion (internal or external), and most PVC and other plastic pipe force main failures are attributed to improper installation.

AGE OF MATERIAL: All pipe materials age and deteriorate over time due to abrasive, structural and mechanical forces, and corrosive agents. All pipelines, therefore, have a finite useful service life, but that service life is extremely difficult to predict because of the multitude of variables impacting it. 50 years is generally accepted as a reasonable design service life for a pressure pipeline.

STREAM/RIVER CROSSINGS: Force main segments that cross streams or rivers represent a special concern for TRAVERSE CITY given the potential for accelerated rates of corrosion in the coastal environment and a history of failures at such locations. Deterioration of these pipe segments can be severe for ferrous and cement-based pipe materials, especially those segments that are exposed to such conditions over an extended period of time.

NUMBER OF FORCE MAIN JUNCTIONS (TAPS): For the purposes of this analysis, a force main tap was defined as the location at which one force main is connected or joined to another force main by means of a structural or mechanical modification to the receiving force main segment. The location of the structural or mechanical modification is assumed to be a potential point of failure. Each segment may have 0, 1 or 2 taps associated with it. This criterion was scored based on the number of taps present on a force main segment.

Consequence of Failure Criteria

Consequence of failure scores are intended to represent the degree of impact of a force main failure on the service area located in close proximity to the force main. Consequence of failure criteria typically consider direct impacts, such as loss of service and cost for repair and cleanup, health and environmental impacts, such as public health risks and environmental resource impacts, and socioeconomic impacts, such as transportation and business disruptions (Thomson). Following is a brief description of the consequence of failure criteria used by TRAVERSE CITY for the criticality analysis.

QUANTITY OF FLOW: This criterion is based on the potential quantity of flow discharged to the environment as a result of a force main segment failure. Average daily flow rates for each pumping station in the system was provided by TRAVERSE CITY and incorporated into the criticality analysis.

SURFACE WATERS: This criterion is based on potential impacts to surface waters as a result of a force main segment failure. Force main segments located in closest proximity to surface waters were scored higher (greater consequence of failure) than force main segments located farthest from surface waters.

GROUNDWATER WELLS: This criterion is based on the potential impacts to public and private groundwater wells in the event of a force main segment failure. Force main segments located in closest proximity to groundwater wells are scored higher (greater consequence of failure) than force main segments located farthest from groundwater wells.

HIGH QUALITY WATER AND OUTSTANDING RESOURCE WATER (HQW-ORW) MANAGEMENT ZONES: This criterion is based on the potential impacts to high quality waters or outstanding resource waters as a result of a force main segment failure. Force main segments located in closest proximity to high quality waters or outstanding resource waters were scored higher (greater consequence of failure) than force main segments located farthest from high quality waters or outstanding resource waters.

TRANSPORTATION SYSTEMS: This criterion is based on the potential impacts to transportation systems in the event of a force main segment failure. This criterion was scored based on the number and type of transportation systems crossed by a force main segment.

PRESENCE OR ABSENCE OF REDUNDANT FORCE MAIN: This criterion is based on the presence or absence of a redundant force main in the event of a force main segment failure. Force main segments without a redundant force main were scored higher than force segments with a redundant force main.

CULTURAL RESOURCE IMPACTS: This criterion is based on the potential impacts to cultural resources in the event of a force main segment failure. Force main segments that crossed historic districts were scored higher than force main segments that did not cross historic districts.

RESIDENTIAL IMPACTS: This criterion is based on the potential impacts to residents in the event of a force main segment failure. This criterion was scored based on the estimated number of residential parcels located within an anticipated construction repair corridor for each force main segment.

COMMERCIAL IMPACTS: This criterion is based on the potential impacts to commerce in the event of a force main segment failure. This criterion was scored based on the estimated number of commercial parcels located within an anticipated construction repair corridor for each force main segment.

The above Forcemain Condition Assessment methods were modified from the original Abstract Paper identified below:

CRITICALITY ANALYSIS AND INSPECTION METHODS FOR FORCE MAIN CONDITION ASSESSMENT

Authors: Ray Cox [(1)], Kelly Derr [(2)], Jim Perotti [(2)], Clayton Glatt [(2)] ***(1 – Highfill Infrastructure Engineering, 2 – Brown & Caldwell)***

REFERENCES: Thomson, James C., et al. *Inspection Guidelines for Wastewater Force Mains*. Water Environment Research Foundation (WERF). IWA Publishing: London, UK, 2010. WERF Publication 04-CTS- 6URa.

Appendix C-C – Assessment and Inventory

Legend for Table C-C-1 by Column Number Heading:

1: Unique Asset ID
2: Associated Pump Station
3: Force Main Material Type
4: Force Main Diameter (Inches)
5: Force Main Segment Length (Feet)
6: Installation Year
7: Expected Asset Life (Years): Based on typical material life
8: Remaining Life Based on Installation Date (Years):
    [8] = [7] – (Evaluation Year – [6])
9: Percent Remaining Useful Life
    [9] = ([8] / [7]) * 100
10: Consequence of Failure: Assigned based on the criticality factors in Table B-2
11: Probability of Failure: Assigned based on the criticality factors in Table B-3
12: Business Risk Exposure
    [12] = $((1/3)*[10] + (2/3)*[11])^2$
13: Replacement Year
    [13] = Current Evaluation Year + [8]
14: 2016 Replacement Cost: Assigned based on the judgement of experienced engineer
15: 2016 Value Assuming Linear Depreciation: Assumes depreciation based on asset's total predicted life [15] = [9] * [14]
16: CIPP vs Replacement: Shows whether replacement cost is based on a full replacement of the force main or CIPP.

Appendix C-C, Table C-C-1 Force Main Inventory and Assessment

Evaluation Year: 2016

									Risk Weighting:	33.3%	66.7%				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Asset ID	Associated Pump Station	Material	Diameter (Inches)	Length (Feet)	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Install Date (Years)	Percent Remaining Useful Life	Consequence of Failure (1-5)	Probability of Failure (1-5)	Business Risk Exposure (1-25)	Replacement Year	2016 Replacement Cost	2016 Value Assuming Linear Depreciation	CIPP vs Replacement
SSFM-32	Riverine	PVC	12	681	1982	90	56	62%	3.2	1.8	5.1	2072	$136,106	$84,688	Replacement
SSFM-153	Riverine	PVC	12	9	1982	90	56	62%	2.9	1.8	4.6	2072	$1,798	$1,119	Replacement
SSFM-10	Bay	CI	8	1126	1931	60	-25	0%	2.9	4.0	13.1	1991	$180,084	$0	CIPP
SSFM-148	Front Street	CI	16	973	1931	60	-25	0%	4.2	4.0	16.4	1991	$233,558	$0	Replacement
SSFM-150	Front Street	CI	16	1559	1931	60	-25	0%	4.0	4.2	16.8	1991	$374,275	$0	Replacement
SSFM-251	Front Street - WWTP	CI	16	3	**1931**	60	-25	0%	3.5	4.2	15.6	1991	$695	$0	Replacement
SSFM-252	Front Street - WWTP	DI	16	2	**1931**	70	-15	0%	3.5	4.2	15.6	2001	$480	$0	Replacement
SSFM-282	Front Street - WWTP	DI	**18**	57	**1931**	70	-15	0%	2.7	4.0	12.7	2001	$14,315	$0	Replacement
SSFM-261	Front Street - WWTP	DI	18	195	**1931**	70	-15	0%	2.9	4.0	13.2	2001	$48,750	$0	Replacement
SSFM-250	Front Street - WWTP	CI	16	16	**1931**	60	-25	0%	2.9	4.2	14.0	1991	$3,885	$0	Replacement
SSFM-281	Front Street - WWTP	DI	**24**	41	**1931**	70	-15	0%	2.7	4.0	12.7	2001	$11,470	$0	Replacement
SSFM-259	Front Street - WWTP	DI	24	150	**1931**	70	-15	0%	2.8	4.0	13.0	2001	$41,941	$0	Replacement
SSFM-280	Front Street - WWTP	DI	**16**	112	**1931**	70	-15	0%	2.8	4.2	13.8	2001	$26,996	$0	Replacement
SSFM-289	Hull	PVC	4	47	**2001**	90	75	83%	1.9	1.2	2.1	2091	$3,723	$3,102	CIPP
SSFM-291	Hull	PVC	4	50	**2001**	90	75	83%	1.9	1.2	2.1	2091	$4,000	$3,333	CIPP
SSFM-287	Hull	HDPE	2	222	**2001**	100	85	85%	1.8	1.2	2.0	2101	$5,319	$4,522	Replacement
SSFM-286	Hull	PVC	2	2	**2001**	90	75	83%	1.6	1.4	2.1	2091	$48	$40	Replacement
SSFM-202	Woodmere	DI	6	12	**1992**	70	46	66%	1.8	1.6	2.7	2062	$1,408	$925	CIPP
SSFM-189	Woodmere	DI	6	34	**1992**	70	46	66%	1.8	1.6	2.7	2062	$4,028	$2,647	CIPP
SSFM-188	Woodmere	DI	6	42	**1992**	70	46	66%	1.8	1.6	2.7	2062	$5,028	$3,304	CIPP
SSFM-203	Woodmere	DI	6	12	**1992**	70	46	66%	1.8	1.6	2.7	2062	$1,416	$931	CIPP
SSFM-182	Woodmere	PVC	**6**	1	**1992**	90	66	73%	1.8	1.6	2.7	2082	$120	$88	CIPP
SSFM-185	Woodmere	PVC	**6**	2	**1992**	90	66	73%	1.8	1.6	2.7	2082	$180	$132	CIPP
SSFM-179	Woodmere	DI	6	4	**1992**	70	46	66%	2.4	1.6	3.4	2062	$420	$276	CIPP
SSFM-180	Woodmere	DI	6	4	**1992**	70	46	66%	2.4	1.6	3.4	2062	$420	$276	CIPP
SSFM-181	Woodmere	DI	6	4	**1992**	70	46	66%	2.4	1.7	3.8	2062	$420	$276	CIPP
SSFM-171	Woodmere	DI	8	14	**1992**	70	46	66%	2.4	1.6	3.4	2062	$2,240	$1,472	CIPP
SSFM-169	Woodmere	DI	8	2	1992	70	46	66%	2.4	1.7	3.8	2062	$320	$210	CIPP
SSFM-167	Woodmere	**CI**	8	4	**1992**	60	36	60%	1.6	1.8	3.1	2052	$640	$384	CIPP
SSFM-176	Woodmere	CI	8	3	**1992**	60	36	60%	1.6	1.7	2.7	2052	$400	$240	CIPP
SSFM-166	Woodmere	**CI**	8	18	**1992**	60	36	60%	2.6	2.0	4.9	2052	$2,880	$1,728	CIPP
SSFM-192	Woodmere	DI	14	669	**1992**	70	46	66%	2.7	1.9	4.6	2062	$147,100	$96,666	Replacement
SSFM-231	Woodmere	CI	10	372	1992	60	36	60%	2.4	1.8	4.1	2052	$67,775	$40,665	Replacement
SSFM-18	Woodmere	CI	10	655	1992	60	36	60%	2.4	1.7	3.7	2052	$119,208	$71,525	Replacement
SSFM-4	Woodmere+Coast Guard + Hull	PVC	**16**	341	**1992**	90	66	73%	2.9	1.7	4.5	2082	$81,840	$60,016	Replacement
SSFM-284	Woodmere+Coast Guard + Hull	DI	**16**	96	**1992**	70	46	66%	2.3	1.6	3.2	2062	$23,016	$15,125	Replacement
SSFM-276	Woodmere+Coast Guard + Hull	DI	16	21	**1992**	70	46	66%	2.3	1.7	3.7	2062	$5,016	$3,296	Replacement
SSFM-277	Woodmere+Coast Guard + Hull	DI	16	24	**1992**	70	46	66%	2.3	1.6	3.2	2062	$5,664	$3,722	Replacement
SSFM-295	Coast Guard	DI	8	58	1996	70	50	71%	2.4	1.4	3.1	2066	$9,280	$6,629	CIPP
SSFM-24	Coast Guard	CI	8	4090	1943	60	-13	0%	2.9	4.0	13.1	2003	$654,369	$0	CIPP
SSFM-23	Coast Guard	**CI**	8	3175	1943	60	-13	0%	3.0	4.2	14.3	2003	$507,956	$0	CIPP
SSFM-198	Coast Guard	DI	12	51	**1943**	70	-3	0%	2.7	4.0	12.6	2013	$10,267	$0	Replacement
SSFM-196	Coast Guard	DI	12	499	1996	70	50	71%	3.2	1.6	4.5	2066	$99,824	$71,303	Replacement
SSFM-199	Coast Guard	DI	12	2	1996	70	50	71%	2.6	1.6	3.8	2066	$374	$267	Replacement
SSFM-207	Coast Guard	DI	12	5	1996	70	50	71%	2.8	1.4	3.5	2066	$980	$700	Replacement

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Asset ID	Associated Pump Station	Material	Diameter (Inches)	Length (Feet)	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Install Date (Years)	Percent Remaining Useful Life	Consequence of Failure (1-5)	Probability of Failure (1-5)	Business Risk Exposure (1-25)	Replacement Year	2016 Replacement Cost	2016 Value Assuming Linear Depreciation	CIPP vs Replacement
SSFM-208	Coast Guard	DI	12	5	1996	70	50	71%	2.8	1.4	3.5	2066	$980	$700	Replacement
SSFM-211	Coast Guard	DI	12	471	1996	70	50	71%	2.8	1.4	3.5	2066	$94,135	$67,239	Replacement
SSFM-214	Coast Guard	DI	12	5	1996	70	50	71%	2.5	1.4	3.2	2066	$980	$700	Replacement
SSFM-215	Coast Guard	DI	12	5	1996	70	50	71%	2.5	1.4	3.2	2066	$1,000	$714	Replacement
SSFM-216	Coast Guard	DI	12	517	1996	70	50	71%	2.5	1.6	3.6	2066	$103,331	$73,808	Replacement
SSFM-220	Coast Guard+Hull	DI	12	4	1996	70	50	71%	2.8	1.4	3.6	2066	$800	$571	Replacement
SSFM-218	Coast Guard+Hull	PVC	**12**	1	1996	90	70	78%	2.8	1.5	3.7	2086	$200	$156	Replacement
SSFM-151	TBA	AC	12	16	1970	80	34	43%	3.2	2.1	6.2	2050	$3,300	$1,402	Replacement
SSFM-28	TBA	AC	12	4834	1970	80	34	43%	2.9	2.2	6.0	2050	$966,889	$410,928	Replacement
SSFM-154	Birchwood	CI	14	26	**1956**	60	0	0%	2.9	4.0	13.2	2016	$5,720	$0	Replacement
SSFM-30	Birchwood	CI	14	2557	1956	60	0	0%	3.1	4.0	13.6	2016	$562,558	$0	Replacement
SSFM-122	Clinch Park	DI	4	1	2002	70	56	80%	1.9	1.5	2.6	2072	$81	$65	CIPP
SSFM-123	Clinch Park	DI	4	1	2002	70	56	80%	1.9	1.3	2.2	2072	$79	$63	CIPP
SSFM-124	Clinch Park	DI	4	3	2002	70	56	80%	1.9	1.3	2.2	2072	$222	$177	CIPP
SSFM-127	Clinch Park	DI	4	2	2002	70	56	80%	1.9	1.5	2.6	2072	$132	$106	CIPP
SSFM-125	Clinch Park	DI	4	1	2002	70	56	80%	1.9	1.5	2.6	2072	$78	$63	CIPP
SSFM-126	Clinch Park	DI	4	3	2002	70	56	80%	1.9	1.3	2.2	2072	$220	$176	CIPP
SSFM-128	Clinch Park	DI	4	2	2002	70	56	80%	1.9	1.5	2.6	2072	$164	$131	CIPP
SSFM-129	Clinch Park	DI	4	1	2002	70	56	80%	1.9	1.5	2.6	2072	$60	$48	CIPP
SSFM-130	Clinch Park	DI	4	1	2002	70	56	80%	1.9	1.5	2.6	2072	$108	$86	CIPP
SSFM-120	Clinch Park	DI	4	7	2002	70	56	80%	1.8	1.6	2.8	2072	$592	$474	CIPP
SSFM-121	Clinch Park	PVC	**4**	7	2002	90	76	84%	1.8	1.4	2.3	2092	$522	$441	CIPP
SSFM-119	Clinch Park	DI	4	3	2002	70	56	80%	1.8	1.5	2.5	2072	$200	$160	CIPP
SSFM-118	Clinch Park	PVC	**4**	171	2002	90	76	84%	2.4	1.2	2.6	2092	$13,707	$11,575	CIPP
SSFM-117	Clinch Park	DI	4	149	2002	70	56	80%	2.5	1.3	2.9	2072	$11,930	$9,544	CIPP
SSFM-131	Clinch Park Area	PVC	2	42	2002	90	76	84%	2.2	1.4	2.7	2092	$1,004	$848	Replacement
SSFM-132	Clinch Park Area	PVC	2	19	2002	90	76	84%	2.2	1.5	3.1	2092	$458	$387	Replacement
SSFM-155	Coast Guard-Woodmere Bypass	**DI**	10	69	**1992**	70	46	66%	2.6	1.6	3.6	2062	$12,573	$8,262	Replacement
SSFM-161	Coast Guard-Woodmere Bypass	**CI**	6	5	**1992**	60	36	60%	2.0	1.8	3.6	2052	$599	$359	CIPP
SSFM-162	Coast Guard-Woodmere Bypass	**CI**	6	8	**1992**	60	36	60%	2.0	1.7	3.2	2052	$953	$572	CIPP
SSFM-163	Coast Guard-Woodmere Bypass	**CI**	6	3	**1992**	60	36	60%	2.0	1.8	3.6	2052	$359	$215	CIPP
SSFM-156	Coast Guard-Woodmere Bypass	CI	10	3	**1992**	60	36	60%	2.0	1.7	3.2	2052	$546	$328	Replacement
SSFM-157	Coast Guard-Woodmere Bypass	CI	10	3	**1992**	60	36	60%	2.0	1.7	3.2	2052	$546	$328	Replacement
SSFM-158	Coast Guard-Woodmere Bypass	**CI**	10	2	**1992**	60	36	60%	2.0	1.8	3.6	2052	$364	$218	Replacement
SSFM-160	Coast Guard-Woodmere Bypass	CI	10	2	**1992**	60	36	60%	2.0	1.8	3.6	2052	$364	$218	Replacement
SSFM-164	Coast Guard-Woodmere Bypass	CI	10	9	**1992**	60	36	60%	2.6	1.8	4.4	2052	$1,638	$983	Replacement
SSFM-201	Coast Guard - Cleanout Branch	DI	12	40	1996	70	50	71%	1.8	1.4	2.4	2066	$8,000	$5,714	Replacement
SSFM-200	Coast Guard - Cleanout Branch	DI	**12**	2	1996	70	50	71%	1.8	1.6	2.8	2066	$353	$252	Replacement
SSFM-271	WWTP	DI	16	26	**1931**	70	-15	0%	2.5	4.2	13.0	2001	$6,240	$0	Replacement
SSFM-263	WWTP	PVC	**16**	32	**1931**	90	5	6%	2.9	3.8	12.5	2021	$7,680	$427	Replacement
SSFM-283	WWTP	DI	**16**	44	**1931**	70	-15	0%	2.9	4.0	13.2	2001	$10,451	$0	Replacement
SSFM-270	WWTP	PVC	**16**	27	**1931**	90	5	6%	2.3	3.8	11.1	2021	$6,480	$360	Replacement
SSFM-273	WWTP	PVC	**16**	5	**1931**	90	5	6%	2.3	3.8	11.1	2021	$1,200	$67	Replacement

*Items in bold were unknown and assumed based on available information.

Legend for Table C-C-2 by Column Number Heading:

1: Unique Asset ID
2: Associated Pump Station
3: Force Main Diameter (Inches)
4: Force Main Segment Length (Feet)
5: Pump Station Firm Capacity (gpm): Upstream pump station capacity
6: Road ADT Value: Highest annual average daily traffic count for the streets that the force main segment travels under
7: Railroad Crossings: Labeled N if no crossings occurred and Y if a force main crossed under a railroad.
8: Distance to Closest High Quality Surface Water (feet): Surface waters around Traverse City include the Boardman River, Boardman Lake, and Grand Traverse Bay.
9: Distance to Closest Drinking Water Well (feet): Determined using DEQ Wellogic information
10. Redundant Force Main: Y if a flows can be routed around this segment using another force main, N if no bypass force main is present.
11. Crosses Historic District: Y if the force main travels through a historic district, N if not
12. Number of Residential Parcels: Number of residential parcels within the anticipated construction repair zone for the force main
13. Number of Commercial Parcels: Number of commercial parcels within the anticipated construction repair zone for the force main
14: Quantity of Flow Rating (1-5): Assigned a rating based on [5] and below table

Rating Scale	Pump Station Capacity Description
5	GPM>=1,500
4	500<=GPM<1,500
3	250<=GPM<500
2	100<=GPM<250
1	GPM<100

15: High Quality Surface Water Rating (1-5): Assigned a rating based on [8] and below table

Rating Scale	Surface Water Description
5	0-50 feet from surface water
4	51-100 feet from surface water
3	101- 200 feet from surface water
2	201- 300 feet from surface water
1	Over 300 feet from surface water

16: Groundwater Wells Rating (1-5): Assigned a rating based on [9] and below table

Rating Scale	Groundwater Wells Descriptions
5	0-100 feet from well
4	101-200 feet from well
3	201-500 feet from well
2	501-1,000 feet from well
1	Greater than 1,000 feet from well

17: Transportation Systems Rating (1-5): Assigned a rating based on [6], [7], and below table

Rating Scale	Transportation Description
5	Railroad Crossed
4	ADT >= 15,000
3	5,000 <= ADT < 15,000
2	0 < ADT < 5,000
1	Unrated/Pervious Surface

18: Redundant Force Main Rating (1-5): Assigned a rating based on [10] and below table

Rating Scale	Redundant Force Main Description
5	No redundant force main
1	Redundant force main present

19: Cultural Impact Rating (1-5): Assigned a rating based on [11] and below table

Rating Scale	Cultural Impact Description
5	Within historic district
1	Not within historic district

20: Residential Impact Rating (1-5): Assigned a rating based on [12] and below table

Rating Scale	Residential Impact Description
5	Over 20 Parcels
4	11-20 Parcels
3	4-10 Parcels
2	1-3 Parcels
1	0 Parcels

21: Commercial Impact Rating (1-5): Assigned a rating based on [13] and below table

Rating Scale	Commercial Impact Description
5	Over 10 Parcels
4	6-10 Parcels
3	3-5 Parcels
2	1-2 Parcels
1	0 Parcels

22: Consequence of Failure: Weighted average of columns [14]-[21]

Appendix C-C, Table C-C-2 Force Main Criticality Factors

COF Factor Weights:												40.0%	10.0%	10.0%	10.0%	15.0%	5.0%	5.0%	5.0%	100.0%
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Asset ID	Associated Pump Station	Diameter (Inches)	Length (Feet)	Pump Station Firm Capacity (gpm)	Road ADT Value	Railroad Crossing (Y or N)	Closest High Quality Surface Water (feet)	Distance to Closest Drinking Water Well (feet)	Redundent Force Main (Y or N)	Crosses Historic Districts (Y or N)	Number of Residential Parcels	Number of Commercial Parcels	Quantity of Flow Rating (1-5)	High Quality Surface Water Rating (1-5)	Groundwater Wells Rating (1-5)	Transportation Systems Rating (1-5)	Redundant Force Main Rating (1-5)	Cultural Impact Rating (1-5)	Residential Impact Rating (1-5)	Commercial Impact Rating (1-5)	Consequence of Failure (1-5)
SSFM-32	Riverine	12	681	350	24054	N	130	379	N	N	2	2	3	3	3	4	5	1	2	2	3.2
SSFM-153	Riverine	12	9	350	0	N	120	370	N	N	0	1	3	3	3	1	5	1	1	2	2.9
SSFM-10	Bay	8	1126	430	928	N	155	3000	N	N	5	1	3	3	1	2	5	1	3	2	2.9
SSFM-148	Front Street	16	973	3600	24054	N	30	741	N	N	1	4	5	5	2	4	5	1	2	3	4.2
SSFM-150	Front Street	16	1559	3600	7868	Y	231	580	N	N	1	4	5	2	2	5	5	1	2	3	4.0
SSFM-251	Front Street - WWTP	16	3	3600	0	N	195	780	N	N	0	0	5	3	2	1	5	1	1	1	3.5
SSFM-252	Front Street - WWTP	16	2	3600	0	N	195	780	N	N	0	0	5	3	2	1	5	1	1	1	3.5
SSFM-282	Front Street - WWTP	**18**	57	3600	0	N	325	875	Y	N	0	0	5	1	2	1	1	1	1	1	2.7
SSFM-261	Front Street - WWTP	18	195	3600	0	N	195	775	Y	N	0	0	5	3	2	1	1	1	1	1	2.9
SSFM-250	Front Street - WWTP	16	16	3600	0	N	195	780	Y	N	0	0	5	3	2	1	1	1	1	1	2.9
SSFM-281	WWTP	**24**	41	3600	0	N	325	875	Y	N	0	0	5	1	2	1	1	1	1	1	2.7
SSFM-259	Front Street - WWTP	24	150	3600	0	N	213	790	Y	N	0	0	5	2	2	1	1	1	1	1	2.8
SSFM-280	Front Street - WWTP	**16**	112	3600	0	N	213	785	Y	N	0	0	5	2	2	1	1	1	1	1	2.8
SSFM-289	Hull	4	47	**30**	0	N	65	1450	N	N	0	0	1	4	1	1	5	1	1	1	1.9
SSFM-291	Hull	4	50	**30**	0	N	55	1450	N	N	0	0	1	4	1	1	5	1	1	1	1.9
SSFM-287	Hull	2	222	60	0	N	105	1350	N	N	0	0	1	3	1	1	5	1	1	1	1.8
SSFM-286	Hull	2	2	60	0	N	320	1350	N	N	0	0	1	1	1	1	5	1	1	1	1.6
SSFM-202	Woodmere	6	12	450	0	N	370	2545	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-189	Woodmere	6	34	450	0	N	418	2583	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-188	Woodmere	6	42	450	0	N	350	2535	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-203	Woodmere	6	12	450	0	N	370	2545	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-182	Woodmere	**6**	1	450	0	N	370	2535	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-185	Woodmere	**6**	2	450	0	N	350	2535	Y	N	0	0	3	1	1	1	1	1	1	1	1.8
SSFM-179	Woodmere	6	4	450	0	N	340	2540	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-180	Woodmere	6	4	450	0	N	340	2540	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-181	Woodmere	6	4	450	0	N	340	2540	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-171	Woodmere	8	14	450	0	N	340	2530	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-169	Woodmere	8	2	450	0	N	340	2530	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-167	Woodmere	8	4	0	0	N	340	2530	N	N	0	0	1	1	1	1	5	1	1	1	1.6
SSFM-176	Woodmere	8	3	0	0	N	340	2530	N	N	0	0	1	1	1	1	5	1	1	1	1.6
SSFM-166	Woodmere	8	18	450	13247	N	330	2510	N	N	0	0	3	1	1	3	5	1	1	1	2.6
SSFM-192	Woodmere	14	669	450	13247	N	330	2225	N	N	0	1	3	1	1	3	5	1	1	2	2.7
SSFM-231	Woodmere	10	372	450	0	N	380	1230	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-18	Woodmere	10	655	450	0	N	441	1589	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-4	Woodmere+Coast Guard + Hull	**16**	341	975	0	N	350	950	N	N	0	0	4	1	2	1	5	1	1	1	2.9
SSFM-284	Woodmere+Coast Guard + Hull	**16**	96	975	0	N	315	875	Y	N	0	0	4	1	2	1	1	1	1	1	2.3
SSFM-276	Woodmere+Coast Guard + Hull	16	21	975	0	N	370	935	Y	N	0	0	4	1	2	1	1	1	1	1	2.3
SSFM-277	Woodmere+Coast Guard + Hull	16	24	975	0	N	345	970	Y	N	0	0	4	1	2	1	1	1	1	1	2.3
SSFM-295	Coast Guard	8	58	465	0	N	3000	1420	N	N	0	0	3	1	1	1	5	1	1	1	2.4
SSFM-24	Coast Guard	8	4090	465	11967	Y	2840	1445	N	N	2	0	3	1	1	5	5	1	2	1	2.9
SSFM-23	Coast Guard	8	3175	465	26039	N	330	2590	N	N	25	5	3	1	1	4	5	1	5	3	3.0

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Asset ID	Associated Pump Station	Diameter (Inches)	Length (Feet)	Pump Station Firm Capacity (gpm)	Road ADT Value	Railroad Crossing (Y or N)	Closest High Quality Surface Water (feet)	Distance to Closest Drinking Water Well (feet)	Redundent Force Main (Y or N)	Crosses Historic Districts (Y or N)	Number of Residential Parcels	Number of Commercial Parcels	Quantity of Flow Rating (1-5)	High Quality Surface Water Rating (1-5)	Groundwater Wells Rating (1-5)	Transportation Systems Rating (1-5)	Redundant Force Main Rating (1-5)	Cultural Impact Rating (1-5)	Residential Impact Rating (1-5)	Commercial Impact Rating (1-5)	Consequence of Failure (1-5)
SSFM-198	Coast Guard	12	51	465	13247	N	325	2555	N	N	0	1	3	1	1	3	5	1	1	2	2.7
SSFM-196	Coast Guard	12	499	465	13247	Y	75	2135	N	N	0	2	3	4	1	5	5	1	1	2	3.2
SSFM-199	Coast Guard	12	2	465	13247	N	303	2566	N	N	0	0	3	1	1	3	5	1	1	1	2.6
SSFM-207	Coast Guard	12	5	465	0	N	75	2140	N	N	0	1	3	4	1	1	5	1	1	2	2.8
SSFM-208	Coast Guard	12	5	465	0	N	75	2135	N	N	0	1	3	4	1	1	5	1	1	2	2.8
SSFM-211	Coast Guard	12	471	465	0	N	75	1730	N	N	0	1	3	4	1	1	5	1	1	2	2.8
SSFM-214	Coast Guard	12	5	465	0	N	265	1735	N	N	0	0	3	2	1	1	5	1	1	1	2.5
SSFM-215	Coast Guard	12	5	465	0	N	265	1730	N	N	0	0	3	2	1	1	5	1	1	1	2.5
SSFM-216	Coast Guard	12	517	465	0	N	265	1235	N	N	0	0	3	2	1	1	5	1	1	1	2.5
SSFM-220	Coast Guard+Hull	12	4	525	0	N	380	1235	N	N	0	0	4	1	1	1	5	1	1	1	2.8
SSFM-218	Coast Guard+Hull	12	1	525	0	N	380	1235	N	N	0	0	4	1	1	1	5	1	1	1	2.8
SSFM-151	TBA	12	16	700	0	Y	1825	3960	N	N	0	0	4	1	1	5	5	1	1	1	3.2
SSFM-28	TBA	12	4834	700	3339	N	1825	1420	N	N	0	0	4	1	1	2	5	1	1	1	2.9
SSFM-154	Birchwood	14	26	800	0	N	295	4055	N	N	0	0	4	2	1	1	5	1	1	1	2.9
SSFM-30	Birchwood	14	2557	800	1244	N	310	4000	N	N	19	0	4	1	1	2	5	1	4	1	3.1
SSFM-122	Clinch Park	4	1	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-123	Clinch Park	4	1	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-124	Clinch Park	4	3	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-127	Clinch Park	4	2	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-125	Clinch Park	4	1	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-126	Clinch Park	4	3	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-128	Clinch Park	4	2	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-129	Clinch Park	4	1	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-130	Clinch Park	4	1	175	0	N	90	3110	Y	Y	0	0	2	4	1	1	1	5	1	1	1.9
SSFM-120	Clinch Park	4	7	175	0	N	140	3105	Y	Y	0	0	2	3	1	1	1	5	1	1	1.8
SSFM-121	Clinch Park	4	7	175	0	N	140	3105	Y	Y	0	0	2	3	1	1	1	5	1	1	1.8
SSFM-119	Clinch Park	4	3	175	0	N	155	3105	Y	Y	0	0	2	3	1	1	1	5	1	1	1.8
SSFM-118	Clinch Park	4	171	175	0	N	155	3105	N	Y	0	0	2	3	1	1	5	5	1	1	2.4
SSFM-117	Clinch Park	4	149	175	6883	N	210	3110	N	Y	0	0	2	2	1	3	5	5	1	1	2.5
SSFM-131	Clinch Park Area	2	42	15	0	N	5	3150	N	Y	0	0	1	5	1	1	5	5	1	1	2.2
SSFM-132	Clinch Park Area	2	19	15	0	N	0	3170	N	Y	0	0	1	5	1	1	5	5	1	1	2.2
SSFM-155	Coast Guard-Woodmere Bypass	10	69	465	13247	N	325	2515	N	N	0	0	3	1	1	3	5	1	1	1	2.6
SSFM-161	Coast Guard-Woodmere Bypass	6	5	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-162	Coast Guard-Woodmere Bypass	6	8	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-163	Coast Guard-Woodmere Bypass	6	3	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-156	Coast Guard-Woodmere Bypass	10	3	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-157	Coast Guard-Woodmere Bypass	10	3	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-158	Coast Guard-Woodmere Bypass	10	2	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-160	Coast Guard-Woodmere Bypass	10	2	465	13247	N	330	2530	Y	N	0	0	3	1	1	3	1	1	1	1	2.0
SSFM-164	Coast Guard-Woodmere Bypass	10	9	465	13247	N	330	2510	N	N	0	0	3	1	1	3	5	1	1	1	2.6
SSFM-201	Coast Guard - Cleanout Branch	12	40	0	13247	N	325	2560	N	N	0	0	1	1	1	3	5	1	1	1	1.8
SSFM-200	Coast Guard - Cleanout Branch	12	2	0	13247	N	325	2560	N	N	0	0	1	1	1	3	5	1	1	1	1.8
SSFM-271	WWTP	16	26	450	0	N	360	920	N	N	0	0	3	1	2	1	5	1	1	1	2.5

Appendix C, Table C-C-2: Force Main Criticality Factors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Asset ID	**Associated Pump Station**	**Diameter (Inches)**	**Length (Feet)**	**Pump Station Firm Capacity (gpm)**	**Road ADT Value**	**Railroad Crossing (Y or N)**	**Closest High Quality Surface Water (feet)**	**Distance to Closest Drinking Water Well (feet)**	**Redundent Force Main (Y or N)**	**Crosses Historic Districts (Y or N)**	**Number of Residential Parcels**	**Number of Commercial Parcels**	**Quantity of Flow Rating (1-5)**	**High Quality Surface Water Rating (1-5)**	**Groundwater Wells Rating (1-5)**	**Transportation Systems Rating (1-5)**	**Redundant Force Main Rating (1-5)**	**Cultural Impact Rating (1-5)**	**Residential Impact Rating (1-5)**	**Commercial Impact Rating (1-5)**	**Consequence of Failure (1-5)**
SSFM-263	WWTP	**16**	32	**915**	0	N	340	895	N	N	0	0	4	1	2	1	5	1	1	1	2.9
SSFM-283	WWTP	**16**	44	**915**	0	N	315	875	N	N	0	0	4	1	2	1	5	1	1	1	2.9
SSFM-270	WWTP	**16**	27	975	0	N	400	930	Y	N	0	0	4	1	2	1	1	1	1	1	2.3
SSFM-273	WWTP	**16**	5	975	0	N	400	950	Y	N	0	0	4	1	2	1	1	1	1	1	2.3

*Items in bold were unknown and assumed based on available information.

Legend for Table C-C-3 by Column Number Heading:

1: Unique Asset ID
2: Associated Pump Station
3: Force Main Material Type
4: Force Main Diameter (Inches)
5: Force Main Segment Length (Feet)
6: Installation Year
7: Expected Asset Life (Years): Based on typical material life
8: Remaining Life Based on Installation Date (Years):
[8] = [7] – (Evaluation Year – [6])
9: Percent Remaining Useful Life
[9] = ([8] / [7]) * 100
10: History of Repairs: Number of repairs that have been needed
11: Stream or River Crossing: Y if force main crosses under a stream or river, N if not.
12: Number of Junctions: Number of additional force main connections at the upstream and downstream end of the force main.
13: Age Rating (1-5): Assigned a rating based on [9] and the estimated exponential relationship between the remaining life and probability of failure as shown in Figure 1 and Table 2
14: Repair Rating (1-5): Assigned a rating based on [10] and below table

Rating Scale	Repair History Descriptions
5	>= 4 Repairs
4	3 Repairs
3	2 Repairs
2	1 Repair
1	0 Repairs

15: Stream Crossing Rating (1-5): Assigned a rating based on [11] and below table

Rating Scale	Stream Crossing Description
5	Stream or river crossing
1	No crossing

16: Junction Rating (1-5): Assigned a rating based on [12] and below table

Rating Scale	Junction Descriptions
5	2 Junctions
3	1 Junction
1	0 Junctions

17: Probability of Failure: Weighted average of columns [13] to [16] the four consequence ratings.

Appendix C, Table C-C-3 Force Main Probability of Failure

Evaluation Year: 2016

POF Factor Weights: 75.0% | 8.3% | 8.3% | 8.3%

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Asset ID	Associated Pump Station	Material	Diameter (Inches)	Length (Feet)	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation	Percent Remaining Useful Life	History of Repairs	Stream or River Crossing (Y or N)	Number of Junctions	Age Rating (1-5)	Repair Rating (1-5)	Stream Crossing Rating (1-5)	Junction Rating (1-5)	Probability of Failure (1-5)
SSFM-32	Riverine	PVC	12	681	1982	90	56	62%		N	1	1.8	1	1	3	1.8
SSFM-153	Riverine	PVC	12	9	1982	90	56	62%		N	1	1.8	1	1	3	1.8
SSFM-10	Bay	CI	8	1126	1931	60	-25	0%		N	0	5.0	1	1	1	4.0
SSFM-148	Front Street	CI	16	973	1931	60	-25	0%		N	0	5.0	1	1	1	4.0
SSFM-150	Front Street	CI	16	1559	1931	60	-25	0%		N	1	5.0	1	1	3	4.2
SSFM-251	Front Street - WWTP	CI	16	3	**1931**	60	-25	0%		N	1	5.0	1	1	3	4.2
SSFM-252	Front Street - WWTP	DI	16	2	**1931**	70	-15	0%		N	1	5.0	1	1	3	4.2
SSFM-282	Front Street - WWTP	DI	**18**	57	**1931**	70	-15	0%		N	0	5.0	1	1	1	4.0
SSFM-261	Front Street - WWTP	DI	18	195	**1931**	70	-15	0%		N	0	5.0	1	1	1	4.0
SSFM-250	Front Street - WWTP	CI	16	16	**1931**	60	-25	0%		N	1	5.0	1	1	3	4.2
SSFM-281	Front Street - WWTP	DI	**24**	41	**1931**	70	-15	0%		N	0	5.0	1	1	1	4.0
SSFM-259	Front Street - WWTP	DI	24	150	**1931**	70	-15	0%		N	0	5.0	1	1	1	4.0
SSFM-280	Front Street - WWTP	DI	**16**	112	**1931**	70	-15	0%		N	1	5.0	1	1	3	4.2
SSFM-289	Hull	PVC	4	47	**2001**	90	75	83%		N	0	1.3	1	1	1	1.2
SSFM-291	Hull	PVC	4	50	**2001**	90	75	83%		N	0	1.3	1	1	1	1.2
SSFM-287	Hull	HDPE	2	222	**2001**	100	85	85%		N	0	1.3	1	1	1	1.2
SSFM-286	Hull	PVC	2	2	**2001**	90	75	83%		N	1	1.3	1	1	3	1.4
SSFM-202	Woodmere	DI	6	12	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-189	Woodmere	DI	6	34	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-188	Woodmere	DI	6	42	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-203	Woodmere	DI	6	12	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-182	Woodmere	PVC	**6**	1	**1992**	90	66	73%		N	1	1.5	1	1	3	1.6
SSFM-185	Woodmere	PVC	**6**	2	**1992**	90	66	73%		N	1	1.5	1	1	3	1.6
SSFM-179	Woodmere	DI	6	4	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-180	Woodmere	DI	6	4	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-181	Woodmere	DI	6	4	**1992**	70	46	66%		N	1	1.7	1	1	3	1.7
SSFM-171	Woodmere	DI	8	14	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-169	Woodmere	DI	8	2	1992	70	46	66%		N	1	1.7	1	1	3	1.7
SSFM-167	Woodmere	**CI**	8	4	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-176	Woodmere	CI	8	3	**1992**	60	36	60%		N	0	1.9	1	1	1	1.7
SSFM-166	Woodmere	**CI**	8	18	**1992**	60	36	60%		N	2	1.9	1	1	5	2.0
SSFM-192	Woodmere	DI	14	669	**1992**	70	46	66%	2	N	1	1.7	3	1	3	1.9
SSFM-231	Woodmere	CI	10	372	1992	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-18	Woodmere	CI	10	655	1992	60	36	60%		N	0	1.9	1	1	1	1.7
SSFM-4	Woodmere+Coast Guard + Hull	PVC	**16**	341	**1992**	90	66	73%		N	2	1.5	1	1	5	1.7
SSFM-284	Woodmere+Coast Guard + Hull	DI	**16**	96	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Asset ID	Associated Pump Station	Material	Diameter (Inches)	Length (Feet)	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation	Percent Remaining Useful Life	History of Repairs	Stream or River Crossing (Y or N)	Number of Junctions	Age Rating (1-5)	Repair Rating (1-5)	Stream Crossing Rating (1-5)	Junction Rating (1-5)	Probability of Failure (1-5)
SSFM-276	Woodmere+Coast Guard + Hull	DI	16	21	**1992**	70	46	66%		N	1	1.7	1	1	3	1.7
SSFM-277	Woodmere+Coast Guard + Hull	DI	16	24	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-295	Coast Guard	DI	8	58	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-24	Coast Guard	CI	8	4090	1943	60	-13	0%		N	0	5.0	1	1	1	4.0
SSFM-23	Coast Guard	**CI**	8	3175	1943	60	-13	0%	2	N	0	5.0	3	1	1	4.2
SSFM-198	Coast Guard	DI	12	51	**1943**	70	-3	0%		N	0	5.0	1	1	1	4.0
SSFM-196	Coast Guard	DI	12	499	1996	70	50	71%		N	1	1.6	1	1	3	1.6
SSFM-199	Coast Guard	DI	12	2	1996	70	50	71%		N	1	1.6	1	1	3	1.6
SSFM-207	Coast Guard	DI	12	5	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-208	Coast Guard	DI	12	5	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-211	Coast Guard	DI	12	471	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-214	Coast Guard	DI	12	5	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-215	Coast Guard	DI	12	5	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-216	Coast Guard	DI	12	517	1996	70	50	71%		N	1	1.6	1	1	3	1.6
SSFM-220	Coast Guard+Hull	DI	12	4	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-218	Coast Guard+Hull	PVC	**12**	1	1996	90	70	78%		N	1	1.4	1	1	3	1.5
SSFM-151	TBA	AC	12	16	1970	80	34	43%		N	0	2.5	1	1	1	2.1
SSFM-28	TBA	AC	12	4834	1970	80	34	43%	1	N	0	2.5	2	1	1	2.2
SSFM-154	Birchwood	CI	14	26	**1956**	60	0	0%		N	0	5.0	1	1	1	4.0
SSFM-30	Birchwood	CI	14	2557	1956	60	0	0%		N	0	5.0	1	1	1	4.0
SSFM-122	Clinch Park	DI	4	1	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-123	Clinch Park	DI	4	1	2002	70	56	80%		N	0	1.4	1	1	1	1.3
SSFM-124	Clinch Park	DI	4	3	2002	70	56	80%		N	0	1.4	1	1	1	1.3
SSFM-127	Clinch Park	DI	4	2	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-125	Clinch Park	DI	4	1	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-126	Clinch Park	DI	4	3	2002	70	56	80%		N	0	1.4	1	1	1	1.3
SSFM-128	Clinch Park	DI	4	2	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-129	Clinch Park	DI	4	1	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-130	Clinch Park	DI	4	1	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-120	Clinch Park	DI	4	7	2002	70	56	80%		N	2	1.4	1	1	5	1.6
SSFM-121	Clinch Park	PVC	**4**	7	2002	90	76	84%		N	1	1.3	1	1	3	1.4
SSFM-119	Clinch Park	DI	4	3	2002	70	56	80%		N	1	1.4	1	1	3	1.5
SSFM-118	Clinch Park	PVC	**4**	171	2002	90	76	84%		N	0	1.3	1	1	1	1.2
SSFM-117	Clinch Park	DI	4	149	2002	70	56	80%		N	0	1.4	1	1	1	1.3
SSFM-131	Clinch Park Area	PVC	2	42	2002	90	76	84%		N	1	1.3	1	1	3	1.4
SSFM-132	Clinch Park Area	PVC	2	19	2002	90	76	84%		Y	0	1.3	1	5	1	1.5
SSFM-155	Coast Guard-Woodmere Bypass	**DI**	10	69	**1992**	70	46	66%		N	0	1.7	1	1	1	1.6
SSFM-161	Coast Guard-Woodmere Bypass	**CI**	6	5	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-162	Coast Guard-Woodmere Bypass	**CI**	6	8	**1992**	60	36	60%		N	0	1.9	1	1	1	1.7
SSFM-163	Coast Guard-Woodmere Bypass	**CI**	6	3	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8

Appendix C-C, Table C-C-3: Force Main Probability of Failure

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Asset ID	Associated Pump Station	Material	Diameter (Inches)	Length (Feet)	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation	Percent Remaining Useful Life	History of Repairs	Stream or River Crossing (Y or N)	Number of Junctions	Age Rating (1-5)	Repair Rating (1-5)	Stream Crossing Rating (1-5)	Junction Rating (1-5)	Probability of Failure (1-5)
SSFM-156	Coast Guard-Woodmere Bypass	CI	10	3	**1992**	60	36	60%		N	0	1.9	1	1	1	1.7
SSFM-157	Coast Guard-Woodmere Bypass	CI	10	3	**1992**	60	36	60%		N	0	1.9	1	1	1	1.7
SSFM-158	Coast Guard-Woodmere Bypass	**CI**	10	2	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-160	Coast Guard-Woodmere Bypass	CI	10	2	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-164	Coast Guard-Woodmere Bypass	CI	10	9	**1992**	60	36	60%		N	1	1.9	1	1	3	1.8
SSFM-201	Coast Guard - Cleanout Branch	DI	12	40	1996	70	50	71%		N	0	1.6	1	1	1	1.4
SSFM-200	Coast Guard - Cleanout Branch	DI	**12**	2	1996	70	50	71%		N	1	1.6	1	1	3	1.6
SSFM-271	WWTP	DI	16	26	**1931**	70	-15	0%		N	1	5.0	1	1	3	4.2
SSFM-263	WWTP	PVC	**16**	32	**1931**	90	5	6%		N	1	4.6	1	1	3	3.8
SSFM-283	WWTP	DI	**16**	44	**1931**	70	-15	0%		N	0	5.0	1	1	1	4.0
SSFM-270	WWTP	PVC	**16**	27	**1931**	90	5	6%		N	1	4.6	1	1	3	3.8
SSFM-273	WWTP	PVC	**16**	5	**1931**	90	5	6%		N	1	4.6	1	1	3	3.8

*Items in bold were unknown and assumed based on available information.

Appendix C-D– 5-Year Asset Replacement Recommendations

Appendix C-D: 5-Year Asset Replacement Recommendations

Year	Max Segment BRE	Station and Location	Original Replacement Year Based on Material and Install Date	Asset	Length (ft)	Replacement Cost	Funding Source	
							OM&R	CIP
2017	No Replacements							
						Annual Total	**$0**	**$0**
2018	16.8	Front Street	1991	Force Main	2533	$607,834		X
	15.6	Front Street - WWTP	1991	Force Main	19	$4,579		X
	14.3	Front Street - WWTP	2001	Force Main	557	$143,951		X
						Annual Total	**$0**	**$756,364**
2019	No Replacements							
						Annual Total	**$0**	**$0**
2020	No Replacements							
						Annual Total	**$0**	**$0**
2021	14.3	Coast Guard	2003	Force Main	7265	$1,162,326		X
	12.6	Coast Guard	2013	Force Main	51	$10,267		X
						Annual Total	**$0**	**$1,172,593**

Appendix D: Pump Station Inventory and Assessment Technical Memorandum

Appendix D: Pump Station Inventory and Assessment Technical Memorandum

A. Introduction

This memorandum summarizes the collection and assessment of data for nine pumping stations in Traverse City's sanitary collection system. These stations are shown in the map in Appendix D-A. The assets associated with each station were inventoried and evaluated for condition and criticality. The goal of this process is to provide an estimate of the needed annual reserves for asset maintenance and replacement. An analysis of the annual reserves for replacement are also included with a criticality based Capital Improvement Plan.

B. Data Collection and Inventory

The nine pumping stations in Traverse City's collection system are shown on the map in Appendix D-A. The major components inventoried within each station include but are not limited to pumps, check/control valves, motors, level control systems, backup power, structure, wet well, valve vault, and telemetry. The detailed asset inventory was collected through field visits, operator input, suppliers' input, and other sources. Each asset's information, including name, category, location, installation date, typical useful life, redundancy, and an estimated cost to replace, was collected and compiled into the spreadsheet shown in Appendix D-B.

The current condition was assigned based on the judgement of experienced facility design engineers. The condition rating range from 1 to 5 with 1 being the best condition as shown in Table D-1.

Table D-1: Condition Ratings

Ratings Index	Asset Condition
1	Excellent, appears new
2	Good, appropriate wear
3	Average, minor life cycle altering defects
4	Poor, significant wear but functional
5	Very poor, failure of intended function

Asset types or categories (i.e. pumps, valves, electrical components, etc.) have expected useful life numbers based on manufacturer experiences that can predict when an asset is likely to stop functioning. However, each asset has a unique useful life number based on the current condition and the age of an individual asset. The determination of the unique useful life number for each asset was modified considering current condition, age, and the judgement of experienced facility design engineers.

A Probability of Failure (POF) value was determined based on the percentage of remaining useful life. The POF predicts the likelihood of an asset to fail. The POF for each asset was

determined using the chart and the trend line shown in Tables D-2, D-3 and D-4 and Figures D-1 and 2. Different trend lines were developed for the mechanical and electrical components and the structural components. Structural components like wet wells or valve vaults are less likely to fail since they have much longer useful lives and are often repaired instead of replaced. Generally, impending structural failure is visually apparent and can be addressed in a timely manner.

Table D-2: Probability of Failure

Score	Description
1	Improbable
2	Remote, unlikely but possible
3	Possible
4	Probable, likely
5	Imminent, likely in near future

Table D-3: Probability of Failure for Mechanical and Electrical Assets

Remaining Useful Life	Probability of Failure
10%	5
15%	4
25%	3
40%	2
50%	1.5
70%	1

Table D-4: Probability of Failure for Structural Assets

Remaining Useful Life	Probability of Failure
10%	4
18%	3.5
25%	3
35%	2.5
45%	2
70%	1

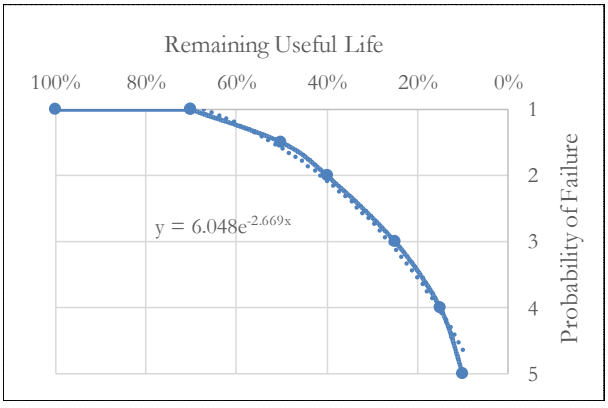


Figure D-1: Probability of Failure for Structural Assets

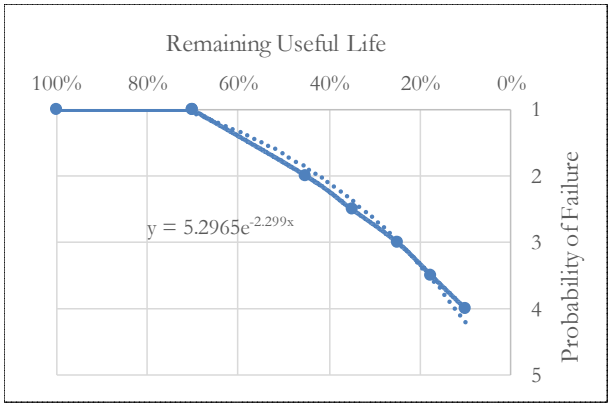


Figure D-2: Probability of Failure for Mechanical and Electrical Assets

The Consequence of Failure (COF) determines the effect of an individual asset failure on system operations. Each value was determined by an experienced engineer corresponding to the descriptions in Table D-5.

Table D-5: Consequence of Failure

Score	Effect
1	Negligible, minor loss of function
2	Minimal or marginal
3	Noticeable, may suspend some operations
4	Critical, temporarily suspends operations
5	Catastrophic disruption

The Consequence of Failure and Probability of Failure are multiplied to determine a Business Risk Exposure (BRE). The BRE is used to determine the criticality of an asset to system operation and is helpful for prioritizing limited funding. BRE ranges from 1-25. Generally, assets with BRE less than 8 are considered non-critical and greater than 16 are considered critical. Assets with higher BRE scores are more likely to need immediate attention. Assets with lower BRE have longer remaining useful lives but still need to be maintained.

C. Field Investigative Findings and Issues

Traverse City's pump stations are very well maintained. Many assets are functioning past the manufacturer specified useful life. The system is likely incurring higher annual maintenance and repair costs to forestall greater capital costs in the future.

There are several stations with critical assets likely to fail in the near future. These are noted in Table D-6, along with any other notable comments from inventory. A detailed list of the assets expected to fail over the next five years is available in Appendix D-C.

Table D-6: Pumping Station Issues

Facility ID	Station	Structure Type	Approx. Install Year	Issue
SSNS-6	Riverine	Lift Station	1983	• Pumps, motors and check valves are nearing the end of the expected service life and should be monitored closely. • Heavy grease load at this station can adversely affect the pumps and check valves.
SSNS-10	Coast Guard	Lift Station	1995	• Both submersible pumps are near the end of their expected service life. Although they are functioning, they should be closely monitored. • The chart recorder is not in service.
SSNS-18	Hull Park	Lift Station	2001	• In 2015 it appeared that the pump was not properly seated causing recirculation in the wet well.
SSNS-4	Clinch Park	Lift Station	2003	• No adverse comments.
SSNS-2	Bay Street	Lift Station	1994	• Both submersible pumps are near the end of their expected service life. Although they are functioning, they should be closely monitored.
SSNS-7	Birchwood	Lift Station	2002	• No adverse comments.
SSNS-16	Front St	Lift Station	1930/1996	• Pumps need to be frequently unclogged due to rags and other debris. The result is high maintenance costs. In the future when the pumps need to be replaced, consider dry pit submersible pumps that have better solids handling ability.

D. Annual Capital Reserves and Capital Improvement Plan

This analysis provides an overview of the cost projections with the anticipation that a combination of funding sources will be the best solution to manage Traverse City's pumping station assets. The breakdown considers the annual cash reserves to set aside annually to replace assets with Expected Asset Lives of 20 years or less. It also considers the total capital costs to replace assets with Expected Asset Lives greater than 20 years. The annual reserve needed is based on the assets' replacement cost divided by the Expected Asset Life. The total capital cost is that of replacing the asset at the year of failure. If an asset is expected to be replaced using cash reserves, a replacement fund should be incorporated into revenue requirement calculations. Capital assets with Expected Asset Lives greater than 20 years are not funded annually by a

replacement fund and are not incorporated into the revenue requirement. The capital costs are substantial and should have some additional funding sources which may include bonds or other established accounts. The values used are based on 2015 dollars and do not include inflation. It is anticipated that Traverse City will need to review and revise the projected repair and replacement schedule to ensure that resulting revenue requirements are reasonable.

Table D-7 includes both the cash reserves set aside in a replacement fund and capital costs summed over the next five years and by station. As the pump stations age, it may be useful to consider replacing several assets at one station at once. In many instances, a number of assets in one station are expected to fail around the same time. It may also be practical to consider prioritizing stations that are more critical to the system or those with capacity issues. The issues listed for the pump stations in Table D-6 provide a manageable starting point for improvement necessary in the next five years. A detailed list of the assets expected to fail over the next five years is available in Appendix D-C.

The annual cash reserves that should be set aside for replacement and repair of existing assets over the next 5 years is shown in Table D-7 by station. The replacement costs for each asset at each station are divided by the manufacturer predicted lifetime of the asset to calculate the replacement funds to be set aside annually in an OM&R account. Taking into account the ages of current assets with Expected Asset Lifetimes of 20 years or less, Traverse City's OM&R fund should already contain approximately $140,000 for upcoming replacements at the City's pumping stations.

Table D-7: Annual Cash Reserves for Replacement and Repair

Station	Annual Replacement	Capital Fund					
		2016	2017	2018	2019	2020	2021
Bay Street	$2,450	$0	$0	$0	$15,000	$0	$0
Birchwood	$500	$0	$0	$0	$0	$0	$0
Clinch Park	$1,000	$0	$0	$0	$0	$0	$0
Coast Guard	$2,700	$0	$0	$0	$0	$15,000	$0
Front St	$1,300	$0	$0	$0	$0	$0	$45,000
Hull Park	$230	$0	$0	$0	$0	$0	$0
Riverine	$250	$0	$0	$39,400	$0	$0	$0
TBA	$250	$0	$36,000	$15,000	$0	$4,000	$0
Woodmere	$450	$8,500	$0	$0	$0	$34,500	$0
Grand Total	**$9,130**	**$8,500**	**$36,000**	**$54,400**	**$15,000**	**$53,500**	**$45,000**

In Figure D-3, the cash reserves necessary for replacement are compared to the capital cost for replacement at failure year. The capital cost spikes are due to estimated failures at the indicated year.

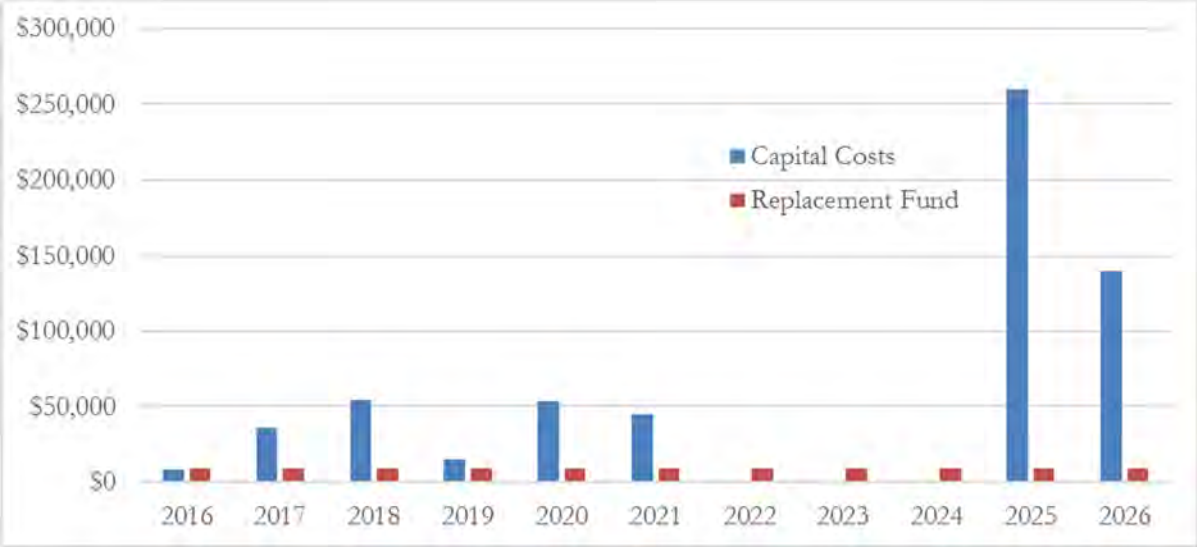


Figure D-3: Funding Necessary over Time

E. Recommendations

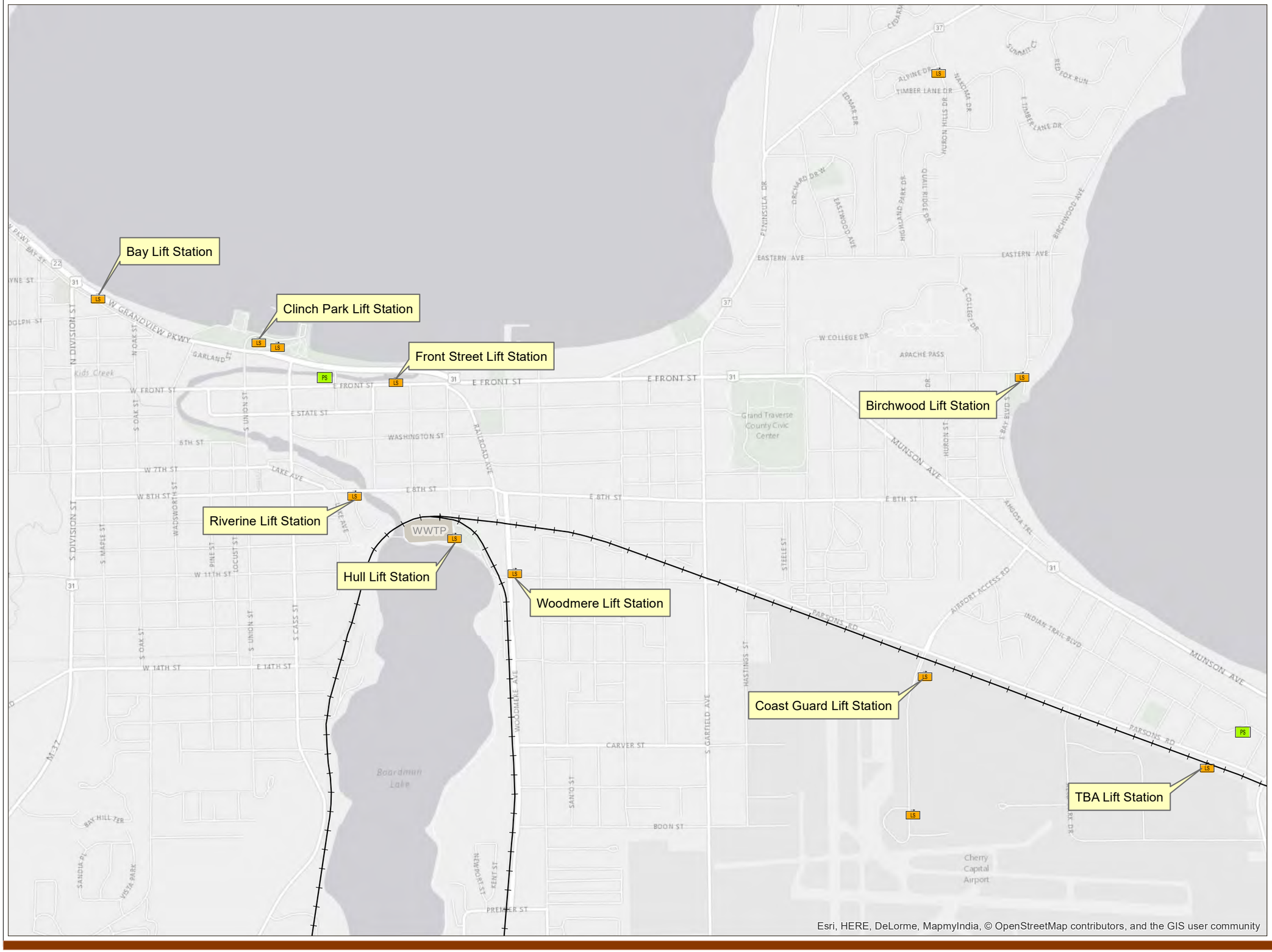
The multitudes of information gathered during the inventory and assessment will be compiled into a GIS geodatabase. The data presented in this memorandum provide an overview of the

cost projections with the understanding that some combination of funding sources will be the best solution to manage Traverse City's pumping station assets. Future iterations will be documented with final agreed upon plan and funding mechanisms presented to the MDEQ in the rate analysis and Asset Management Plan. This section of the report will be expanded to reflect the final decisions.

Future work will include a comprehensive capital improvement plan for the system. A holistic approach to future improvements will incorporate results from assessments of the rest of the collection and treatment system.

In any AMP, it is vital to actively assess your system. As the pump station assets age and are replaced, their probability of failure and system criticality change. These changes should be reflected in planning.

Appendix D-A: Map of Traverse City's Lift Stations



Traverse City

Figure D-A-1. Lift Station Locations

Legend

- LS — Lift Station
- PS — Pump Station
- Railroads

0 — 1,500 — 3,000 Feet

1" = 1,500'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: June 5, 2017

OHM
888.522.6711 | ohm-advisors.com

Appendix D-B: Assessment and Inventory Table

Legend by Column Number Heading:

1: Unique Asset ID
2: Pump Station
3: Asset Type
4: Description of Asset
5: Installation Year
6: Expected Asset Life (Year): Based on manufacturer specifications
7: Remaining Life Based on Installation Date (Years):
    7 = 5 + 6 – Current Evaluation Year
8: Condition: Assigned based on the judgement of experienced facility design engineer
9: Predicted Remaining Life Based on Condition (Years): Assigned based on the judgement of experienced facility design engineer
10: Asset Life Based on Install Date and Predicted Life (Years):
    10 = Current Evaluation Year + 9 – 5
11: Percent Remaining Useful Life
    11 = (9 / 10) * 100%
12: Consequence of Failure: Assigned based on the judgement of experienced facility design engineer
13: Probability of Failure: Empirically based on Remaining Useful Life
    13 = function of 11
14: Business Risk Exposure
    14 = 12 * 13
15: Replacement Year
    15 = Current Evaluation Year + 9
16: 2015 Replacement Cost: Assigned based on the judgement of experienced facility design engineer
17: 2015 Value Assuming Linear Depreciation: Assumes depreciation based on asset's total predicted life
    17 = 11 * 16
18: Annual Replacement Cost When Predicted Life < 20 Years: If an asset has a total predicted life of less than 20 years, it should be funded from a dedicated replacement fund on an annual basis
    18 = 16 / 10 if 16 < 20 years
19: Funding Source: CIP for assets with useful life > 20 years assumes no dedicated saving annually for asset replacement vs OM&R for assets with useful life < 20 years assumes a dedicated replacement fund on an annual basis

Appendix D-B: Assessment and Inventory Table

Asset ID	Station	Asset	Description	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation Date (Years)	Condition	Predicted Remaining Life Based on Condition (Years)	Asset Life Based on Install Date and Predicted Life (Years)	Percent Remaining Useful Life	Consequence of Failure	Probability of Failure	Business Risk Exposure	Replacement Year	2015 Replacement Cost	2015 Value Assuming Linear Depreciation	Annual Replacement Cost When Predicted Life < 20 Years	Funding Source
	TBA	Pump #1	Dry Pit Vertical	1969	30	-16	4	2	48	4%	3	5.0	15.0	2017	$18,000	$750	$0	CIP
	TBA	Pump #2	Dry Pit Vertical	1969	30	-16	4	2	48	4%	3	5.0	15.0	2017	$18,000	$750	$0	CIP
	TBA	Check/Control Valve #1	Swing Check 6"	1969	35	-11	3	5	51	10%	3	4.7	14.0	2020	$2,000	$196	$0	CIP
	TBA	Check/Control Valve #2	Swing Check 6"	1969	35	-11	3	5	51	10%	3	4.7	14.0	2020	$2,000	$196	$0	CIP
	TBA	Motor #1	Dry pit ODP	1969	30	-16	3	2	48	4%	3	5.0	15.0	2017	$0	$0	$0	CIP
	TBA	Motor #2	Dry pit ODP	2012	30	27	3	27	30	90%	3	1.0	3.0	2042	$0	$0	$0	CIP
	TBA	Control Panel		1969	25	-21	4	3	49	6%	4	5.0	20.0	2018	$15,000	$918	$0	CIP
	TBA	Level Control System	Floats	1969	10	-36	3	5	51	10%	4	4.7	18.6	2020	$500	$49	$50	OM&R
	TBA	Telemetry	Sensiphone autodialer	1969	20	-26	2	5	51	10%	2	4.7	9.3	2020	$4,000	$392	$200	OM&R
	TBA	Dry Well	Steel Can	1969	70	24	4	10	56	18%	4	3.5	14.1	2025	$20,000	$3,571	$0	CIP
	TBA	Wet Well	large wet well with cat walk	1969	70	24	3	24	70	34%	4	2.4	9.6	2039	$15,000	$5,143	$0	CIP
	Riverine	Pump #1	Dry Pit Vertical	1983	30	-2	3	3	35	9%	3	4.8	14.4	2018	$11,000	$943	$0	CIP
	Riverine	Pump #2	Dry Pit Vertical	1983	30	-2	3	3	35	9%	3	4.8	14.4	2018	$11,000	$943	$0	CIP
	Riverine	Check/Control Valve #1	Swing Check 4"	1983	35	3	3	3	35	9%	3	4.8	14.4	2018	$1,200	$103	$0	CIP
	Riverine	Check/Control Valve #2	Swing Check 4"	1983	35	3	3	3	35	9%	3	4.8	14.4	2018	$1,200	$103	$0	CIP
	Riverine	Motor #1	Dry pit	1983	30	-2	3	3	35	9%	3	4.8	14.4	2018	$0	$0	$0	CIP
	Riverine	Motor #2	Dry pit	1983	30	-2	3	3	35	9%	3	4.8	14.4	2018	$0	$0	$0	CIP
	Riverine	Control Panel		1983	25	-7	3	3	35	9%	4	4.8	19.2	2018	$15,000	$1,286	$0	CIP
	Riverine	Level Control System	Floats	1983	10	-22	2	5	37	14%	3	4.2	12.7	2020	$500	$68	$50	OM&R
	Riverine	Backup Floats	Floats	1983	10	-22	2	5	37	14%	3	4.2	12.7	2020	$500	$68	$50	OM&R
	Riverine	Telemetry	Sensiphone autodialer	1983	20	-12	2	5	37	14%	2	4.2	8.4	2020	$3,000	$405	$150	OM&R
	Riverine	Dry Well	Steel Can	1983	70	38	2	38	70	54%	4	1.5	6.1	2053	$20,000	$10,857	$0	CIP
	Riverine	Wet Well	8'diameter	1983	70	38	2	38	70	54%	4	1.4	5.7	2053	$15,000	$8,143	$0	CIP
	Coast Guard	Pump #1	Submersible	1995	20	0	3	5	25	20%	3	3.5	10.6	2020	$18,000	$3,600	$900	OM&R
	Coast Guard	Pump #2	Submersible	1995	20	0	3	5	25	20%	3	3.5	10.6	2020	$18,000	$3,600	$900	OM&R
	Coast Guard	Check/Control Valve #1	Swing Check 6"	1995	35	15	3	15	35	43%	3	1.9	5.8	2030	$2,000	$857	$0	CIP
	Coast Guard	Check/Control Valve #2	Swing Check 6"	1995	35	15	3	15	35	43%	3	1.9	5.8	2030	$2,000	$857	$0	CIP
	Coast Guard	Control Panel		1995	25	5	3	5	25	20%	4	3.5	14.2	2020	$15,000	$3,000	$0	CIP
	Coast Guard	Level Control System	Milltronics sonic	1995	20	0	2	5	25	20%	3	3.5	10.6	2020	$4,000	$800	$200	OM&R
	Coast Guard	Flow Meter	F & P Magmeter	1995	20	0	4	0	20	0%	1	5.0	5.0	2015	$10,000	$0	$500	OM&R
	Coast Guard	Telemetry	Sensiphone autodialer	1995	20	0	2	5	25	20%	3	3.5	10.6	2020	$4,000	$800	$200	OM&R
	Coast Guard	Structure	Brick & block building	1995	70	50	2	50	70	71%	4	1.0	4.0	2065	$15,000	$10,714	$0	CIP
	Coast Guard	Wet Well	concrete, 10' Dia Precast	1995	70	50	3	50	70	71%	4	1.0	4.0	2065	$15,000	$10,714	$0	CIP
	Coast Guard	Valve Vault	Concrete	1995	70	50	3	50	70	71%	4	1.0	4.0	2065	$6,000	$4,286	$0	CIP
	Hull Park	Pump #1	Grinder	2013	20	18	2	18	20	90%	3	1.0	3.0	2033	$3,600	$3,240	$180	OM&R
	Hull Park	Control Panel		2001	25	11	2	11	25	44%	3	1.9	5.6	2026	$15,000	$6,600	$0	CIP
	Hull Park	Level Control System	Floats	2001	10	-4	2	5	19	26%	3	3.0	9.0	2020	$500	$132	$50	OM&R
	Hull Park	Wet Well	3' FRP	2001	70	56	2	56	70	80%	3	1.0	3.0	2071	$4,000	$3,200	$0	CIP

Asset ID	Station	Asset	Description	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation Date (Years)	Condition	Predicted Remaining Life Based on Condition (Years)	Asset Life Based on Install Date and Predicted Life (Years)	Percent Remaining Useful Life	Consequence of Failure	Probability of Failure	Business Risk Exposure	Replacement Year	2015 Replacement Cost	2015 Value Assuming Linear Depreciation	Annual Replacement Cost When Predicted Life < 20 Years	Funding Source
	Clinch Park	Pump #1	Submersible	2003	20	8	3	8	20	40%	3	2.1	6.2	2023	$7,500	$3,000	$375	OM&R
	Clinch Park	Pump #2	Submersible	2013	20	18	2	18	20	90%	3	1.0	3.0	2033	$7,500	$6,750	$375	OM&R
	Clinch Park	Check/Control Valve #1	Swing Check 4"	2003	35	23	3	23	35	66%	3	1.0	3.1	2038	$1,200	$789	$0	CIP
	Clinch Park	Check/Control Valve #2	Swing Check 4"	2003	35	23	3	23	35	66%	3	1.0	3.1	2038	$1,200	$789	$0	CIP
	Clinch Park	Control Panel		2003	25	13	3	13	25	52%	4	1.5	6.0	2028	$15,000	$7,800	$0	CIP
	Clinch Park	Level Control System	Floats	2003	10	-2	2	5	17	29%	3	2.8	8.3	2020	$500	$147	$50	OM&R
	Clinch Park	Backup Floats		2003	10	-2	2	5	17	29%	3	2.8	8.3	2020	$500	$147	$50	OM&R
	Clinch Park	Telemetry	Sensiphone autodialer	2003	20	8	3	8	20	40%	2	2.1	4.2	2023	$3,000	$1,200	$150	OM&R
	Clinch Park	Wet Well	concrete, 6' Dia Precast	2003	70	58	2	58	70	83%	4	1.0	4.0	2073	$15,000	$12,429	$0	CIP
	Clinch Park	Valve Vault	Concrete	2003	70	58	2	58	70	83%	4	1.0	4.0	2073	$6,000	$4,971	$0	CIP
	Bay Street	Pump #1	Submersible	1994	20	-1	3	3	24	13%	2	4.3	8.7	2018	$11,000	$1,375	$550	OM&R
	Bay Street	Pump #2	Submersible	1994	20	-1	3	3	24	13%	2	4.3	8.7	2018	$11,000	$1,375	$550	OM&R
	Bay Street	Check/Control Valve #1	Swing Check 6"	1994	35	14	3	14	35	40%	2	2.1	4.2	2029	$2,000	$800	$0	CIP
	Bay Street	Check/Control Valve #2	Swing Check 6"	1994	35	14	3	14	35	40%	2	2.1	4.2	2029	$2,000	$800	$0	CIP
	Bay Street	Control Panel		1994	25	4	2	4	25	16%	2	3.9	7.9	2019	$15,000	$2,400	$0	CIP
	Bay Street	Level Control System	Milltronics sonic	1994	20	-1	2	5	26	19%	3	3.6	10.9	2020	$4,000	$769	$200	OM&R
	Bay Street	Telemetry	Sensiphone dialer	1994	20	-1	2	5	26	19%	2	3.6	7.2	2020	$4,000	$769	$200	OM&R
	Bay Street	Backup Floats		1994	10	-11	3	5	26	19%	4	3.6	14.5	2020	$500	$96	$50	OM&R
	Bay Street	Flow Meter	F & P Magmeter	1994	20	-1	4	1	22	5%	1	5.0	5.0	2016	$10,000	$455	$500	OM&R
	Bay Street	Structure	Brick & glazed block building	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$15,000	$10,500	$0	CIP
	Bay Street	Wet Well	concrete, 8' Dia Precast	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$15,000	$10,500	$0	CIP
	Bay Street	Other	Mixer	2014	10	9	3	9	10	90%	2	1.0	2.0	2024	$4,000	$3,600	$400	OM&R
	Bay Street	Valve Vault	Concrete	1994	70	49	2	49	70	70%	2	1.1	2.1	2064	$6,000	$4,200	$0	CIP
	Woodmere	Pump #1	Dry Pit Submersible	1994	25	4	4	1	22	5%	3	5.0	15.0	2016	$8,500	$386	$0	CIP
	Woodmere	Pump #2	Dry Pit Submersible	1994	25	4	3	5	26	19%	3	3.6	10.9	2020	$8,500	$1,635	$0	CIP
	Woodmere	Check/Control Valve #1	Swing Check 6"	2011	35	31	2	31	35	89%	3	1.0	3.0	2046	$2,000	$1,771	$0	CIP
	Woodmere	Check/Control Valve #2	Swing Check 6"	2011	35	31	2	31	35	89%	3	1.0	3.0	2046	$2,000	$1,771	$0	CIP
	Woodmere	Control Panel		1994	25	4	2	5	26	19%	4	3.6	14.5	2020	$15,000	$2,885	$0	CIP
	Woodmere	Level Control System	Milltronics sonic	1994	20	-1	2	5	26	19%	3	3.6	10.9	2020	$4,000	$769	$200	OM&R
	Woodmere	Backup Floats		1994	10	-11	3	5	26	19%	3	3.6	10.9	2020	$500	$96	$50	OM&R
	Woodmere	Telemetry	Sensiphone autodialer	1994	20	-1	3	5	26	19%	2	3.6	7.2	2020	$4,000	$769	$200	OM&R
	Woodmere	Flow Meter	E & H Magmeter	1994	25	4	3	5	26	19%	1	3.6	3.6	2020	$11,000	$2,115	$0	CIP
	Woodmere	Structure	Brick & block building	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$15,000	$10,500	$0	CIP
	Woodmere	Wet Well	6'x8' Concrete	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$15,000	$10,500	$0	CIP
	Woodmere	Valve Vault	Concrete	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$6,000	$4,200	$0	CIP
	Woodmere	Dry Well	8'x8'	1994	70	49	2	49	70	70%	4	1.1	4.2	2064	$6,000	$4,200	$0	CIP
	Birchwood	Pump #1	Dry Pit Submersible	2002	30	17	2	17	30	57%	3	1.3	4.0	2032	$18,000	$10,200	$0	CIP
	Birchwood	Pump #2	Dry Pit Submersible	2002	30	17	2	17	30	57%	3	1.3	4.0	2032	$18,000	$10,200	$0	CIP
	Birchwood	Check/Control Valve #1	Swing Check 8"	2002	35	22	2	22	35	63%	3	1.1	3.4	2037	$3,000	$1,886	$0	CIP
	Birchwood	Check/Control Valve #2	Swing Check 8"	2002	35	22	2	22	35	63%	3	1.1	3.4	2037	$3,000	$1,886	$0	CIP
	Birchwood	Control Panel		2002	25	12	2	12	25	48%	4	1.7	6.7	2027	$15,000	$7,200	$0	CIP
	Birchwood	Level Control System	Milltronics sonic	2002	20	7	3	7	20	35%	3	2.4	7.1	2022	$4,000	$1,400	$200	OM&R
	Birchwood	Backup Floats		2002	10	-3	3	2	15	13%	3	4.2	12.7	2017	$500	$67	$50	OM&R
	Birchwood	Telemetry	Sensiphone autodialer	2002	20	7	2	7	20	35%	2	2.4	4.8	2022	$5,000	$1,750	$250	OM&R
	Birchwood	Backup Power	Generator on site	2002	30	17	2	17	30	57%	3	1.3	4.0	2032	$38,000	$21,533	$0	CIP
	Birchwood	Structure	Concrete & Brick	2002	70	57	2	57	70	81%	4	1.0	4.0	2072	$20,000	$16,286	$0	CIP
	Birchwood	Wet Well	4'x13' Concrete	2002	70	57	2	57	70	81%	4	1.0	4.0	2072	$15,000	$12,214	$0	CIP
	Birchwood	Pump & Valve Vault	Concrete	2002	70	57	2	57	70	81%	4	1.0	4.0	2072	$6,000	$4,886	$0	CIP

Appendix D-B: Assessment and Inventory Table

Asset ID	Station	Asset	Description	Installation Year	Expected Asset Life (Years)	Remaining Life Based on Installation Date (Years)	Condition	Predicted Remaining Life Based on Condition (Years)	Asset Life Based on Install Date and Predicted Life (Years)	Percent Remaining Useful Life	Consequence of Failure	Probability of Failure	Business Risk Exposure	Replacement Year	2015 Replacement Cost	2015 Value Assuming Linear Depreciation	Annual Replacement Cost When Predicted Life < 20 Years	Funding Source
	Front St	Pump #2	Dry Pit Vertical	1996	30	11	3	10	29	34%	2	2.4	4.8	2025	$80,000	$27,586	$0	CIP
	Front St	Pump #3	Dry Pit Vertical	1996	30	11	3	10	29	34%	2	2.4	4.8	2025	$80,000	$27,586	$0	CIP
	Front St	Pump #4	Dry Pit Vertical	1996	30	11	3	10	29	34%	2	2.4	4.8	2025	$80,000	$27,586	$0	CIP
	Front St	Check/Control Valve #2	Swing Check 12"	1996	35	16	3	16	35	46%	2	1.8	3.6	2031	$7,000	$3,200	$0	CIP
	Front St	Check/Control Valve #3	Swing Check 12"	1996	35	16	3	16	35	46%	2	1.8	3.6	2031	$7,000	$3,200	$0	CIP
	Front St	Check/Control Valve #4	Swing Check 12"	1996	35	16	3	16	35	46%	2	1.8	3.6	2031	$7,000	$3,200	$0	CIP
	Front St	Motor #2	Dry Pit	1996	30	11	2	10	29	34%	2	2.4	4.8	2025	$0	$0	$0	CIP
	Front St	Motor #3	Dry Pit	1996	30	11	3	10	29	34%	2	2.4	4.8	2025	$0	$0	$0	CIP
	Front St	Motor #4	Dry Pit	1996	30	11	3	10	29	34%	2	2.4	4.8	2025	$0	$0	$0	CIP
	Front St	Control Panel #2	VFD	1996	25	6	3	6	25	24%	2	3.2	6.4	2021	$15,000	$3,600	$0	CIP
	Front St	Control Panel #3	VFD	1996	25	6	3	6	25	24%	2	3.2	6.4	2021	$15,000	$3,600	$0	CIP
	Front St	Control Panel #4	VFD	1996	25	6	3	6	25	24%	2	3.2	6.4	2021	$15,000	$3,600	$0	CIP
	Front St	Level Control System	Milltronics sonic	1996	20	1	3	5	24	21%	3	3.5	10.4	2020	$4,000	$833	$200	OM&R
	Front St	Backup Floats	Floats	1996	10	-9	3	2	21	10%	3	4.7	14.1	2017	$1,000	$95	$100	OM&R
	Front St	SCADA Panel	Wireless link 2 2 PLC 5	1996	20	1	3	5	24	21%	3	3.5	10.4	2020	$20,000	$4,167	$1,000	OM&R
	Front St	Backup Power	Generator on site	1996	30	11	3	11	30	37%	4	2.3	9.1	2026	$125,000	$45,833	$0	CIP
	Front St	Structure	37'x22', Brick, stone	1930	70	-15	3	25	110	23%	4	3.1	12.6	2040	$80,000	$18,182	$0	CIP
	Front St	Wet Well	37'x6'	1930	70	-15	3	25	110	23%	4	3.1	12.6	2040	$30,000	$6,818	$0	CIP

Appendix D-C: 5-Year Asset Replacement Recommendations

Appendix D-C: 5-Year Asset Replacement Recommendations

Year	Asset ID	Station	Asset	Business Risk	Replacement Cost	Funding Source	
						OM&R	CIP
2015	0	Coast Guard	Flow Meter	5	10000	X	
					Annual Total	**$10,000**	**$0**
2016	0	Bay Street	Flow Meter	5	10000	X	
	0	Woodmere	Pump #1	15	8500		X
					Annual Total	**$10,000**	**$8,500**
2017	0	Birchwood	Backup Floats	13	500	X	
	0	Front St	Backup Floats	14	1000	X	
	0	TBA	Pump #1	15	18000		X
	0	TBA	Pump #2	15	18000		X
	0	TBA	Motor #1	15	0		X
					Annual Total	**$1,500**	**$36,000**
2018	0	Bay Street	Pump #1	9	11000	X	
	0	Bay Street	Pump #2	9	11000	X	
	0	Riverine	Pump #1	14	11000		X
	0	Riverine	Pump #2	14	11000		X
	0	Riverine	Check/Control Valve #1	14	1200		X
	0	Riverine	Check/Control Valve #2	14	1200		X
	0	Riverine	Motor #1	14	0		X
	0	Riverine	Motor #2	14	0		X
	0	Riverine	Control Panel	19	15000		X
	0	TBA	Control Panel	20	15000		X
					Annual Total	**$22,000**	**$54,400**
2019	0	Bay Street	Control Panel	8	15000		X
					Annual Total	**$0**	**$15,000**
2020	0	Bay Street	Level Control System	11	4000	X	
	0	Bay Street	Telemetry	7	4000	X	
	0	Bay Street	Backup Floats	14	500	X	
	0	Clinch Park	Level Control System	8	500	X	
	0	Clinch Park	Backup Floats	8	500	X	
	0	Coast Guard	Pump #1	11	18000	X	
	0	Coast Guard	Pump #2	11	18000	X	
	0	Coast Guard	Control Panel	14	15000		X
	0	Coast Guard	Level Control System	11	4000	X	
	0	Coast Guard	Telemetry	11	4000	X	
	0	Front St	Level Control System	10	4000	X	
	0	Front St	SCADA Panel	10	20000	X	
	0	Hull Park	Level Control System	9	500	X	
	0	Riverine	Level Control System	13	500	X	
	0	Riverine	Backup Floats	13	500	X	
	0	Riverine	Telemetry	8	3000	X	
	0	TBA	Check/Control Valve #1	14	2000		X
	0	TBA	Check/Control Valve #2	14	2000		X
	0	TBA	Level Control System	19	500	X	

Appendix D-C: 5-Year Asset Replacement Recommendations

Year	Asset ID	Station	Asset	Business Risk	Replacement Cost	Funding Source	
						OM&R	CIP
	0	TBA	Telemetry	9	4000	X	
	0	Woodmere	Pump #2	11	8500		X
	0	Woodmere	Control Panel	14	15000		X
	0	Woodmere	Level Control System	11	4000	X	
	0	Woodmere	Backup Floats	11	500	X	
	0	Woodmere	Telemetry	7	4000	X	
	0	Woodmere	Flow Meter	4	11000		X
					Annual Total	**$95,000**	**$53,500**
2021	0	Front St	Control Panel #2	6	15000		X
	0	Front St	Control Panel #3	6	15000		X
	0	Front St	Control Panel #4	6	15000		X
					Annual Total	**$0**	**$45,000**

Appendix E: Hydrologic and Hydraulic Technical Memorandum

Appendix E: Hydrologic and Hydraulic Technical Memorandum

A. Introduction

Using SAW Grant Program Assistance, Traverse City retained OHM Advisors to assess infiltration and inflow concerns within the Traverse City wastewater system. To address these concerns, OHM worked with Martin Control Services (MCS) to install 8 temporary flow meters and one rain gauge for the duration of 6 months during 2015. Flows were recorded from these meters, as well as the permanent Wastewater Treatment Plant (WWTP) flow meter, under varying antecedent moisture conditions and used to determine a wet weather response for the development of hydrologic modeling parameters. These parameters were applied to a hydraulic model of the system's main trunks and used to evaluate the current system.

This memorandum summarizes the results from the Antecedent Moisture Model (AMM) method to estimate peak flow rates, hydraulic modeling to evaluate conditions during peak flow rates, and a comparison of modeled peak flows to lift station capacities.

Most of the system showed little to no discernable wet weather response, indicating that wet weather flows are not generally a significant issue within this system. The one exception was Meter District 3 (Figure E-1), where increased peak flows in response to wet weather conditions were observed and an AMM was developed. Benchmarking data suggests that the capture coefficient (percentage of rainfall that enters the collection system) for these storm events is fairly low compared to other sanitary sewer systems, however the effect on peak flows is fairly high with a peaking factor in the top 80th percentile of benchmarked systems. A model for the WWTP was also completed to verify the overall wet weather response of the system, including the incremental areas downstream of the temporary meters. The WWTP also had a low wet weather response, making it one of the driest systems OHM has ever observed. The AMM model was applied at these two locations for the following uses:

- Meter District 3
  - This model was developed for Meter District 3, which had the greatest wet weather response. This area is to the west of Boardman Lake and enters the main trunk just upstream of Meter 4. Results were used to determine peak flows for the meter district and in benchmarking comparisons to other systems.

- WWTP
  - This model was developed to measure the wet weather flow response of the entire Traverse City System. Results were used in benchmarking comparisons to other systems and to determine the flow rate during peak flows.

For the Traverse City flow analysis, the calibrated models from the two analysis points were used to determine the 10-year frequency peak wet weather flows. The 10-year frequency flow is critical in Michigan, as the 2002 SSO Policy (MDEQ) makes a specific reference to collection systems being designed so as to overflow less than once in ten years; in other words, systems should be designed to safely convey the 10-year recurrence interval flow rate.

The remaining districts were evaluated using a peaking factor determined from the Ten State Standards formula for peak design flows. It was found that the Ten State Standards formula resulted in a higher (more conservative) peak hour flow when the incremental WWTP districts were summed than the 10-year flow predicted by the WWTP AMM model. This confirmed that the use of Ten State Standards would not cause an under prediction of peak flows within the model. For Meter District 3, the 10-year frequency peak flow was greater than the Ten State Standards peak design flow and so the 10-year frequency flow was used. Hydraulic conditions during these peak hour flows were evaluated using an EPA SWMM hydraulic model and lift station capacities were compared to expected inflows. Any deficiencies within the system are summarized and recommendations provided.

District	District Area (acres)	Meter Math
1	1450	M1
2	320	M2 - M1
3	326	M3
4	2067	M4 - M3 - M2 - M5
5	178	M5
6	153	M6
7	451	M7
8	212	M8b
WWTP Incremental	8917	WWTP - M4 - M6 - M7 - M8b

Breakdown of WWTP Incremental

District	District Area (acres)
East	3696
Northeast	1245
South Central	2559
Airport	1124
Central	293

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Traverse City

Figure E-1. Meter Districts

Legend

- 2015 Meter Locations
- Lift Station
- Pump Station
- Force Main
- Sanitary Gravity Main
- Traverse City Boundary
- Manhole

Meter Districts

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- East
- Northeast
- South Central
- Airport
- Central

0 5,200 10,400
Feet

1" = 5200'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: May 23, 2017

OHM
888.522.6711 | ohm-advisors.com

B. Background

1. Purpose and Scope

1. *Temporary Flow Metering*: The purpose of this task was to install temporary flow meters near existing pump stations and other key locations within the Traverse City collection system to capture local sewer flow response during both dry and wet weather conditions. Once the data were gathered, meter math was conducted for each meter district to obtain incremental flows and identify locations of higher inflow/infiltration.
2. *Develop hydrologic model for selected metered districts*. The purpose of using the AMM was to create a continuous hydrologic model that predicts the effects of a wet weather response. The model is calibrated to optimize the accuracy of fit to the observed conditions. Only meter districts which showed sufficient inflow/infiltration responses were modeled.
3. *Develop hydraulic model of the collection system's trunk*. The purpose of this task was to evaluate the hydrologic responses and hydraulic performance of the wastewater collection system, noting any specific problems related to elevated base flows, wet weather flows, and hydraulic deficiencies under peak flow conditions. This analysis focused on the City's larger-diameter sewer systems, primarily downstream of key sewersheds and pump stations.
4. *Transition the hydraulic model files to City staff and provide training*. The model was created with EPA SWMM version 5.1 which is available as a free download from the EPA's website. This task will be completed following the submittal of this memo and will ensure that staff have an understanding of the model structure and capabilities.

C. Hydrology

1. Antecedent Moisture Model (AMM)

This study utilizes the AMM, which is a continuous hydrologic model that can accurately account for antecedent moisture and its effect on sanitary sewer wet weather response over continually varying climate conditions. Antecedent moisture is a term that describes the relative wetness or dryness of a sewershed. The AMM takes into consideration the ground's moisture and more accurately predicts the sewershed response to base groundwater flow and rainfall dependent inflow and infiltration over an extended period of time using rainfall and air temperature data.

2. Development of Antecedent Moisture Model

AMMs were developed for Meter District 3 and the WWTP. Other metered districts had wet weather flow responses that were too low to develop a reliable hydrologic model. The metering data for the other districts was necessary to determine that inflow and infiltration during wet weather was not a major concern. With the meter data successfully demonstrating that they were in good shape, Meter District 3 and the WWTP could be focused on.

Once the meter and rain data were formatted and filtered, meter math was conducted for each meter district in order to isolate the contributing sewersheds for each meter. The meter districts are shown in Figure E-1 with the meter math used to determine the flows from each district.

Long term hourly rainfall data used for the AMM frequency analysis were obtained for the period of 1958-2013 through the National Oceanic and Atmospheric Administration's (NOAA) website from COOP: 208246. This station is located within 2.3 miles of the Wastewater Treatment Plant. Daily temperature data for the same time period were obtained from the Cherry Capital Airport Weather Station (WMO: 726387).

3. Calibration

Six months (March 27 – September 4, 2015) of meter data were used to build and calibrate the AMM. To calibrate the models, the diurnal flow pattern was filtered out and specific storms were defined. The daily diurnal flow pattern was filtered so that the resulting observed flow signal only contained inflow and infiltration (I/I). The storms that were chosen were based on the total event rainfall. These storms each have a minimum of 0.5 inches of total rainfall and generally consist of uniform rainfall distribution. The storm events used in this analysis are listed in Table E-1. Only the May 24 – 25th storm exceed the 24-hour 1-year storm event rainfall (2.0 inches) as defined by NOAA's Atlas 14 Precipitation Frequency Estimates.

Table E-1: Summary of Model Storms -- 2015 Temporary Monitoring Period

Storm Events	Total Rainfall (in)
4/9/2015*	1.1
5/24/2015	2.1
8/2/2015	1.3
8/18/2015	1.0

** The 4/9/2015 storm event was not used for Meter District 3 AMM model calibration due to changing diurnal patters that prohibited proper filtering of the diurnal flows.*

Calibration adjustments were made based on the model flow fitting the observed meter flow data as accurately as possible.

4. Accuracy of Fit

To quantify the percent error of peak flows and volumes for each storm, accuracy of fit plots were created. These plots are illustrated in Appendix E-A. For each storm, the total errors for peak flow and volume were calculated as well as the net error of each. Net error is the average of all the errors and allows positive and negative values. Total error is the average of the absolute value of the errors. The goal of this study was to reach a net error close to 0 percent and a total error less than 20 percent. The summary of the calculated net

and total errors is listed in Table E-2. Negative values indicate that the AMM under-predicts and positive values indicate that the AMM over-predicts the observed flows.

Table E-2 Summary of Net and Total Error for Each AMM Model

	Net Peak Error	Total Peak Error	Net Volume Error	Total Volume Error
Meter District 3	-3.7%	3.7%	23.0%	23.0%
WWTP	-1.0%	12.8%	1.5%	3.6%

Due to issues with the flow meter data from Meter 3, only one storm was used for accuracy of fit analysis for Meter District 3. The May 24th storm was the largest storm and was used for this purpose. The total errors indicate that the AMM predicted peak flows and peak volumes to within 13% of observed values for the WWTP and 23% of observed values for Meter District 3. Net errors indicate that the AMM for the WWTP was not biased towards over- or under-prediction of flows or volumes while the AMM for Meter District 3 tended to over-predict volumes. Because of high variability in the Meter 3 data and unusual storm event responses, the model was purposefully kept more conservative in volume predictions.

5. Validation

It is preferable to verify a model's performance against storm events not used in the calibration. In this case there were insufficient suitable storms to perform this validation. For most districts, there was no discernable wet weather response in the flow metering data, and the Ten State Standards formula combined with average flows from metering was used to establish peak flows.

6. Frequency Analyses

A frequency analysis was performed for each model to determine the expected 10- and 25-year frequency peak flows. The calibrated AMMs were used in conjunction with temperature and precipitation data from the period of 1958 to 2013 to estimate annual peak flows. The Log Pearson Type III methodology was then used to determine the design 10-year and 25-year peak flows listed in Table E-3. The plots also include the 95% confidence interval and are illustrated in Appendix E-B.

Table E-3 Summary of Peak Flows

Model	10-year (cfs)	25-year (cfs)
Meter District 3	3.4	4.1
WWTP	12.7	14.1

7. Benchmarking

In order to adequately characterize Traverse City's wastewater collection system, the modeled wet weather response was compared to those of other Midwest U.S. collection systems. OHM Advisors has, through similar analyses, developed a benchmarking tool that allows for comparisons to 56 other metered sewer districts in the Midwest U.S.

The peak flows and capture coefficients predicted from the AMMs for a 1-inch, 1-hour event are presented in Table E-4 along with a typical Midwest collection system for comparison. Figure E-2 and E-3 provide a graphical comparison of the peak flow and capture coefficients at the WWTP and Meter District 3 compared to other Midwest collection systems. These figures reveal that Traverse City's collection system as a whole has less inflow and infiltration than any other system that OHM Advisors has modeled. Meter District 3 has high peak flows with a lower capture coefficient, suggesting that inflows are creating high peak flows and little infiltration is occurring causing a smaller volume of the storm to be captured. This may indicate the presence of directly connected stormwater sources in this district, which may be cost effective to locate and remove.

Table E-4 Peak Flow (cfs per 1,000 acres) and Capture Coefficient (%)

Model	Peak Flow (cfs per 1,000 acres)	Peak Flow Benchmark Ranking	Capture Coefficient (%)	Capture Coefficient Benchmark Ranking
Meter District 3	4.4	82.5%	1.2%	10.5%
WWTP	0.2	0%	0.1%	0%
Typical Midwest System	2.0	50%	2.6%	50%

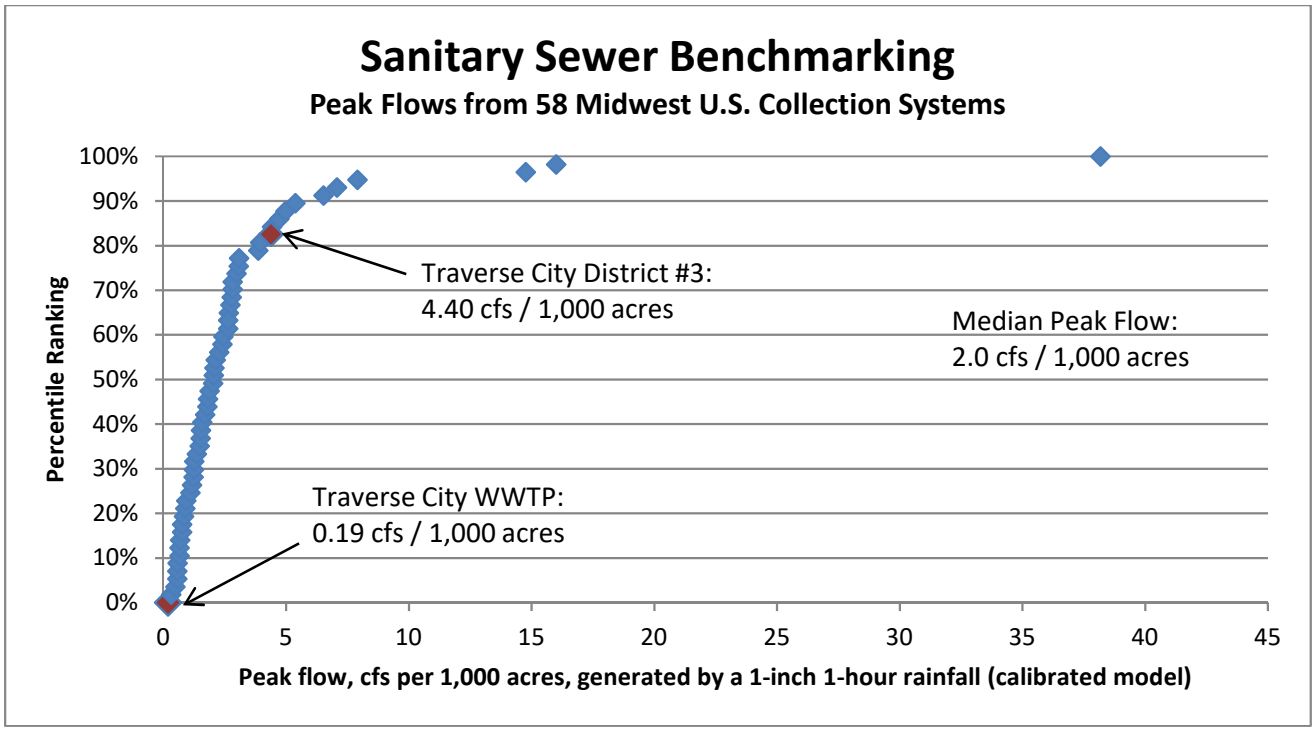


Figure E-2: Peak Flows from 58 Typical Midwest U.S. Collection Systems

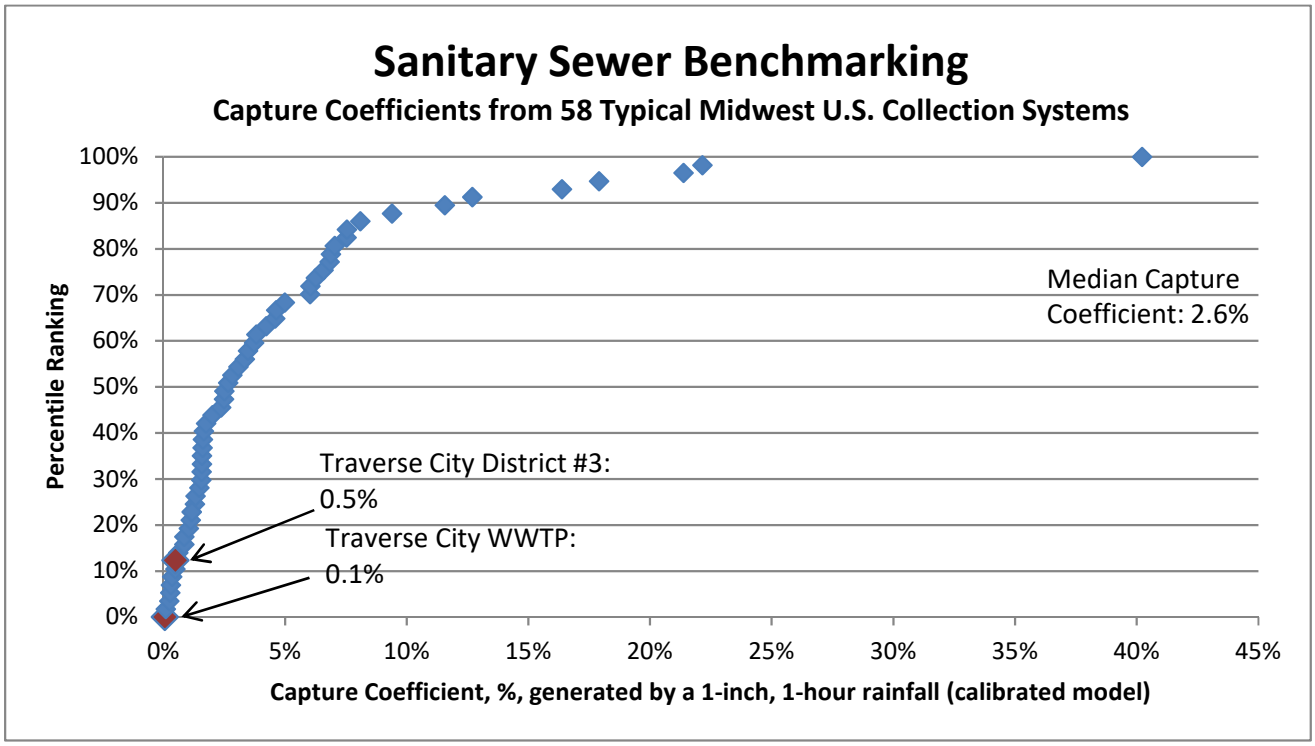


Figure E-3: Capture Coefficients from 58 Typical Midwest U.S. Collection Systems

8. Lake Michigan Level

Due to Traverse City's location on a bay of Lake Michigan, it is very possible that lake levels could be a driving factor in groundwater infiltration. Lake level data alongside monthly WWTP flows was provided by the City and is included in Appendix E-D. The monthly flows make it difficult to extract historical diurnal patterns and differentiate between changes in flows from groundwater and flows from other sources. More recent lake level data was also obtained from the US Army Corps of Engineers. As shown in Figure E-4, lake levels during the meter data collection were above average. Elevated lake levels continued into 2016. Groundwater levels and infiltration of groundwater into pipes as a result of these levels is taken into account in the base flow when calibrating the AMMs. A complete analysis of lake levels was outside the scope of this study and it is uncertain how lake levels will behave in the future.

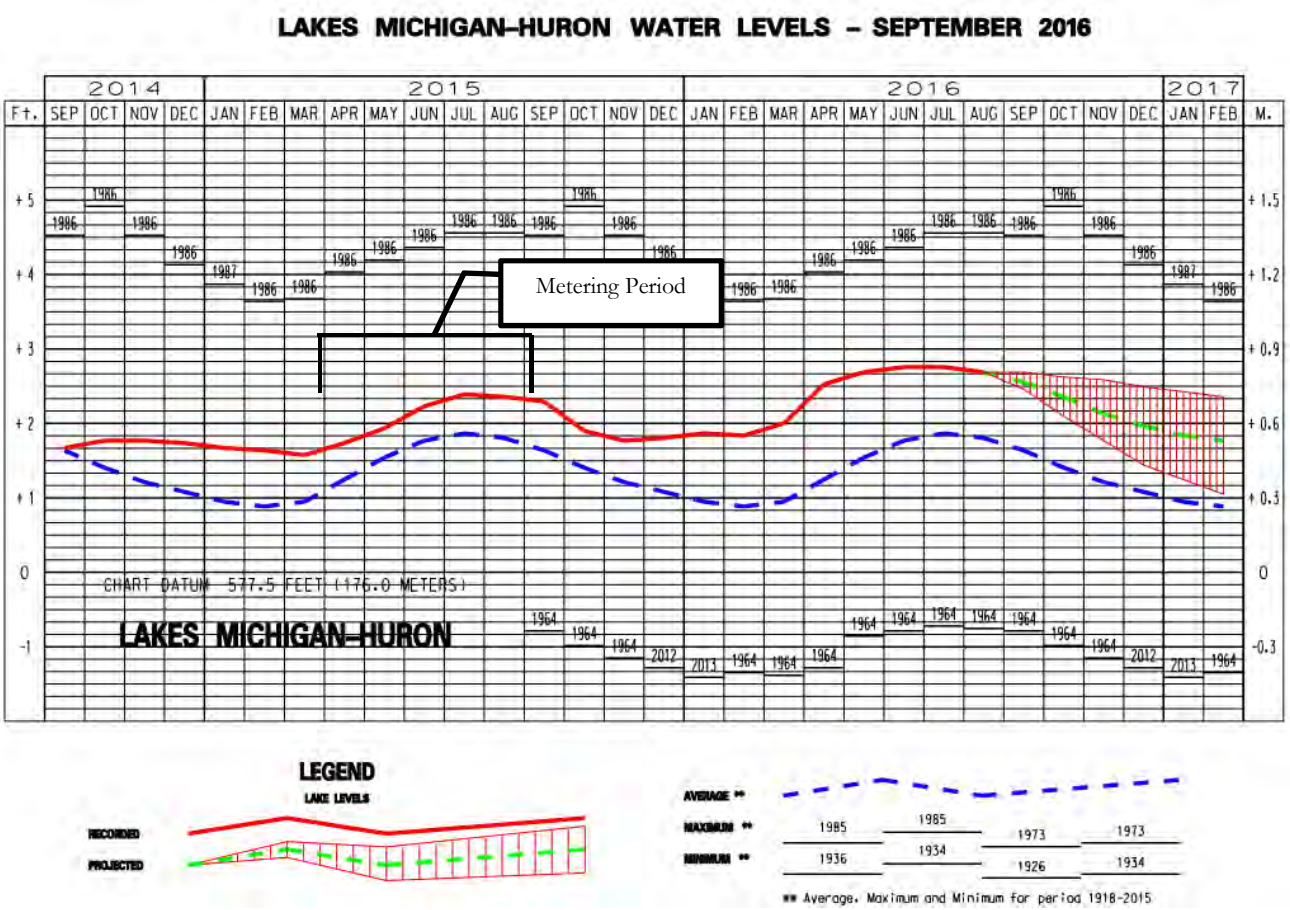


Figure E-4: Lake Michigan and Huron water levels and predictions from US Army Corps of Engineers

D. Hydraulic Model

1. Development of Hydraulic Model

A hydraulic model was created using EPA-SWMM and Traverse City's existing GIS data. LIDAR data was used where GIS data did not provide manhole rim elevations. Traverse City supplied additional information for the siphon located at Front and Oak Street and the siphon under Kids Creek. The major trunks of the collection system that ran east and west through downtown Traverse City were the focus of the hydraulic model, as these sewers convey the majority of flow in the City's collection system. Flows from the west side of the city were modeled starting at Meter 2 (South Oak Street between 6th and 7th street), following the main trunk north on South Oak until intersecting with the 18-inch and 21-inch sewers just north of West Front Street, and then east under the Boardman River until it reached the

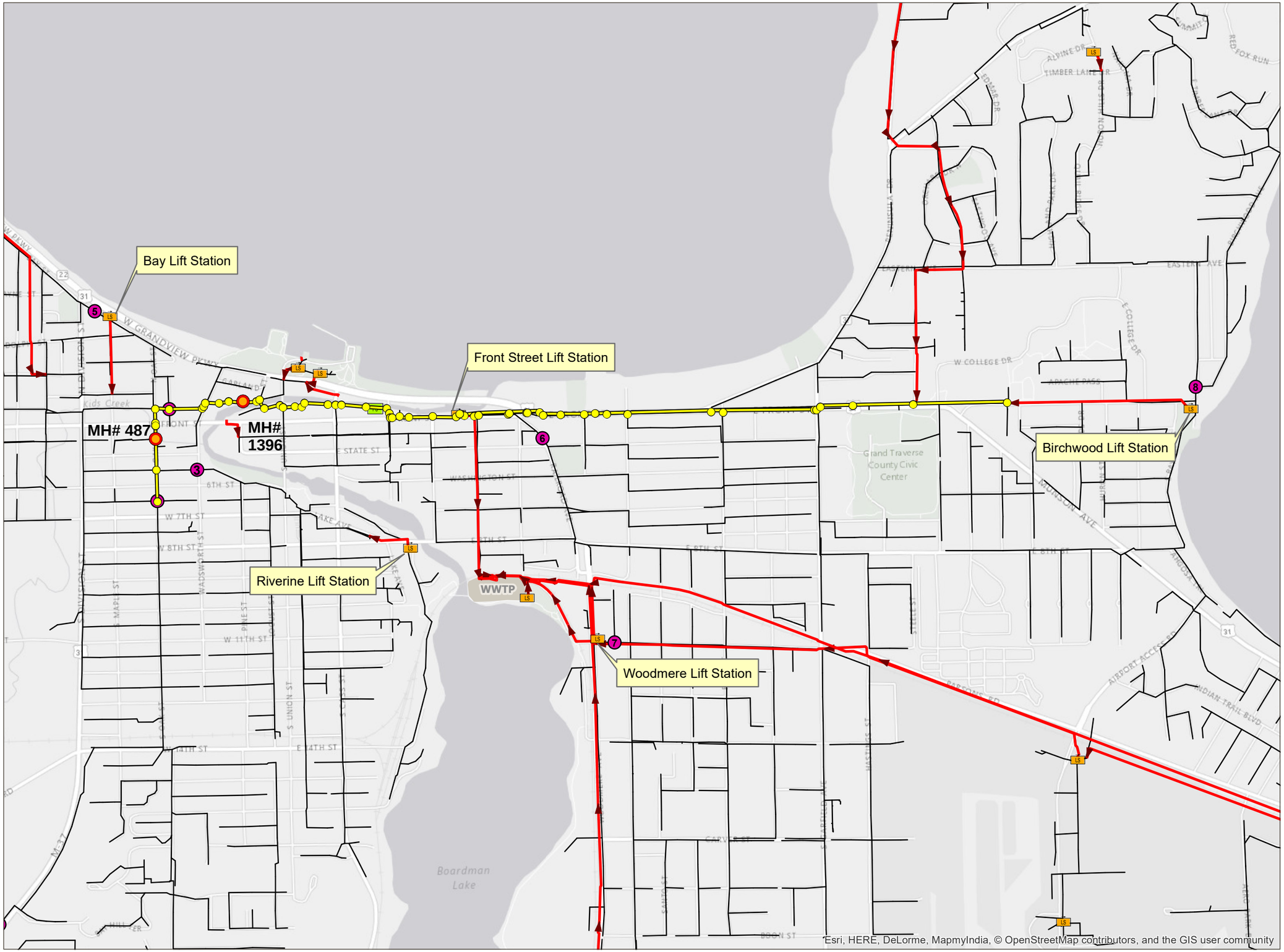
Front Street lift station. Flows for the east side of the city were modeled starting at the downstream end of the Birchwood force main and traveling west along East Front Street until also converging at the Front Street lift station. The modeled sections of the system are illustrated in Figure E-5.

The Ten State Standards design peaking factors for peak hourly flows were used in conjunction with average flows from meter data to estimate peak flows for all districts except Meter District 3, which demonstrated higher wet weather responses. Population information for the peaking factor calculations was determined for each area using ESRI's GIS-based U.S. Census Bureau 2010 Census Information. The modeled peak flows, summarized in Table E-5, were compared to the peak flows obtained from 2015 metering data and the 10-year peak flows from the AMM for Meter District 3 and the WWTP. The highest predicated peak flow from each method was used in the model to increase confidence that the EPA SWMM model would not under predict flows within Traverse City and to surpass the minimum 10-year flow event requirement for this model.

Table E-5 Summary of Peak Flows

Meter District	2015 observed peak flow (cfs)	AMM 10-year peak flow (cfs)	Ten State Standards peak flow (cfs)	Peak flow used in model (cfs)	Manhole at which modeled flows were added
1	1.3		4.4	4.4	333
2	1.4				
3	2.4	3.4	1.6	3.4	481
4	1.1		3.0	3.0	211
5	0.7				
6	0.4		0.4	0.4	1496
7	1.2		1.4	1.4	WWTP
8	0.4		0.7	0.7	1452
East	not metered		1.0	1.0	WWTP
Northeast			0.8	0.8	1452 (42%) 1470 (34%) 880 (17%) 1458 (7%)
South Central			1.0	1.0	WWTP
Airport			0.01	0.01	WWTP
Central			0.3	0.3	1499 (60%) 1399 (40%)
WWTP	9.0	12.7	14.6	16.4	

Peak flows were added to the hydraulic model at the manholes downstream of the temporary meters where a district's flow entered a modeled trunk. The manholes where flows were introduced are listed in Table E-5 and correspond to the manhole numbers in the GIS provided by Traverse City. In some cases, flows from multiple districts entered the modeled trunk at the same manhole and the peak flows were summed. Districts with manholes along the modeled trunk that weren't directly metered had their flows split between multiple manholes with flows proportional to the upstream acreage for that individual manhole. In this situation the percentage of the district's total peak flow added to each manhole is also shown in Table E-5. Lastly, four of the districts never contributed to flows in the modeled trunks. These are considered only as additional flows to the WWTP and are not present in the hydraulic model.



Traverse City

Figure E-5. Modeled Sanitary Trunk

Legend

- 2015 Meter Locations
- Lift Station
- Pump Station
- Force Main
- Sanitary Gravity Main
- Modeled Manholes
- Modeled SSO at Manhole
- Modeled Trunk

0 1,300 2,600
Feet

1" = 1,300'

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: May 23, 2017

OHM
888.522.6711 | ohm-advisors.com

P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\Figure E-5 Modeled San Mains.mxd

E. Evaluation of System Deficiencies

1. Hydraulic Model – Anticipated problem areas

Using peak flow rates established with Ten State Standards peaking factors and results from the AMM, the EPA SWMM model was used to simulate hydraulic conditions during peak flows. The model demonstrated that the main trunk handling flows from the east side of the city has sufficient capacity to handle peak flows with no surcharging or sanitary sewer overflows (SSOs). On the other hand, the main trunk handling flows on the west side of the city showed significant surcharging with a model-predicted SSO at MH #487 on South Oak Street. This manhole is called out in Figure E-5 and is the location of a pipe diameter change from 24-inch upstream to 12-inch downstream. This pipeline diameter decrease precedes a double barreled siphon with a 12-inch and 10-inch line. Profile views from the model for the east and the west side are presented in Appendix E-C Figures E-C.1. and E-C.2.

The model was then run with the 335 feet of 12-inch diameter pipe near the Oak Street Siphon upgraded to a 24-inch diameter pipe. This removed the most significant restriction within the main trunk on the west side and was used to determine the success improvements would have on the system hydraulics. Surcharging was significantly reduced with this upgrade. The predicted SSO at MH#487 was removed, however the problem moved downstream and a SSO was predicted at a low elevation manhole just upstream of the Boardman River Siphon (MH#1389). Figure E-C.3. shows the new profile view for the west side of the city and Figure E-5 depicts the location of this new SSO.

To address the new SSO at manhole #1389, the 2,910 ft of 24-inch diameter pipe downstream of the Boardman River siphon was upgraded to 30-inch diameter pipe. This removed the predicted SSO and surcharging was eliminated with the exception of a 695 foot section of 21-inch diameter pipe directly downstream of the Oak Street Siphon. Figure E-C.4 shows these upgrades. A further upgrade of this section of 21-inch diameter pipe to 30-inch eliminated the remaining surcharging. The profile of the system with all recommended upgrades is shown in Figure E-C.5.

The last scenario evaluated was a reduction in peak hour flows from Meter District 3. Peak flows could likely be reduced by removing infiltration and inflow sources through a Sanitary Sewer Evaluation Survey (SSES). The peak flow used for this model was determined using the Ten State Standards peaking factor calculation. As shown in Table E-5, this would be a reduction in Meter District 3 peak flows from 3.4 cfs to 1.6 cfs. This scenario does not require any pipe size upgrades and would address the model-predicted SSOs. However, significant surcharging would still be present along most of the western trunk under this scenario. A profile view from this scenario is presented in Figure E-C.6. A reduction in peak

flows of this magnitude from source removal is not guaranteed and therefore use of other upgrades is recommended in conjunction with source removal.

2. Flow Meter Limits at WWTP

During the September 5, 2014 rain event in Traverse City, the peak flow at the WWTP could not be accurately established because the flow meter maxed out at 9.5 cfs causing a flat line (Figure E-6). Maxing out of the meter was seen in several other locations in the 2013-2015 5-minute interval data for the WWTP. To accurately record peak flows at the WWTP the flow meter should be upgraded to one that can record higher maximum flows. Given our prediction of design-event peak flows exceeding 12 cfs, the flow capacity of the WWTP influent meter should at a minimum exceed this flow.

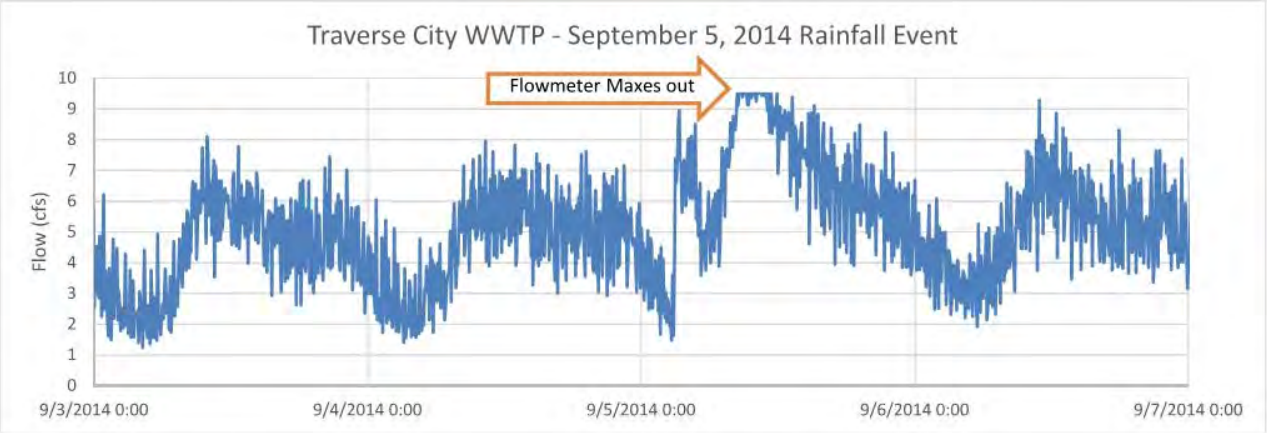


Figure E-6: Flows recorded at WWTP during the September 5, 2014 storm event

3. Lift Station Evaluation

The capacities of major lift stations within Traverse City were compared to expected inflows from the peak flow model. Only lift stations that were associated with the calculated peak flows were evaluated. This caused the Clinch Park and Hall lift stations to be excluded Predicted flows were proportionally scaled based on acreage if only part of a meter district contributed to lift station flows. A summary of lift station capacities and expected peak flows is presented in Table E-6. Several lift stations were identified as having firm capacities below the estimated peak flows.

Although we are not recommending immediate pump replacement, the City should consider upgrading the firm capacities to match the modeled peak flows in Table E-6 when the existing pumps reach the end of their respective useful lives. In some cases, this may require more substantial facility improvements, including force main replacement.

Table E-6 Lift Station Capacities and Peak Flows

Lift Station	Firm Capacity (gpm)	1997 Pump Test Capacity (gpm)	Upstream Area	Modeled Peak Flow (gpm)
Riverine	350	-	Meter District 3 (45 ac)	180
Bay	430	560	Meter District 5	516
Front Street	6200	6200	Total Modeled Flows	5198
Birchwood	800	-	Meter District 8	314
Woodmere	450	670	Meter District 7 + South Central (100 ac)	646
Coast Guard	400	535	Airport Meter District (454 ac)	18*
TBA	700	760	Airport Meter District (670 ac)	27*

Capacities in red are exceeded by modeled peak flow.

**These peak flows are associated with unmetered districts where flows were distributed based on residential populations. Flows are transported directly to the WWTP and not part of the modeled collection system trunks. They are likely higher than indicated because of flows from non-residential sources.*

F. Evaluation of Alternatives and Recommendations

Flow meter information for the WWTP does not accurately capture actual peak flows due to a maximum measurement capacity of 9.5 cfs. It is recommended that the flow meter at the WWTP be upgraded to one that is capable of measuring flows up to 16-18 cfs. This accommodates the projected design-event flows and provides additional flexibility for future growth in the collection system.

Lift Station pump capacities at Bay and Woodmere were insufficient for the modeled peak hour flows. When pumps at these stations need to be replaced due to pump/motor equipment condition, larger capacity pumps should be considered.

During the estimated peak hour flows, surcharging and SSOs are predicted in the hydraulic model for the main collection system trunk on the west side of the city. To correct these concerns, it is recommended that the following upgrades be completed if flows can't be reduced:

- 335 feet of 12-inch diameter pipe along South Oak Street upgraded to 24-inch
- 695 feet of 21-inch diameter pipe downstream of the Oak Street Siphon upgraded to 30-inch
- 2,910 feet of 24-inch diameter pipe downstream of the Boardman River Siphon upgraded to 30-inch

The conditions of the pipes at these recommended upgrade locations were reviewed when recent CCTV inspections were available. The 12-inch diameter pipe on South Oak Street upstream of the inverted siphon was in relatively good condition but could not be fully inspected because of high water levels caused by the siphon. The 12-inch pipe directly downstream of the siphon had some longitudinal cracks, suggesting an upgrade of the pipe in this location would also be structurally beneficial. Most of the remaining locations were lined less than 15 years ago and were not inspected. Those that were inspected were in good shape structurally with a few O&M concerns from the presence of deposits and high water marks. The relative good shape of the system supports actions to reduce flows before proceeding with upgrades.

Meter District 3 was identified as one of the main sources of increased wet weather flows. AMM results and benchmarking information suggest that inflows are the most prevalent flow source in District 3 and infiltration is minimal. Removal of these inflow sources will serve to further reduce peak flows and surcharging in the system and may reduce the amount of recommended upgrades. It is suggested that a SSES that includes smoke testing should be conducted in this district to locate possible direct connections (i.e. roof drains, footing drains, etc.) before the above upgrades are performed.

In addition to the SSES, it is recommended that basement surveys are conducted along the western trunk. These surveys would provide information on the degree of surcharging that could be present without causing basement flooding and help prioritize pipeline upgrades. Following these surveys, an additional flowmeter study should be conducted for District 3 to determine the extent that wet weather flows were eliminated. Based on the results, it can be re-evaluated which pipeline upgrades are required. A recommended schedule and estimated costs for completing these activities is below.

Table E-7 Summary of Recommended Actions and Estimated Costs

	Task	Estimated Cost	Time Frame
1	Upgrade WWTP flow meter to one capable of recording flows up to 16-18 cfs.	$10,000	Year 1-2
2	Conduct Sanitary Sewer Evaluation Survey (SSES) with smoke testing in Meter District 3 to locate and remove inflow sources.	$30,000	Year 1-2
3	Conduct basement surveys along western trunk to identify allowable surcharging levels.	$12,000	Year 1-2
4	Clean and televise siphons. Based on the televising, plan for rehabilitation (regular cleaning) or replacement of siphon(s)	$25,000	Year 1-2
5	Perform additional metering in District 3 to evaluate new wet weather flows. Re-evaluate the recommended upgrades based on new flows.	$30,000	Year 3-5
6	Plan funding for recommended system upgrades.	-	Year 6-7
7	Perform recommended upgrades to the system. Current recommendations are to upgrade the 355 feet of 12-inch diameter sewer main along South Oak Street to 24-inch sewer, 695 feet of 21-inch diameter pipe downstream of the Oak Street Siphon to 30-inch, and 2,910 feet of 24-inch diameter pipe downstream of the Boardman River Siphon upgraded to 30-inch.	$2,705,000*	Year 8-10
8	Install larger capacity pumps (and, if necessary, force mains) for Bay and Woodmere during scheduled pump replacements	N/A**	During scheduled replacements

**Upgrade recommendations may change with completion of recommended surveys and metering. Construction method to be determined during preliminary design. Cost estimate assumes significant regulatory and geotechnical issues*

***Pump station upgrades are not included in this cost estimate, as they will occur as part of ongoing pump station operations and planned pump replacements as components age out. Pump station replacement costs and future force main rehabilitation and replacement costs are covered in separate technical memoranda.*

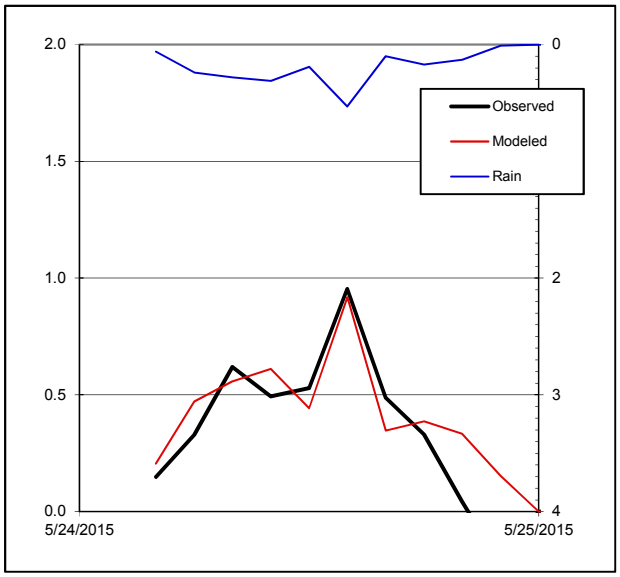
Appendix E-A: AMM Accuracy of Fit Figures

Traverse City Sanitary Sewer Wet Weather Evaluation Project - Antecedent Moisture Model - Accuracy of Fit Analysis
Meter District #3 -2015

Storm	Rain (in)	Observed Peak (cfs)	Model Peak (cfs)	Peak Flow Error (%)	Observed Vol (1000's cf)	Model Vol (1000's cf)	Volume Error (%)	Notes
05/24/15	2.05	0.95	0.92	-3.7%	13	17	23.0%	
08/02/15	1.32	Storms removed from the analysis due to issues with the data.						
08/18/15	1.04							

Net Average Error	-3.7%		23.0%
Total Average Error	3.7%		23.0%

RDII Flow (cfs) on primary Y axis, Rain (in) on secondary Y axis)

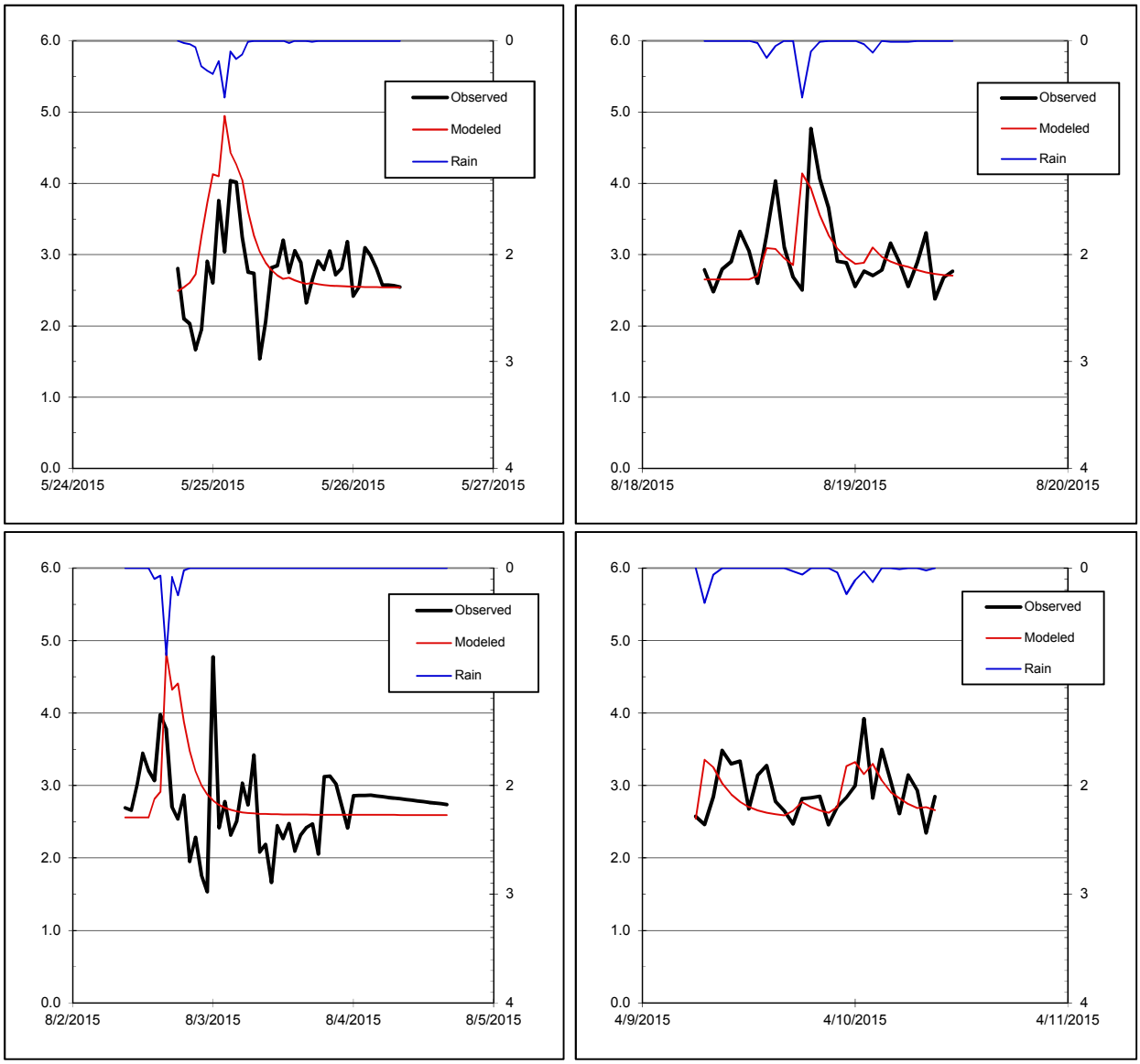


Traverse City Sanitary Sewer Wet Weather Evaluation Project - Antecedent Moisture Model - Accuracy of Fit Analysis
Meters-WWTP - 2015

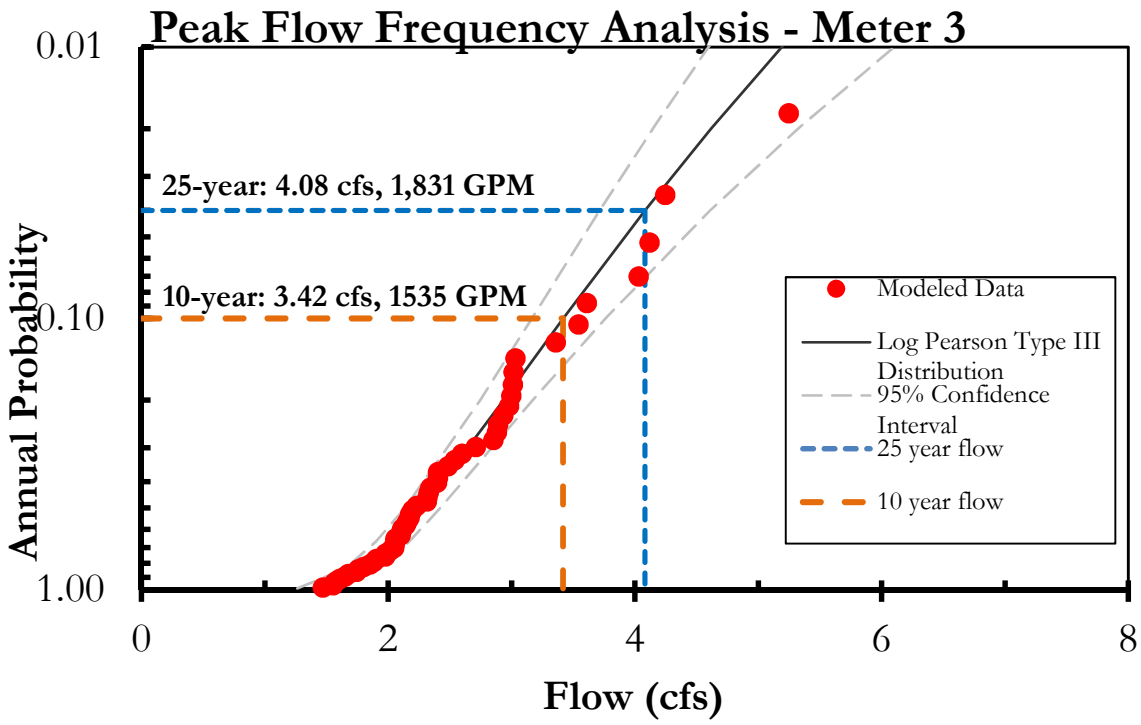
Storm	Rain (in)	Observed Peak (cfs)	Model Peak (cfs)	Peak Flow Error (%)	Observed Vol (1000's cf)	Model Vol (1000's cf)	Volume Error (%)	Notes
05/24/15	2.1	4.04	4.95	22.5%	394	425	7.9%	
08/18/15	1.04	4.77	4.14	-13.2%	324	318	-1.8%	
08/02/15	1.32	4.78	4.83	1.2%	557	569	2.2%	
04/09/15	1.05	3.92	3.36	-14.5%	294	287	-2.3%	

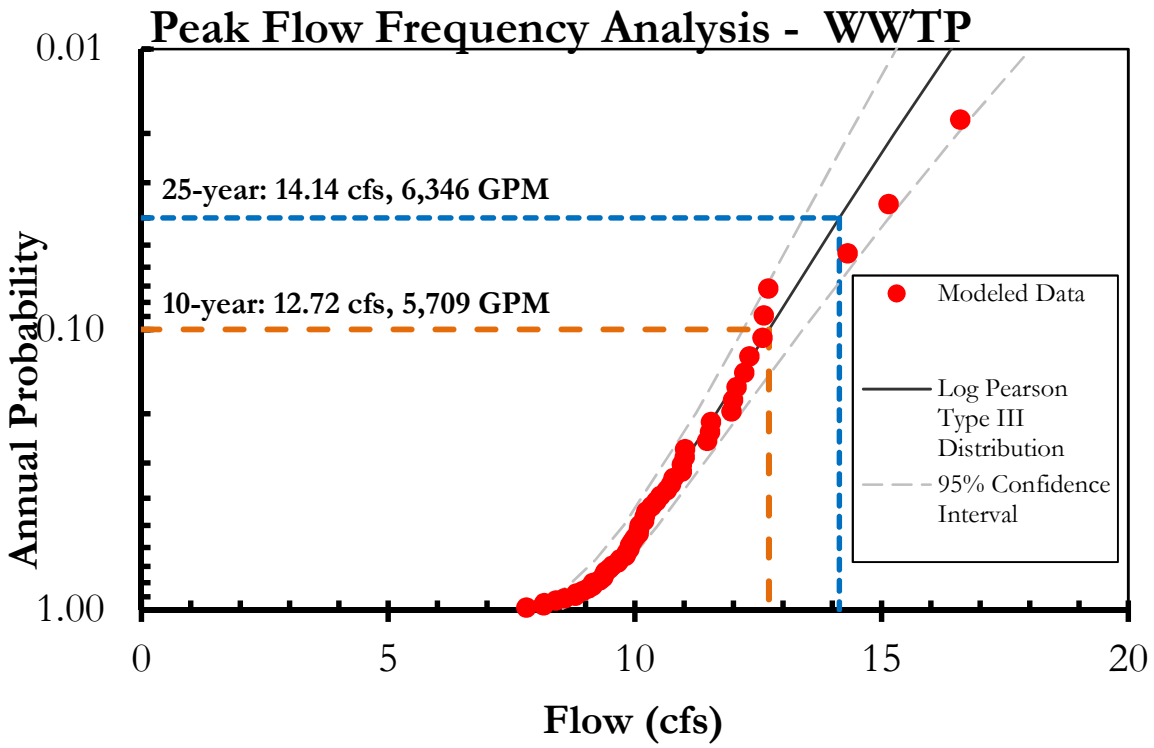
Net Average Error	-1.0%		1.5%
Total Average Error	12.8%		3.6%

RDII Flow (cfs) on primary Y axis, Rain (in) on secondary Y axis)



Appendix E-B: AMM Frequency Analysis Figures


Peak Flow Frequency Analysis - Meter 3
0.01
0.10
1.00
Annual Probability
25-year: 4.08 cfs, 1,831 GPM
10-year: 3.42 cfs, 1535 GPM
Modeled Data
Log Pearson Type III Distribution
95% Confidence Interval
25 year flow
10 year flow
0
2
4
6
8
Flow (cfs)


Peak Flow Frequency Analysis - WWTP
0.01
0.10
1.00
Annual Probability
25-year: 14.14 cfs, 6,346 GPM
10-year: 12.72 cfs, 5,709 GPM
Modeled Data
Log Pearson Type III Distribution
95% Confidence Interval
0
5
10
15
20
Flow (cfs)

Appendix E-C: SWMM Model Profiles

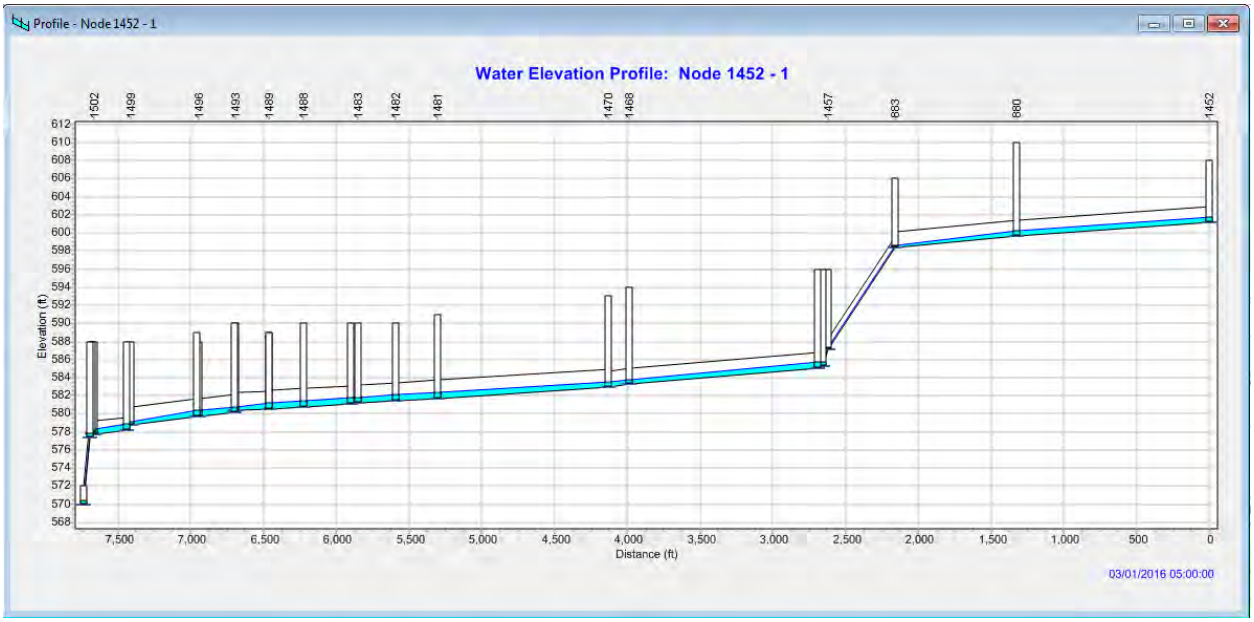


Figure E-C-1: East side during peak hourly flows
No SSOs or surcharging

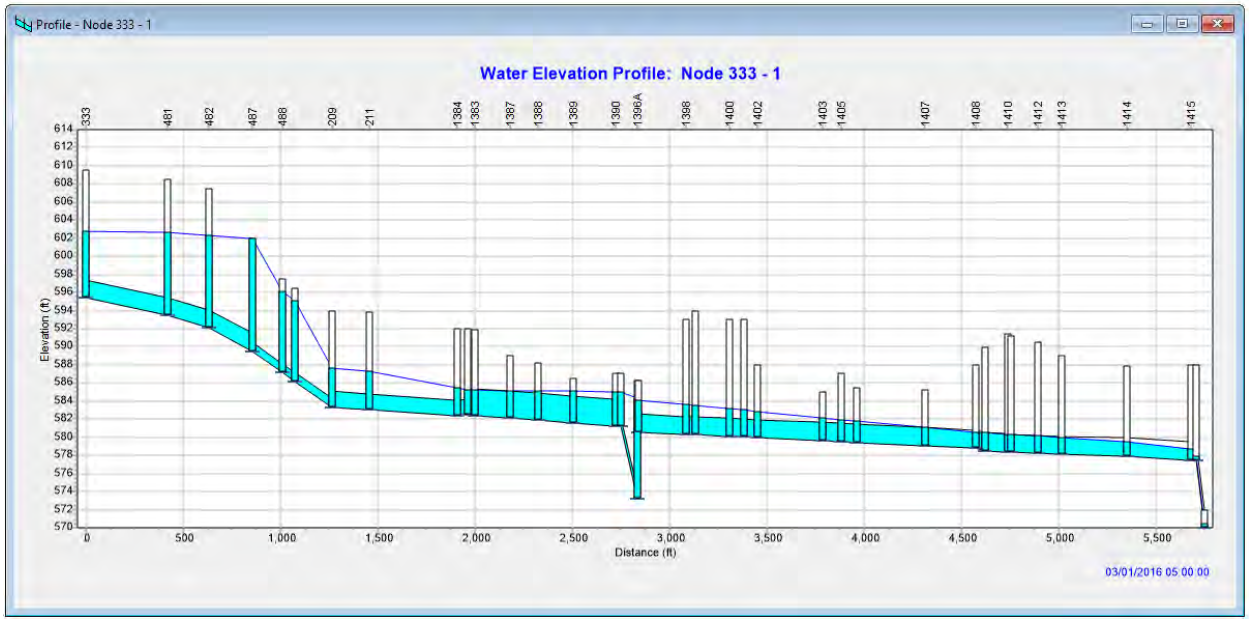


Figure E-C-2: West side during peak hourly flows
Surcharging along line and SSO occurs at MH#487

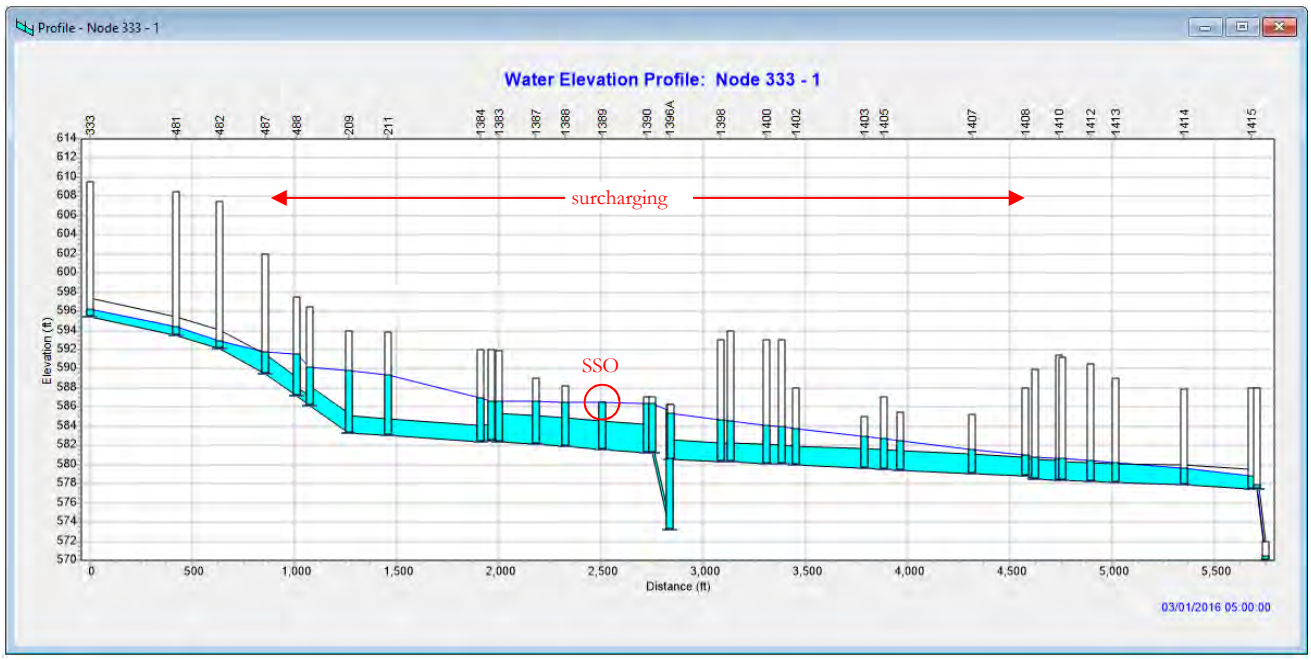


Figure E-C-3: West side during peak hourly flows with 12" lengths upgraded to 24" Reduced surcharging upstream, increased surcharging downstream, and SSO now at MH#1389

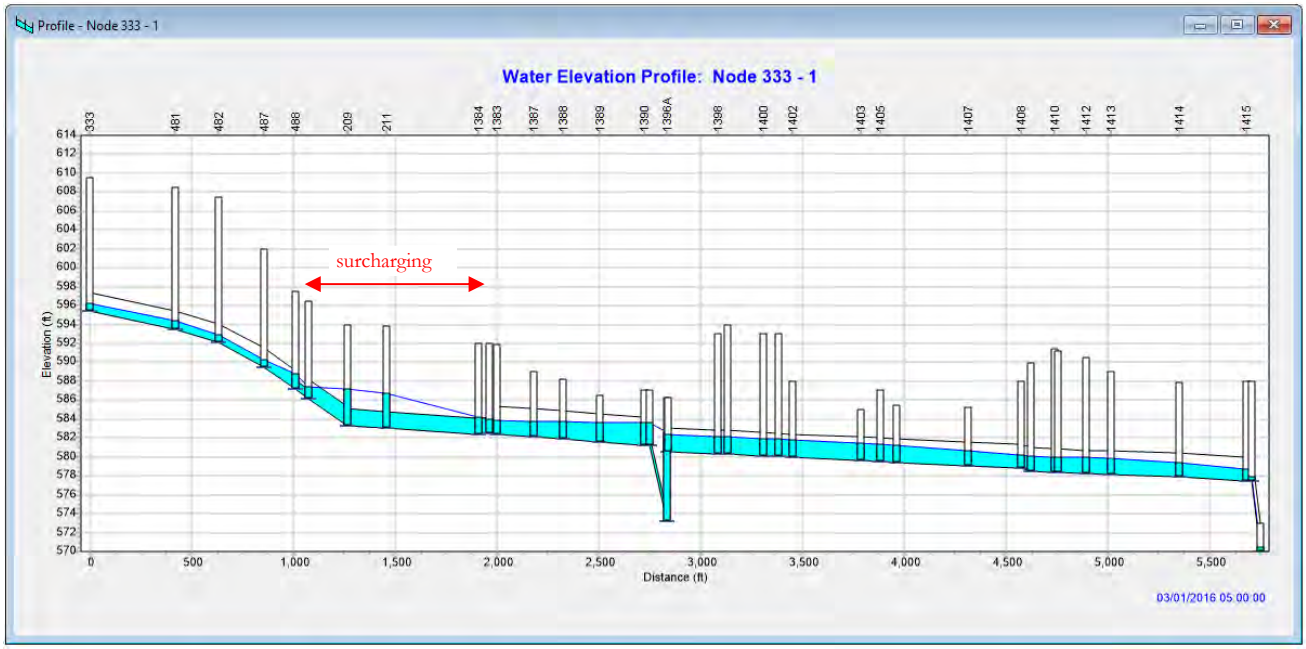


Figure E-C-4: West side during peak hourly flows with all 12" lengths upgraded to 24" and 24" downstream of Boardman Siphon upgraded to 30" SSO removed and surcharging greatly reduced

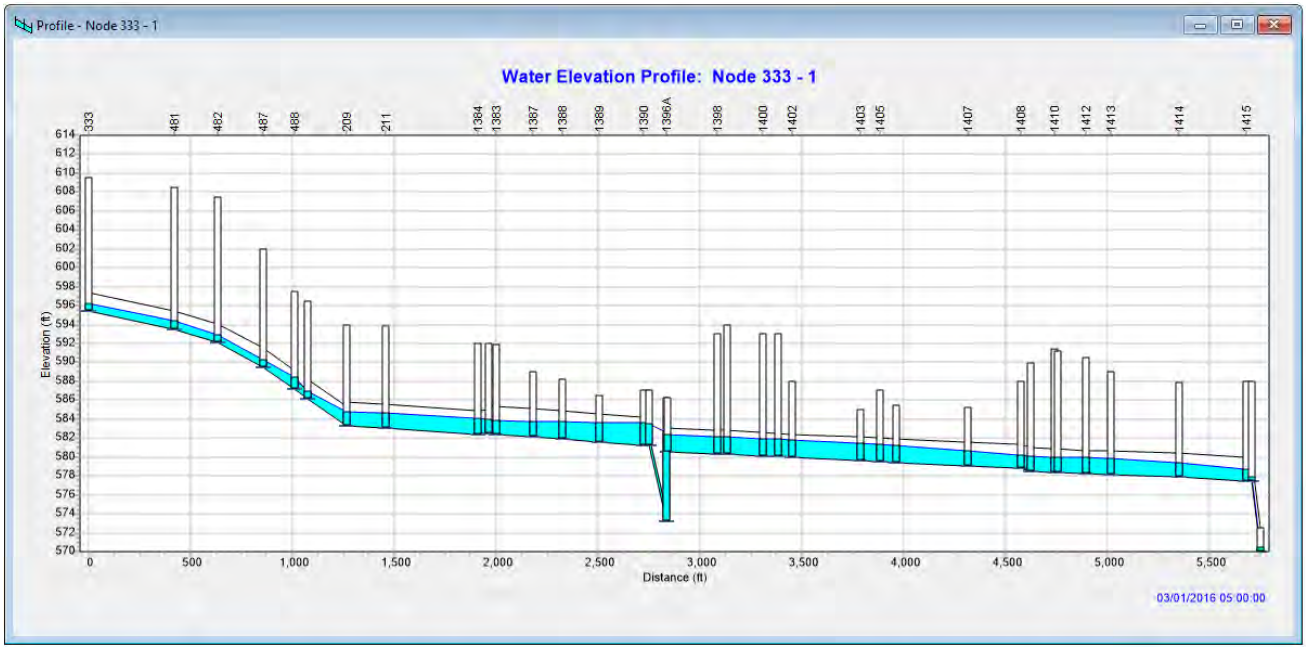


Figure E-C-5: West side during peak hourly flows with all 12" lengths upgraded to 24", all 24" downstream of Boardman Siphon upgraded to 30", and all 21" upgraded to 30" No SSOs and no surcharging present

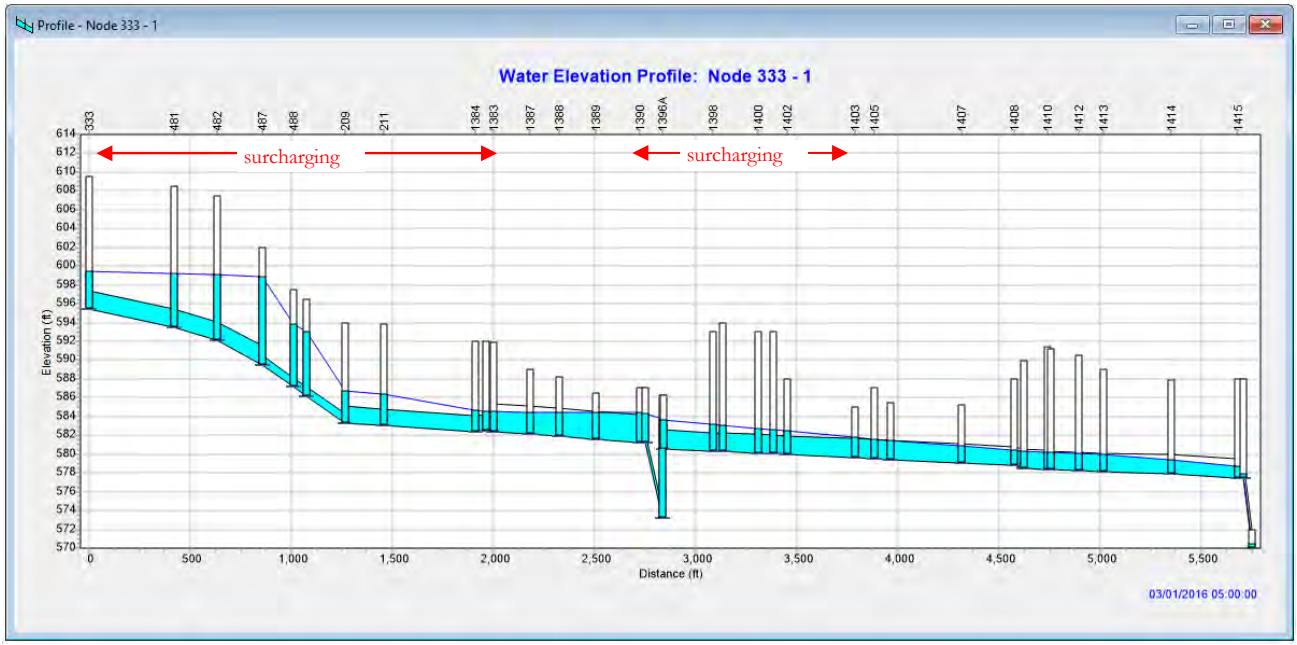
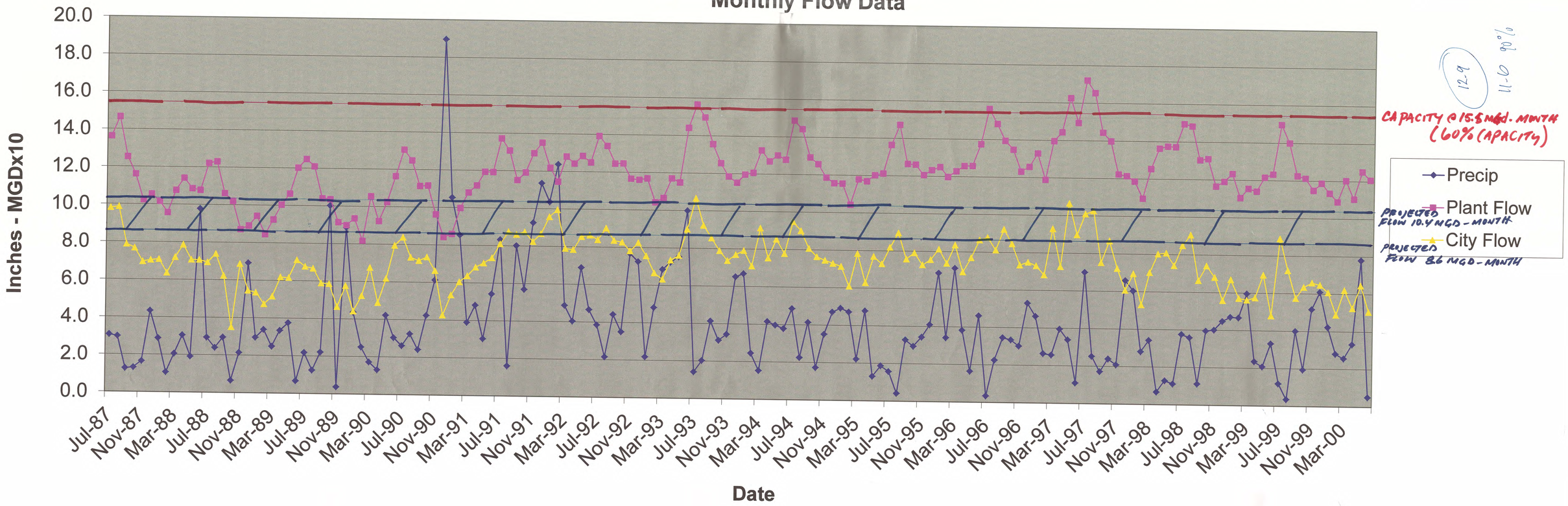


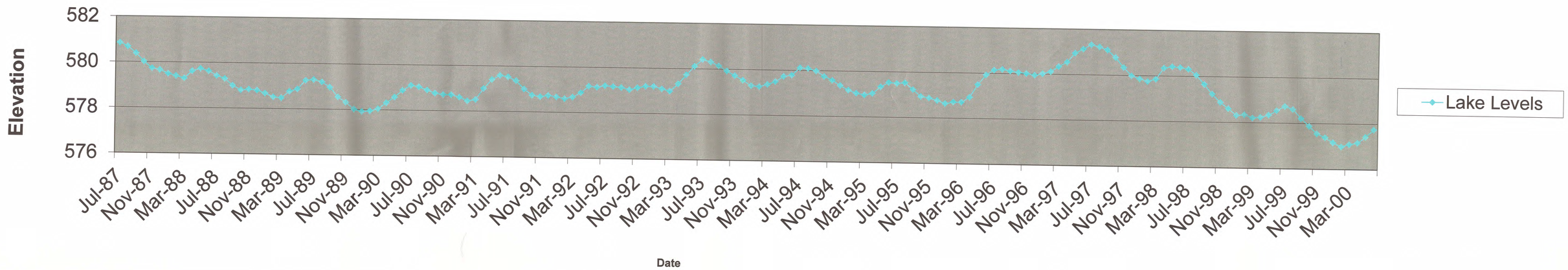
Figure E-C-6: West side during peak hourly flows reduced flows from Meter District 3 Significant surcharging, no SSO

Appendix E-D: Historic WWTP Flows and Lake Levels

Monthly Flow Data



Lake Levels



Appendix F: Collection System Criticality and Capital Improvement Plan

Appendix F: Collection System Criticality and Capital Improvement

A. Criticality

Determining the assets most critical to system operation allows a community to manage risk, support Capital Improvement Plans (CIP), and efficiently allocate O&M funds. The two key factors used to determine criticality are Probability of Failure (PoF) and Consequence of Failure (CoF). PoF and CoF are multiplied to determine the Business Risk Exposure (BRE). Figure F-A-1 illustrates Traverse City's PoF for its assessed collection systems assets and Figure F-A-2 illustrates Traverse City's CoF for its collection systems assets.

PoF considers the physical condition or age of an asset and is often based on the Structural MACP or PACP Index Rating. If an asset was not inspected, predicted remaining useful life can be used as a proxy for condition. A standardized rating of one through five is assigned to each asset with a score of five being the worst condition as shown in Table F-1.

Table F-1: Probability of Failure

Score	Description
1	Improbable
2	Remote, unlikely but possible
3	Possible
4	Probable, likely
5	Imminent, likely in near future

CoF focuses on social, environmental, and economic cost impacts for a community. The economic CoF encompasses the impacts of direct and indirect economic losses to the affected organization and third parties due to asset failure (NASSCO, 2015). The social consequence represents the impact of society due to asset failure, and the environmental consequence of failure considers the impact to ecological conditions occurring as a result of asset failure (NASSCO, 2015). Each type of community impact is measure with individual CoF factors as indicated in Table F-2. The following CoF factors are combined to determine the final CoF: Network Position, Diameter of Pipe, Location of Pipe, Proximity to Sensitive Environment Features, and Top Users.

Table F-2: Consequence of Failure

Score	Description
1	Negligible, minor loss of function
2	Minimal or marginal
3	Noticeable, may suspend some operations
4	Critical, temporarily suspends operations
5	Catastrophic disruption

Table F-3: Consequence of Failure Community Impacts

CoF Community Impact	Weighting for CoF	CoF Factors
Social	25%	Location of Pipe; Diameter; Network Position; Top Users
Environmental	25%	Proximity to Sensitive Environment Features
Economic	50%	Location of Pipe; Diameter

The factors are rated on a one through five scale for each asset. Each CoF factor (Network Position, Diameter, Location, Proximity to Sensitive Environment, and Top Users) is weighted equally to calculate the CoF for each type of community impact as shown in Table F-3. The final CoF is then computed by taking a weighted average of the CoF Community Impacts as depicted in Figure F-1. The economic impacts are considered 50% of the final CoF score with social and environmental impacts each worth 25%. The final CoF score maintains a one through five scale as described in Table F-2. If one factor is deemed more important, the weighting can be skewed to give that factor more influence. The factors and their rating scales are described in the following section.

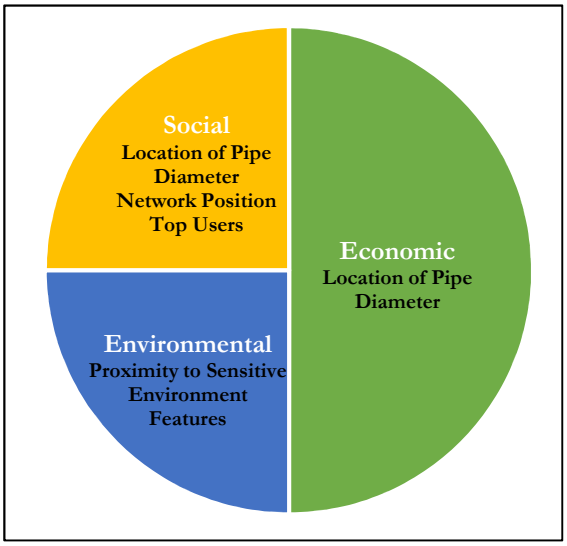


Figure F-1: CoF Community Impacts

Location of Pipe: The Location of Pipe factor analyzes the type of pervious surface that overlays the pipes and the Average Daily Traffic (ADT) score. An ADT score evaluates the frequency of road travel for local roads, highways, collector roads, etc. Pipes that are under pervious surfaces have a lower CoF compared to pipes under impervious locations with heavy traffic. A higher rating is an indication that repairs or replacement will likely result in higher costs due to the impervious conditions and increased disruption of traffic. For each community, the Location of Pipe rankings are scaled to represent the community more accurately.

Table F-4 is an example of the rating scale used for the Location of Pipe factor.

Table F-4: CoF Factor: Location of Pipe

Rating Scale	Description
1	Pervious: Vegetation, one or 2 driveways, small stretches of sidewalk
2	Location of pipe is under an impervious surface and has less than 5,000 vehicles travel over the surface in a day
3	Location of pipe is under an impervious surface and has between 5,000 and 10,000 vehicles travel over the surface in a day
4	Location of pipe is under an impervious surface and has between 15,500 and 10,000 vehicles travel over the surface in a day
5	Location of pipe is under an impervious surface and has 15,500 or more vehicles travel over the surface in a day

Relative Network Position of Pipe: The Relative Network Position factor is the cumulative sum of the number of pipe segments connected (discharging) to the pipe being rated (similar methodology to watershed stream order). The Relative Network Position factor scales how many customers would be affected upstream in the case of a failed pipe. A higher CoF is assigned to pipes that have a higher Relative Network Position since more customers would be affected if a pipe were to fail. Table F-5, below, is a guide to help scale Relative Network Position of Pipe.

Table F-5: CoF Factor: Relative Network Position of Pipe

Rating Scale	Description (# of Customers Impacted)
1	10 or less
2	11 – 30
3	31 – 70
4	71 – 120
5	121 or more

Top Users: Top Users are customers who are significant to the community's well-being. The Top Users factor will add risk to areas that may experience severe difficulties due to a service disruption. A higher rating is assigned to pipes that are closer in linear feet to Top Users such as hospitals, healthcare facilities, schools, or large industrial users with potentially greater health risks. Community input is often requested to help identify additional Top Users for consideration within this category. Table F-6 summarizes the rating scale.

Table F-6: CoF Factor: Top Users

Rating Scale	Description
1	20,000 LF or More
2	15,000 LF – 20,000 LF
3	10,000 LF – 15,000 LF
4	5,000 LF – 10,000 LF
5	Less Than 5,000 LF

Diameter: The Diameter factor considers the diameter of the pipes in the collection system. When large diameter pipes fail they generally cost more to repair, service, and replace. In addition, large diameter pipes generally serve more customers, so they are assigned a higher CoF. Table F-7 summarizes the rating scale.

Table F-7: CoF Factor: Diameter

Rating Scale	Description (pipe diameter)
1	Less than 10 in
2	$\geq$ 10 in - < 15 in
3	$\geq$ 15 in - < 18 in
4	$\geq$ 18 in - < 24 in
5	$\geq$ 24 in

Environmentally Sensitive Features: Environmentally Sensitive Features include railroads, drinking water source areas, and bodies of water such as rivers, creeks. Pipes may be installed within a close distance to environmentally sensitive features, which can make it difficult to access the pipe and may cause significant environmental damage if the pipe fails. A CoF factor for Sensitive Features is based on the distance between a pipe and an environmentally sensitive feature. Table F-8 summarizes the rating scale.

Table F-8: CoF Factor: Sensitive Features

Rating Scale	Description (proximity to sensitive feature)
1	150 LF or more
2	100 – 150 LF
3	75 – 100 LF
4	50 – 75 LF
5	Less than 50 LF

Pavement Surface Evaluation and Rating (PASER) is a rating system for road pavement conditions developed by the University of Wisconsin-Madison Transportation Information Center. The State of Michigan has selected PASER as the statewide standard for pavement condition. Rating one is considered a failing road and requires reconstruction, and ten is considered a road in excellent condition and needs no maintenance. PASER can help prioritize manhole or pipe replacement projects to take place during roadway replacement or reconstruction. The PASER ratings system is shown in Table F-9.

Table F-9: PASER Scale

PASER Rating	Pavement Condition
9-10	Excellent/New
7-8	Good
5-6	Fair
3-4	Poor
1-2	Failed
NA	Data Not Available

B. Business Risk Exposure and Capital Improvement Plan

A Capital Improvement Plan (CIP) is a core component of an Asset Management Plan (AMP) and an essential planning tool that allows for a community to properly plan for high cost, non-recurring projects. A CIP should detail capital needs related to future/upcoming regulations, major asset replacements, system expansions, system consolidation or regionalization, and improved technology.

The City of Traverse City CIP incorporates the Business Risk Exposure (BRE) score as well as institutional knowledge. The BRE is calculated by multiplying the Probability of Failure (PoF) and Consequence of Failure (CoF) for each asset (i.e. for each manhole or sewer segment). The BRE matrix is shown in Figure F-2. The wastewater assets in Traverse City were given high, medium or low priority based on their BRE shown in Figure F-2.

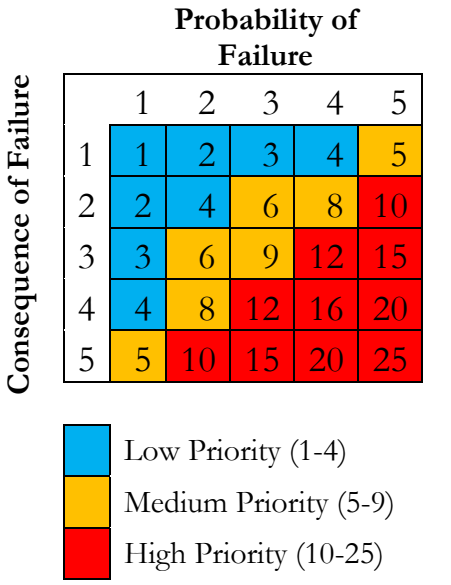


Figure F-2: BRE Prioritization Matrix

The funding needed to address the CIP projects identified from the inspected pipes is approximately $3,540,300 and from the inspected manholes is approximately $642,230. The City has currently allocated $680,000 per year to gravity sewer rehabilitation and repair and $150,000 per year to manhole rehabilitation and repair.

This CIP includes a detailed project table for an initial three (3) year planning period, with the first projects reflecting those with the highest BRE score which generated rehabilitation recommendations or those occurring near projects with the highest BRE scores. Some projects were manually moved higher on the list if a known street project will occurring in the affected area or if a higher priority project were occurring immediately adjacent to the project (to reduce mobilization costs). The capital projects for each year are provided in Table F-10 through F-15. Each table lists the associated project and associated planning-level costs. The associated projects listed are for high level planning; the City should further evaluate the wastewater infrastructure before beginning the CIP design process.

Priority of the wastewater CIP projects listed below should be revisited if any stormwater projects are occurring within the vicinity of identified rehabilitation areas for wastewater in order to reduce mobilization costs and potential pavement disturbance costs.

Since the City of Traverse City has already gone through the majority of the budget planning process for FY2017/2018, the first year of the proposed CIP begins in FY2018/2019. However, the City may choose to begin implementing high priority projects right away, should budget be available in FY2017/2018.

Table F-10: Capital Improvement Projects for Year 1 (FY2018/2019)

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-6293	24	60	3	3	9	Grouting	$5,224.57	E. Front St
SSGM-6294	24	5	3	3	9	Cleaning	$33.80	E. Front St
SSGM-6687	8	24	1	5	5	Spot Liner(s), Cleaning	$3,486.42	Wellington St
SSGM-7986	15	161	3	4	12	Cleaning	$760.36	N. Cedar St.
SSGM-7987	15	183	3	6	18	Heavy Cleaning	$1,856.14	N. Cedar St.
SSGM-7988	15	165	3	5	15	Monitor Closely, Heavy Cleaning	$1,674.32	N. Cedar St.
SSGM-7990	18	185	4	5	20	Grouting, Cleaning, Lateral Cutting, Letter to Customer(s)	$12,304.08	N. Division St.
SSGM-8276	12	147	3	5	15	Monitor Closely, Spot Liner(s), Cleaning, Cutting and Grouting	$11,552.41	N. Division St.
SSGM-8277	12	242	2	5	10	Full Liner	$16,348.11	N. Division St.
SSGM-8278	6	221	1	5	5	Monitor Closely, Spot Liner(s), Heavy Cleaning, Cutting and Grouting	$10,921.02	N. Division St.
SSGM-8279	6	125	1	5	5	Heavy Cleaning	$1,011.29	N. Division St.
SSGM-8284	12	216	2	5	10	Spot Liner(s), Cleaning	$6,418.89	N. Division St.
SSGM-8326	15	187	2	5	10	Full Liner, Lateral Cutting	$19,582.31	N. Cedar St.
SSGM-8327	15	218	2	4	8	Grouting	$9,583.91	N. Cedar St.
SSGM-8329	6	349	3	4	12	Heavy Cleaning	$2,829.31	N. Cedar St.
SSGM-8332	15	148	3	5	15	Grouting	$6,501.88	N. Cedar St.
SSGM-8333	15	176	3	5	15	Heavy Cleaning	$1,785.72	N. Cedar St.
SSGM-8336	12	150	3	5	15	Full Liner	$10,148.06	N. Cedar St.
SSGM-8337	12	289	3	5	15	Grouting	$9,737.96	N. Cedar St.
SSGM-8342	6	70	2	5	10	Heavy Cleaning	$566.08	N. Cedar St.
SSGM-8908	24	16	4	5	20	Grouting, Spot Liner(s), Cleaning	$12,288.00	E. Front St
SSGM-8909	24	15	4	4	16	Cleaning	$102.99	E. Front St
SSGM-8910	18	224	4	6	24	Grouting, Full Liner	$41,535.45	E. Front St

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM -8911	18	26	4	6	24	Grouting, Full Liner	$4,870.60	E. Front St
SSGM -8915	24	167	3	5	15	Full Liner	$33,880.15	E. Front St
SSGM -8916	12	123	2	6	12	Full Liner	$8,286.81	E. Front St
SSGM -8917	12	97	2	6	12	Full Liner	$6,522.81	E. Front St
SSGM -8918	12	235	2	6	12	Full Liner, Letter to Customer(s)	$15,894.35	E. Front St
SSGM -8919	24	238	3	4	12	Grouting	$20,922.17	E. Front St
SSGM -8920	24	240	3	4	12	Grouting	$21,030.84	E. Front St
SSGM -8921	24	458	4	4	16	Grouting	$40,210.75	E. Front St
SSGM -8922	12	331	2	4	8	Spot Liner(s), Cleaning	$12,365.80	E. Front St
SSGM -8923	24	322	3	4	12	Grouting	$28,288.06	E. Front St
SSGM -8924	24	49	3	4	12	Cleaning	$331.73	E. Front St
SSGM -8929	24	258	3	3	9	Cleaning	$1,743.49	E. Front St
SSGM -8930	24	290	3	3	9	Cleaning	$1,960.36	E. Front St
SSGM -8932	9	196	1	5	5	Cleaning	$927.31	Barlow St.
SSGM -8933	12	193	2	4	8	Spot Liner(s)	$12,150.00	Hope St.
SSGM -8943	24	527	4	4	16	Spot Liner(s), Cleaning	$46,756.05	E. Front St
SSGM -8944	24	375	3	5	15	Full Liner	$75,875.56	Railroad Ave
SSGM -9006	18	256	2	4	8	Spot Liner(s), Heavy Cleaning	$10,859.85	Wellington St
SSGM -9007	12	268	1	5	5	Full Liner, Cutting and Grouting	$28,012.06	Wellington St
SSGM -9020	8	188	1	5	5	Spot Liner(s), Heavy Cleaning	$8,273.27	Wellington St
SSGM -9021	8	327	1	5	5	Full Liner, Cleaning	$19,217.26	Wellington St
SSGM -9022	6	202	2	5	10	Full Liner	$10,915.42	Wellington St
SSGM -9076	10	221	2	6	12	Full Liner, Heavy Cleaning	$15,205.46	E. Front St
SSGM -9077	24	249	3	3	9	Grouting	$21,810.68	E. Front St
SSGM -9082	10	302	2	6	12	Spot Liner(s), Heavy Cleaning	$6,494.43	E. Front St
SSGM -9085	10	322	2	4	8	Spot Liner(s), Heavy Cleaning, Letter to Customer(s)	$6,662.03	E. Front St

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM -10341	15	180	3	5	15	Grouting	$7,902.67	N. Cedar St.
SSGM -10343	16	17	3	3	9	Cleaning	$89.24	N. Cedar St.
SSGM -10344	16	129	3	3	9	Cleaning	$694.50	N. Cedar St.
SSGM -10345	16	97	3	5	15	Heavy Cleaning	$1,043.25	N. Cedar St.
SSGM -10347	16	13	2	3	6	Cleaning	$71.21	N. Cedar St.
SSGM -10348	15	69	2	4	8	Full Liner	$6,992.47	N. Cedar St.
SSGM -10614	12	156	2	5	10	Full Liner, Heavy Cleaning, Letter to Customer(s)	$11,821.00	Wellington St
SSGM -11660	6	52	3	3	9	Cleaning	$243.81	Wellington St
SSGM -10699	24	134	3	4	12	Cleaning	$907.75	Railroad Ave
						Estimated Total CIP Cost*	**$675,486**	

The estimated total CIP cost for Year 1 is slightly lower than the Gravity Sewer Rehabilitation & Repair annual funding. The difference in cost is made up in the estimated total CIP cost for Year 2. In the fiscal year of 2017/2018, Front Street from N. Division St. to N. Elmwood Ave will be under construction to address water main issues. Wastewater sewer pipes that are along and near this reach have been incorporated into the CIP for the 2018/2019 fiscal year in anticipation that the 2017/2018 road projects will potentially go through 2018.

Table F-11: Capital Improvement Projects for Year 2 (FY2019/2020)

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM -6286	12	414	2	5	10	Full Liner, Lateral Cutting	$28,647.30	Rose St.
SSGM -6287	10	387	2	5	10	Grouting, Spot Liner(s), Heavy Cleaning	$29,784.67	Rose St.
SSGM -6290	12	139	2	5	10	Spot Liner(s), Heavy Cleaning	$11,923.86	Wellington St.
SSGM -6685	10	354	2	5	10	Spot Liner(s), Cutting and Grouting	$18,607.02	Peninsula Dr.
SSGM -8020	10	187	2	5	10	Grouting	$5,049.00	Peninsula Dr.
SSGM -8022	12	304	2	5	10	Spot Liner(s), Letter to Customer(s)	$10,806.75	Peninsula Dr.
SSGM -8024	12	228	2	5	10	Spot Liner(s), Cutting and Grouting	$19,279.61	Peninsula Dr.
SSGM -8026	12	380	2	4	8	Cleaning	$1,794.15	Peninsula Dr.
SSGM -8027	8	208	1	5	5	Heavy Cleaning	$1,684.47	N. Garfield Ave.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM -8028	8	197	1	5	5	Heavy Cleaning	$1,595.60	N. Garfield Ave.
SSGM -8035	10	160	2	3	6	Grouting	$4,307.70	Peninsula Dr.
SSGM -11631	12	194	2	3	6	Cleaning	$917.14	Peninsula Dr.
SSGM -8045	10	241	2	4	8	Cleaning	$1,137.04	Peninsula Dr.
SSGM -8234	12	288	1	5	5	Spot Liner(s), Cutting and Grouting	$16,206.75	Silver Dr.
SSGM -8238	12	290	2	5	10	Heavy Cleaning	$2,349.74	Silver Dr.
SSGM -8555	12	313	2	4	8	Spot Liner(s), Cutting and Grouting, Letter to Customer(s)	$17,010.22	Barlow St.
SSGM -8556	12	374	2	5	10	Grouting, Full Liner	$37,855.23	Barlow St.
SSGM -8565	10	349	2	3	6	Spot Liner(s)	$4,050.00	Woodmere Ave.
SSGM -8567	10	371	2	4	8	Spot Liner(s), Heavy Cleaning, Letter to Customer(s)	$7,062.41	Woodmere Ave.
SSGM -8568	10	349	2	5	10	Heavy Cleaning	$2,823.69	Carver St.
SSGM -8570	10	394	2	5	10	Remove and Replace, Letter to Customer(s)	$47,892.33	Woodmere Ave.
SSGM -8571	10	307	2	5	10	Heavy Cleaning	$2,490.50	Woodmere Ave.
SSGM -8611	10	313	2	4	8	Cleaning, Letter to Customer(s)	$1,487.53	S. Garfield Ave.
SSGM -8612	10	33	2	4	8	Heavy Cleaning	$264.40	S. Garfield Ave.
SSGM -8618	10	328	2	4	8	Cleaning	$1,551.29	S. Garfield Ave.
SSGM -8619	10	203	2	5	10	Heavy Cleaning, Letter to Customer(s)	$1,647.59	S. Garfield Ave.
SSGM -8626	10	333	3	4	12	Cutting and Grouting, Letter to Customer(s)	$9,908.89	S. Garfield Ave.
SSGM -8627	10	330	3	5	15	Spot Liner(s), Cutting and Grouting, Letter to Customer(s)	$15,426.12	S. Garfield Ave.
SSGM -8678	12	305	2	4	8	Cutting and Grouting	$11,331.96	Barlow St.
SSGM -8684	12	333	2	5	10	Cutting and Grouting	$12,371.97	Barlow St.
SSGM -8840	15	262	2	4	8	Full Liner, Cleaning	$27,795.72	Boardman Ave
SSGM -8975	8	300	2	4	8	Cleaning	$1,419.66	Boardman Ave
SSGM -8976	8	260	2	5	10	Spot Liner(s), Cutting and Grouting, Letter to Customer(s)	$10,128.70	Boardman Ave
SSGM -11635	15	156	2	4	8	Spot Liner(s), Cleaning	$7,487.17	Wellington St.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM -8988	12	330	2	5	10	Full Liner	$22,270.88	Wellington St.
SSGM -9008	12	205	2	3	6	Cleaning, Letter to Customer(s)	$977.11	Boardman Ave
SSGM -9009	12	181	2	4	8	Cutting and Grouting	$6,735.61	Boardman Ave
SSGM -9010	12	49	2	5	10	Heavy Cleaning	$396.01	Boardman Ave
SSGM -9011	6	203	2	3	6	Spot Liner(s)	$4,050.00	Boardman Ave
SSGM -9014	6	99	2	5	10	Full Liner	$5,334.64	Boardman Ave
SSGM -9017	6	158	2	5	10	Full Liner	$8,520.22	Boardman Ave
SSGM -9018	6	110	2	6	12	Remove and Replace, Full Liner	$19,245.30	Boardman Ave
SSGM -9019	6	50	2	5	10	Full Liner	$2,714.26	Boardman Ave
SSGM -9038	15	262	3	4	12	Cleaning	$1,236.61	E. 8th St.
SSGM -9040	10	66	2	4	8	Cleaning	$310.75	Hannah Ave.
SSGM -9041	8	64	2	4	8	Grouting	$1,517.43	Hannah Ave.
SSGM -9042	8	179	2	3	6	Grouting	$4,228.93	Woodmere Ave.
SSGM -9047	8	376	2	6	12	Full Liner	$20,294.98	Woodmere Ave.
SSGM -9048	15	234	3	4	12	Heavy Cleaning	$2,373.41	Hannah Ave.
SSGM -9051	15	220	3	3	9	Grouting	$9,639.22	Hannah Ave.
SSGM -9059	15	428	2	5	10	Full Liner, Cleaning, Cutting and Grouting	$66,064.43	Hannah Ave.
SSGM -9061	15	416	2	4	8	Spot Liner(s), Letter to Customer(s)	$6,756.75	Hannah Ave.
SSGM -9069	10	327	3	3	9	Cleaning	$1,545.24	S. Garfield Ave.
SSGM -9071	12	342	2	5	10	Spot Liner(s), Heavy Cleaning	$8,169.68	Hannah Ave.
SSGM -9072	12	340	2	4	8	Spot Liner(s)	$5,400.00	Hannah Ave.
SSGM -9084	12	63	2	4	8	Cleaning	$299.93	Peninsula Dr.
SSGM -9093	9	255	1	6	6	Monitor Closely, Spot Liner(s), Cleaning	$5,256.70	E. Front St.
SSGM -9095	9	325	1	5	5	Full Liner	$17,525.75	E. Front St.
SSGM -9097	9	54	1	5	5	Spot Liner(s), Heavy Cleaning	$4,487.40	E. Front St.
SSGM -9100	15	38	2	5	10	Heavy Cleaning	$389.74	E. Front St.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-9101	15	228	2	4	8	Spot Liner(s)	$13,500.00	E. Front St.
SSGM-9103	15	230	2	3	6	Spot Liner(s)	$20,250.00	E. Front St.
SSGM-9108	10	437	2	5	10	Cleaning, Letter to Customer(s)	$2,069.38	S. Garfield Ave.
SSGM-9109	10	343	2	5	10	Heavy Cleaning	$2,782.34	S. Garfield Ave.
SSGM-9111	8	137	2	4	8	Heavy Cleaning	$1,107.03	S. Garfield Ave.
SSGM-9112	8	317	2	4	8	Heavy Cleaning	$2,570.87	S. Garfield Ave.
SSGM-9117	8	275	2	3	6	Cleaning	$1,301.33	S. Garfield Ave.
SSGM-9118	8	378	2	4	8	Cutting and Grouting	$9,822.13	S. Garfield Ave.
SSGM-9124	8	422	1	5	5	Spot Liner(s), Heavy Cleaning	$6,791.50	Washington St.
SSGM-9182	21	222	2	4	8	Heavy Cleaning	$2,401.04	E. Front St.
SSGM-9240	8	431	2	5	10	Cutting and Grouting, Letter to Customer(s)	$11,211.98	E. 8th St.
SSGM-9342	8	276	2	3	6	Spot Liner(s)	$3,375.00	E. 8th St.
SSGM-9343	8	158	2	5	10	Monitor Closely, Spot Liner(s)	$3,375.00	E. 8th St.
SSGM-10716	8	121	1	5	5	Heavy Cleaning	$980.79	Silver Dr.
SSGM-11640	10	65	2	3	6	Grouting	$1,751.41	Peninsula Dr.
						Estimated Total CIP Cost*	**$683,127**	

Table F-12: Capital Improvement Projects for Year 3 (FY2020/2021)

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-6353	12	394	3	3	9	Monitor Closely, Spot Liner(s), Cleaning	$7,260.12	S. Union St.
SSGM-6678	6	176	1	5	5	Heavy Cleaning	$1,426.10	N. Maple St.
SSGM-6705	8	73	2	3	6	Cleaning	$345.71	6th St.
SSGM-6710	8	184	2	5	10	Full Liner, Cleaning	$10,798.76	6th St.
SSGM-6716	12	177	2	4	8	Spot Liner(s), Heavy Cleaning	$6,833.18	Park St.
SSGM-7920	10	231	2	5	10	Grouting	$6,245.92	Bay St.
SSGM-7975	8	356	1	5	5	Spot Liner(s), Cutting and Grouting, Letter to Customer(s)	$12,632.77	N. Spruce St.
SSGM-7982	15	111	2	4	8	Cleaning, Letter to Customer(s)	$529.06	N. Cedar St.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-7983	15	229	2	6	12	Full Liner	$23,222.39	N. Cedar St.
SSGM-8010	12	199	3	6	18	Remove and Replace	$30,223.10	S. Union St.
SSGM-8013	10	312	2	5	10	Spot Liner(s)	$4,050.00	W. Grandview Pkwy
SSGM-8014	8	28	2	6	12	Full Liner, Heavy Cleaning	$1,726.50	W. Grandview Pkwy
SSGM-8195	6	109	2	4	8	Spot Liner(s), Cutting and Grouting	$12,949.66	S. Elmwood Ave.
SSGM-8196	6	93	2	4	8	Cutting and Grouting	$2,419.79	S. Elmwood Ave.
SSGM-8198	6	165	2	4	8	Spot Liner(s), Cutting and Grouting, Letter to Customer(s)	$7,670.10	S. Elmwood Ave.
SSGM-8199	8	50	2	5	10	Heavy Cleaning	$405.50	S. Elmwood Ave.
SSGM-8202	12	46	2	3	6	Grouting	$1,558.43	7th St.
SSGM-8204	12	33	2	3	6	Grouting	$1,098.57	S. Elmwood Ave.
SSGM-8206	10	146	2	4	8	Grouting, Spot Liner(s)	$8,004.82	S. Elmwood Ave.
SSGM-8208	10	110	2	3	6	Cleaning	$522.09	S. Madison St.
SSGM-8210	8	233	2	3	6	Grouting	$5,509.03	6th St.
SSGM-8212	8	92	2	4	8	Cutting and Grouting	$2,398.45	S. Madison St.
SSGM-8213	8	222	2	5	10	Full Liner	$11,995.12	Circle Ave.
SSGM-8214	8	137	2	5	10	Spot Liner(s), Cutting and Grouting	$6,932.75	Circle Ave.
SSGM-8215	8	216	2	5	10	Full Liner	$11,658.85	Circle Ave.
SSGM-8217	8	302	2	5	10	Spot Liner(s),Heavy Cleaning	$5,818.40	S. Madison St.
SSGM-8226	10	66	2	3	6	Grouting	$1,769.83	S. Elmwood Ave.
SSGM-8227	10	240	2	3	6	Grouting	$6,492.72	S. Elmwood Ave.
SSGM-8250	18	276	3	4	12	Spot Liner(s)	$8,100.00	N. of 6th St.
SSGM-8251	18	228	3	4	12	Full Liner	$29,207.48	N. of 6th St.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-8280	8	117	2	5	10	Cleaning	$554.26	S. Oak St.
SSGM-8282	8	23	1	5	5	Spot Liner(s)	$3,375.00	N. Maple St.
SSGM-8286	6	359	1	6	6	Full Liner, Cleaning	$21,101.76	N. of 6th St.
SSGM-8287	6	361	1	5	5	Full Liner	$19,505.51	N. of 6th St.
SSGM-8288	6	232	1	5	5	Full Liner	$12,503.18	N. of 6th St.
SSGM-8290	12	213	2	5	10	Heavy Cleaning	$1,722.14	S. Division St.
SSGM-8314	12	218	2	5	10	Spot Liner(s), Heavy Cleaning	$7,163.61	S. Division St.
SSGM-8339	12	253	3	3	9	Grouting	$8,538.75	7th St.
SSGM-8341	12	374	2	4	8	Grouting, Letter to Customer(s)	$12,625.30	7th St.
SSGM-8344	6	98	2	5	10	Full Liner	$5,310.57	6th St.
SSGM-8345	6	200	2	4	8	Cutting and Grouting	$5,196.67	6th St.
SSGM-8364	10	56	2	6	12	Heavy Cleaning	$455.82	S. Oak St.
SSGM-8366	10	88	1	5	5	Cleaning	$415.88	S. Oak St.
SSGM-8388	10	136	2	3	6	Cleaning	$643.79	Veterans Dr.
SSGM-8391	10	182	2	6	12	Cutting and Grouting	$5,399.75	Veterans Dr.
SSGM-8397	10	313	2	5	10	Cutting and Grouting	$9,300.02	Veterans Dr.
SSGM-8398	10	319	2	4	8	Cutting and Grouting	$9,474.91	Veterans Dr.
SSGM-8442	12	41	3	5	15	Cleaning	$195.90	W. 14th St.
SSGM-8450	15	348	2	5	10	Heavy Cleaning	$3,522.15	M-37
SSGM-8451	15	322	2	4	8	Cleaning	$1,523.55	M-38
SSGM-8453	15	112	2	4	8	Heavy Cleaning	$1,130.80	M-39
SSGM-8494	6	263	1	6	6	Full Liner	$14,215.98	W. Griffin St.
SSGM-8495	10	197	2	6	12	Full Liner	$11,950.08	Locust St.
SSGM-8521	12	213	2	5	10	Monitor Closely, Spot Liner(s), Cutting and Grouting	$13,296.38	S. Cass St.
SSGM-8719	18	58	3	4	12	Cutting and Grouting	$3,688.51	6th St.
SSGM-8767	12	891	2	5	10	Heavy Cleaning	$7,214.24	E. of Union

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-8771	15	207	2	3	6	Cleaning	$977.76	E. of Union
SSGM-8778	12	425	2	4	8	Spot Liner(s), Heavy Cleaning	$8,845.36	E. of Union
SSGM-8799	12	192	2	5	10	Spot Liner(s), Letter to Customer(s)	$27,006.75	Locust St.
SSGM-8835	12	119	2	4	8	Spot Liner(s)	$5,400.00	Park St.
SSGM-8841	15	54	3	6	18	Full Liner	$5,468.48	Park St.
SSGM-8844	24	49	4	4	16	Cleaning	$329.80	Park St.
SSGM-8845	9	70	1	5	5	Full Liner, Heavy Cleaning	$4,365.72	Park St.
SSGM-8846	12	59	2	5	10	Spot Liner(s), Heavy Cleaning	$5,874.56	Park St.
SSGM-8847	12	19	2	5	10	Heavy Cleaning	$151.69	Park St.
SSGM-8849	12	182	2	6	12	Full Liner	$12,297.88	Park St.
SSGM-8850	15	172	2	6	12	Full Liner	$17,415.78	Park St.
SSGM-8851	12	334	3	3	9	Spot Liner(s), Cleaning	$12,377.94	Park St.
SSGM-8854	24	95	3	6	18	Heavy Cleaning	$1,286.63	E. Front St.
SSGM-8863	10	180	3	5	15	Heavy Cleaning	$1,457.19	N. Cass St.
SSGM-8874	12	161	2	3	6	Spot Liner(s)	$4,050.00	S. Union St.
SSGM-8875	12	258	2	5	10	Full Liner	$17,390.99	S. Union St.
SSGM-8876	8	190	2	4	8	Cleaning	$895.61	S. Union St.
SSGM-8877	8	53	1	5	5	Full Liner, Cleaning	$16,630.65	S. Union St.
SSGM-8885	9	142	1	5	5	Full Liner	$7,662.79	Park St.
SSGM-8887	12	302	2	5	10	Spot Liner(s), Heavy Cleaning, Letter to Customer(s)	$7,854.42	Park St.
SSGM-9402	8	406	2	5	10	Full Liner, Cutting and Grouting, Letter to Customer(s)	$32,507.96	3rd St.
SSGM-9472	10	68	2	5	10	Grouting	$1,846.78	S. Elmwood Ave.
SSGM-9473	10	204	2	5	10	Grouting	$5,507.42	S. Elmwood Ave.
SSGM-10324	12	51	2	3	6	Grouting	$1,719.37	S. Elmwood Ave.

Facility ID	Diameter (in)	Length (ft)	CoF	PoF	BRE	Project	Planning-Level Cost	Street Name
SSGM-10325	12	32	2	3	6	Grouting	$1,063.22	S. Elmwood Ave.
SSGM-10673	12	68	2	4	8	Spot Liner(s), Cleaning	$16,523.09	N. Cass St.
SSGM-10817	12	119	2	5	10	Heavy Cleaning	$963.90	S. of Lake Ave.
SSGM-11659	12	143	3	3	9	Grouting	$4,830.36	7th St.
SSGM-11648	12	431	2	4	8	Full Liner, Heavy Cleaning	$47,557.13	E. of Union
						Estimated Total CIP Cost*	**$680,089**	

In the fiscal year 2020/21, Griffin Street from Pine St to Locust St will be under construction to address pavement, sanitary, and water main and 10th Street from S. Union St and Lake Ave will be under construction to address pavement, sanitary, and water main. In the fiscal year 2021/22, Fitzhugh Drive from US-31 to Terminus will be under construction to address pavement, sanitary, and water main and E. Eleventh St from S. Union S. to Lake Ave will be under construction to address pavement, sanitary, and water main. Wastewater sewer pipes that are along and near this reach have been incorporated into the CIP for that fiscal year.

Table F-13: Manhole Capital Improvement Projects Year 1 (FY2018/2019)

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-1495	4	4	16	Monitor Closely, Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-813	3	5	15	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-475	3	5	15	Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-154	3	5	15	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-1628	3	4	12	Sewer Cleaning/Vactoring	$675.00
SSM-474	3	4	12	Monitor Closely, Minor Point Repair	$135.00
SSM-397	3	4	12	Monitor Closely, Minor Point Repair	$135.00
SSM-208	3	4	12	Minor Point Repair, Chimney Liner	$607.50
SSM-824	2	5	10	Monitor Closely, Sewer Cleaning/Vactoring, Root Treatment	$877.50
SSM-355	2	5	10	Monitor Closely, Sewer Cleaning/Vactoring, Replace Chimney, Full Manhole Liner	$7,357.50
SSM-359	2	5	10	Minor Point Repairs, Full Manhole Liner	$4,320.00
SSM-394	2	5	10	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-418	2	5	10	Sewer Cleaning/Vactoring, Major Point Repair, Full Manhole Liner	$5,062.50
SSM-400	2	5	10	Minor Point Repair, Cone Liner	$1,215.00
SSM-347	2	5	10	Sewer Cleaning/Vactoring, Major Point Repairs, Full Manhole Liner	$5,400.00

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-345	2	5	10	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-167	2	5	10	Replace Chimney, Replace Cone	$6,480.00
SSM-146	2	5	10	Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-147	2	5	10	Minor Point Repair, Wall Liner	$3,510.00
SSM-983	2	5	10	Chimney Liner	$472.50
SSM-173	2	5	10	Sewer Cleaning/Vactoring, Minor Point Repair, Root Treatment, Full Manhole Liner	$5,062.50
SSM-185	2	5	10	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-183	2	5	10	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-28	2	5	10	Minor Point Repair, Major Point Repair	$472.50
SSM-1703	2	5	10	Sewer Cleaning/Vactoring	$675.00
SSM-1794	2	5	10	Sewer Cleaning/Vactoring	$675.00
SSM-1627	3	3	9	Sewer Cleaning/Vactoring, Minor Point Repairs	$1,080.00
SSM-1384	3	3	9	Chimney Liner	$472.50
SSM-839	2	4	8	Full Manhole Liner	$4,050.00
SSM-555	2	4	8	Full Manhole Liner	$4,050.00
SSM-553	2	4	8	Sewer Cleaning/Vactoring, Chimney Liner	$1,147.50
SSM-389	2	4	8	Major Point Repair, Full Manhole Liner	$4,387.50
SSM-406	2	4	8	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-402	2	4	8	Sewer Cleaning/Vactoring, Minor Point Repair, Chimney Liner	$1,282.50
SSM-344	2	4	8	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-1522	2	4	8	Full Manhole Liner	$4,050.00
SSM-42	2	4	8	Minor Point Repair, Cone Liner	$1,215.00
SSM-189	2	4	8	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-21	2	4	8	Minor Point Repair	$135.00
SSM-809	2	3	6	Chimney Liner	$472.50
SSM-820	1	5	5	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-1541	1	5	5	Sewer Cleaning/Vactoring, Major Point Repair, Full Manhole Liner	$5,062.50
SSM-426	1	5	5	Sewer Cleaning/Vactoring, Chimney Liner	$1,147.50
SSM-392	1	5	5	Replace Chimney, Full Manhole Liner	$6,682.50
SSM-1385	1	5	5	Sewer Cleaning/Vactoring	$675.00
SSM-1382	1	5	5	Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-38	1	5	5	Sewer Cleaning/Vactoring, Chimney Liner	$1,147.50
SSM-39	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-24	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-18	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-14	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-1516	1	5	5	Chimney Liner, Cone Liner	$1,552.50
SSM-1757	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repairs	$1,080.00
SSM-1751	1	3	3	Sewer Cleaning/Vactoring	$675.00
				Estimated Total Cost*	**$150,795.00**

The manhole capital projects were selected based on high BRE scores and their vicinity to the Year 1 – 3 sewer pipe capital projects. If a manhole that generated rehab recommendations based on its inspection data was near a sewer pipe capital project, it was evaluated and placed in the proper capital project year even if its BRE score was in the medium to low range in order to reduce disturbance and mobilization costs.

Table F-14: Manhole Capital Improvement Projects Year 2 (FY2019/2020)

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-707	3	5	15	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-718	3	5	15	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-696	2	5	10	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-1552	2	5	10	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-837	2	5	10	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-547	2	5	10	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-647	2	4	8	Monitor Closely, Major Point Repair	$337.50
SSM-1454	2	4	8	Full Manhole Liner	$4,050.00
SSM-1455	2	4	8	Full Manhole Liner	$4,050.00
SSM-863	2	4	8	Reset Frame, Replace Chimney, Full Manhole Liner	$7,222.50
SSM-1235	2	4	8	Minor Point Repair, Chimney Liner	$607.50
SSM-388	2	4	8	Sewer Cleaning/Vactoring, Major Point Repair	$1,012.50
SSM-1654	2	4	8	Chimney Liner	$472.50
SSM-731	2	3	6	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-645	2	3	6	Full Manhole Liner	$4,050.00
SSM-764	2	3	6	Full Manhole Liner	$4,050.00
SSM-895	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring, Minor Point Repair	$810.00
SSM-601	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-602	1	5	5	Sewer Cleaning/Vactoring, Root Treatment, Chimney Liner	$1,552.50
SSM-606	1	5	5	Sewer Cleaning/Vactoring, Chimney Liner	$1,147.50
SSM-580	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-582	1	5	5	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-583	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring, Minor Point Repair	$810.00

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-588	1	5	5	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-587	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-867	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-1243	1	5	5	Sewer Cleaning/Vactoring, Replace Chimney, Full Manhole Liner	$7,357.50
SSM-771	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-772	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-857	1	5	5	Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-856	1	5	5	Sewer Cleaning/Vactoring, Major Point Repair, Chimney Liner	$1,485.00
SSM-551	1	5	5	Sewer Cleaning/Vactoring, Major Point Repair, Full Manhole Liner	$5,062.50
SSM-563	1	5	5	Sewer Cleaning/Vactoring	$675.00
SSM-362	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repairs, Replace Chimney, Full Manhole Liner	$7,627.50
SSM-363	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring, Replace Chimney	$3,307.50
SSM-1277	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-266	1	5	5	Monitor Closely, Reset Frame, Cone Liner	$1,822.50
SSM-295	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repair, Chimney Liner, Cone Liner	$2,362.50
SSM-296	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repair	$810.00
SSM-504	1	5	5	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-505	1	5	5	Sewer Cleaning/Vactoring, Major Point Repair, Chimney Liner	$1,485.00
SSM-312	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring, Reset Frame, Cone Liner	$3,577.50
SSM-321	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-1656	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repairs	$945.00
SSM-762	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-1362	1	5	5	Sewer Cleaning/Vactoring	$675.00
SSM-579	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
				Estimated Total Cost*	**$148,568.00**

Table F-15: Manhole Capital Improvement Projects Year 3 (FY2020/2021)

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-1503	3	5	15	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-734	3	5	15	Sewer Cleaning/Vactoring	$675.00
SSM-735	3	5	15	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-1411	4	3	12	Sewer Cleaning/Vactoring	$675.00

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-478	3	4	12	Sewer Cleaning/Vactoring, Minor Point Repair, Chimney Liner	$1,282.50
SSM-479	3	4	12	Monitor Closely, Major Point Repair	$337.50
SSM-461	2	5	10	Minor Point Repair, Major Point Repair, Root Treatment, Full Manhole Liner	$4,725.00
SSM-231	2	5	10	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-1651	2	5	10	Minor Point Repair	$135.00
SSM-137	2	5	10	Sewer Cleaning/Vactoring, Minor Point Repair	$810.00
SSM-135	2	5	10	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-159	2	5	10	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-1372	2	5	10	Sewer Cleaning/Vactoring, Minor Point Repair, Replace Chimney	$3,442.50
SSM-1375	2	5	10	Sewer Cleaning/Vactoring	$675.00
SSM-536	2	4	8	Minor Point Repairs	$270.00
SSM-1639	2	4	8	Replace Chimney, Full Manhole Liner	$6,480.00
SSM-557	2	4	8	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-452	2	4	8	Minor Point Repair, Full Manhole Liner	$4,185.00
SSM-249	2	4	8	Minor Point Repair, Major Point Repair, Cone Liner	$1,552.50
SSM-148	2	4	8	Major Point Repair, Full Manhole Liner	$4,387.50
SSM-149	2	4	8	Full Manhole Liner	$4,050.00
SSM-1437	2	4	8	Wall Liner	$3,375.00
SSM-1436	2	4	8	Minor Point Repairs, Full Manhole Liner	$4,320.00
SSM-232	2	3	6	Root Treatment	$202.50
SSM-239	2	3	6	Sewer Cleaning/Vactoring, Chimney Liner, Cone Liner	$2,227.50
SSM-303	2	3	6	Sewer Cleaning/Vactoring, Chimney Liner	$1,147.50
SSM-1646	2	3	6	Minor Point Repair	$135.00
SSM-180	2	3	6	Sewer Cleaning/Vactoring	$675.00
SSM-1085	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repairs, Chimney Liner	$1,417.50
SSM-498	1	5	5	Minor Point Repair, Rebuild Bench, Full Manhole Liner	$4,995.00
SSM-737	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring	$675.00
SSM-105	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-111	1	5	5	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-36	1	5	5	Monitor Closely, Sewer Cleaning/Vactoring, Chimney Liner, Cone Liner	$2,227.50
SSM-1593	1	5	5	Sewer Cleaning/Vactoring, Minor Point Repairs, Root Treatment, Reset Frame	$1,890.00
SSM-102	1	5	5	Sewer Cleaning/Vactoring, Cone Liner	$1,755.00
SSM-219	1	4	4	Monitor Closely, Replace Chimney	$2,632.50
SSM-1343	1	4	4	Minor Point Repair, Chimney Liner, Cone Liner	$1,687.50
SSM-510	1	4	4	Full Manhole Liner	$4,050.00

Facility ID	CoF	PoF	BRE	Project	Planning-Level Cost
SSM-350	1	4	4	Sewer Cleaning/Vactoring, Major Point Repair, Full Manhole Liner	$5,062.50
SSM-356	1	4	4	Sewer Cleaning/Vactoring, Minor Point Repair, Full Manhole Liner	$4,860.00
SSM-366	1	4	4	Sewer Cleaning/Vactoring, Minor Point Repair, Major Point Repair, Full Manhole Liner	$5,197.50
SSM-11	1	4	4	Sewer Cleaning/Vactoring, Root Treatment, Full Manhole Liner	$4,927.50
SSM-10	1	4	4	Monitor Closely, Cone Liner	$1,080.00
SSM-703	1	3	3	Full Manhole Liner	$4,050.00
SSM-1342	1	3	3	Full Manhole Liner	$4,050.00
SSM-1711	1	3	3	Sewer Cleaning/Vactoring, Minor Point Repairs	$1,080.00
SSM-581	1	3	3	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-367	1	3	3	Full Manhole Liner	$4,050.00
SSM-319	1	3	3	Sewer Cleaning/Vactoring, Full Manhole Liner	$4,725.00
SSM-323	1	3	3	Chimney Liner, Cone Liner	$1,552.50
SSM-324	1	3	3	Minor Point Repair, Chimney Liner	$607.50
SSM-752	1	3	3	Root Treatment, Full Manhole Liner	$4,252.50
				Estimated Total Cost*	**$150,390.00**

Figure F-A-4 shows the capital improvement projects per year for the three year period.

C. Continuing the Asset Management Plan Beyond 2017

As the capital and rehabilitation projects are completed for both the wastewater sewer pipes and manholes, ***the City wastewater geodatabase must be continuously updated*** to reflect the changing conditions. For example, the PoF variable, which indicates structural condition, must be reset after a pipe or manhole is replaced or repaired. This could consist of the PACP structural rating changing from a 5 to a 1 or 2. This can be done using the same data collection methodologies developed during the SAW Grant project. The continuation of the sewer inspection program will allow the City to maintain a current set of structural conditions that can be used to guide the Capital Improvement Planning process every year.

This process is not entirely automated. When the annual CIP table is updated in future years, City staff should evaluate the following manual adjustments:

- Assets with a mid-range BRE should be moved up the list if a proposed roadway project coincides with the asset location.
- If assets with mid-range BREs are immediately adjacent to a high BRE, consider adding the mid-range asset to the CIP, as the adjacency may increase cost efficiencies and avoid an unnecessary re-mobilization.

Appendix F-A: Maps

Figures

Figure F-A-1: Probability of Failure
Figure F-A-2: Consequence of Failure
Figure F-A-3: Business Risk Exposure
Figure F-A-4: Capital Improvement Plan

Figure F-A-1
Probability of Failure

Traversa City, MI

N
W E
S

0 800 1,600 2,400
Feet

1" = 800'

Sanitary Sewer Manholes
- No Associated Value

Probability of Failure
- 1
- 2
- 3
- 4
- 5

Sewer Gravity Mains
- No Associated Value

Probability of Failure
- 1
- 2
- 3
- 4
- 5
- 6
- Traverse City

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: May 18, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advisors
888.522.6711 | ohm-advisors.com

P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170518 Traverse City CIP Maps\20170518 Probability of Failure.mxd

Figure F-A-2
Consequence of Failure

Traverse City, MI

N
W E
S

0 1,100 2,200 3,300
Feet

1" = 1,100'

Sanitary Sewer Manholes
- No Associated Value

Consequence of Failure
- 1
- 2
- 3
- 4

Sewer Gravity Mains
- No Associated Value

Consequence of Failure
- 1
- 2
- 3
- 4
- Traverse City

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: May 18, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advisors
888.522.6711 | ohm-advisors.com

Figure F-A-3
Business Risk

Traveres City, MI

N
W E
S

0 800 1,600 2,400
Feet

1" = 800'

Sanitary Sewer Manholes
- No Associated Value

Business Risk
- Low Priority (1-4)
- Medium Priority (5-9)
- High Priority (10-25)

Sewer Gravity Mains
- No Associated Value

Business Risk
- Low Priority (1-4)
- Medium Priority (5-9)
- High Priority (10-25)
- Traverse City

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: May 18, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advisors
888.522.6711 | ohm-advisors.com

P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170518 Traverse City CIP Maps\20170518 Business Risk.mxd

Figure F-A-4
CIP Yearly Projects

Traversing Traverse City, MI

N
W E
S

0 700 1,400 2,100
Feet

1" = 700'

Sanitary Sewer Manholes

CIP Year
- Year 1
- Year 2
- Year 3
- No Associated Year

Sewer Gravity Mains

CIP Year
- Year 1
- Year 2
- Year 3
- No Associated Year
- Traverse City

Source: Data provided by Traverse City. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan Central FIPS 2112 Feet Intl

Map Published: May 18, 2017

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advisors
Advancing Communities
ARCHITECTS ENGINEERS PLANNERS
888.522.6711 | ohm-advisors.com

Appendix G: CH2M WWTP CIP and O&M Strategies

City of Traverse City
Asset Management Plan
Wastewater Plant and Collections System

City of Traverse City
Asset Management Plan
Wastewater Plant and Collections System

Prepared for

City of Traverse City

Date 8/1/2016

CITY of TRAVERSE CITY MICHIGAN

Grand Traverse County 1851

ch2m

Contents

Section Page

City of Traverse City, Asset Management Plan, Wastewater Plant and Collections System 1

1.0 Plan Overview 1
2.0 Staffing Plans 2
3.0 System Description 4
3.1 Effluent Discharge Criteria 4
3.2 Plant Design Criteria 4
3.3 Acronyms and Abbreviation List 5
3.4 Glossary of Terminology 7
3.5 Preliminary Screening Description 13
3.6 Grit Removal Description 14
3.7 Primary Settling Description 15
3.8 Process Description 15
3.9 Fine Screening Description 17
3.10 Screened Primary Effluent Pumping and Distribution Description 17
3.11 Secondary Treatment Description 18
3.12 Membrane Process (MBR) Description 21
3.13 Mixed Liquor Recirculation Description 23
3.14 Process Air Blower Description 23
3.15 Ultraviolet Disinfection Description 25
3.16 Waste Activated Sludge Concentration Description 26
3.17 Primary Sludge and CWAS Distribution to Anaerobic Digestion Description 27
3.18 Anaerobic Digestion Process Description 28
3.19 Digested Sludge Description 30
3.20 Biosolids Storage and Haul Out Description 31
3.21 Sludge Concentration – Polymer System Description 32
3.22 Odor Control System 32
3.23 Lift Stations Operated and Maintained by CH2M 33
4.0 Inventory or Fixed Assets 35
5.0 Business Risk Evaluation Process 35
6.0 Operation and Maintenance Budgets/Rate Calculation Process 35
7.0 Capital Improvement Plans 36
8.0 Current Improvement Initiatives 36
9.0 Annual Reporting 36

Attachments

1 Map of the Traverse City Collection System
2 Traverse City's Collection System Fixed Assets
3 TCRWWTP and Lift Stations Fixed Assets
4 Traverse City's SAW Grant Scope of Work
5a Traverse City's Wastewater Fund
5b Traverse City's Rate Calculation
6a Summary of Traverse City's CIP
6b Narrative of Traverse City's CIP

Section Page

Exhibits

1 Traverse City Collection System Staffing 2
2 CH2M's Staffing for the TCRWWTP and City Lift Stations 3
3 Traverse City Effluent Objectives and Compliance Criteria 4
4 Summary of Plant and Biological System Design Criteria 4
5 Acronyms and Abbreviations 5
6 Design Criteria Table 8-1: MBR – Design Criteria 19
7 MBR – Process Flow Diagram 20
8 Membrane Functional Schematic 22
9 WAS Concentration Design Criteria 26
10 WAS Concentration – Process Flow Diagram 27
11 CH2M Operated and Maintained Lift Stations 33
12 TCRWWTP and Lift Stations Improvement Initiatives 36

Document Revision History

VERSION	AUTHOR	DATE	CHANGES
1.0			

City of Traverse City, Asset Management Plan, Wastewater Plant and Collections System

1.0 Plan Overview

This document lays out a process by which assets required to collect and treat wastewater for residents and businesses serviced by the Traverse City Regional Wastewater Treatment Plant (TCRWWTP) are operated and maintained to reliably meet the service and permit requirements while controlling asset life-cycle cost. This process has become known as Asset Management. The key factors in an Asset Management Plan are;

- Know what you own
- Know the relative criticality of each asset
- Know how long it has been in service
- Know what the current condition of the assets are
- Know what it is currently costing to maintain the assets
- Know what it will cost to replace the assets

The TCRWWTP is supported by three separate teams working together to provide wastewater collection and treatment services in Traverse City and Grand Traverse County. The City of Traverse City operates the portion of the collection system located within the city through the Traverse City Department of Public Services (TCDPS). The portion of the collection system and lift stations located outside the city in Grand Traverse County is operated by Grand Traverse County Lift Stations and collections System (GTC). The wastewater treatment plant and the lift stations located within the city are operated by CH2M under contract to The City of Traverse City (The City). Working collectively each team is advancing the assets within it's' realm of responsibility. Asset inventories for the city collection system have been entered into GIS and for the TCRWWTP and lift stations into Maintenance Connection (MC). The assets have been arranged by location and process to facilitate accurate collection of data and reporting. Processes are being developed and documented for the continual updating of the asset inventory as assets are replaced or changed. The fixed assets in the GTC lift stations and collection system are currently being located and entered into a GIS system. A more complete reporting of the fixed assets will be available by June 30, 2017.

A complete assessment of the condition of all the assets at the TCRWWTP and city Lift Stations is scheduled to be performed before December 31, 2016 with a condition assessment report available by February 1, 2017. Plans are proceeding to complete an assessment of at least a portion of the assets of the city collections system. Grand Traverse County will begin assessing assets in the GTC collection system and lift stations following the completion of an asset inventory.

An evaluation of the relative risk of assets in the system will be conducted no later than the end of the first quarter of 2017. At present CH2M and The City and meet once at review a matrix system which ranks the consequences of a failure and the likelihood of a failure at the process level. Final agreement on the categories a loss of service represent and the factors which can best predict the likelihood and asset will fail in the future are still being refined. Once the structure of the matrices is complete representatives from The City, plant operations staff and plant maintenance staff will establish a consequence of failure score and a likelihood of failure score for each process. The total risk represented by each process will be

calculated using the classic risk formula Consequence of Failure X Likelihood of Failure = Total Risk. These risk scores will then be applied to each asset within the process.
Details of the Asset Management Plan are outlined in greater detail in the following sections and attachments to this report.

2.0 Staffing Plans

Staffing plans for the Traverse City Collection System and the Traverse City Regional Wastewater Treatment Plant (TCRWWTP) and lift stations are highlighted in Exhibits 1 and 2. Staffing for the Grand Traverse County Collections System and Lift Stations Staffing will be determined by July 30, 2017.

Exhibit 1. Traverse City Collection System Staffing

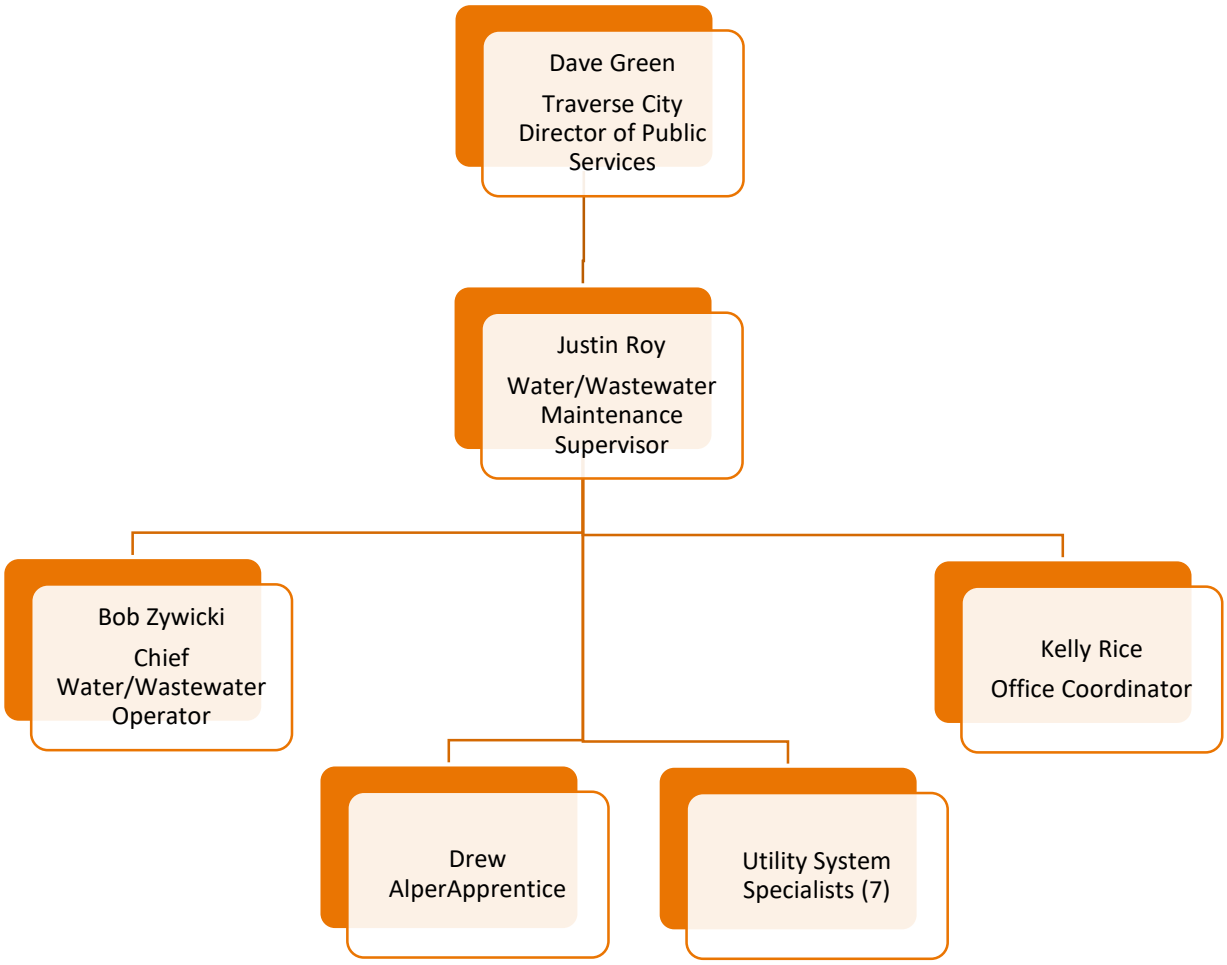
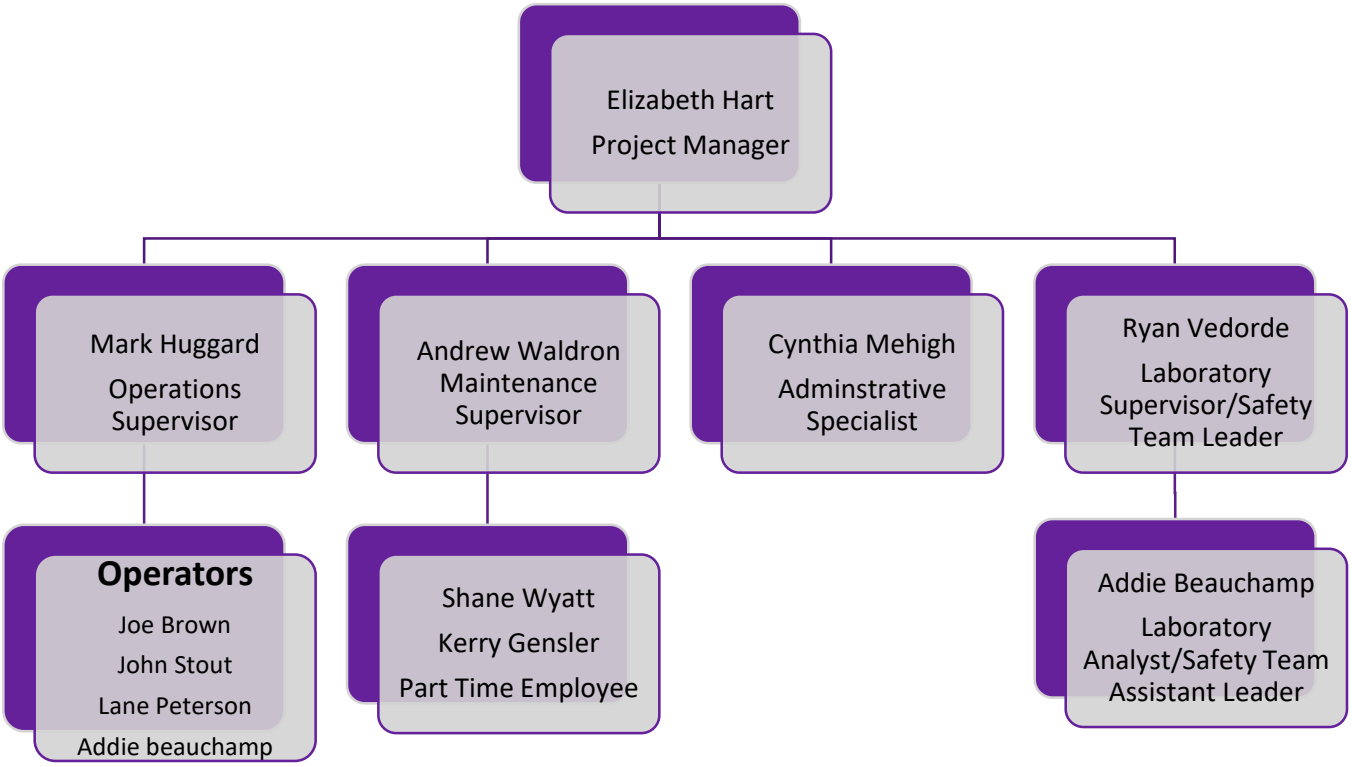


Exhibit 2. CH2M's Staffing for the TCRWWTP and City Lift Stations



CH2M's roles and responsibilities include:

- The project manager oversees the scheduling and planning of capital improvement projects, implementation and scheduling of new preventive maintenance (PM) work orders and corrective maintenance (CM) work orders. This is done with the input and assistance of the supervisory team.
- The operations supervisor assists in planning major repairs, and is responsible for the scheduling of lower level PM tasks. He/she works closely with the maintenance supervisor in prioritizing repairs, scheduling equipment shutdowns, if needed, and coordinating staffing efforts.
- The operations staff, under their supervisor's direction, performs low level PM tasks, assists in CM, and the completion of capital improvement projects.
- The maintenance supervisor schedules and assigns CM work orders, oversees predictive maintenance (PdM), capital improvement projects, and is also charged with the completion of higher-level PM work orders.
- The maintenance staff, under their supervisor's direction, performs higher level PM work orders, CM work orders, PdM, and capital improvement projects.
- All supervisors and the project manager are responsible for making sure PdM, PM, and CM are performed according to CH2M safety standards.
- The administrative specialist helps with creating vendor and contractor accounts, setting up a means to pay invoices, as well as, assisting with safety requirements.
- The safety team leader heads up the safety effort, and is a resource for any safety concerns or questions pertaining to day to day work, or large projects.

3.0 System Description

A map of the Traverse City Collection System, including Lift Stations is located in Attachment 1.

The system description for the Grand Traverse County Collection System will be determined by June 30, 2017.

TCRWWTP and Lift Stations process descriptions are outlined in the remainder of Section 3.

3.1 Effluent Discharge Criteria

The TCRWWTP is designed to comply at a minimum with the current Michigan Department of Environmental Quality (DEQ) requirements for wastewater treatment. However, in order to provide the most environmentally desirable discharge possible, Traverse City has also set voluntary target objectives for the TCRWWTP's effluent quality. The requirements and objectives for TCRWWTP's effluent are listed in Exhibit 3.

Exhibit 3. Traverse City Effluent Objectives and Compliance Criteria

Effluent Parameter	Average Monthly Concentrations (mg/L)	
	Effluent Objective	Discharge Permit Requirement
Biochemical Oxygen Demand (BOD)	4	25
Total Suspended Solids (TSS)	4	30
Ammonia Nitrogen (NH3 - N)	1	11
Phosphorus	0.5	0.5

3.2 Plant Design Criteria

The plant is capable of treating the following influent flows and nutrient loadings, and has the following criteria for its biological system (Exhibit 4.

Exhibit 4. Summary of Plant and Biological System Design Criteria

Plant Influent Design Criteria	Maximum Flows		Maximum Monthly Loads	
	(mgd)	(m^3/d)	(lb/d)	(kg/d)
Average Flow	8.5	32,000		
Peak Flow	17	64,000		
BOD			20,200	9,200
TSS			36,500	16,550
Ammonia (NH_3)			2,200	1,000

Biological System Design Criteria	Minimum Time (days)	Minimum Temperature		Maximum Concentration (mg/L)
		(°F)	(°C)	
Solids Retention Time	6.5 to 8.5 days at Design Max Month			
Wastewater Temperature at Peak Monthly Loadings		55	13	
Maximum MLSS Concentration at the Membranes				10,000

3.3 Acronyms and Abbreviation List

The acronyms and abbreviations used throughout this manual are listed in Exhibit 5 in alphabetical order and serve as a reference listing.

Exhibit 5. Acronyms and Abbreviations

Abbreviation/ Acronym	Definition
ADP	Air diaphragm pump
AS	Activated sludge
AT	Aeration Tank
BNR	Biological nutrient removal
BOD	Biochemical oxygen demand
BOD_5	Five-day biochemical oxygen demand
btu	British thermal unit(s)
°C	Degree(s) Celsius
CDS	Concentrated digested sludge
cf/hr	Cubic feet per hour
cfm	Cubic feet per minute
COD	Chemical oxygen demand
cu.	Cubic
CWAS	Concentrated waste activated sludge (WAS)
DO	Dissolved oxygen
DWP	Dynamic wet pressure
°F	Degree(s) Fahrenheit
F/M	Food-to-microorganism ratio
ft.	Foot/feet
GBC	Gravity belt concentrator
gpm	Gallons per minute
GSFD	Gallons per square foot of available membrane area per day
hp	Horsepower
HRT	Hydraulic retention time
Hz	Hertz
in.	Inch(es)
IPP	Industrial Pretreatment Program
kg	Kilogram(s)
lb.	Pound(s)
LCP	Local control panel
LED	Light Emitting Diode
MBR	Membrane Bioreactor
MCC	Motor control center

Exhibit 5. Acronyms and Abbreviations

Abbreviation/ Acronym	Definition
MCRT	Mean cell residence time
mgd	Million gallons per day
mg/L	Milligram(s) per liter
min.	Minute
mL	Milliliters(s)
ML	Mixed liquor
MLR	Mixed liquor recycle
MLSS	Mixed liquor suspended solids
MLVSS	Mixed liquor volatile suspended solids
mm	Millimeter(s)
NH_3-N	Ammonia nitrogen
NO_2-N	Nitrite nitrogen
NO_3-N	Nitrate nitrogen
NTU	Nephelometric turbidity unit(s)
O&M	Operations and maintenance
OUR	Oxygen uptake rate
PDT	Pressure decay test
PA	Process air
PAC	Process air compressor
PAO	Polyphosphate accumulating organism
PID	Proportional, Integral, Derivative (tuning parameters used in computer/PLC controls)
PE	Primary effluent OR Pressure element depending on the context
PI	Primary influent, Pressure indicator, or Proportional-Integral depending on the context
P&ID	Process & Instrumentation Diagrams
PLC	Programmable logic controller
PRS	Recycled primary sludge
PS	Primary sludge
psi	Pounds per square inch
RAS	Return activated sludge
RPS	Recycled primary sludge also referred to as primary recycle
SCADA	Supervisory control and data acquisition
scfm	Standard cubic feet per minute
SDC	Sieve drum concentrator
SOP	Standard operating procedure(s)
SOUR	Specific oxygen uptake rate
SP	Soluble phosphorus

Exhibit 5. Acronyms and Abbreviations

Abbreviation/ Acronym	Definition
SRT	Solids retention time
SVI	Sludge volume index
SWD	Side water depth
TDH	Total dynamic head
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TMP	Trans-membrane pressure
TP	Total phosphorus
TSS	Total suspended solids
UCT	University of Cape Town
UV	Ultraviolet
UVT	Ultraviolet transmissivity
VFA	Volatile fatty acids
VFD	Variable frequency drive
VS	Volatile solids
VSS	Volatile suspended solids
VTS	Total volatile solids
W3	Plant service water
WAS	Waste activated sludge
W/m^3	Watt(s) per cubic meter
WWTP	Wastewater treatment plant
$\mu Wsec/cm^2$	Micro-watts-seconds per centimeter square (measure of UV intensity)
%	Percent

3.4 Glossary of Terminology

This glossary is intended to define certain terms associated with wastewater treatment that are found in the text material.

Activated Sludge: A mixture of microorganisms that accumulates after aeration of wastewater containing organic contaminants and a suitable bacterial seed.

Activated Sludge Process: A biological wastewater treatment process comprised of one or more aeration tanks and secondary clarifiers or membrane bioreactors. The wastewater is brought into contact with the activated sludge in an aeration tank and the sludge is separated from the mixed liquor and returned to the process. A portion of the sludge is wasted to maintain the quantity of microorganisms present in the system in equilibrium. The supernatant or permeate may be further treated (e.g., disinfection and sometimes tertiary treatment) before final discharge to a river, lake, stream, or alternative discharge point.

Aeration: The process of supplying air or oxygen to water, whether by natural or mechanical means.

Aeration Tank: The tank in which air, microorganisms, and wastewater are mixed in an activated sludge process.

Aerobic: A microbial process that occurs in the presence of dissolved oxygen. Also sometimes referred to as oxic.

Aerobic Zone: Also referred to as an Aerated Zone. An environment where dissolved oxygen is present, usually provided by the transfer of oxygen using aeration blowers and diffusers located at the bottom of the Aeration Tank or Membrane Tank. Aerobic microorganisms utilize oxygen to oxidize organic matter and to convert ammonia (NH_3) to oxidized forms of nitrogen (nitrite and/or nitrate), i.e. the nitrification process.

Anaerobic Zone: An environment completely devoid of dissolved oxygen and oxidized forms of nitrogen (typically nitrate). The environment supports only bacteria that grow in the absence of oxygen, i.e. anaerobic bacteria.

Anoxic Zone: An environment completely devoid of dissolved oxygen but where oxidized forms of nitrogen (typically nitrate) are present. The environment supports microorganisms that can use nitrate or nitrite as a source of oxygen for respiration, i.e. the denitrification process; nitrogen gas (N_2) is the primary product of denitrification and is released to the atmosphere.

Aerobic Bacteria: Bacteria that require the presence of oxygen for their growth.

Aerobic Digestion: The stabilization of microorganisms produced by the activated sludge process by prolonged aeration in the absence of food.

Algae: Primitive plants with one or many cells, usually aquatic and capable of synthesizing their carbon source from carbon dioxide and water by photosynthesis.

Aliquot: Equal portion of an equal volume composite sample.

Alkalinity: The capacity of water to neutralize acids due to the presence of carbonate, bicarbonates and hydroxides; expressed in milligrams per liter of equivalent calcium carbonate ($CaCO_3$).

Alum: Name used for commercial hydrated aluminum sulphate (chemical formula: $Al_2(SO_4)_3 \cdot xH_2O$), a metal salt, used in wastewater treatment for phosphorus removal.

Bacteria: A group of unicellular microscopic organisms lacking chlorophyll. Bacteria are usually spheroid, rod-like, curved, or filamentous in shape.

Biochemical Oxygen Demand (BOD): A measure of the strength of wastewater as determined by the oxygen consumed by microorganisms during the aerobic degradation of organic matter. BOD_5 refers to the oxygen consumed during a five-day test period under prescribed incubation conditions.

Biodegradability: The ability of microorganisms to biologically metabolize a specific compound or a wastewater containing a mixture of compounds.

Biological Nutrient Removal (BNR): Removal of phosphorus and or nitrogen using microorganisms.

Biological Slime: A complex population of organisms that form a slime growth within the aeration tank and break down organic matter in the wastewater. These slimes are a viscous characteristic of the activated sludge process and caused by the accumulation of adsorbed but unmetabolized BOD.

Biological Treatment: Wastewater treatment performed by microorganisms, primarily bacteria.

Biomass: General name applied to a biological culture such as the microorganisms in the activated sludge process.

Biosolids: Term used to distinguish between untreated sludges such as primary sludge and waste activated sludge versus solids that have been digested or dried. The digestion or drying process

significantly reduce the putrescence, odor, vector attraction, and pathogen concentration characteristics compared to the sludges prior to this treatment.

Bugs: Common name given collectively to the population of microorganisms in the aeration tank.

Bulking sludge: Poor settling sludge floc due to an excessive number of filamentous microorganisms that bridge between solids and thereby inhibit settling and compaction of the activated sludge.

Carbonaceous Biochemical Oxygen Demand (CBOD): As with BOD, a measure of the strength of wastewater as determined by the oxygen consumed by microorganisms during the aerobic degradation of organic matter. $CBOD_5$ refers to the oxygen consumed during a five-day test period under prescribed incubation conditions. The CBOD test differs from the BOD test in that a chemical is added to the CBOD test to inhibit nitrification from occurring. The BOD test frequently over predicts the oxygen demand due to organic matter because of some oxygen consumption associated with partial nitrification.

Chemical Oxygen Demand (COD): The quantity of organic and inorganic matter present in a wastewater, which can be chemically oxidized under controlled test conditions, expressed as an oxygen equivalent.

Clarification: The action of settling suspended solids from the liquid. The liquid discharged from above the settled solids is referred to as supernatant and the settled solids are referred to as sludge.

Clarifier: A settling tank that separates suspended solids from water by gravity as a result of density differences.

Coagulation: The agglomeration of finely dispersed particles into larger particles (flocs) by chemical addition or other physical/chemical means.

Coliform Bacteria: A group of bacteria predominantly inhabiting the intestines of humans or animals but also occasionally found elsewhere. Their presence in water is evidence of contamination by fecal material.

Colloidal Matter: Finely divided solids that will not settle due to the small size of the particles or electrical charges on the particles.

Composite Wastewater Sample: A combination of individual portions of wastewater taken at selected time intervals to minimize the effect of the variability of the individual samples. Individual samples may be of equal volume or may be proportioned to the flow at the time of sampling.

Concentration: Processes that thicken sludge or biosolids by removing water from sludge or biosolids by physical and/or mechanical means (gravity belt thickeners, centrifuges, etc.). More commonly referred to as thickening at other plants. Typically, the term concentration or thickening is used when the thickened sludge or biosolids is in the range of 3% to 10% solids by weight and the term dewatering is reserved for processes that remove more water and thereby generate higher (e.g., typically 15% or greater) solids concentrations.

Declining Growth Phase: The stage of growth of microorganisms at which the depletion of the food supply results in a reduced rate of microbial growth and cell multiplication.

Denitrification: The conversion of nitrate to molecular nitrogen by specific microorganisms under anoxic conditions.

Detention Time: The theoretical length of time required for a given volume of liquid to flow through a tank or unit. It is calculated by dividing the tank volume by the rate of inflow. Also called Retention Time.

Dewatering: Processes that remove water from concentrated sludge or biosolids (usually digested biosolids) by physical and/or mechanical means (centrifuges, belt presses, etc.)

Digested Sludge: Sludge that has been stabilized by long-term exposure to an environment without an external food source. In recent years commonly referred to as biosolids to distinguish it from untreated sludge.

Disinfection: The destruction of potentially harmful or disease-causing microorganisms in water or wastewater, usually by chlorination, ozonation or exposure to ultraviolet radiation.

Dispersed Growth: Non-flocculating microorganisms with poor settling characteristics whose presence in treated wastewater results in a turbid effluent.

Dissolved Oxygen (DO): The free oxygen dissolved in water, usually as a result of contact with air.

Effluent: Discharge from a tank, reservoir, basin or treatment plant; usually partially or completely treated wastewater.

Endogenous Growth Phase. The stage of growth of microorganisms at which they consume their own cellular material due to the depletion of their food source.

Equalization: A process in which variations in flow or strength are averaged or reduced.

Eutrophication: The process by which a lake or other water body becomes enriched with dissolved nutrients (e.g. nitrogen and phosphorus) resulting in higher levels of algae and plant growth.

Extended Aeration Process. A modification of the conventional activated sludge process in which longer detention times in the aeration basin and lower organic loading rates are utilized. The extended aeration process operates in the endogenous phase of the microbial growth curve.

Facultative Bacteria. Bacteria that can grow in either an aerobic or an anaerobic environment. Most activated sludge microorganisms are facultative.

Ferric Chloride: Name used for commercial iron solution (chemical formula: $FeCl_3$), a metal salt, used in wastewater treatment for phosphorus removal. Also referred to as simply *ferric* in wastewater terminology.

Ferrous Chloride: Reduced form of ferric chloride, a waste product of various metal industries. Chemical formula is $FeCl_2$. Can also be used for phosphorus removal.

Filamentous Microorganisms: Species of microorganisms, i.e. bacteria and fungi, which grow in the form of strands or filaments.

Floc: A particle formed by the agglomeration of a number of smaller particles.

Flotation: The raising of suspended matter to the liquid surface by gases.

Food: The substances used by organisms for the growth (synthesis) of new cellular material and the production of energy; see also substrate. Usually measured as BOD_5 or $CBOD_5$ in the wastewater.

Food-to-Microorganism Ratio (F/M): The ratio of the amount of food applied to the biological system relative to the number of microorganisms in the system available to degrade the food, measured as the volatile fraction of the mixed liquor.

Grab Wastewater Sample: A single, independent wastewater sample taken at some instant in time. A composite sample is made up of numerous grab samples.

Gravity Belt Concentrator: Process equipment that is utilized to thicken waste activated sludge or digested sludge. Commonly referred to as a Gravity Belt Thickener in other plants.

High Rate Aeration Process: A modification of the conventional activated sludge process in which relatively short detention times in the aeration basin and higher organic loading rates are experienced.

Hydraulic Loading Rate: The rate of flow applied to a process.

Influent: Water, wastewater, or other liquid flowing into a tank, reservoir, basin, treatment plant, or any unit thereof.

Lagoon: An artificial pond of earthen construction used to hold wastewater for treatment by means of biological stabilization.

Loading Rate: The quantity of waste, expressed in units of volume (hydraulic load) or in mass of BOD, COD, suspended or volatile solids (organic load), that is discharged to a wastewater treatment facility or watercourse.

Logarithmic Growth Phase: The stage of microbial growth in which maximum cell growth and multiplication is taking place due to the presence of an abundant food supply.

Mean Cell Residence Time (MCRT): The average length of time that the activated sludge is maintained in the activated sludge system, calculated as the solids inventory in the Aeration Tanks and Membrane Tanks divided by the sludge wasted plus the solids lost in the secondary effluent. If solids lost in the secondary effluent are insignificant than they are commonly excluded from the calculation. Also referred to as Solids Retention Time SRT.

Membrane Bioreactor (MBR): The Membrane Bioreactor (MBR) as defined for the TCRWWTP is the biological secondary treatment process consisting of the Aeration Tanks, Membrane Tanks, and associated ancillary equipment.

Membrane Tanks: The Membrane Tanks are a major component of the MBR. The Membrane Tanks contain the membranes which perform the separation of the liquids (permeate) from the solids (activated sludge). The Membrane Tanks are aerated tanks which provide additional aerobic treatment to the mixed liquor from the Aeration Tanks.

Microbial: Pertaining to the activity of microorganisms.

Microorganism: Very small organisms that can only be seen through a microscope. Some microorganisms use the wastes in the wastewater for a source of food, thereby removing or altering much of the undesirable matter.

Mixed Liquor: The mixture of activated sludge microorganisms and wastewater in the Aeration Tanks, Membrane Tanks, and channels between these tanks.

Mixed Liquor Suspended Solids (MLSS): A measure of the concentration of residual solids and microorganisms present in the mixed liquor of an activated sludge system.

Mixed Liquor Volatile Suspended Solids (MLVSS): The MLSS that is volatile based on laboratory analysis under defined conditions; usually used to represent the concentration of microorganisms in the aeration tank mixed liquor.

Nitrification: The microbial conversion of ammonia to nitrite and nitrate in the presence of oxygen.

Nutrients: Organic and inorganic compounds, such as nitrogen, phosphorus, and some trace metals, which are required by microorganisms to support growth.

Oil and Grease (O&G): The material that can be extracted from a sample using an organic solvent; also referred to as *Solvent Extractable Material* or SEM. The O&G test indicates the total amount of oils, greases, and fats in the wastewater.

Operator Interface: Refers to the SCADA computer in the operator control station, i.e., the place at which the operator interfaces (controls and monitors) the operating equipment and processes.

Organic Loading: The mass of BOD per day introduced to the biological system. Sometimes expressed per unit volume of the aeration tanks (i.e., the Aeration Tanks and Membrane Tanks in the case of the TCRWWTP).

Organic Loading Rate: The measure of the rate at which organic food (BOD) is applied to a wastewater treatment process or watercourse.

Oxygen Uptake Rate (OUR): The rate at which activated sludge microorganisms consume oxygen during their metabolic processes.

Overflow Rate: Equal to the flow to a clarifier or settling tank divided by the tank surface area. Equivalent to the average up flow velocity.

Pathogenic Organisms: Microorganisms that can cause disease in humans or other animals.

pH: A term used to express the intensity of the acid or alkaline condition of a solution.

Receiving Body (Water): A watercourse, lake, or ocean into which treated or untreated water is discharged.

Recycle/Recirculation: The return of a fluid or solids stream from a treatment process to an upstream location in the wastewater or mixed liquor flow.

Refractory: Resistant to treatment.

Retention Time: See Detention Time; usually expressed as hydraulic retention time or HRT.

Return Activated Sludge: The separated activated sludge that is recirculated from the liquid/solids separation process (clarifier or membrane system) back to the Aeration Tanks to maintain the mixed liquor concentration. Typically abbreviated as RAS. Also called recycle sludge.

Rising Sludge: A condition that can occur in secondary clarifiers in which denitrification of stale sludge leads to the formation of nitrogen gas bubbles. These attach themselves to the sludge mass, causing it to become buoyant and float to the surface of the clarifier.

Screening: The removal of relatively coarse debris and solids from wastewater by straining through grates or screens.

Secondary Treatment: The wastewater treatment process following primary treatment, involving biological waste stabilization. The Activated Sludge process is one example.

Settleability Test: A laboratory determination of the settling properties of solids suspended in a liquid.

Settleable Solids: Those solids in wastewater that settle to the bottom of a sedimentation tank. Also referred to as the volume of solids that settle to the bottom of an Imhoff cone in one hour.

Sludge: Solids produced in treatment processes.

Sludge Age: Synonymous with Solids Retention Time.

Sludge Blanket: The layer of sludge formed in a settling tank (Primary Clarifier; Secondary Clarifier).

Sludge Bulking: Sludge occupying excessive volumes and having poor settling and compaction characteristics due to an excessive number of filamentous microorganisms.

Sludge Digestion: The process by which organic matter in the sludge is converted into more stable compounds through the activities of either anaerobic or aerobic organisms.

Sludge Volume Index: A measure of the settleability/compaction of the mixed liquor, equal to the volume in milliliters occupied by one gram of activated sludge after 30 minutes of settling under laboratory conditions.

Sodium Hypochlorite: Chemical name for commercial liquid chlorine usually delivered as 12.5% active chemical. Used for disinfection of wastewater effluent and/or odor control in some applications (also referred to as hypochlorite). As comparison, household liquid chlorine is typically sold as 5% active chemical.

Solids Loading: An important design parameter for secondary settling tanks which measures the mass of solids applied per unit surface area of the tank.

Solids Retention Time (SRT): See MCRT.

Substrate: The substances (food) used by microorganisms for the growth (synthesis) of new cellular material and the production of energy.

Supernatant: The liquid phase above settling solids and sludge.

Suspended Solids (SS): Solids that are in suspension in liquids; measured as the solids removable by filtration with a specific filter under controlled laboratory conditions.

Toxicity: In wastewater typically used in reference to the inhibition or deleterious effect on microbial activity due to a poisoning or interference with intracellular or extracellular reactions or inhibition or deleterious effect of the treated effluent on aquatic organisms.

Treatment Efficiency: A measure of the amount of a specific pollutant, such as BOD_5 or suspended solids, removed by a waste treatment process, usually expressed in percentage removal.

Volatile Solids: The quantity of solids lost on ignition at 550°C under controlled laboratory conditions; generally considered to be equivalent to the fraction of suspended solids that are biological in origin. See also *MLVSS*.

Waste Activated Sludge: The excess cellular mass produced as a result of microbial degradation of organic matter, i.e., the activated sludge that must be removed from the Activated Sludge system to maintain an appropriate MLSS concentration in the aeration tank to achieve a constant F/M and/or SRT.

Weir Loading Rate: Upflow Rate: The Weir Loading Rate is calculated as the maximum flow that can be applied to the length of the effluent weir. Settling tanks (clarifiers) are designed with a maximum weir loading rate to prevent the influence of excessive density currents causing solids to be re-suspended and carried away in the effluent from the clarifier.

3.5 Preliminary Screening Description

3.5.1 Process Intent or Function

Preliminary treatment is provided to protect all downstream equipment from damage or clogging from rags, debris, or grit. The Preliminary Screening Unit Process is the first process in the treatment plant flow stream. It receives the raw sewage entering the treatment plant from the wastewater collection system and discharges screened wastewater to the grit removal process.

Note: The Preliminary Screening (Headworks) building main equipment room (which contains the main influent channel and bar screen) is a Class 1, Division 1, Group D classified area. All electrical equipment and wiring within this area must comply with NEC requirements for this classification.

3.5.2 Process Description

Wastewater enters the screening building by two forcemains. Isolation valves are available to stop flow to the screen building and divert it directly to the grit system. The purpose of the screen is to prevent large debris from entering the plant and interfering with plant equipment and performance.

The Rotomat screen is automatically cleaned and debris is removed from the flow channel, washed, compressed, and deposited into a hopper for landfill disposal. The automatic screen initiates a cleaning cycle based on an ultrasonic level sensor on the upstream side of the screen. When the level increases to a preset depth, the screen initiates a cleaning sequence. If there is no call from the level controller for a cleaning cycle within a 60-minute period, a timed cleaning cycle will be initiated.

Under normal operations, only the automatic screen is in service. A manual bar screen is also provided for by-pass or emergency operation. The manual bar screen also provides passive operation during periods of very high wastewater levels upstream of the screens.

Discharge from the automatic screens can be directed to the East, West, or to both grit removal units depending on the configuration of the discharge valves. Discharge from the manual bar screen can be directed to the West or both Grit Removal units, but not to the East unit alone.

A detailed description of the equipment operation, start up and shut down procedures, troubleshooting guide, and maintenance requirements can be found in the Lakeside Rotomat Shop Drawing and O&M Manuals located in the ops and maintenance office.

3.6 Grit Removal Description

3.6.1 Process Intent or Function

Two grit tanks (east and west) are available at the plant. Depending on plant flow, only one unit may need to be in operation at any time.

The purpose of the grit tanks is to remove the inorganic sand and grit from the waste stream. Sand and grit enter the wastewater flow from inappropriate storm sewer connections to the sanitary sewer, surface maintenance hole covers and/or from leaky pipe joints. Excessive grit adversely affects the sludge handling systems of the plant and creates excessive wear and tear on pumps and other mechanical equipment. The grit tanks are intended to maintain a minimum velocity to keep lower specific gravity solids (e.g., organic solids) in suspension, and allow heavier grit particles to settle to the bottom.

Note: The grit collector tanks are enclosed tanks and are a confined space and a Class 1, Division 2, Group D classified area. The room housing the grit processing equipment and hopper is a Class 1, Division 2, Group D classified area. All electrical equipment and wiring within these areas must comply with NEC requirements for this classification.

3.6.2 Process Description

The grit collector consists of a square tank, a rotating collector mechanism referred to as a grit scraper arm, a reciprocating grit rake arm for grit removal, and an organic return pump.

Flow entering the tank is uniformly dispersed using a number of adjustable baffles on the inlet end. The tank is sized to produce a velocity necessary to settle grit solids, but keep organic material suspended. The water level in the tank is controlled with an outlet weir.

The settled grit is continually moved from the bottom of the grit tank with a grit scraper arm to the corner of the grit tank where a reciprocating rake arm moves the grit up out of the water on an inclined trough which projects into a building. There is an "organics return pump" (an impeller on a shaft over a hole in the concrete) that circulates wastewater over the grit being raked upwards to rinse organics back into the wastewater flow through the grit tank. There are baffles that can be inserted to control the degree of the rinsing. At the end of the trough the washed grit is discharged into a hopper for landfill disposal. A detailed description of the equipment operation, start up and shut down procedures, troubleshooting guide, and maintenance requirements are provided in the equipment manufacturer’s shop drawings and O&M Manuals located in the maintenance office.

3.7 Primary Settling Description

3.7.1 Process Intent or Function

Primary Clarifiers are provided to reduce TSS and BOD to the activated sludge treatment process. Scum and grease are also removed in this process. Typically, well operated primary clarifiers will remove 50 percent to 65 percent of the TSS and 30 percent BOD.

The goals of operating the primary clarifiers are:

- Remove as much BOD and TSS from the influent as possible upstream of the activated sludge system.
- Thicken settled material into as high a concentration primary sludge as possible for delivery to anaerobic digesters.
- Generate and liberate volatile fatty acids (VFAs) into the primary effluent to improve biological uptake of phosphorous in the activated sludge system.

Note: The Primary Clarifiers are enclosed tanks and are a confined space and a Class 1, Division 1, Group D classified area. All electrical equipment and wiring within this area must comply with NEC requirements for this classification.

3.8 Process Description

3.8.1 General

Wastewater discharges from the grit removal process and enters the Primary Clarifiers. Influent valves allow the wastewater to be distributed to all eight (8) Primary Clarifiers or to be isolated from a specific clarifier. The Primary Clarifiers provide a hydraulic detention time of 1 to 3 hours depending on the flow rate and the number of units in service. This detention time allows solids to settle to the bottom of the tank. Primary effluent overflows effluent weirs and is delivered to the activated sludge process. Floatable material is captured by baffles at the effluent weir and is periodically removed.

A continuously operating chain and flight sludge collector scrapes the bottom of the Primary Clarifier and moves sludge to one end where a hopper is provided for sludge removal. The flights also push floating material towards the scum removal mechanisms.

3.8.2 Scum Removal

Scum is removed by manually activating a helical scraper that moves scum into a scum trough where it is sent by the Primary Sludge Pumps to the digesters.

3.8.3 Primary Sludge Removal

The plant has eight (8) Primary Clarifiers. Each Primary Clarifier has one sludge hopper. Primary Sludge is withdrawn from sludge hoppers located beneath the influent end of the Primary Clarifier. Each hopper has one powered withdrawal valve.

There are two Primary Sludge Pumps (80-P-3A and 80-P-3B). One pump is for duty; the other is a standby. The pumps are pneumatically powered diaphragm type referred to as air operated diaphragm pumps. Stroke filling and emptying times are adjusted locally via suction and discharge air regulator sets. The amount pumped is set by a combination of air operated diaphragm pump strokes per minute and the number of minutes the pump is operated per hopper. The regulators on the air diaphragm pumps' control panels are only adjusted to get full volume per stroke.

Sludge distribution to the five digesters (only three are currently in service digesters 3, 4, and 5) is normally operated automatically, to feed each operating digester in sequence, based on timing entered at a SCADA station.

Primary sludge can also be recycled from the sludge hoppers back to the inlet of the Primary Clarifiers, using the Primary Sludge Pumps. Recycled primary sludge (RPS) aids VFA production in the Primary Clarifiers. VFAs are formed during the decomposition of the sludge. The carbon available in the VFAs, in turn, aids the biological phosphorus removal process in the secondary treatment portion of the plant.

The recycled primary sludge line branches off a common 6-inch primary sludge discharge line. This common primary sludge line also continues on to all five digester inlets via the digester feed header. A pair of automatic block valves, (FV-80-6 and FV-80-7) operating in a flip flop fashion, direct the primary sludge to either the digesters feed header or the primary settling tanks recycle header, respectively. Normally, the primary sludge is recycled. Recycling pauses while feeding the digesters, this occurs on an intermittent basis.

Primary sludge withdrawal from the primary hoppers, delivery and distribution to the five (5) digesters and to the influent header all occur according to operator settings in the plant SCADA.

3.8.4 Primary Sludge Pumps

The duty Primary Sludge Pump never stops operating while the recycled primary sludge program is enabled. There is always one of the eight sludge withdrawal valves open. When advancing to the next sludge hopper, the valve on the previous hopper remains open until the next valve is confirmed open. In the event the plant PLC does not get confirmation from the open-end limit switch from the next valve after a reasonable time, the PLC initiates a fail-to-open alarm, issues a close command to the failed valve, and continues on to try the next available hopper withdrawal valve. The common primary sludge discharge line is always pressurized.

The pumps are arranged such that either or both of the two pumps can be used. Duty selection is made only at the pumps.

While recycling, valve FV-80-7 is open and the Primary Sludge Pump operates at a reduced output. When primary sludge is feeding a digester, the Primary Sludge Pump operates at full output. At a SCADA operator interface, the operator may adjust the pump speed set points. There are two separate setpoints, one for use during recycling and another for use while pumping to digesters.

3.8.5 Primary Recycle (recycled primary sludge) Control Program

Primary recycle should be used to produce the VFA concentrations in the primary effluent necessary to maintain the desired level of biological phosphorus removal in the activated sludge system. With recycling, the sludge concentration may decrease, thereby requiring a higher setting for the pumping time to digesters.

The primary recycle control program includes operator adjustments. At a SCADA station, the operator may:

- Enable or disable the recycling of primary sludge, depending on seasonal needs.
- Adjust control program parameters such as timers.

Note that some adjustments entered in the middle of a valve control sequence will always take effect at the beginning of the next Digester Feed Cycle and/or when the whole auto control strategy is restarted.

While the recycle program is disabled, valve FV-80-6 (to the digester feed header) remains open and valve FV-80-7 remains closed all the time to avoid unnecessary wear on the valves.

3.9 Fine Screening Description

3.9.1 Process Intent or Function

New fine screen equipment provides for the screening of Primary Clarifier effluent, prior to conveyance to the secondary treatment system. Two screening channels, each 2 feet wide, are provided with a mechanically cleaned band screen rated at 10 MGD. The channels have a design water surface depth of approximately 3 feet. The channel depth is controlled by a fixed weir, installed in the effluent channel of each screen. The screened effluent discharges to the influent bay of the screw pumps. The screens have perforated openings of 2 mm, which is the opening size preferred by the membrane system manufacturer.

Material collected on the screen is lifted out of the channel by the rotating screen and removed using a rotating brush and spray water. Each screen discharges the collected screenings to a screenings flume. Effluent water flushes the screenings from the screen and serves as sluicing water to convey the screenings, via the flume, to a screenings compactor for removal of excess water. The compacted or dewatered screenings are bagged to prevent excessive odors with a screenings bagger for periodic removal.

Note: The Fine Screening Building equipment room is a Class 1, Division 1, Group D classified area. All electrical equipment and wiring within this area must comply with NEC requirements for this classification.

3.9.2 Process Description

Normally, one screen is in service at a time. The fine screens operate automatically from the local control panel for each screen. Each screen is equipped with an adjustable speed drive. Each screen will start, based on the differential between the upstream and downstream liquid levels in the screening channel. The screen speed will vary, depending on the differential level. Each screen is anticipated to build up a layer, or mat, of material that will act to prevent slender stringy material from passing thereby enhancing the performance of the screens. This further ensures fouling protection of the membranes.

The screenings compactor will automatically start whenever a screen starts. The compactor will stop, after a time delay, when the screen stops.

In the event that flow exceeds the capacity of the screens, overflow to the screw pump wet well is provided via the two adjustable weir gates. **The weir gates are downward opening and should be positioned at elevation 112.15 (approximately 5 feet below the floor grade). If the weir gates are set higher than 112.15, then overflow would occur through the existing primary effluent overflow directly to the Boardman River.**

3.10 Screened Primary Effluent Pumping and Distribution Description

3.10.1 Process Intent or Function

The purpose of the screened primary effluent pumping and distribution system is to lift the screened primary effluent to the hydraulic level of the Aeration Tank inlet channels and to distribute the flow to the two Aeration Tanks as secondary influent.

Note: The primary effluent screw pumps area is unclassified.

3.10.2 Process Description

Overview. Screened primary effluent is conveyed by gravity from the fine screens to the screw pump influent well. Spiral screw pumps lift the screened primary effluent to the level of the Aeration Tanks. The pump discharge is hydraulically split into two parallel Aeration Tank inlet channels. A motorized

slide gate is located in each channel and positioned to adjust the desired flow split between the north and south Aeration Tanks. The secondary influent flow is monitored downstream of the motorized slide gates via Parshall flumes.

Screened Primary Effluent Pumping. Screened primary effluent pumping consists of three (3) constant speed spiral screw pumps. The pumping process is a continuous operation.

During normal operations, the screened primary effluent flows into the screw pump influent well and one screw pump transfers the influent to the Aeration Tank inlet channels. A second pump is started when the flow exceeds the capacity of the first pump. There is also an adjustable flow setpoint on the SCADA that the operator can adjust, at this setpoint the lag screw pump will turn on automatically. This option was added to help better buffer flow during high flow events. The flow setpoint is based off of influent flows in MGD, normally set at 10 MGD. The pumps are normally assigned a lead-lag-standby duty arrangement and the start/stop operation of the second pump is automatic. Should the lead or lag pump fail, the standby pump automatically starts.

Constant speed screw pumps provide a flexible flow rate, even though they rotate at a constant speed. As the level in the influent well increases and more of the pump becomes submerged, the flow delivered by the pump also increases. The pumping rate is proportional to the water depth in the influent well until the water level goes above the top of the bottom end of the center tube. At that point, the pump reaches its maximum capacity and any further level rise will provide the same pumping rate.

Screw pump inlet sluice gates are provided to isolate screw pumps for maintenance purposes. The gates are manually operated.

The pumps are connected to the existing standby generator, to ensure their operation during times of utility company power failures.

Flow Measurement. Each Aeration Tank inlet channel contains an 18-inch Parshall flume. The contraction (18” throat) of the flume allows for accurate flow measurement as a function of level. An ultrasonic level is used for continuous instantaneous level measurement. The level readings are then converted to flow.

Screened Primary Effluent Distribution. Two (2) motorized screened primary effluent flume gates located upstream of the Parshall flumes are used to adjust the flow split between the north channel and south channel. The gates are automatically positioned based on operator selectable flow split parameters.

3.11 Secondary Treatment Description

3.11.1 Process Intent or Function

Secondary treatment is a biological treatment process. Secondary treatment is provided to remove soluble organic matter, particulate organic and inorganic matter, ammonia, and phosphorus. The process provided also removes a portion of the nitrate formed from the oxidation of ammonia.

Note: The Secondary Treatment areas are unclassified.

3.11.2 Basis of Design

The TCRWWTP effluent discharges into the Boardman River and ultimately Grand Traverse Bay. The facility has been designed to comply with the Michigan Department of Environmental Quality requirements for wastewater treatment including monthly average effluent five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) of 25 mg/L and 30 mg/L respectively. The current discharge permit also establishes a seasonal effluent limit for ammonia nitrogen (NH_3-N) of 11 mg/L and an effluent total phosphorus (TP) limit of 1 mg/L. The Traverse City effluent objectives have been established as 4 mg/L for BOD_5 and TSS, 1 mg NH_3-N /L, and 0.5 mg TP/L.

The Secondary Treatment Process at the TCRWWTP is an activated sludge process that incorporates biological nutrient removal (BNR) and membranes and is herein referred to as a *Membrane Bioreactor* (MBR). The MBR includes Aeration Tanks and Membrane Tanks. The Aeration Tanks include unaerated anaerobic and anoxic zones as well as aerated zones also referred to as aerobic zones. The membrane tanks are aerated tanks with membrane equipment for separation of liquid and solids. The MBR provides biological absorption and oxidation of organic matter (quantified as $CBOD_5$), biological oxidation of ammonia to nitrate, enhanced biological uptake of phosphorus, biological conversion of a portion of the nitrate formed to nitrogen gas, flocculation of colloidal matter, chemical precipitation of phosphorus to supplement biological uptake, and physical separation of liquids and solids.

The process is based on the University of Cape Town (UCT) process configuration, with the anoxic, anaerobic zones and recycle configured to accomplish enhanced biological phosphorus removal. The MBR is capable of treating maximum monthly loads of 20,200 lb/day BOD at 8.5 MGD. The design peak flow is 17 MGD. The membrane bioreactor equipment will allow the effluent TSS and BOD limits to be met, using biological treatment.

The major design criteria for the MBR are presented in Exhibit 6.

Exhibit 6. Design Criteria Table 8-1: MBR – Design Criteria

Parameter	Value/Range1
Number of Aeration Tanks	2
Total Treatment Volume	1.885 MG
Anaerobic Volume	0.059 MG
Anoxic Volume	0.210 MG
Aerated Volume	0.673 MG
Total Volume each Tank	0.942 MG
Solids Retention Time (min SRT)	Min. 6.5 to 8.5 days @ Design Max. Month
Aerated Hydraulic Retention Time	Min. 4.8 hours @ Avg. day flow
Wastewater Temperature	Min. 55^0F (13^0C)
Sludge Yield	0.7-0.8 lb TSS/lb BOD removed
Mixed Liquor Suspended Solids (at membranes)	8,000 - 10,000 mg/L
Mixed Liquor Suspended Solids (Aerated zone)	3,000 – 7,000 mg/L
Oxygen Demand for BOD	0.72 lb/lb BOD applied
Oxygen Demand for TKN	4.6 lb/lb TKN applied
TKN: NH_3-N Ratio	1.2:1
VSS/TSS	70%
Minimum Oxygen Transfer Efficiency	18%
Mixed Liquor Recycle: % Secondary Influent flow rate	
Aerated Zone to Anoxic Zone	100% or 200%
Anoxic Zone to Anaerobic Zone	100% or 200%
Membrane Tanks to Aerated Zone (max.)	400%

3.11.3 Process Description

The influent to the MBR is pumped from the primary effluent screening facility to two (2) secondary influent channels, each with a Parshall flume and individual sluice gates that are controlled to split the flow to the in-service Aeration Tanks.

The Aeration Tanks are arranged in two (2) parallel trains. The tanks are configured in three passes: an anaerobic zone representing a percentage of the first pass, an anoxic zone for the remainder of the first and all of the second passes (with swing zone capabilities) and the final pass an aerated zone. The

secondary influent and mixed liquor recycle containing biological solids are introduced into the anaerobic zone. The combined wastewater referred to as mixed liquor because of the presence of biological solids flows through the anaerobic zone, anoxic zones, and aerated zones of the Aeration Tanks. The flow pattern is generally *plug flow* through the individual Aeration Tank zones. The ML ultimately overflows from the discharge end of the aerated zone into a common Membrane Tanks influent channel.

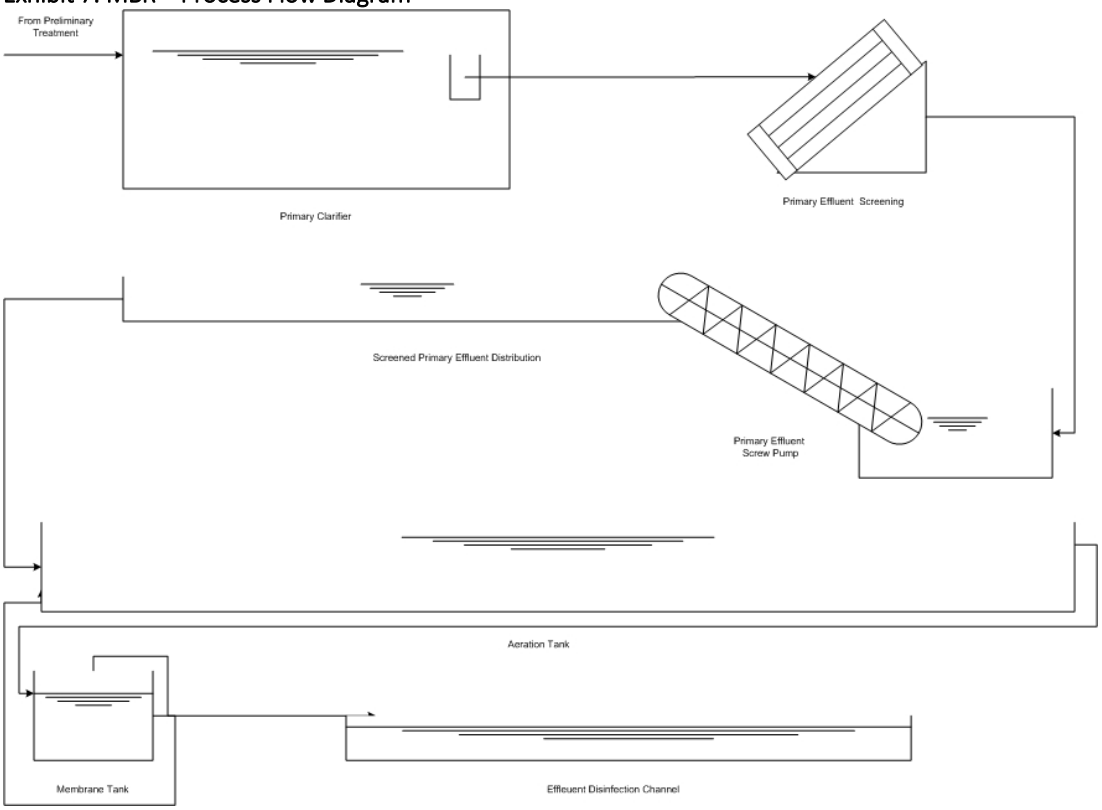
The mixed liquor (ML) from the Aeration Tanks is channeled to the in-service Membrane Tanks. The membrane equipment effectively separates the solids from the liquid phase of the ML by applying suction to the inside of individual membranes with large centrifugal pumps. The separated solids from the ML side (outside) of the membranes, referred to as activated sludge, overflows adjustable gates at the discharge side of the Membrane Tanks. Most of the activated sludge (AS) is recirculated to the front of the aerated zones in the Aeration Tanks as return activated sludge (RAS) and the remaining portion of the activated sludge is directed to the solids handling processes as waste activated sludge (WAS).

Biological phosphorus removal is the main mechanism for phosphorus removal but chemical may be added to the MBR to supplement the phosphorus removal process.

3.11.4 General Arrangement Schematic

Exhibit 7 presents a schematic overview of the Traverse City process flow.

Exhibit 7. MBR – Process Flow Diagram



3.11.5 Relationship to Other Processes

Solids are maintained in the biological system by the return activated sludge (RAS) system, one of three ML recycle systems, that returns the activated sludge solids from Membrane Tanks to the Aeration Tanks. Details are provided in Chapter 10 – RAS Mixed Liquor Recirculation System.

Process air is continuously provided to the aerated zone(s) of the in-service Aeration Tank(s) as supplied by four (4) process air blowers. The aerated zones in the tanks are aerated using a grid system of fine bubble diffusers.

The mixed liquor recycles (MLR) are internal recycles within the Aeration Tanks to allow ML transfer from the final aerated zone to the anoxic zones and from the anoxic zones to the anaerobic zone. The return activated sludge (RAS) system returns biological solids from the Membrane Tanks to the aerated zone of the Aeration Tanks. Excess solids, the *waste* activated sludge (WAS), are removed from the system and directed to Solids Treatment Processes. The WAS is thickened on a Gravity Belt Concentrator and discharged to the Anaerobic Digestion system for further processing.

Recycle streams from Solids Treatment Processes are routed to the Aeration Tanks as internal recycle streams, including the filtrate from the WAS Concentration process and filtrate from the Digested Sludge Concentration process.

Ferric chloride is added to the mixed liquor as it leaves the Aeration Tanks to precipitate remaining phosphorus.

3.12 Membrane Process (MBR) Description

3.12.1 Process Intent or Function

Membrane Bioreactors (MBR) are a combination of suspended growth activated sludge and membrane equipment, with the latter performing the critical solids/liquid separation function that is traditionally accomplished using secondary clarifiers.

MBRs rely upon membrane equipment for liquids/solids separation prior to discharge of the effluent. The membrane equipment installed at the TCRWWTP is an immersed system, i.e. a system that is designed for installation within bioreactor tanks, which utilizes hollow fiber membranes. The system configuration allows the Membranes to withstand the high concentrations and types of solids from the MBR process provided. The MBR design allows:

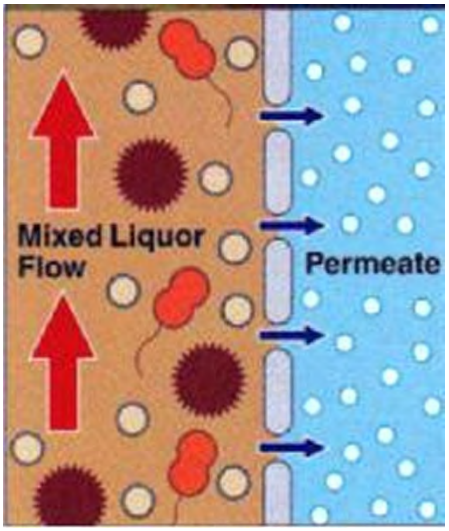
- Biomass to be completely retained; effluent solids concentrations are generally <1 mg/L
- Sufficient solids retention times (SRT) for nitrification;
- SRT to be separate from hydraulic retention time (HRT) allowing independent control of both
- Problems associated with settling and filtration of activated sludge to be eliminated
- Processes to be automated reducing operations requirements
- Reduction of effluent pathogens, such as the chlorine-resistant organisms *Cryptosporidium* and *Giardia*

Note: The Membrane Tanks and equipment areas are unclassified.

3.12.2 Process Description

Membrane Tanks. Mixed liquor flow from the Aeration Tanks is conveyed, by gravity, to the Membrane Tanks. Each of the eight (8) Membrane Tanks are designed to provide continuous treatment of the wastewater (mixed liquor). The number of in-service Membrane Tanks is dependent on the flow. The treated effluent (*permeate*) from the Membrane Tanks is transferred by Membrane Permeate Pumps to the UV Disinfection channel for discharge as plant final effluent (Chapter 11: Effluent Disinfection).

Exhibit 8. Membrane Functional Schematic



The mixed liquor (ML) from the Aeration Tanks is discharged to a ML Channel upstream of the Membrane Tanks. Lowering motorized weir gates at the inlet of each Membrane Tank controls the influent to each of the Membrane Tanks. The Membrane Tank inlet gates are normally fully opened (lowered) to allow unrestricted flow into the in-service tanks.

Each Membrane Tank has an associated variable speed membrane permeate pump. Treated effluent flow is controlled by modulation of the speed of the individual pumps.

The separated activated sludge solids overflow Membrane Tank outlet gates to a common Membrane Tank ML effluent channel referred to as the Return Activated Sludge (RAS) Channel. As in more conventional activated sludge systems the solids are returned to the Aeration Tanks to maintain the biology of the system. The position of the tank outlet gates for the in-service tanks should be similar allowing equal discharge from each tank. Generally, the RAS rate required to *flush* the membranes exceeds the biological requirements and may be as high as 400% of primary effluent flow to the MBR.

The position of the inlet and outlet gates determines whether a tank is in or out of service. The inlet and outlet gates must be fully closed (raised to the maximum position) when a Membrane Tank is taken out of service. Tanks may be off line, i.e. in standby mode or undergoing maintenance and recovery cleaning sequences (discussed in detail in the Maintenance section). The off line (standby) Membrane Tank's membrane permeate pump is also taken out of service. The Membrane Tank service air blowers required during operation for air scour may be operated intermittently to discourage settling and septicity in the off line Membrane Tank.

Membrane permeate pumps are normally controlled such that the flow from the pumps varies with the total flow through the screened primary effluent Parshall flumes. The permeate pump speed control, and therefore the discharge flow, is trimmed based on the level in the RAS Channel. Permeate pumps may be operated to control the differential pressure across the membrane - the trans-membrane pressure (TMP) - at a selected maximum. The level in the Membrane Tanks is monitored such that high level causes the in-service permeate pump speed to increase to a preset maximum. If the level continues to rise the screened primary effluent pump(s) will be stopped.

Note: In the event that primary effluent flow total is zero indicating possible primary effluent flow meter failure, the membrane permeate pumps will vary based off of primary influent flow. This feature was added to the programming to prevent the trains from seeing no flow and going into a standby mode. The system will remain in influent flow mode until primary effluent flow metering is restored and primary effluent flow is selected at the SCADA.

Range of Operation. The permeate rate, i.e. the rate of transfer of liquid across the membrane, is referred to as the flux rate and is measured as gallons per square foot of available membrane area per day. This is typically abbreviated as GSFD. The more concentrated the solids in the feed solution, the lower the flux rate. The remaining (rejected) solids slurry, the difference between the feed rate and the permeate rate, remains as flow through the Membrane Tank. A relatively high ratio of feed volume to permeate volume, controlled in part by the recycle rate, allows the membrane to be self-cleaning. The rejected (recirculated) ML (RAS) continues to concentrate until the flux rate drops to an unacceptable level unless removed from the system, or wasted.

Reduced membrane flux - resulting from short SRT operation - may be related to the fouling of the membrane by the extra-cellular excretions from younger sludge. Immersed membrane operation is not

affected significantly by biopolymer fouling provided that the SRT is at least long enough to perform nitrification, a requirement of the TCRWWTP. Fouling that does occur can be effectively controlled by automated membrane clean-in-place (CIP) procedures.

Higher biological life forms in the MBR (i.e. microorganisms such as protozoa and rotifers) consume particulate organics, which results in more dispersed (smaller) floc particles. The shearing action of the air scour system may also result in more dispersed floc particles. The MBR system avoids issues of filamentous sludge bulking and other floc settling and clarification problems.

The mixed liquor suspended solids (MLSS) concentration in the MBR system will range from 6,000 to 10,000 milligrams per liter (mg/L).

3.13 Mixed Liquor Recirculation Description

3.13.1 Process Intent or Function

The mixed liquor recirculation, referred to as the Return Activated Sludge (RAS) process, is a continuous operation to return the activated sludge biomass separated from the permeate in the Membrane Tanks to the Aeration Tanks. This is required to maintain a high population of microorganisms in the Aeration Tanks to biologically treat the wastewater from primary treatment. The rapid recirculation of solids also minimizes high solids concentration at the membranes, which in turn would cause higher trans-membrane pressures (TMP).

Note: The RAS equipment area is unclassified.

3.13.2 Process Description

Three constant speed RAS pumps (one standby) recirculate mixed liquor from the Membrane Tanks to the head of the aerated zones in the Aeration Tanks.

Each RAS pump has a rated capacity of 15 MGD, for a total of 30 MGD with two pumps operating. RAS is pumped from the bottom of the membrane mixed liquor effluent channel and is conveyed to the aerated portion of the Aeration Tanks through two separate pipes.

The dissolved oxygen concentration of the RAS is expected to typically be about 6 mg/L, which reduces the airflow demand in the aerated zones of the Aeration Tanks.

RAS rates to the Aeration Tanks depend on plant flow and mixed liquor suspended solids concentration (MLSS). Flow control valves on the discharge side of the pumps control the RAS flow to the north and south Aeration Tanks to operator adjustable set points and prevent the RAS pumps from running dry by maintaining a minimum level in the mixed liquor effluent channel. The flow rate is monitored by the SCADA for record keeping purposes.

3.14 Process Air Blower Description

3.14.1 Process Intent or Function

The purpose of the process air blower system is to supply the low pressure air to the aerated zones of the Aeration Tanks. The process air is injected to provide the required dissolved oxygen (DO) content and to keep the contents of the aerated zones adequately mixed.

Note: The Air Blower room is unclassified.

3.14.2 Process Description

Overview. The process air blower system consists of four (4) inlet throttled constant speed drive centrifugal multistage process air blowers, a low pressure air piping system, and fine bubble diffusers to supply process air to the aerated zones of the Aeration Tanks. The process air blower output is varied by

pneumatic butterfly valves, one valve located on the inlet side of each process air blower, to maintain a pressure set point in the air header.

There are two (2) air flow meters, one for each Aeration Tank. Air flow control valves adjust the air flow rate to the aerated zones of each of the Aeration Tanks. Dissolved oxygen (DO) probes are used to monitor the oxygen level in the aerated zones of each Aeration Tank.

DO Control and Minimum Mixing Air Requirements. When automatic DO control is selected, the air flow control valves respond to the DO level in the corresponding aerated zones of each Aeration Tank and will adjust their position to maintain the selected DO setpoint. The operator selects the desired DO probe and the desired DO setpoint to be used for control in the aerated zones of the north and south Aeration Tanks. The DO control system will not allow air flow to go below the minimum air flow setpoint (0.5 cfm/diffuser). The minimum air flow setpoint to the aerated zones of each Aeration Tanks is an operator adjustable parameter and may be modified at SCADA, if required.

Automatic Process Air Blower Control. When automatic process air blower control is selected, the process air blowers in service will automatically adjust output to maintain the selected air header pressure setpoint. The lag process air blower will start/stop automatically if the base-load process air blower(s) does not provide sufficient flow to satisfy the pressure setpoint.

The automatic process air blower control system operates to optimize energy. Energy savings can be obtained by operating the system at the lowest sufficient pressure. Equilibrium can occur with the most open valve in almost any position, but the most efficient operation is with the most open valve at 70-80% open. The automatic process air blower control system monitors the most open air flow control valve. If the valve is greater than 80% open, the process air blower system will increase the amount of air delivered through the valve by increasing the air header pressure setpoint as required. Conversely, if the most open valve is less than 70% open, the process air blower system will decrease the amount of air by decreasing the air header pressure setpoint as required.

The operator may also start/stop the process air blowers manually from SCADA or locally from the MCC/local control panel.

3.14.3 Chemical System Description

Process Intent or Function. The in-service membranes require cleaning on a regular routine basis. Two methods of in-tank cleaning, also referred to as Clean-In-Place (CIP), have been provided. Separate chemical systems are in place to feed sodium hypochlorite or citric acid to the membranes without removing the membrane cassettes from their respective tanks. The citric acid cleaning system is presented first followed by the sodium hypochlorite system.

Note: The Membrane Building areas are unclassified.

Process Description. The Membrane Building contains a chemical storage area and feed systems used for all membrane cleaning operations. Citric acid is fed to the membranes via a system of pumps and delivery piping. Two (2) citric acid dosing pumps are available and operate as duty-standby to deliver chemical as required. Bulk chemical is delivered in totes to the chemical storage area and transferred to a storage tank in the storage area. Concrete curbs provide containment in the event of a spill.

An alternative is available to cleaning membranes. Individual cassettes can also be cleaned using the Dip Tanks. This is a manual operation where the desired concentration in the dip tank is achieved by manually transferring citric acid with the pneumatic dosing pumps.

Maintenance cleaning with sodium hypochlorite is operator selectable (maximum cleaning interval is once every four (4) days) except on days when cleaning with citric acid is performed (maximum cleaning interval every 12 days). Recovery cleaning of each train of membranes is performed at a maximum interval of three (3) times per year with sodium hypochlorite and one (1) time per year with citric acid.

The operator, using the Zenon PLC via SCADA, will initiate the desired cleaning operation. The backpulse flow rate is pre-set depending on the cleaning operation. The backpulse flow rate is automatically monitored and controlled using a flow meter and flow control valve by the Zenon PLC. The backpulse pump can also be operated manually, with start, stop, and speed controls at the local control panel.

Each citric acid pump is equipped with a high rate and low rate air supply. Air supply pressure regulators permit field adjustment of the high and low delivery rates. The air supply valves will be operated via the Zenon PLC. Depending on the type of cleaning sequence selected, the high rate or low rate will provide the desired volume to achieve the required concentration, by establishing a flow-proportional flow with the backpulse. The required concentration of citric acid is 1000 mg/L when combined with backpulse water for a full tank maintenance cleaning and 2000 mg/L for an empty tank maintenance cleaning. The required concentration of citric acid for recovery cleaning is 8,000 mg/L. The cleaning sequence is initiated by the operator from SCADA and the operator can abort the CIP or maintenance procedure at any step of the sequence. The system will then return the tank to the service mode, including filling and backpulsing.

The level in the membrane tank is continuously monitored with a level sensor. The level signal is used by the Zenon PLC for tank filling, tank draining, and establishing the level of chemical solution for cleaning.

3.15 Ultraviolet Disinfection Description

3.15.1 Process Intent or Function

Disinfection is the final treatment process prior to final discharge. The Ultraviolet (UV) disinfection process uses ultraviolet light to inactivate pathogens (disease causing microorganisms which include certain bacteria, viruses, and protoza) before final effluent discharge.

Note: The UV area is unclassified.

3.15.2 Process Description

Wastewater from the membrane permeate pump enters the UV channel inlet wet well. The inlet wetwell splits the flow into two channels. Normally, both UV channels are in service but isolation gates are available if one channel is in need of service. Isolation gates are also available to stop flow to the UV channel and divert it directly to the outfall.

The channels have locations for fourteen UV lamp modules, seven (7) per channel. However, in order to pass peak design flow only eight (8) modules, four (4) per channel are installed. There is one bank per two modules. Each bank consists of one module in each channel. The two modules in a bank are adjacent to each other in the two channels and turn on and off together when UV dosage is flow paced. Each module contains 40 vertically oriented UV lamps. The modules may be removed and the total number of modules in a channel at any given time can vary. As wastewater flows through each channel it passes through this series of lamps and is disinfected. Banks of modules can be turned on or off to match the proper dosage to the flow.

The water level in the channel must be maintained within a range of 57.5 inches to 62 inches. If the water level is lower than the minimum depth, a portion of the UV lamp may be exposed to the atmosphere. This could lead to lamp overheating, and possible exposure of the UV light to plant operators. If the water depth is higher than the maximum, then some of the wastewater may not be fully disinfected or the electrical components could become flooded.

At the end of the UV channel, an adjustable weir is provided to maintain the proper depth of water in the channel over a wide range of flow conditions. Wastewater passing over the weir falls into a final wetwell and is routed to the plant outfall. During periods of high flow and/or high lake level, the water elevation in the final wetwell may exceed the level of the back of the automatic weir. In this situation the operator should manually lift the weir gate to allow maximum flow over the weir.

3.16 Waste Activated Sludge Concentration Description

3.16.1 Process Intent

The purpose of waste activated sludge (WAS) concentration is to remove water from (i.e., thicken) the waste sludge from the Membrane Bioreactor (MBR), thereby reducing the volume pumped to the anaerobic digesters. This may also reduce the volume stored in the on-site biosolids storage facilities and hauled for land disposal (i.e., injected into farmland).

Note: The WAS Concentration area is unclassified.

3.16.2 Basis of Design

The design criteria are detailed in Exhibit 9.

Exhibit 9. WAS Concentration Design Criteria

Parameter	Value/Range
Design Average WAS Solids	11,600 lb./day
Design Average WAS Concentration	7,000 to 10,000 mg/L
Design Average WAS Flow	139,100 to 198,700 gpd
Design Peak Week WAS Solids	16,100 lb./day
Design Peak Week WAS Concentration	10,000 mg/L
Design Peak Week WAS Flow	193,000 gpd
Average Processing Time	8 hr/day
Thickened WAS Concentration	5.5 percent, dry solids

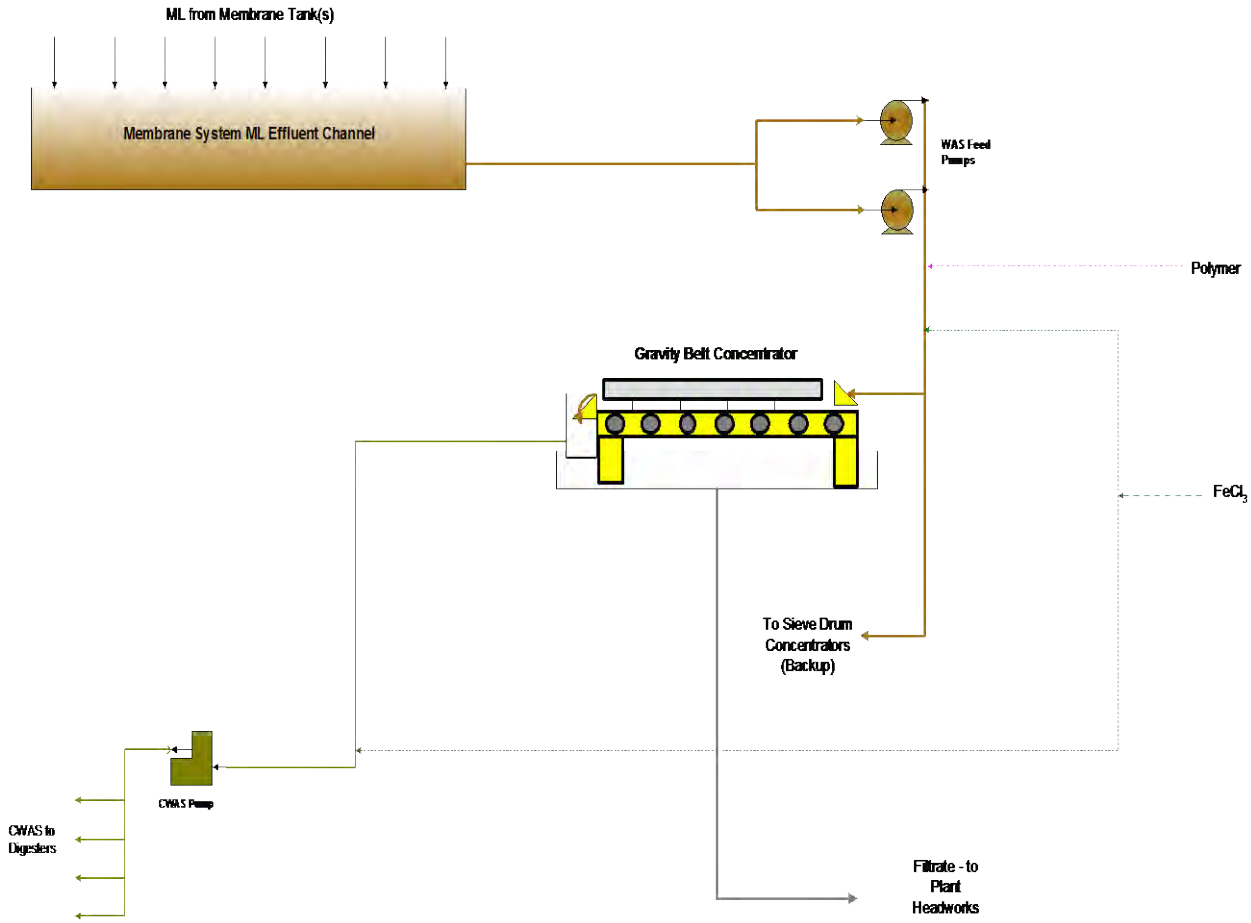
3.16.3 Process Description

The waste activated sludge (WAS) is pumped from the WAS Box to the Gravity Belt Concentrator (GBC). The GBC consists of a permeable, continuous belt that travels horizontally across a series of rollers. Polymer is injected into the WAS in the pump discharge header upstream of the GBC to flocculate the activated sludge solids. Conditioned activated sludge fills a floc tank at the head of the GBC, which is designed to provide adequate mixing and reaction time of the polymer with the sludge solids. The conditioned activated sludge fills the tank and overflows onto the traveling belt. The belt travel speed is operator adjustable to optimize the retention time of the conditioned sludge on the belt to allow maximum water release and, therefore, maximize the concentration of the activated sludge at the end of the belt travel. The lateral position of stationary plows or chicanes along the belt are manually adjustable to create furrows and open clear sections of the belt to aid in free water release and belt drainage. A polyethylene doctor blade, with an adjustable tensioning arm, removes the thickened sludge from the belt at the discharge end of the machine. Concentrated waste activated sludge (CWAS) is discharged to a thickened sludge hopper that directly feeds an open throat progressive cavity pump. From there it is pumped to the Anaerobic Digestion system. The liquid released from the sludge drains through the belt to a filtrate collection box.

Ferric chloride can be added to the WAS upstream or the CWAS downstream of the GBC to chemically fix the phosphorus that was taken up biologically in the activated sludge system.

3.16.4 General Arrangement Schematic

Exhibit 10. WAS Concentration – Process Flow Diagram



3.17 Primary Sludge and CWAS Distribution to Anaerobic Digestion Description

3.17.1 Process Intent or Function

Primary sludge (PS) and concentrated WAS (CWAS) are stabilized within the five anaerobic digesters. Flow control and proper distribution to each digester is important in maintaining effective anaerobic treatment.

Note: Galleries containing digester gas piping are rated as follows:

- Class 1, Division 2 when ventilated at less than 6 air changes per hour
- Unclassified when ventilated at 6 or more air changes per hour

All electrical equipment and wiring within these areas must comply with NEC requirements for this classification.

3.17.2 Process Description

Overview. Concentrated WAS (CWAS) and primary sludge is pumped to the digesters for solids stabilization. See section 1.1.9 for primary sludge removal description.

Concentrated Waste Activated Sludge (CWAS). The digesters also receive concentrated waste activated sludge from CWAS pumps (85-P-1, 80-P-8, and 80-P-9). CWAS is normally produced seven days a week during day shifts. It is continually transferred to all operational digesters via the digester feed header.

3.18 Anaerobic Digestion Process Description

3.18.1 Process Intent or Function

The objectives of anaerobic sludge digestion are:

- Reduction of pathogenic organisms (viruses, bacteria, parasites)
- Decomposition of putrescible organic material
- Reduction of mass of solids for disposal
- Production of methane gas that can be utilized as fuel

Note: Digesters are enclosed tanks and are a confined space and a Class 1, Division 1 classified area. Digester Control Building No. 2 has the following ratings:

- Pump Room: Unclassified when ventilated at 6 or more air changes per hour
- Gas Equipment Room: Class 1, Division 2
- Boiler Room and Electrical Room: Unclassified

Underground Galleries containing digester gas piping:

- Class 1, Division 2 if ventilated at less than 6 air changes per hour
- Unclassified if ventilated at 6 or more air changes per hour
- Within 10 feet of digester gas valves and appurtenances is Class 1, Division 1 at < 6 air changes per hour and Class 1, Division 2 at ≥ 6 air changes per hour

All electrical equipment and wiring within these areas must comply with NEC requirements for this classification.

3.18.2 Description

Overview. The anaerobic digestion system consists of five anaerobic digesters, complete with the following auxiliary systems:

- Sludge recirculation pumping
- Sludge heating system
- Sludge mixing system
- Digester gas handling system

Digestion. The anaerobic digestion process produces acid forming reactions and methane fermentation reactions. Both types of reactions are influenced by temperature, pH and food conditions. The rate of the two types of reactions must be approximately equal in order to maintain a balanced system.

Sludge Recirculation, Heating and Mixing.

Recirculation. The digesters are equipped with recirculation pumps:

- 80-P-1A and 80-P-1B service Digesters 1 and 2
- 95-P-1 and 95-P-2 services Digesters 3 and 4
- 97-P-2A and 97-P-2B service Digester 5

Normally, one sludge recirculation pump per digester will be operating whenever the digester is in service. The operator will adjust valve positions to divert recirculating sludge through heat exchangers to the degree necessary to maintain desired digester operating temperature. The operator normally operates each sludge recirculation pump locally.

The operator will adjust a throttling valve to regulate the portion of the sludge flow which passes through the sludge heater. Closing the throttling valve on the sludge heater bypass line will force more

flow through the heater. If the valve is not closed enough, insufficient sludge will be heated and the desired digester temperature might not be maintained.

If the valve is closed too much, insufficient sludge will be recirculated to the mixing nozzles in the digesters and mixing performance might not be maintained.

Normally, the boilers will operate automatically to provide hot water. The boilers will respond to a temperature probe on the hot water supply and will add heat to maintain a selected temperature.

Heating. The temperature in the digesters should be maintained evenly at all levels of the digester at 95°F (+/-1°F). It is important to never change the temperature more than 1°F per day. Maintaining the correct operating temperature in the digesters is an important process requirement. The raw sludge that enters the digesters is well below the operating temperature of 95°F. Therefore, heat is required to raise the temperature of the raw sludge. There is also some heat loss from the digesters and from the piping. That heat loss also represents a demand for thermal energy.

The heat exchangers, or sludge heaters, use hot water from two boiler packages to provide heat to the sludge. The heated sludge is then returned to the originating digester. Sludge is heated by directing a portion of the main flow through the sludge heater. Digester No. 5 has a dedicated sludge heater (97-HE-1). Digesters No. 1 and 2 alternately share a sludge heater (80-HE-1), and Digesters 3 and 4 have a dedicated sludge heater that are piped to allow either digester to be circulated through either heater.

Two boilers provide hot water for all sludge heaters. The boilers use digester gas or natural gas for fuel and are sized to utilize all the digester gas available. Hot water circulation pumps move the hot water around the hot water loop, while each sludge heater is served by a local secondary hot water circulation pump.

Mixing. Digester mixing is essential to the digestion process, the ability of the mixing equipment to keep the tank completely mixed speeds digestion greatly. Several important objectives accomplished in a well-mixed digester are as follows:

- Immediate inoculation of the raw sludge with the microorganisms
- Prevention of a scum blanket
- Maintaining the contents within the tank homogeneous: including the even distribution of food, organisms, alkalinity, heat and waste bacterial products
- Minimum build-up of grit and inert solids on the bottom of the digester, thus enabling the utilization of the maximum total contents and minimizing digester cleaning

The recirculation pumps are used in digester mixing by pumping the sludge through mixing nozzles located throughout digesters No. 1, 2, and 5. Digesters No. 3 and 4 use gas lift mixers for primary mixing, and their sludge recirculation pump provides secondary, or added, mixing.

Digester Gas Handling. Digester gas is generated during the anaerobic digestion process. The gas is withdrawn from the gas collection space above the sludge liquid level. The digester gas flow is primarily utilized for the operation of the boilers and excess digester gas is burned in the waste gas flare.

Digester gas bubbles through the liquid sludge and gathers in the digester headspaces. These headspaces are gas-tight, and retain the gas so that the pressure under the roofs increases as gas production continues. The floating cover on Digester 4 will also rise and fall in response to a digester gas pressure increase or decrease. Free passage of the digester gas from the headspace of each digester to the digester gas utilization system and flares must be maintained at all times to prevent damage to the digester roofs and discharge of digester gas to the atmosphere. Free passage is maintained by ensuring the isolation valve on the digester gas pipe from each digester is open at all times when that digester is in service, by ensuring condensate is drained as frequently as required to keep the digester gas pipes

free of water accumulation, and by addressing foaming or high sludge level conditions in the digester to keep the digester gas piping free of solids accumulations.

Pressure/vacuum relief valves (PVRVs) are provided on the roof of Digester's 3, 4, and 5 and water seals are provided on Digesters 1 and 2 to protect the digesters from over pressurization which if allowed to occur would likely do serious structural damage to the digesters. The PVRV assembly on the newest digester, Digester 5, includes two PVRVs and a 3-way isolation valve rather than a traditional manual isolation valve. This 3-way valve ensures that one of the two pressure PVRVs is always open to the atmosphere.

The digester gas in the headspace is at roughly 95 °F (35 °C) and is saturated with respect to water. As the digester gas exits the digesters through the digester gas piping it will cool and water vapor will condense. Therefore, drip traps are provided at low points in the digester gas system to remove the condensate. There are 6 or 7 drip traps. Without regular removal of the condensate the water will block the flow of the digester gas to the boilers and flares. This will result in a release of digester gas through the pressure relief valves on the roof of each digester. This is comparable to a natural gas leak on top of the digesters and represents an explosion risk, fire risk, oxygen deficient atmosphere risk. Also, because hydrogen sulfide is also present in digester gas, a release also represents a toxicity risk. Depending on the concentration, inhalation of hydrogen sulfide can be instantly fatal and has killed many WWTP personnel. The drip traps provide a safe means of removing condensate without risk of releasing digester gas into the room. The drip traps contain a positive shut off so that when opened to drain condensate the drip trap is isolated from the digester gas piping. A sediment trap is also provided from Digester 5 to remove solids carried out in the digester gas and to provide some storage of condensate prior to draining with a drip trap.

Digester gas pressure in the system will be controlled by digester gas utilization in the boilers unless digester gas production exceeds utilization. If this occurs the digester gas pressure will be controlled by the pressure relief valve to the flare and digester gas will be flaring.

3.19 Digested Sludge Description

3.19.1 Process Intent or Function

Digested sludge is stored in the sludge holding tanks before being transported by tanker truck to be land applied.

The purpose of concentrating or thickening the digested sludge is to both reduce the volume of biosolids to be hauled from the plant, as well as provide a suitable product for land application.

Note: The sludge concentration areas are unclassified.

3.19.2 Process Description

Overview. Digested sludge is normally concentrated via two sieve drum concentrators (SDCs), located in Facility 80. Four digested sludge transfer pumps are used to transfer the digested sludge to the SDCs. Polymer is added upstream of the SDCs in order to assist the thickening process.

The concentrated digested sludge, CDS, is pumped to the sludge storage tanks.

Normal Operation - Digested Sludge Concentration. Digested sludge concentration operates daily, usually for an eight-hour shift. All control functions are available at the local control panel, LCP-80-SDC-1A and LCP-80-SDC-2A.

Alternate Operation – Digested Sludge Concentration. In the unlikely event that both sieve drum concentrators are out of service, the gravity belt concentrator (GBC) can be used to concentrate digested sludge. All valving is manually set to provide the desired flow route.

Alternate Operation – WAS Concentration. In the event that the gravity belt concentrator or CWAS pump is out of service, the WAS can be directed to a sieve drum concentrator for processing. Using a sieve drum concentrator will require more processing time, as the hydraulic capacity of a sieve drum concentrator is much lower than a gravity belt concentrator.

WAS is provided by WAS pumps located at the Membrane Building. The concentrated waste activated sludge (CWAS) is pumped from the concentrators to the digesters via the concentrated sludge pumps. All valving is manually set to provide the desired flow route.

3.20 Biosolids Storage and Haul Out Description

3.20.1 Process Intent or Function

Sludge storage tanks provide storage of concentrated digested sludge prior to loading to trucks for agricultural application. Additional sludge storage was created from the former final settling tanks and the former sludge thickener. These tanks are covered and provided with mixing nozzles fed from chopper type recirculation pumps located in the Sludge Loadout Building, which was the former Sludge Return and Thickener Building.

Concentrated digested sludge is normally delivered to the sludge storage facilities by sludge pumps located by the sieve drum concentrators in the Sludge Concentrator and Polymer Addition Building. In the unlikely event that both sieve drum concentrators are out of service, the gravity belt concentrator may be used to process digested sludge and transfer the concentrated digested sludge to storage. Each of the three new storage tanks will be mixed intermittently, using one of the two mixing pumps provided. A branch line off the recirculation pump discharge line is used to load tank trucks up to 9,000 gallons.

Note: The sludge storage tanks are a confined space and a Class 1, Division 1 classified area. All electrical equipment and wiring within these areas must comply with NEC requirements for this classification. The sludge loadout areas are unclassified.

3.20.2 Process Description

The sludge storage recirculation and loading system is operated manually. The operator determines the desired tank to receive sludge and adjusts the valve positions to direct the sludge flow accordingly. Sludge flows to storage from the sieve drum concentrators are monitored with a flow meter. In the event that both sieve drum concentrators are out of service and the gravity belt concentrator is processing digested sludge, the concentrated digested sludge is conveyed to the sludge storage tanks using a different metered line.

In the Sludge Loadout Building, the piping and recirculation pumps are arranged such that either of the two pumps can be used for any one of the three tanks. Normally, only one pump is in service, mixing one tank at any given time. The operator will open and close the appropriate valves to redirect the recirculated sludge flow to a different tank to mix and blend the contents. The incoming concentrated sludge can be directed to the suction line of the operating recirculation pump, or conveyed directly to a storage tank without using the recirculation pump.

A branch line connected to the recirculation pump discharge header is used to load tank trucks periodically. The operator manually opens and closes the loadout valve to start and stop loading, respectively. The operator can start and stop the recirculation pump and adjust the pump speed via local controls at the loading platform. The loading platform controls can be disabled, using a selector switch in the pump house.

In the Sludge Storage Facility, sludge is directed to one of the four sludge storage tanks (Tanks 1 to 4) by opening the appropriate inlet valve. Recirculating mixers are available to mix the sludge if needed. Telescoping valves are available for each tank to decant supernatant.

Sludge loadout is controlled manually using the Marlow pump to fill tanker trucks.

Manual measurements of storage tank levels are used for recordkeeping. Each sludge storage tank is provided with high level float switches, which will initiate an alarm when the tank liquid level reaches a high level.

3.21 Sludge Concentration – Polymer System Description

3.21.1 Process Intent or Function

Polymer conditioning of sludge is required prior to sludge feed to a sieve drum concentrator (SDC) or gravity belt concentrator (GBC). The polymer flocculates the sludge particles so that water can be released from the sludge and the sludge concentrated (i.e., thickened). Polymer conditioning is also necessary to achieve a high solids capture. Concentrating the sludge minimizes the size required for the digesters and sludge storage tanks and high solids capture prevents the solids from being recycled back into the liquid treatment processes.

Note: The Polymer system areas are unclassified.

3.21.2 Process Description

Overview. Polymers are chemicals that assist in binding smaller sludge particles into larger sludge particles or flocs, which can be more easily removed by thickening and dewatering equipment. Polymers can be anionic (negative charge), cationic (positive charge), or non-ionic (neutral charge). Some polymers work better than others, based on the properties of the sludge stream to be conditioned. As a result, the polymer systems have been designed to store, prepare (mix), and meter both cationic and anionic polymers. The actual selection of polymers used at the plant were determined by pilot testing, along with technical and economic analyses. The selected polymer can change over time if sludge characteristics vary, polymer prices change, new polymers become available and is reevaluated every few years or as needed.

Sludge Concentration Polymer Units. The current selection is a high-molecular weight cationic polymer and it is used to condition both the waste activated sludge (WAS) and the digested sludge prior to thickening (concentration).

The polymer is delivered in 50-pound bags, which are manually emptied into the hopper of the polymer make-up system. The dry polymer is mixed with plant service water (W2) and aged in the mix tank. The solution is then gravity drained to the holding tank.

The polymer solution, usually mixed to approximately 0.5% concentration, is further diluted in the post-dilution unit with plant effluent (W3), and pumped to the injection ports upstream of both the gravity belt concentrator and the sieve drum concentrators where it is mixed with the feed sludge.

3.22 Odor Control System

3.22.1 Description

Process Intent or Function. Foul air is generated at several locations at the plant. Two odor control systems are provided to capture and treat foul air to control odors. One system uses activated carbon to remove hydrogen sulfide and other odor producing compounds. The other system uses the aerated zones of the Aeration Tanks to treat foul air.

Process Description. The activated carbon system (Phoenix system) treats foul air from the east and west grit buildings, the primary clarifiers, the sludge concentrator building, and the WAS thickening building. Air is drawn from these buildings by Blower B-2, located outside of the odor control building. Foul air is delivered to the Phoenix system and flows through the activated carbon canisters and is discharged to the atmosphere.

Activated carbon is limited in the amount of H_2S and other compounds it can adsorb. When the carbon is no longer effective at removing odors, it can be regenerated by washing with water. An automatic controller operates the regeneration and drying cycles on the Phoenix system. The length of time between regenerations and other variables are operator adjustable. A detailed description of the operator set points is provided in the manufacturer's O&M manual.

Foul air from the preliminary treatment building, the primary effluent screw pumps and the fine screen building is conveyed in a system of foul air ducts to the intake structure for the process air blowers. The foul air is used as process air in the aerated zones of the Aeration Tanks. The odorous compounds are removed in the activated sludge process by a combination of adsorption onto the biological floc particles and the biological activity in the system. No additional controls are necessary for this system.

3.23 Lift Stations Operated and Maintained by CH2M

3.23.1 Lift Stations Description

CH2M is currently contracted to operate and maintain the following lift stations in Exhibit 11 for the City of Traverse City. This includes routine inspections, maintenance, and emergency response. A 6-inch self-priming diesel bypass pump is available for emergency bypassing.

Exhibit 11. CH2M Operated and Maintained Lift Stations

Lift station	6-inch or 4-inch Bypass Capable	Portable Generator Capable	Standby Generator Onsite
Bay Street	Yes	Yes	No
Birchwood	Yes	No	Yes
Clinch park	Yes	Yes	No
Coast Guard	Yes	Yes	No
Hull Park	No	No	No
Front Street	No	No	Yes
Riverine	Yes	Yes	No
Woodmere	Yes	No	Yes
TBA	Yes	Yes	No

3.23.2 Birchwood Lift Station

Birchwood Lift Station is located at 2060 East Front Street in Traverse City. This station consists of two non-clog dry pit Hydodynamic pumps capable of pumping 800 gpm at 40 foot TDH. The station maintains a wet well level via a milltronics level transducer that cycles the pumps in a lead lag configuration based on the level. The station also consists of high level and low level float switch alarms and power failure alarms that trigger an alarm dialer to call the on-call person or persons. In the event of a loss of power supply to the lift station, a Genset 55 KW diesel powered standby generator with an automatic transfer switch will start and supply power to the station. An alarm will initiate to let the on-call operator know the station is on generator power. The generator has an estimated full tank run time of 24 hours.

3.23.3 Bay Street Lift Station

Bay Street Lift Station is located at 580 Bay Street in Traverse City. This station consists of two 4 inch submersible 9.4 HP pumps capable of pumping 430 gpm at 32 feet TDH. The station maintains a wet

well level via a milltronics level transducer that cycles the pumps in a lead lag configuration based on the level. The station also consists of high level and low level float switch alarms and power failure alarms that trigger an alarm dialer to call the on-call person or persons. This station does not have standby generator power and must be supplemented with a portable generator. This station is also equipped with a mixer to help homogenize the waste within the well and aid in buildup of grease and other materials.

3.23.4 Clinch Park Lift Station

Clinch Park Lift Station is located at 111 East Grandview Parkway in Traverse City. This station consists of two submersible 3 inch 2.4 HP Flygt pumps capable of pumping 175 gpm at 21 feet TDH. This station operates via float switches consisting of a low level, stop, start, lag and high level floats with a lead/lag alternator. An alarm dialer is set to call out in the event of a low level, high level or power failure. This station does not have standby generator power and must be supplemented with a portable generator.

3.23.5 Coast Guard Lift Station

Coast Guard Lift Station is located at 911 Airport Access Road in Traverse City. This station consists of two submersible 4 inch 17.5 HP ABS pumps capable of pumping 400 gpm at 70 feet TDH. The station maintains a wet well level via a milltronics level transducer that cycles the pumps in a lead lag configuration based on the level. The station also consists of high level and low level float switch alarms and power failure alarms that trigger an alarm dialer to call the on-call person or persons. This station does not have standby generator power and must be supplemented with a portable generator.

3.23.6 Hull Park Lift Station

Hull Park Lift Station is located at 660 Hannah Avenue in Traverse City. This station consists of one submersible 1 ¼ inch 2.0 HP Hydromatic grinder pump. The station maintains a wet well level via a float switch configuration of pump on, pump off and high level. This station is only operated seasonally and is equipped with an alarm light located on top of the control cabinet that indicates a high level condition. This station is located just outside the Traverse City WWTP gate and is monitored for alarm conditions daily.

3.23.7 Front Street Lift Station

Front Street Lift Station is located at 439 East Front Street in Traverse City. This station consists of three dry pit VFD run ITT A-C pumps capable of pumping 3100 gpm each. Front Street is equipped with a diesel powered 230 KW standby generator with an automatic transfer switch. This delivers the most amount of flow to the TCRWWTP and is the only station currently monitored from the SCADA system at the treatment facility. Front Street is set up with a backup float control system in the event of a milltronics level sensor failure. The station will also contact the on-call operator through the TCRWWTP SCADA system in the event a low level alarm, high level alarm, power failure, VFD failure, or PLC failure occurs.

3.23.8 Riverine Lift Station

Riverine Lift Station is located at 318 East Eight Street in Traverse City. This station consists of two nonclog dry pit 4 inch 7.5 HP pumps capable of delivering 350 gpm at 37 feet TDH. This station is a can-style pump station with a ladder access to access the pump control room below grade. The station is equipped with a fresh air supply blower that starts when the can lid is opened. The pumps operate off a float switch system that includes low level alarm, stop, start, lag pump start, and high level alarm. The low level and high level alarms and loss of power are connected to an auto dialer that calls out to the oncall operator when condition exist. This station does not have a standby generator and in the event of a power loss would need to be supplied with a portable generator.

3.23.9 Woodmere Lift Station

Woodmere Lift Station is located at 645 Woodmere Avenue in Traverse City. This station consists of two submersible 4 inch 6.4 HP Flygt pumps capable of pumping 450 gpm at 25 feet TDH. The station maintains a wet well level via a milltronics level transducer that cycles the pumps in a lead lag configuration based on the level. The station also consists of high level and low level float switch alarms and power failure alarms that trigger an alarm dialer to alert on-call staff. This station is equipped with a standby natural gas powered generator with an automatic transfer switch.

3.23.10 TBA Lift Station

TBA Lift Station is located at 890 Parsons Road in Traverse City. This station is a can-style station equipped with a fresh air blower system that is enabled when the lid is opened. The pumps and control panel are accessed via a ladder into the bottom of the station. This station consists of two dry pit 5 inch 15 HP pumps capable of delivering 700 gpm at 35 feet TDH. The pumps operate off a float switch system that includes low level alarm, stop, start, lag pump start, and high level alarm. The low level and high level alarms and loss of power are connected to an auto dialer that calls out to the on-call operator when condition exist. This station does not have a standby generator and in the event of a power loss would need to be supplied with the portable generator. This station can be bypassed using the 6-inch diesel bypass pump. TBA will be upgraded in summer of 2016, this upgrade includes coating of inside of can, new pumps, controls, and a new control cabinet that will be mounted at grade outside of the can.

4.0 Inventory or Fixed Assets

Refer to Attachment 2 (Traverse City's Collection System Fixed Assets) for the Traverse City Collection System asset inventory. Refer to Attachment 3 (TCRWWTP and Lift Stations Fixed Assets) for the TCRWWTP and Lift Stations. The Grand Traverse County Collection System asset inventory is in the process of being completed.

5.0 Business Risk Evaluation Process

The Traverse City Collection System Risk Evaluation- SAW grant scope of work is scheduled to be completed by June 30, 2017. (See Attachment 4, Traverse City's SAW Grant Scope of Work). The Grand Traverse County Collection System Risk Evaluation schedule has yet to be determined. Meanwhile, CH2M has identified all the major assets at the TCRWWTP and Lift Stations. A condition assessment and an asset management analysis will be performed on these assets by June 30, 2017.

6.0 Operation and Maintenance Budgets/Rate Calculation Process

The Rate Calculation and budget for the Traverse City Collection System is located in Attachment 5A (Traverse City's Wastewater Fund) and 5B (Traverse City's Rate Calculation). The Grand Traverse County Collection System rate calculation is yet to be determined.

CH2M has $115,000 budgeted for equipment repairs for the TCRWWTP and Lift Stations in the coming year. If additional funds are needed, CH2M will request separate funding (Approval) from the City. Capital Improvements and large maintenance expenditures are funded through Traverse City's Wastewater fund and by Grand Traverse County. (Please refer to Attachment 5A and 5B).

7.0 Capital Improvement Plans

Traverse City Collection System, Lift Stations, and TCRWWTP Capital Improvement Plans are located in Attachment 6A (Summary of Traverse City's CIP) and 6B (Narrative of Traverse City's CIP). A plan for the Grand Traverse County Collection System and Lift Stations is yet to be determined.

8.0 Current Improvement Initiatives

Current Improvement Initiatives for the Traverse City Collection System are located in Attachment 4.

Grand Traverse County Collection Improvement Initiatives have yet to be determined.

The TCRWWTP and Lift Stations improvement initiatives are located in Exhibit 12.

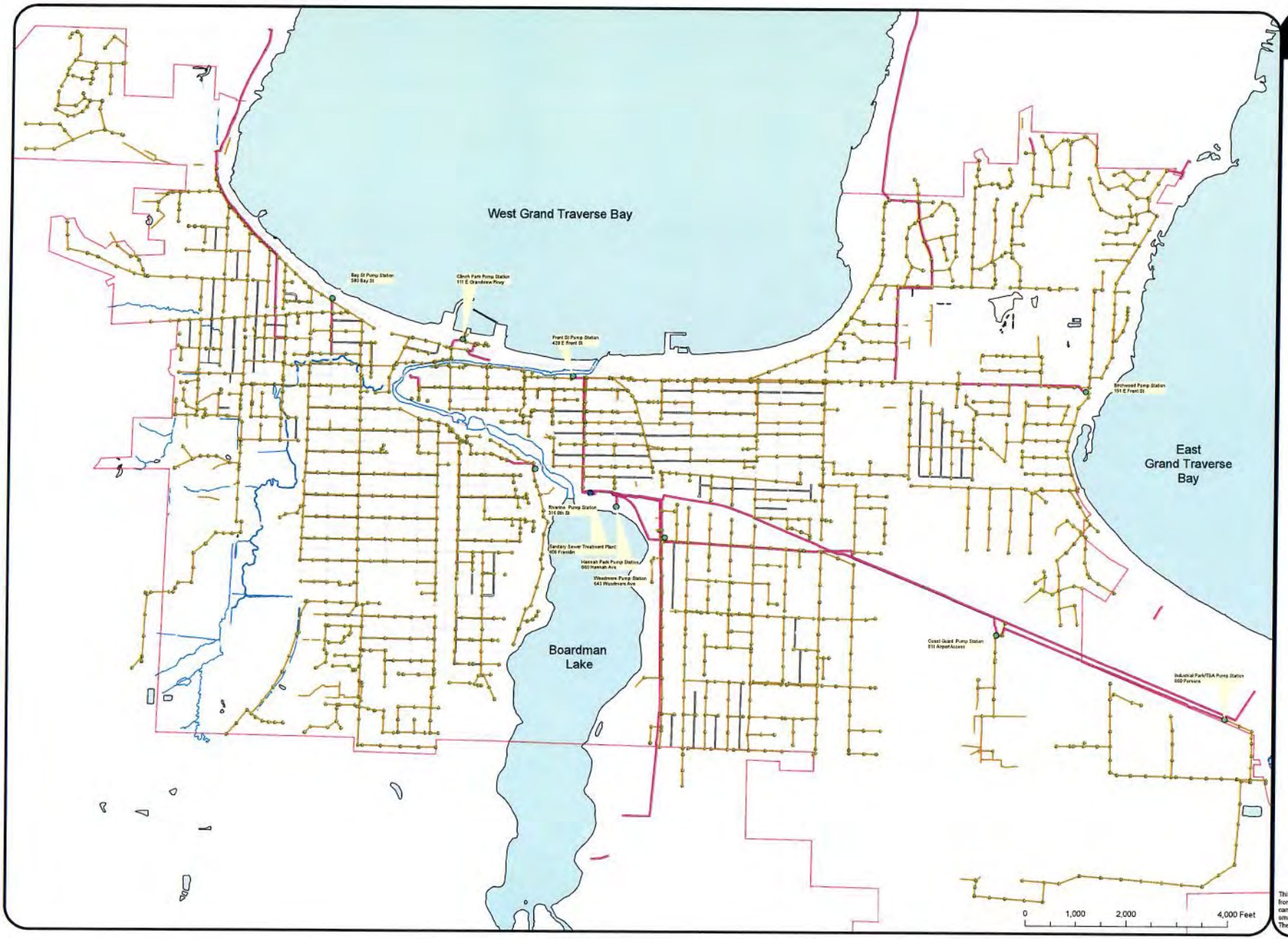
Exhibit 12. TCRWWTP and Lift Stations Improvement Initiatives

Initiative	Description	Completion Date	Responsible Party
TBA Lift Station Upgrade	Install new above ground upgraded control panel, install new pumps, line the lift station can with a tnemac coating and install new cathodic protection	Summer 2017	Elizabeth Hart
Perform Condition Assessment of all Major Assets at the TCRWWTP and Lift Stations	Assess the Condition of all major Assetsat the TCRWWTP and Lift Stations	Summer 2017	Elizabeth Hart
Screw Pump #1-Replacement and trough reconditioning	Overhaul motor, and gear reducer,replace screw body, replace deflector plates, recondition concrete trough and wet well per engineer'srecommendations, replace upper and lower bearings	Fall 2017	Elizabeth Hart
Digest #3 Condition Assessment	Clean Digester #3, have structural engineer assess the condition of thedigester	Fall 2017	Elizabeth Hart
Headworks Engineering Study	Have engineering study performed onthe preliminary and primary system including screw pumps #2 and #3	Spring 2018	Elizabeth Hart
Riverine Lift Station Engineering Study	Evaluate condition of the can and wetwell assess capacity	Fall 2019	Elizabeth Hart
Upgrade the PLC5 at Front St Lift Station and at the TCRWWTP	Upgrade the PLC5s at both locations to a more up to date better support PLC	Fall 2019	Elizabeth Hart
Membrane Gate Replacement	Replace the 8 remaining Aluminum gateassemblies with Stainless Steel gate assemblies	Spring 2020	Elizabeth Hart
Membrane Replacement	Replace the 500C membranes in trains3,4,5, and 8 with 500Ds membranes	Spring 2022	Elizabeth Hart

9.0 Annual Reporting

CH2M submitted the first annual asset management report on behalf of the City of Traverse City on July 30, 2016. CH2M will continue to submit this annual report for the duration of our contract with the City of Traverse City.

Attachment 1
Map of the Traverse City Collection System



Department of Public Services
City of Traverse City

City of Traverse City
Sanitary Sewer Collection System

Legend

- Sanitary Sewer Treatment Plant
- Pump Station
- Sanitary Manholes
- Sanitary Pressurized Mains
- Sanitary Sewer Mains

N

cblack
7/11/2016

This map is based on digital databases from the City of Traverse City. Traverse City cannot accept any responsibility for errors, ommissions or positional accuracy. There are no warranties expressed or implied.

Document Path: X:\TCPROJ\ENGINEER\Maps\sewer\Overall\Sewer.mxd

Attachment 2
Traverse City's Collection System
Fixed Assets

City of Traverse City
Sanitary Sewer System

Main Sizes and Lengths

Sanitary Main Diameter (inches)	Approximate Length of Sanitary Main (feet)	Approximate Length of Sanitary Main (miles)	Percentage of Total (%)
4	94	.02	.02
6	21,139	4.0	4.80
8	246,633	46.71	56.00
9	8,295	1.57	1.88
10	77,358	14.65	17.57
12	41,395	7.84	9.40
15	14,300	2.71	3.25
16	558	.11	.13
18	6,853	1.30	1.56
21	5,337	1.01	1.21
24	12,288	2.33	2.79
Unknown	6,112	1.16	1.39
Total	440,362	83.40	100

Main Materials

Type Distribution	Approximate Length of Sanitary Main (feet)	Approximate Length of Sanitary Main (miles)	Percentage of Total (%)
Asbestos Concrete	2,284	.43	.52
Cast Iron	3,014	.57	.68
Clay	7,735	1.46	1.76
Concrete	2,751	.52	.62
Ductile Iron	1,425	.27	.32
HDPE	509	.10	.12
PVC	73,569	13.93	16.71
Tansite	591	.11	.13
Other	13,520	2.56	3.07
Vitrified Pipe	224,228	42.47	50.92
Unknown	110,736	20.97	25.15
Total	440,362	83.40	100

Approximate Ages

Year Installed	Approximate Length of Sanitary Main (feet)	Approximate Length of Sanitary Main (miles)	Percentage of Total (%)
1930 – 1939	16,376	3.10	3.71
1940 – 1949	136,841	25.91	31.07
1950 – 1959	122,132	23.13	27.73
1960 – 1969	30,162	5.71	6.84
1970 – 1979	24,208	4.58	5.49
1980 – 1989	6,796	1.28	1.54
1990 – 1999	13,333	2.52	3.02
2000 – 2009	36,613	6.93	8.31
2010 – 2015	20,147	3.81	4.57
Unknown	33,754	6.39	7.66
Total	440,362	83.40	100

7/12/2016

Attachment 3
TCRWWTP and Lift Stations
Fixed Assets

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0001	Bldg #010, Rotomat, Preliminary Screening, Course Screening
TRA-0002	Room, Electrical, Rotomat Screening Building
TRA-0003	Flowmeter, Miltronic, Control Panel, Rotomat
TRA-0004	Gas Detector, Rotomat Bldg Electrical Room
TRA-0005	MCC, Rotomat Bldg
TRA-0006	Screening Building Power Rm Space Heater
TRA-0007	Room, Rotomat, Rotomat Screening Building
TRA-0009	Sampler, Primary Influent - Sigma
TRA-0010	Screen, Course, Rotomat (Lakeside)
TRA-0011	Motor, Rotomat Screen
TRA-0012	Rotomat, Sumitomo, Helical, Gearbox
TRA-0013	Screen, Manual Bar, Screening Building
TRA-0014	Screening Bldg Winch To Pull Dumpster
TRA-0015	Sluice Gate, Main influent, Course Screen Building (Bar Screen)
TRA-0016	Sluice Gate, Main influent, Course Screen Building (RotoMat)
TRA-0017	Three Ton Chain Fall
TRA-0018	Bldg #015, Fine Screening Building
TRA-0019	Control Room, Fine Screen Building
TRA-0020	Distribution Panel, Fine Screen
TRA-0021	Fan, Supply, Fine Screen Control Room
TRA-0022	Heating control panel
TRA-0023	Lighting Panel, Fine Screen
TRA-0024	Screening Room, Fine Screening Building
TRA-0025	East Fine Screen
TRA-0026	Fine Screen East Brush Drive Motor
TRA-0027	Fine Screen East Brush Drive Motor Reducer
TRA-0028	Fine Screen East Drive Motor Gear Reducer
TRA-0029	Fine Screen East Screen Drive Motor
TRA-0030	Valve, Gate, Inlet, East Fine Screen
TRA-0031	Valve, Gate, Outlet, East Fine Screen
TRA-0032	West Fine Screen
TRA-0033	Fine Screen West Brush Drive Motor
TRA-0034	Fine Screen West Brush Drive Motor Reducer
TRA-0035	Fine Screen West Drive Motor Gear Reducer
TRA-0036	Fine Screen West Screen Drive Motor
TRA-0037	Valve, Gate, Inlet, West Fine Screen
TRA-0038	Valve, Gate, Outlet, West Fine Screen
TRA-0039	Screw Compactor / Bagger
TRA-0040	Jones & Attwood Compactor Drive Gear
TRA-0041	Jones & Attwood Compactor Rotating Assembly
TRA-0042	Jones & Atwood Compactor Drive Motor
TRA-0043	10' Step Ladder, Orange Fiberglass, Fine Screen Bldg
TRA-0044	16' Extension Ladder, Orange Fiberglass, Fine Screen Bldg
TRA-0045	Eyewash, Bottle, Fine Screen Building

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0046	Fine Screen Building Make Up Air UNIT
TRA-0047	Gas Detector, Fine Screen Bldg
TRA-0048	Overhead Door
TRA-0049	Pump, Circulating, Hot Water In Fine Screen Building
TRA-0050	Pump, Circulation, Glycol In Fine Screen Building
TRA-0051	Screening Building Electric Heated Make Up Air System
TRA-0053	Pump , Organic Return, West Grit Chamber
TRA-0054	Motor, West Organic Return
TRA-0055	Fixed Ladder, Classifier Deck, West Grit Bldg
TRA-0056	Fixed Ladder, Classifier Deck, West Grit Bldg
TRA-0057	Fixed Ladder, Classifier Deck, West Grit Bldg
TRA-0058	Fixed Ladder, Classifier Deck, West Grit Bldg
TRA-0059	Flowmeter, Miltronic, Control Panel, West Grit
TRA-0060	Hoist, West Grit Bldg
TRA-0061	West Grit Building Hot Water Heated Make Up Air System
TRA-0062	West Grit Chamber, Basin
TRA-0064	Collector, West Grit
TRA-0065	Gear Reducer, West Grit Basin
TRA-0066	Motor, West Grit Basin
TRA-0067	Classifier, West Grit
TRA-0068	Gear Reducer, West Grit Classifier
TRA-0069	Motor, West Grit Classifier
TRA-0070	Gate, Sluice, Controlling Flow From The West Grit Chamber To The North Side Of The Primary Header
TRA-0071	Gate, Sluice, Controlling Flow From The West Grit Chamber To The South Side Of The Primary Header
TRA-0072	Bldg #021, East Grit
TRA-0073	Pump, East Organic Return
TRA-0074	Motor, East Organic Return
TRA-0075	East Grit Bldg Hoist
TRA-0076	East Grit Building Hot Water Unit Heater
TRA-0077	East Grit Chamber, Basin
TRA-0078	Transmitter, East Grit, Milltronics
TRA-0079	Collector, East Grit
TRA-0080	Gear Reducer, East Grit Basin
TRA-0081	Motor, East Grit Basin
TRA-0082	Gear Reducer, East Grit Collector
TRA-0083	Classifier, East Grit
TRA-0084	Gear Reducer, East Grit Classifier
TRA-0085	Motor, East Grit Classifier
TRA-0086	Gate, Sluice, Controlling Flow To The North Side Of The Primary Header
TRA-0087	Gate, Sluice, Controlling Flow To The South Side Of The Primary Header
TRA-0088	Eyewash, Bottle, East Grit Bldg
TRA-0089	Fixed Ladder, Classifier Deck, East Grit Bldg

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0090	Fixed Ladder, Classifier Deck, East Grit Bldg
TRA-0091	Flowmeter, Miltronic, Control Panel, East Grit
TRA-0092	Hot Water Circ Pump East Grit Building
TRA-0093	Bldg #030, Primary Clarification Deck
TRA-0095	Clarifier, Primary, #1 North
TRA-0096	Chain and Flight Collector
TRA-0097	Drive, Chain, Primary Clarifier
TRA-0098	Motor, Primary Clarifier Drive 1N/2N
TRA-0099	Skimmer, Scum, Primary Tank 1 North
TRA-0100	Scum Skimmer Gearbox 1North
TRA-0101	Motor, Scum Skimmer 1 North
TRA-0102	Clarifier, Primary, #2 North
TRA-0103	Chain and Flight Collector
TRA-0104	Skimmer, Scum, North Primary Tank 2
TRA-0105	Reducer, Gear, Scum Skimmer 2 North
TRA-0106	Motor, Scum Skimmer, 2 North
TRA-0107	Clarifier, Primary, #3 North
TRA-0108	Chain and Flight Collector
TRA-0109	Drive, Chain, Primary Clarifier
TRA-0110	Motor, Primary Clarifier Drive 3N/4N
TRA-0111	Skimmer, Scum, North Primary Tank 3
TRA-0112	Reducer, Gear, Scum Skimmer 3 North
TRA-0113	Motor, Scum Skimmer, 3 North
TRA-0114	Clarifier, Primary, #4 North
TRA-0115	Chain and Flight Collector
TRA-0116	Skimmer, Scum, North Primary Tank 4
TRA-0117	Reducer, Gear, Scum Skimmer 4 North
TRA-0118	Motor, Scum Skimmer, 4 North
TRA-0119	40' Extension Ladder, Yellow Fiberglass, North Primary Deck
TRA-0120	Primary Tanks and Pipe Gallery
TRA-0121	Fan, Exhaust, North Primary Pipe Gallery
TRA-0122	Fan, Exhaust, South Primary Pipe Gallery
TRA-0123	Primary Pipe Gallery Sump Pump
TRA-0124	Primary Piping System North And South
TRA-0125	Pump, Primary Tank Dewatering
TRA-0126	Motor, Pump, Primary Dewatering
TRA-0127	Valve, Sludge Removal
TRA-0128	Valve, Sludge Removal, Primary Tank #1 North
TRA-0129	Actuator, Valve, Primary Sludge Pumping 1 North
TRA-0130	Valve, Sludge Removal, Primary Tank #1 South
TRA-0131	Actuator, Sludge Removal, Primary Tank # 1 South
TRA-0132	Valve, Sludge Removal, Primary Tank #2 North
TRA-0133	Actuator, Sludge Removal, Primary Tank # 2 North
TRA-0134	Valve, Sludge Removal, Primary Tank #2 South

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0135	Actuator, Sludge Removal, Primary Tank # 2 South
TRA-0136	Valve, Sludge Removal, Primary Tank #3 North
TRA-0137	Actuator, Sludge Removal, Primary Tank # 3 North
TRA-0138	Valve, Sludge Removal, Primary Tank #3 South
TRA-0139	Actuator, Sludge Removal, Primary Tank # 3 South
TRA-0140	Valve, Sludge Removal, Primary Tank #4 North
TRA-0141	Actuator, Sludge Removal, Primary Tank # 4 North
TRA-0142	Valve, Sludge Removal, Primary Tank #4 South
TRA-0143	Actuator, Sludge Removal, Primary Tank # 4 South
TRA-0145	Clarifier, Primary, #1 South
TRA-0146	Chain and Flight Collector
TRA-0147	Drive, Chain, Primary Clarifier
TRA-0148	Motor, Prim Clar 1S/2S
TRA-0149	Skimmer, Scum, South Primary Tank 1
TRA-0150	Reducer, Gear, Scum Skimmer 1 South
TRA-0151	Motor, Scum Skimmer, 1 South
TRA-0152	Clarifier, Primary, #2 South
TRA-0153	Chain and Flight Collector
TRA-0154	Drive, Chain, Primary Clarifier
TRA-0155	Motor, Prim Clar 3S/4S
TRA-0156	Skimmer, Scum, South Primary Tank 2
TRA-0157	Reducer, Gear, Scum Skimmer 2 South
TRA-0158	Motor, Scum Skimmer 2 South
TRA-0159	Clarifier, Primary, #3 South
TRA-0160	Chain and Flight Collector
TRA-0161	Drive, Chain, Primary Clarifier
TRA-0162	Motor, Prim Clar 3S/4S
TRA-0163	Skimmer, Scum, 3N
TRA-0164	Skimmer, Scum, South Primary Tank 3
TRA-0165	Reducer, Gear, Scum Skimmer, 3 South
TRA-0166	Motor, Scum Skimmer, 3 South
TRA-0167	Clarifier, Primary, #4 South
TRA-0168	Chain and Flight Collector
TRA-0169	South Primary Tank 4 Scum Skimmer
TRA-0170	Reducer, Gear, Scum Skimmer Drive, 4 South
TRA-0171	4 South Scum Skimmer Motor
TRA-0172	24' Extension Ladder, Orange, Fiberglass, South Primary Deck
TRA-0173	Bldg #032, Phoenix, Odor Control Building
TRA-0174	Blower, Odor Control
TRA-0175	Motor, Blower, Phoenix Blower
TRA-0176	VFD, South, Odor, Blower
TRA-0177	Blower, Phoenix Odor Bldg
TRA-0178	Gas Analyzer, Odor Logger

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0179	Odor Control Ducting To Phoenix Carbon System And To Aeration Blower Intakes
TRA-0180	Phoenix Odor Filter PLC
TRA-0181	Phoenix Building Electric Heater
TRA-0182	Bldg #045, Aeration Basin Deck
TRA-0183	North Aeration Basin
TRA-0184	Actuator, Valve, North Prim Eff Flume
TRA-0185	Motor, North Primary Effluent Flume Gate
TRA-1675	Mixer, North Aeration #1
TRA-1676	Mixer, North Aeration #2
TRA-1697	Mixer, North Aeration #3
TRA-1677	Mixer, North Aeration #4
TRA-1678	Mixer, North Aeration #5
TRA-1679	Mixer, North Aeration #6
TRA-1680	Mixer, North Aeration #7
TRA-1681	Mixer, North Aeration #8
TRA-0186	Mixer, North Aeration #1
TRA-0187	Mixer, North Aeration #2
TRA-0188	Mixer, North Aeration #3
TRA-0189	Mixer, North Aeration #4
TRA-0190	Mixer, North Aeration #5
TRA-0191	Mixer, North Aeration #6
TRA-0192	Mixer, North Aeration #7
TRA-0193	Mixer, North Aeration #8
TRA-0194	No. Aeration Grid Laterals
TRA-0195	North Aeration Basin Air Header To Diffuser Down Legs
TRA-0196	North RAS Piping In Pump Room
TRA-0197	Panel, Control, Primary Effluent Gate Flow
TRA-0198	Probe, Do, NE Aeration Basin
TRA-0199	Probe, Do, NW Aeration Basin
TRA-0200	Pump, Pre-Aeration, #1 North
TRA-0201	Motor, Pre-Aeration Pump 2 South
TRA-1682	Pump, Return, North Aeration #1
TRA-1683	Pump, Return, North Aeration #2
TRA-1684	Pump, Return, North Aeration #4
TRA-1685	Pump, Return, North Aeration Return #3
TRA-0202	Pump, Return, North Aeration #1
TRA-0203	Pump, Return, North Aeration #2
TRA-0204	Pump, Return, North Aeration #4
TRA-0205	Pump, Return, North Aeration Return #3
TRA-0206	Transmitter, RAS Flow, North
TRA-0207	Valve, Butterfly, 24 North Aeration Basin Air Modulation
TRA-0208	Valve, Butterfly, 30 In. On North RAS Line
TRA-0209	South Aeration Basin

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0210	Actuator, South RAS Control Valve A
TRA-0211	Actuator, South RAS Control Valve B
TRA-0212	Actuator, Valve, South Prim Eff Flume
TRA-0213	Motor, South Primary Effluent Flume Gate
TRA-1686	Mixer, South Aeration Tank No.1
TRA-1687	Mixer, South Aeration Tank No.2
TRA-1688	Mixer, South Aeration Tank No.3
TRA-1689	Mixer, South Aeration Tank No.4
TRA-1690	Mixer, South Aeration Tank No.5
TRA-1691	Mixer, South Aeration Tank No.6
TRA-1692	Mixer, South Aeration Tank No.7
TRA-1698	Mixer, South Aeration Tank No.8
TRA-0214	Mixer, South Aeration Tank No.1
TRA-0215	Mixer, South Aeration Tank No.2
TRA-0216	Mixer, South Aeration Tank No.3
TRA-0217	Mixer, South Aeration Tank No.4
TRA-0218	Mixer, South Aeration Tank No.5
TRA-0219	Mixer, South Aeration Tank No.6
TRA-0220	Mixer, South Aeration Tank No.7
TRA-0221	Mixer, South Aeration Tank No.8
TRA-0222	Pump, Pre-Aeration, #2 South
TRA-0223	Motor, Pre-Aeration Pump 2 South
TRA-1693	Pump, Return, South Aeration #1
TRA-1694	Pump, Return, South Aeration #2
TRA-1695	Pump, Return, South Aeration #3
TRA-1696	Pump, Return, South Aeration #4
TRA-0224	Pump, Return, South Aeration #1
TRA-0225	Pump, Return, South Aeration #2
TRA-0226	Pump, Return, South Aeration #3
TRA-0227	Pump, Return, South Aeration #4
TRA-0228	So. Aeration Grid Laterals
TRA-0229	South Aeration Basin Air Header To Diffuser Down Legs
TRA-0231	Transmitter, Flow, RAS South
TRA-0232	Valve, Butterfly, 24 South Aeration Basin Air Modulation
TRA-0233	Valve, Butterfly, 30 In. On South RAS Line
TRA-0234	Bldg #050, Membrane Filtration Building
TRA-0236	Train #1 Membrane Filter System
TRA-0238	Train #1 Membrane Cassette D
TRA-0239	Train #1 Membrane Cassette D 16 Module Membrane Filter
TRA-0240	Train #1 Membrane Cassette D 8 Module Membrane Filter
TRA-0241	Train #1 Membrane Cassette E
TRA-0242	Train #1 Membrane Cassette E 16 Module Membrane Filter
TRA-0243	Train #1 Membrane Cassette E 8 Module Membrane Filter
TRA-0244	Train #1 Membrane Cassette F

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0245	Train #1 Membrane Cassette F 16 Module Membrane Filter
TRA-0246	Train #1 Membrane Cassette F 8 Module Membrane Filter
TRA-0247	Train #1 Membrane Cassette G
TRA-0248	Train #1 Membrane Cassette G 16 Module Membrane Filter
TRA-0249	Train #1 Membrane Cassette G 8 Module Membrane Filter
TRA-0250	Train #1 Membrane Cassette H
TRA-0251	Train #1 Membrane Cassette H 16 Module Membrane Filter
TRA-0252	Train #1 Membrane Cassette H 8 Module Membrane Filter
TRA-0253	Train #1 Membrane Cassette I
TRA-0254	Train #1 Membrane Cassette I 16 Module Membrane Filter
TRA-0255	Train #1 Membrane Cassette I 8 Module Membrane Filter
TRA-0256	Train #1 Membrane Cassette J
TRA-0257	Train #1 Membrane Cassette J 16 Module Membrane Filter
TRA-0258	Train #1 Membrane Cassette J 8 Module Membrane Filter
TRA-0259	Train #1 Membrane Cassette K
TRA-0260	Train #1 Membrane Cassette K 16 Module Membrane Filter
TRA-0261	Train #1 Membrane Cassette K 8 Module Membrane Filter
TRA-0262	Train #1 Membrane Cassette L
TRA-0263	Train #1 Membrane Cassette L 16 Module Membrane Filter
TRA-0264	Train #1 Membrane Cassette L 8 Module Membrane Filter
TRA-0265	Train #1 Membrane Cassette M
TRA-0266	Train #1 Membrane Cassette M 16 Module Membrane Filter
TRA-0267	Train #1 Membrane Cassette M 8 Module Membrane Filter
TRA-0268	Train #1 Membrane Cassette N
TRA-0269	Train #1 Membrane Cassette N 16 Module Membrane Filter
TRA-0270	Train #1 Membrane Cassette N 8 Module Membrane Filter
TRA-0271	Train #1 Membrane Cassette O
TRA-0272	Train #1 Membrane Cassette O 16 Module Membrane Filter
TRA-0273	Train #1 Membrane Cassette O 8 Module Membrane Filter
TRA-0274	Train #1 Membrane Cassette P
TRA-0275	Train #1 Membrane Cassette P 16 Module Membrane Filter
TRA-0276	Train #1 Membrane Cassette P 8 Module Membrane Filter
TRA-0277	Gate, Inlet, Train #1
TRA-0278	Actuator, Inlet Gate, Train 1
TRA-0279	Gate, Discharge, Train #1
TRA-0280	Actuator, Discharge Gate, Train 1
TRA-0281	Transducer, Level, Train 1
TRA-0282	Valve, Course Air Control, Train 1
TRA-0283	Valve, Train 1 Back Pulse
TRA-0284	Train #2 Membrane Filter System
TRA-0286	Train #2 Membrane Cassette D
TRA-0287	Train #2 Membrane Cassette D 24 Module Membrane Filter
TRA-0288	Train #2 Membrane Cassette D 8 Module Membrane Filter
TRA-0289	Train #2 Membrane Cassette E

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0290	Train #2 Membrane Cassette E 24 Module Membrane Filter
TRA-0291	Train #2 Membrane Cassette E 8 Module Membrane Filter
TRA-0292	Train #2 Membrane Cassette F
TRA-0293	Train #2 Membrane Cassette F 24 Module Membrane Filter
TRA-0294	Train #2 Membrane Cassette F 8 Module Membrane Filter
TRA-0295	Train #2 Membrane Cassette G
TRA-0296	Train #2 Membrane Cassette G 24 Module Membrane Filter
TRA-0297	Train #2 Membrane Cassette G 8 Module Membrane Filter
TRA-0298	Train #2 Membrane Cassette H
TRA-0299	Train #2 Membrane Cassette H 24 Module Membrane Filter
TRA-0300	Train #2 Membrane Cassette H 8 Module Membrane Filter
TRA-0301	Train #2 Membrane Cassette I
TRA-0302	Train #2 Membrane Cassette I 24 Module Membrane Filter
TRA-0303	Train #2 Membrane Cassette I 8 Module Membrane Filter
TRA-0304	Train #2 Membrane Cassette J
TRA-0305	Train #2 Membrane Cassette J 24 Module Membrane Filter
TRA-0306	Train #2 Membrane Cassette J 8 Module Membrane Filter
TRA-0307	Train #2 Membrane Cassette K
TRA-0308	Train #2 Membrane Cassette K 24 Module Membrane Filter
TRA-0309	Train #2 Membrane Cassette K 8 Module Membrane Filter
TRA-0310	Train #2 Membrane Cassette L
TRA-0311	Train #2 Membrane Cassette L 24 Module Membrane Filter
TRA-0312	Train #2 Membrane Cassette L 8 Module Membrane Filter
TRA-0313	Train #2 Membrane Cassette M
TRA-0314	Train #2 Membrane Cassette M 24 Module Membrane Filter
TRA-0315	Train #2 Membrane Cassette M 8 Module Membrane Filter
TRA-0316	Train #2 Membrane Cassette N
TRA-0317	Train #2 Membrane Cassette N 24 Module Membrane Filter
TRA-0318	Train #2 Membrane Cassette N 8 Module Membrane Filter
TRA-0319	Train #2 Membrane Cassette O
TRA-0320	Train #2 Membrane Cassette O 24 Module Membrane Filter
TRA-0321	Train #2 Membrane Cassette O 8 Module Membrane Filter
TRA-0322	Train #2 Membrane Cassette P
TRA-0323	Train #2 Membrane Cassette P 24 Module Membrane Filter
TRA-0324	Train #2 Membrane Cassette P 8 Module Membrane Filter
TRA-0325	Gate, Inlet, Train #2
TRA-0326	Actuator, Inlet Gate, Train 2
TRA-032-600O1N	North Basin D.O. Meter
TRA-0327	Gate, Discharge, Train #2
TRA-0328	Actuator, Discharge Gate, Train 2
TRA-0329	Transducer, Level, Train 2
TRA-0330	Valve, Course Air Control, Train 2
TRA-0331	Train #3 Membrane Filter System
TRA-0334	Train #3 Membrane Cassette A

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0335	Train #3 Membrane Cassette B
TRA-0336	Train #3 Membrane Cassette C
TRA-0337	Train #3 Membrane Cassette D
TRA-0338	Train #3 Membrane Cassette E
TRA-0339	Train #3 Membrane Cassette F
TRA-0340	Train #3 Membrane Cassette G
TRA-0341	Train #3 Membrane Cassette H
TRA-0342	Train #3 Membrane Cassette I
TRA-0343	Train #3 Membrane Cassette J
TRA-0344	Train #3 Membrane Cassette K
TRA-0345	Train #3 Membrane Cassette L
TRA-0346	Train #3 Membrane Cassette M
TRA-0347	Train #3 Membrane Cassette N
TRA-0348	Train #3 Membrane Cassette O
TRA-0349	Train #3 Membrane Cassette P
TRA-0350	Gate, Inlet, Train #3
TRA-0351	Actuator, Inlet Gate, Train 3
TRA-0352	Gate, Discharge, Train #3
TRA-0353	Actuator, Discharge Gate, Train 3
TRA-0354	Transducer, Level, Train 3
TRA-0355	Valve, Course Air Control, Train 3
TRA-0356	Train #4 Membrane Filter System
TRA-0358	Train #4 Membrane Cassette A
TRA-0359	Train #4 Membrane Cassette B
TRA-0360	Train #4 Membrane Cassette C
TRA-0361	Train #4 Membrane Cassette D
TRA-0362	Train #4 Membrane Cassette E
TRA-0363	Train #4 Membrane Cassette F
TRA-0364	Train #4 Membrane Cassette G
TRA-0365	Train #4 Membrane Cassette H
TRA-0366	Train #4 Membrane Cassette I
TRA-0367	Train #4 Membrane Cassette J
TRA-0368	Train #4 Membrane Cassette K
TRA-0369	Train #4 Membrane Cassette L
TRA-0370	Train #4 Membrane Cassette M
TRA-0371	Train #4 Membrane Cassette N
TRA-0372	Train #4 Membrane Cassette O
TRA-0373	Train #4 Membrane Cassette P
TRA-0374	Gate, Inlet, Train #4
TRA-0375	Actuator, Inlet Gate, Train 4
TRA-0376	Gate, Discharge, Train #4
TRA-0377	Actuator, Discharge Gate, Train 4
TRA-0378	Transducer, Level, Train 4
TRA-0379	Valve, Course Air Control, Train 4

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0380	Train #5 Membrane Filter System
TRA-0382	Train #5 Membrane Cassette A
TRA-0383	Train #5 Membrane Cassette B
TRA-0384	Train #5 Membrane Cassette C
TRA-0385	Train #5 Membrane Cassette D
TRA-0386	Train #5 Membrane Cassette E
TRA-0387	Train #5 Membrane Cassette F
TRA-0388	Train #5 Membrane Cassette G
TRA-0389	Train #5 Membrane Cassette H
TRA-0390	Train #5 Membrane Cassette I
TRA-0391	Train #5 Membrane Cassette J
TRA-0392	Train #5 Membrane Cassette K
TRA-0393	Train #5 Membrane Cassette L
TRA-0394	Train #5 Membrane Cassette M
TRA-0395	Train #5 Membrane Cassette N
TRA-0396	Train #5 Membrane Cassette O
TRA-0397	Train #5 Membrane Cassette P
TRA-0398	Gate, Inlet, Train #5
TRA-0399	Actuator, Inlet Gate, Train 5
TRA-0400	Gate, Discharge, Train #5
TRA-0401	Actuator, Discharge Gate, Train 5
TRA-0402	Transducer, Level, Train 5
TRA-0403	Valve, Course Air Control, Train 5
TRA-0404	Train #6 Membrane Filter System
TRA-0406	Train #6 Membrane Cassette D
TRA-0407	Train #6 Membrane Cassette E
TRA-0408	Train #6 Membrane Cassette F
TRA-0409	Train #6 Membrane Cassette G
TRA-0410	Train #6 Membrane Cassette H
TRA-0411	Train #6 Membrane Cassette I
TRA-0412	Train #6 Membrane Cassette J
TRA-0413	Train #6 Membrane Cassette K
TRA-0414	Train #6 Membrane Cassette L
TRA-0415	Train #6 Membrane Cassette M
TRA-0416	Train #6 Membrane Cassette N
TRA-0417	Train #6 Membrane Cassette O
TRA-0418	Train #6 Membrane Cassette P
TRA-0420	Gate, Inlet, Train #6
TRA-0421	Actuator, Inlet Gate, Train 6
TRA-0422	Gate, Discharge, Train #6
TRA-0423	Actuator, Discharge Gate, Train 6
TRA-0424	Transducer, Level Control, Train 6
TRA-0425	Valve, Course Air Control, Train 6
TRA-0426	Train #7 Membrane Filter System

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0428	Train #7 Membrane Cassette D
TRA-0429	Train #7 Membrane Cassette D 16 Module Membrane Filter
TRA-0430	Train #7 Membrane Cassette D 8 Module Membrane Filter
TRA-0431	Train #7 Membrane Cassette E
TRA-0432	Train #7 Membrane Cassette E 16 Module Membrane Filter
TRA-0433	Train #7 Membrane Cassette E 8 Module Membrane Filter
TRA-0434	Train #7 Membrane Cassette F
TRA-0435	Train #7 Membrane Cassette F 16 Module Membrane Filter
TRA-0436	Train #7 Membrane Cassette F 8 Module Membrane Filter
TRA-0437	Train #7 Membrane Cassette G
TRA-0438	Train #7 Membrane Cassette G 16 Module Membrane Filter
TRA-0439	Train #7 Membrane Cassette G 8 Module Membrane Filter
TRA-0440	Train #7 Membrane Cassette H
TRA-0441	Train #7 Membrane Cassette H 16 Module Membrane Filter
TRA-0442	Train #7 Membrane Cassette H 8 Module Membrane Filter
TRA-0443	Train #7 Membrane Cassette I
TRA-0444	Train #7 Membrane Cassette I 16 Module Membrane Filter
TRA-0445	Train #7 Membrane Cassette I 8 Module Membrane Filter
TRA-0446	Train #7 Membrane Cassette J
TRA-0447	Train #7 Membrane Cassette J 16 Module Membrane Filter
TRA-0448	Train #7 Membrane Cassette J 8 Module Membrane Filter
TRA-0449	Train #7 Membrane Cassette K
TRA-0450	Train #7 Membrane Cassette K 16 Module Membrane Filter
TRA-0451	Train #7 Membrane Cassette K 8 Module Membrane Filter
TRA-0452	Train #7 Membrane Cassette L
TRA-0453	Train #7 Membrane Cassette L 16 Module Membrane Filter
TRA-0454	Train #7 Membrane Cassette L 8 Module Membrane Filter
TRA-0455	Train #7 Membrane Cassette M
TRA-0456	Train #7 Membrane Cassette M 16 Module Membrane Filter
TRA-0457	Train #7 Membrane Cassette M 8 Module Membrane Filter
TRA-0458	Train #7 Membrane Cassette N
TRA-0459	Train #7 Membrane Cassette N 16 Module Membrane Filter
TRA-0460	Train #7 Membrane Cassette N 8 Module Membrane Filter
TRA-0461	Train #7 Membrane Cassette O
TRA-0462	Train #7 Membrane Cassette O 16 Module Membrane Filter
TRA-0463	Train #7 Membrane Cassette O 8 Module Membrane Filter
TRA-0464	Train #7 Membrane Cassette P
TRA-0465	Train #7 Membrane Cassette P 16 Module Membrane Filter
TRA-0466	Train #7 Membrane Cassette P 8 Module Membrane Filter
TRA-0467	Gate, Inlet, Train #7
TRA-0468	Actuator, Inlet Gate, Train 7
TRA-0469	Gate, Discharge, Train #7
TRA-0470	Actuator, Discharge Gate, Train 7
TRA-0471	Transducer, Level, Train 7

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0472	Valve, Course Air Control, Train 7
TRA-0473	Train #8 Membrane Filter System
TRA-0475	Train #8 Membrane Cassette A
TRA-0476	Train #8 Membrane Cassette B
TRA-0477	Train #8 Membrane Cassette C
TRA-0478	Train #8 Membrane Cassette D
TRA-0479	Train #8 Membrane Cassette E
TRA-0480	Train #8 Membrane Cassette F
TRA-0481	Train #8 Membrane Cassette G
TRA-0482	Train #8 Membrane Cassette H
TRA-0483	Train #8 Membrane Cassette I
TRA-0484	Train #8 Membrane Cassette J
TRA-0485	Train #8 Membrane Cassette K
TRA-0486	Train #8 Membrane Cassette L
TRA-0487	Train #8 Membrane Cassette M
TRA-0488	Train #8 Membrane Cassette N
TRA-0489	Train #8 Membrane Cassette O
TRA-0490	Train #8 Membrane Cassette P
TRA-0491	Gate, Inlet, Train #8
TRA-0492	Actuator, Inlet Gate, Train 8
TRA-0493	gate, Discharge, Train #8
TRA-0494	Actuator, Discharge Gate, Train 8
TRA-0495	Transducer, Level, Train 8
TRA-0496	Valve, Course Air Control, Train 8
TRA-0497	8' Step Ladder, Orange Fiberglass, Membrane Bldg, West Stairs
TRA-0498	Actuator, Wasting Pit Inlet Gate
TRA-0499	Crane, Membrane Tank Bridge
TRA-0500	Fixed Ladder, Upper Hall, Membrane Bldg
TRA-0501	Membrane Building East Stair Supply Fan
TRA-0502	Membrane Building Upper Hall Supply Fan
TRA-0503	Membrane Building West Stair Supply Fan
TRA-0504	Membrane Cassette Lifting Device 1
TRA-0505	Membrane Cassette Lifting Device 2
TRA-0506	Membrane Dip Tank A
TRA-0507	Membrane Dip Tank B
TRA-0508	Switch, Float, Lowlow Level, Trains 1 - 8
TRA-0509	Switch, No Float Control Switch From 110V 20A Pump
TRA-050BLDG-T6D-08	Train #6 Membrane Cassette D 8 Module Membrane Filter
TRA-050BLDG-T6D-16	Train #6 Membrane Cassette D 16 Module Membrane Filter
TRA-050BLDG-T6E-08	Train #6 Membrane Cassette E 8 Module Membrane Filter
TRA-050BLDG-T6E-16	Train #6 Membrane Cassette E 16 Module Membrane Filter
TRA-050BLDG-T6F-08	Train #6 Membrane Cassette F 8 Module Membrane Filter
TRA-050BLDG-T6F-16	Train #6 Membrane Cassette F 16 Module Membrane Filter
TRA-050BLDG-T6G-08	Train #6 Membrane Cassette G 8 Module Membrane Filter

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-050BLDG-T6G-16	Train #6 Membrane Cassette G 16 Module Membrane Filter
TRA-050BLDG-T6H-08	Train #6 Membrane Cassette H 8 Module Membrane Filter
TRA-050BLDG-T6H-16	Train #6 Membrane Cassette H 16 Module Membrane Filter
TRA-050BLDG-T6I-08	Train #6 Membrane Cassette I 8 Module Membrane Filter
TRA-050BLDG-T6I-16	Train #6 Membrane Cassette I 16 Module Membrane Filter
TRA-050BLDG-T6J-08	Train #6 Membrane Cassette J 8 Module Membrane Filter
TRA-050BLDG-T6J-16	Train #6 Membrane Cassette J 16 Module Membrane Filter
TRA-050BLDG-T6K-08	Train #6 Membrane Cassette K 8 Module Membrane Filter
TRA-050BLDG-T6K-16	Train #6 Membrane Cassette K 16 Module Membrane Filter
TRA-050BLDG-T6L-08	Train #6 Membrane Cassette L 8 Module Membrane Filter
TRA-050BLDG-T6L-16	Train #6 Membrane Cassette L 16 Module Membrane Filter
TRA-050BLDG-T6M-08	Train #6 Membrane Cassette M 8 Module Membrane Filter
TRA-050BLDG-T6M-16	Train #6 Membrane Cassette M 16 Module Membrane Filter
TRA-050BLDG-T6N-08	Train #6 Membrane Cassette N 8 Module Membrane Filter
TRA-050BLDG-T6N-16	Train #6 Membrane Cassette N 16 Module Membrane Filter
TRA-050BLDG-T6O-08	Train #6 Membrane Cassette O 8 Module Membrane Filter
TRA-050BLDG-T6O-16	Train #6 Membrane Cassette O 16 Module Membrane Filter
TRA-050BLDG-T6P-08	Train #6 Membrane Cassette P 8 Module Membrane Filter
TRA-050BLDG-T6P-16	Train #6 Membrane Cassette P 16 Module Membrane Filter
TRA-0510	Transmitter, Temperature, East Membrane Channel
TRA-0511	Transmitter, Temperature, Membrane Building Outside Air
TRA-0512	Transmitter, Temperature, West Membrane Channel
TRA-0513	Bldg 050 Basement
TRA-0514	10' Step Ladder, Orange Fiberglass, Pump Rm, Membrane Bldg
TRA-0515	24' Extension Ladder, Orange Fiberglass, Pump Rm, Membrane Bldg
TRA-0516	Air Compressor, Membrane System, #1
TRA-0517	Air Dryer, refrigerated, #1
TRA-0518	Motor, Compressor, #1
TRA-0519	Air Compressor, Membrane System, #2
TRA-0520	Air Dryer, refrigerated, #2
TRA-0521	Motor, Compressor, #2
TRA-0522	Backflow Preventer, Membrane Bldg , 1.5 In
TRA-0523	Control Air Piping In The Membrane Building And Tanks
TRA-0524	Dryer, Membrane Air System, Hankison
TRA-0525	Exhaust Fan #1, Bldg. 50 Basement
TRA-0526	Exhaust Fan #2, Bldg. 50 Basement
TRA-0527	Exhaust Fan #3, Bldg. 50 Basement
TRA-0528	Eyewash, Bottle, Bldg. 50 Basement
TRA-0529	Final Effluent Sampler
TRA-0530	Flow Meter, RAS Discharge North
TRA-0531	Flow Meter, RAS Discharge South
TRA-0532	Flow Meter, W-3 Service Water, Bldg. 50 Basement
TRA-0533	Flow Meter, WAS, Bldg. 50 Basement
TRA-0534	Membrane Back Pulse Piping

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0535	Membrane Citric Acid Feed Piping
TRA-0536	Membrane Permeate Piping
TRA-0537	Membrane Pump Room East Wall Exhaust Fan (Across From RAS Pumps)
TRA-0538	North RAS Piping Below Grade
TRA-0539	Panel, Fan Control, Bldg. 50 Basement
TRA-0540	Panel, W-3 Service Water Pump Control, Bldg. 50 Basement
TRA-0541	Permeate System
TRA-0542	East Vacuum Priming System
TRA-0543	East Vacuum Priming System Dewatering Drain
TRA-0544	East Vacuum Priming System Drain Pneumatic Actuator
TRA-0545	East Vacuum Priming System Dewatering Inlet Valve
TRA-0546	East Vacuum Priming System Pneumatic Inlet Actuator
TRA-0547	East Vacuum Priming System Dewatering Outlet Valve
TRA-0548	East Vacuum Priming System Outlet Pneumatic Actuator
TRA-0549	East Vacuum Priming System Dewatering Vent Valve
TRA-0550	East Vacuum Priming System Vent Pneumatic Actuator
TRA-0551	West Vacuum Priming System
TRA-0552	West Vacuum Priming System Drain Valve
TRA-0553	West Vacuum Priming System Drain Pneumatic Actuator
TRA-0554	West Vacuum Priming System Inlet Valve
TRA-0555	West Vacuum Priming System Inlet Pneumatic Actuator
TRA-0556	West Vacuum Priming System Outlet Valve
TRA-0557	West Vacuum Priming System Outlet Pneumatic Actuator
TRA-0558	West Vacuum Priming System Vent Valve
TRA-0559	West Vacuum Priming System Vent Pneumatic Actuator
TRA-0560	Pump, Vacuum Priming, #1
TRA-0561	#1 Vacuum Pump Motor
TRA-0562	Vacuum Pump A Inlet Valve
TRA-0563	Vacuum Pump A Pneumatic Actuator
TRA-0564	Pump, Vacuum Priming, #2
TRA-0565	#2 Vacuum Pump Motor
TRA-0566	Vacuum Pump B Inlet Valve
TRA-0567	Vacuum Pump B Pneumatic Actuator
TRA-0568	Pump, Vacuum Priming, #3
TRA-0569	#3 Vacuum Pump Motor
TRA-0570	Vacuum Pump C Inlet Valve
TRA-0571	Vacuum Pump C Pneumatic Actuator
TRA-0572	Permeate Train #1, Bldg 50 Basement
TRA-0573	Permeate Tank #1
TRA-0574	Control Head, Turbidity Sensors #1 & 2
TRA-0575	Train 1 Permeate Tank ARV
TRA-0576	Turbidimeter, Train 1
TRA-0577	Pump, Permeate, Train #1
TRA-0578	#1 Permeate Pump Discharge Check Valve

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0579	Permeate Motor, Train 1
TRA-0580	Permeate Pump Discharge Valve 1
TRA-0581	Permeate Pump Suction Valve 1
TRA-0582	Meter, Flow, Permeate Train #1, Bldg 50 Basement
TRA-0583	Switch, Pressure, Permeate Header Pressure Train #1 East
TRA-0584	Switch, Pressure, Permeate Header Pressure Train #1 West
TRA-0585	Transmitter, Pressure, Permeate Train #1, Bldg. 50 Basement
TRA-0586	Permeate Train #2, Bldg 50 Basement
TRA-0587	Permeate Tank #2
TRA-0588	Train 2 Permeate Tank ARV
TRA-0589	Turbidimeter, Train 2
TRA-0590	Pump, Permeate, Train #2
TRA-0591	#2 Permeate Pump Discharge Check Valve
TRA-0592	Permeate Motor, Train 2
TRA-0593	Permeate Pump #2 Discharge Valve
TRA-0594	Permeate Pump #2 Suction Valve
TRA-0595	Meter, Flow, Permeate Train #2, Bldg 50 Basement
TRA-0596	Switch, Pressure, Permeate Header Pressure Train #2 East
TRA-0597	Switch, Pressure, Permeate Header Pressure Train #2 West
TRA-0598	Transmitter, Pressure, Permeate Train #2, Bldg. 50 Basement
TRA-0599	Permeate Train #3, Bldg 50 Basement
TRA-0600	Permeate Tank #3
TRA-0601	Control Head, Turbidity Sensors #3 & 4
TRA-0602	Train 3 Permeate Tank ARV
TRA-0603	Turbidimeter, Train 3
TRA-0604	Pump, Permeate, Train #3
TRA-0605	#3 Permeate Pump Discharge Check Valve
TRA-0606	Permeate Motor, Train 3
TRA-0607	Permeate Pump #3 Discharge Valve
TRA-0608	Permeate Pump #3 Suction Valve
TRA-0609	Meter, Flow, Permeate Train #3, Bldg 50 Basement
TRA-0610	Switch, Pressure, Permeate Header Pressure Train #3 East
TRA-0611	Switch, Pressure, Permeate Header Pressure Train #3 West
TRA-0612	Transmitter, Pressure, Permeate Train #3, Bldg. 50 Basement
TRA-0613	Permeate Train #4, Bldg 50 Basement
TRA-0614	Permeate Tank #4
TRA-0615	Train 4 Permeate Tank ARV
TRA-0616	Turbidimeter, Train 4
TRA-0617	Pump, Permeate, Train #4
TRA-0618	#4 Permeate Pump Discharge Check Valve
TRA-0619	Permeate Motor, Train 4
TRA-0620	Permeate Pump #4 Discharge Valve
TRA-0621	Permeate Pump #4 Suction Valve
TRA-0622	Meter, Flow, Permeate Train #4, Bldg 50 Basement

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0623	Switch, Pressure, Permeate Header Pressure Train #4 East
TRA-0624	Switch, Pressure, Permeate Header Pressure Train #4 West
TRA-0625	Transmitter, Pressure, Permeate Train #4, Bldg. 50 Basement
TRA-0626	Permeate Train #5, Bldg 50 Basement
TRA-0627	Permeate Tank #5
TRA-0628	Control Head, Turbidity Sensors #5 & 6
TRA-0629	Train 5 Permeate Tank ARV
TRA-0630	Turbidimeter, Train 5
TRA-0631	Pump, Permeate, Train #5
TRA-0632	#5 Permeate Pump Discharge Check Valve
TRA-0633	Permeate Motor, Train 5
TRA-0634	Permeate Pump #5 Discharge Valve
TRA-0635	Permeate Pump #5 Suction Valve
TRA-0636	Permeate Pump #5 VFD
TRA-0637	Meter, Flow, Permeate Train #5, Bldg 50 Basement
TRA-0638	Switch, Pressure, Permeate Header Pressure Train #5 East
TRA-0639	Switch, Pressure, Permeate Header Pressure Train #5 West
TRA-0640	Transmitter, Pressure, Permeate Train #5, Bldg. 50 Basement
TRA-0641	Permeate Train #6, Bldg 50 Basement
TRA-0642	Permeate Tank #6
TRA-0643	Train 6 Permeate Tank ARV
TRA-0644	Turbidimeter, Train 6
TRA-0645	Pump, Permeate, Train #6
TRA-0646	#6 Permeate Pump Discharge Check Valve
TRA-0647	Motor, Permeate Pump, Train 6
TRA-0648	VFD, Permeate, pump, Train #6
TRA-0649	Permeate Pump #6 Discharge Valve
TRA-0650	Permeate Pump #6 Suction Valve
TRA-0651	Meter, Flow, Permeate Train #6, Bldg 50 Basement
TRA-0652	Switch, Pressure, Permeate Header Pressure Train #6 East
TRA-0653	Switch, Pressure, Permeate Header Pressure Train #6 West
TRA-0654	Transmitter, Pressure, Permeate Train #6, Bldg. 50 Basement
TRA-0655	Permeate Train #7, Bldg 50 Basement
TRA-0656	Permeate Tank #7
TRA-0657	Control Head, Turbidity Sensors #7 & 8
TRA-0658	Train 7 Permeate Tank ARV
TRA-0659	Turbidimeter, Train 7
TRA-0660	Pump, Permeate, Train #7
TRA-0661	#7 Permeate Pump Discharge Check Valve
TRA-0662	Motor, Permeate Pump, Train 7
TRA-0663	Permeate Pump #7 Discharge Valve
TRA-0664	Permeate Pump #7 Suction Valve
TRA-0665	Meter, Flow, Permeate Train #7, Bldg 50 Basement
TRA-0666	Switch, Pressure, Permeate Header Pressure Train #7 East

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0667	Switch, Pressure, Permeate Header Pressure Train #7 West
TRA-0668	Transmitter, Pressure, Permeate Train #7, Bldg. 50 Basement
TRA-0669	Permeate Train #8, Bldg 50 Basement
TRA-0670	Permeate Tank #8
TRA-0671	Sensor, Turbidity, Train #8
TRA-0672	Train 8 Permeate Tank ARV
TRA-0673	Turbidimeter, Train 8
TRA-0674	Pump, Permeate, Train #8
TRA-0675	#8 Permeate Pump Discharge Check Valve
TRA-0676	Permeate Motor, Train 8
TRA-0677	Permeate Pump #8 Discharge Valve
TRA-0678	Permeate Pump #8 Suction Valve
TRA-0679	Meter, Flow, Permeate Train #8, Bldg 50 Basement
TRA-0680	Switch, Pressure, Permeate Header Pressure Train #8 East
TRA-0681	Switch, Pressure, Permeate Header Pressure Train #8 West
TRA-0682	Transmitter, Pressure, Permeate Train #8, Bldg. 50 Basement
TRA-0683	Pump, Backpulse, Pump #1
TRA-0684	Motor, Back Pulse, Pump #1
TRA-0685	Pump, Backpulse, Pump #2
TRA-0686	Motor, Back Pulse, Pump 2
TRA-0687	Pump, Membrane Building Sump #1
TRA-0688	Pump, Membrane Building Sump #2
TRA-0689	Pump, Recirculation, 50-P-10A
TRA-0690	Motor, Recirculation 50-P-10A
TRA-0691	Pump, Recirculation, 50-P-10B
TRA-0692	Motor, 50-P-10B
TRA-0693	Pump, Return, RAS Unit A
TRA-0694	Motor, RAS Pump A
TRA-0695	Pump, Return, RAS Unit B
TRA-0696	Motor, RAS Pump B
TRA-0697	Pump, Return, RAS Unit C
TRA-0698	Motor, RAS Pump C
TRA-0699	Pump, Sump Drain, Train 1-8
TRA-0700	Membrane Tank Drain Pump Motor
TRA-0701	Pump, W-3 Service Water, #1
TRA-0702	Motor, W-3, #1
TRA-0703	Pump, W-3 Service Water, #2
TRA-0704	Motor, W-3, #2
TRA-0705	Pump, WAS, Unit A
TRA-0706	Motor, Was Unit A
TRA-0707	Pump, WAS, Unit B
TRA-0708	Motor, WAS, Unit B
TRA-0709	Sensor, Temperature, Membrane Mixed Liquor Trains 1 - 4
TRA-0710	Sensor, Temperature, Membrane Mixed Liquor Trains 5 - 8

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0711	Separator, Pre Air Filter / Oil, Hankison Membrane Dryer
TRA-0712	South RAS Piping Below Grade
TRA-0713	Sump Pump Duplex Control Panel; Membrane Bldg Basement
TRA-0715	Valve Actuator, Discharge Valve, RAS, North
TRA-0716	Valve Actuator, Discharge Valve, RAS, South
TRA-0717	Valve, Drain, Membrane Tanks
TRA-0718	Valve, Drain, Membrane Tank #1, Bldg. 50 Basement
TRA-0719	Valve, Drain, Membrane Tank #2, Bldg. 50 Basement
TRA-0720	Valve, Drain, Membrane Tank #3, Bldg. 50 Basement
TRA-0721	Valve, Drain, Membrane Tank #4, Bldg. 50 Basement
TRA-0722	Valve, Drain, Membrane Tank #5, Bldg. 50 Basement
TRA-0723	Valve, Drain, Membrane Tank #6, Bldg. 50 Basement
TRA-0724	Valve, Drain, Membrane Tank #7, Bldg. 50 Basement
TRA-0725	Valve, Drain, Membrane Tank #8, Bldg. 50 Basement
TRA-0726	VFD, Toshiba, Control For RAS Pump 3
TRA-0727	VFD, Toshiba, Control For RAS Pump 1
TRA-0728	VFD, Toshiba, Control For RAS Pump 2
TRA-0729	Bldg 050 Blower Room
TRA-0730	Blower, Scour Air, Blower A
TRA-0731	Motor, Membrane Scour Blower
TRA-0732	Blower, Scour Air, Blower B
TRA-0733	Motor, Membrane Scour Blower
TRA-0734	Blower, Scour Air, Blower C
TRA-0735	Motor, Membrane Scour Blower
TRA-0736	Blower, Scour Air, Blower D
TRA-0737	Motor, Membrane Scour Blower
TRA-0738	Blower, Scour Air, Blower E
TRA-0739	Motor, Membrane Scour Blower
TRA-0740	Crane and Hoist, Membrane Building Blower Room
TRA-0741	Doors, Membrane Blower Room Equipment
TRA-0742	Membrane Blower Room Exhaust Fan 7
TRA-0743	Membrane Blower Room Exhaust Fan 8
TRA-0744	Membrane Blower Room Exhaust Fan 9
TRA-0745	Panel, Fan Control, Bldg. 50 Blower Room
TRA-0746	Bldg 050 Chemical Room
TRA-0747	1 Bleach Feed Pipe Valves 1-12
TRA-0748	6' Step Ladder, Chemical Rm, Membrane Bldg
TRA-0749	Containment Basin, Bldg. 50 Chemical Room
TRA-0750	Door, Membrane Chemical Room East Roll Up
TRA-0751	Door, Membrane Chemical Room West Roll Up
TRA-0752	Exhaust Fan, Membrane Bldg, Chemical Rm
TRA-0753	Eyewash/Safety Shower, Bldg. 50 Chemical Room
TRA-0754	Membrane Bleach Feed Piping
TRA-0755	Membrane Building Chemical Room Heating Control Panel PLC

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0756	Pump, Diaphragm, Citric Acid, East
TRA-0757	Pump, Diaphragm, Citric Acid, West
TRA-0758	Pump, Diaphragm, Sodium Hypochlorite, East
TRA-0759	Pump, Diaphragm, Sodium Hypochlorite, West
TRA-0760	Pump, Metering, Bleach Feeder For W-2 Water
TRA-0761	Tank, Citric Acid, Bldg. 50 Chem Room
TRA-0762	Tank, Sodium Hypochlorite, Bldg. 50 Chem Room
TRA-0763	Bldg 50 Electrical Room
TRA-0764	8' Step Ladder, Yellow Fiberglass, Membrane Bldg, Electrical Rm
TRA-0765	Electrical Main Disconnect Panel, Bldg. 50 Elect. Room
TRA-0766	Exhaust Fan, Membrane Electric Room South Wall
TRA-0767	MCC F1, Bldg 50
TRA-0768	MCC F2, Bldg 50
TRA-0771	Panel, Fan Control, Bldg 50 Elect. Room
TRA-0772	PLC, Membrane Train 1 and 2
TRA-0773	PLC, Membrane Train 3 and 4
TRA-0774	PLC, Membrane Train 5 and 6
TRA-0775	PLC, Membrane Train 7 and 8
TRA-0776	Soft Start For Course Air Blower Motor B
TRA-0777	Supply Fan, Membrane Electric Rm
TRA-0778	Supply Fan, Membrane Electric Room
TRA-0779	Transfer Panel, Generator, Membrane Elect. Room
TRA-0780	Main Breaker, Membrane Bldg., Generator ID#7829
TRA-0781	Main Breaker, Membrane Bldg., Line Power ID#7830
TRA-0782	Main Breaker, Membrane Bldg., Tie ID#7831
TRA-0783	PLC, Generator Transfer Panel, Membrane Elect. Room
TRA-0784	Uninterrupted Power Supply Cabinet
TRA-0785	Uninterrupted Power Supply #1
TRA-0786	Uninterrupted Power Supply #2
TRA-0787	Uninterrupted Power Supply #3
TRA-0788	Uninterrupted Power Supply #4
TRA-0789	Uninterrupted Power Supply #5
TRA-0790	Uninterrupted Power Supply #6
TRA-0791	Uninterrupted Power Supply #7
TRA-0792	VFD, Back Pulse Pump 1
TRA-0793	VFD, Back Pulse Pump 2
TRA-0794	VFD, Permeate Pump 1
TRA-0795	VFD, Permeate Pump 2
TRA-0796	VFD, Permeate Pump 3
TRA-0797	VFD, Permeate Pump 4
TRA-0798	VFD, Permeate Pump 5
TRA-0799	VFD, Permeate Pump 6
TRA-0800	VFD, Permeate Pump 7
TRA-0801	VFD, Permeate Pump 8

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0802	Emergency Diesel Generator, Membrane Building
TRA-0803	Diesel Engine, Membrane Bldg EDG
TRA-0804	Step Stool, Generator, Membrane Bldg
TRA-0805	Transformer, Primary, Membrane Building New (10/2010)
TRA-0806	Vacuum Priming System Control Switches
TRA-0807	Yard Breaker For Membrane Building
TRA-0808	Bldg #060, Ultra-violet Disinfection
TRA-0809	UV Treatment Channels
TRA-0810	Final Sampler - Sigma
TRA-0811	T Spreader For Lifting Uv Modules Out Of The Channel
TRA-0812	Bldg #070, East SST
TRA-0813	SST Tank #5
TRA-0814	Switch, Float, SST Tank 5 Level
TRA-0815	SST Tank #6
TRA-0816	Switch, Float, SST Tank 6 Level
TRA-0817	SST Tank #7
TRA-0818	Switch, Float, SST Tank 7 Level
TRA-0819	Truck Loading Station, East Load Out Building
TRA-0820	North Truck Loadout Valve
TRA-0821	Truck Loading Pipe Isolation Valve
TRA-0822	Truck Loading Valve At The Truck (8)
TRA-0823	Valve, Loading
TRA-0824	Bldg 070 Basement
TRA-0825	6' Step Ladder, Orange Fiberglass, East Load Out Bldg
TRA-0826	Backflow Preventer, East SST Bldg, 2 In
TRA-0827	Eyewash, Bottle, SST East Basement
TRA-0828	Pump, Sludge Loading Station, North
TRA-0829	Motor, East Sludge Loading Pump
TRA-0830	Valve, 12 Discharge Check, 41P1 North
TRA-0831	Pump, Sludge Loading Station, South
TRA-0832	Motor, East Sludge Loading South Pump
TRA-0833	Valve, 12 Discharge Check, 41P2 South
TRA-0834	Pump, Sump, East, SST East Basement
TRA-0835	Pump, Sump, West, SST East Basement
TRA-0836	SST 7 Upper North Chain Valve
TRA-0837	SST 7 Upper South Chain Valve
TRA-0838	Bldg 070 Control Room
TRA-0839	Panel, Light Control, SST East
TRA-0840	Security Camera 1, East Loadout
TRA-0841	Security Camera 2, East Loadout
TRA-0842	Security DVR, East Load Out
TRA-0843	SST East Exhaust Fan
TRA-0844	Supernate Pump, Moyno
TRA-0845	VFD Drive North Sludge Loading Pump 41P1A

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0846	VFD Drive South Sludge Loading Pump 41P1B
TRA-0847	Bldg #072, West SST
TRA-0848	SST Cell #1
TRA-0849	Switch, Float, Level, Cell 1 SST West
TRA-0850	Valve, SST Cell 1, Lower Valve
TRA-0851	Valve, SST Cell 1, Upper Valve
TRA-0852	SST Cell #2
TRA-0853	Switch, Float, Level, Cell 2 SST West
TRA-0854	Valve, SST Cell 2, Lower Valve
TRA-0855	Valve, SST Cell 2, Upper Valve
TRA-0856	SST Cell #3
TRA-0857	Switch, Float, Level, Cell 3 SST West
TRA-0858	Valve, SST Cell 3, Lower Valve
TRA-0859	Valve, SST Cell 3, Upper Valve
TRA-0860	SST Cell #4
TRA-0861	Switch, Float, Level, Cell 34 SST West
TRA-0862	Valve, SST Cell 4, Lower Valve
TRA-0863	Valve, SST Cell 4, Upper Valve
TRA-0864	Bldg 072 SST West Basement
TRA-0865	Pump, SST Centrifugal
TRA-0866	Motor, SST Centrifugal Pump
TRA-0867	Pump, SST Piston
TRA-0868	Motor, SST Piston Pump
TRA-0869	Pump, Sump North, SST West Basement
TRA-0870	Pump, Sump South, SST West Basement
	SST Basement sump pump control panel
TRA-0871	SST Pump Room Exhaust Fan
TRA-0872	Step Stool, Pump Rm, West SST Bldg
TRA-0873	UNIT Heater In The SST Pump Room
TRA-0874	Bldg 072 SST West Electrical Room
TRA-0875	6' Step Ladder, Yellow Fiberglass, Control Rm, West SST Bldg
TRA-0876	Hoist Gantry, SST West Electrical Room
TRA-0877	MCC, SST West
TRA-0878	Bldg #080, SDC Building
TRA-0879	ADP Room - SDC Bldg
TRA-0880	Pump, South SDC Feed
TRA-0881	Motor, South SDC Feed Pump
TRA-0882	Pump, North SDC Feed
TRA-0883	Motor, North SDC Feed Pump
TRA-0884	Switch, Pressure, SDC Feed Pumps - ADP Room
TRA-0885	4' Step Ladder, Orange Fiberglass, ADP Rm, SDC Bldg
TRA-0886	Exchanger, Heat, Glycol System
TRA-0887	Gas Regulator, Digestive System - ADP Room
TRA-0888	Panel, Control, ADP Pump

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0889	Pump, Air Diaphragm, Unit A
TRA-0890	Separator, Moisture ADP Pump A
TRA-0891	Pump, Air Diaphragm, Unit B
TRA-0892	Separator, Moisture ADP Pump B
TRA-0893	Pump, Digester Chopper North, Small - ADP Room
TRA-0894	Pump, Digester Chopper South, Small - ADP Room
TRA-0895	Pump, Digester Circulating, Hot water
TRA-0896	Pump, Glycol Circulation - ADP Room
TRA-0897	Pump, Hot Water Booster - ADP Room
TRA-0898	Pump, Hot Water Circulation - ADP Room
TRA-0899	Pump, Water, Digester 1&2 Heat Exchanger
TRA-0900	T-control, Spiral Heater Exchanger
TRA-0901	Transmitter, Sludge Discharge Pressure
TRA-0902	Valve, Discharge, ADP Pump To Digesters
TRA-0903	Valve, Discharge, ADP Pump To GBC
TRA-0904	Valve, Plug, Primary Sludge Co-mingling
TRA-0905	SDC Room - SDC Bldg
TRA-0906	Concentrator, Sieve Drum #1 (West)
TRA-0907	Motor, SDC No.1 Drum
TRA-0908	Reducer, Gear, SDC No.1 Drum Drive
TRA-0909	Mixer, SDC No.1 Tank
TRA-0910	Motor, SDC No.1 Mix Tank
TRA-0911	Reducer, Gear, SDC No.1
TRA-0912	Pump, Discharge, West #1 SDC
TRA-0913	Motor, No. 1 SDC Discharge Pump
TRA-0914	Reducer, Gear, SDC No.1 Discharge Pump
TRA-0915	VFD, SDC No.1 Discharge Pump
TRA-0916	Pump, Wash Water, SDC No.1
TRA-0917	Control, Panel, SDC 1, West
TRA-0918	Concentrator, SDC #2 East
TRA-0919	Motor, SDC No.2 Drum
TRA-0920	Reducer, Gear, SDC No.2 Drum Drive
TRA-0921	Mixer, SDC No.2 Tank
TRA-0922	Motor, SDC No.2 Mix Tank
TRA-0923	Reducer, Gear, SDC No.2 Mix Tank Gear
TRA-0924	Pump, Discharge, East No. 2 SDC
TRA-0925	Motor, Pump, No. 2 SDC Discharge
TRA-0926	Reducer, Gear, SDC No.2 Discharge Pump
TRA-0927	VFD, SDC No. 2 Discharge Pump
TRA-0928	Pump, Centrifical, SDC No.2 Wash Water
TRA-0929	Control, Panel,SDC 2, East
TRA-0930	Articulating Ladder, SDC Rm, SDC Bldg
TRA-0931	Flowmeter, Magnetic, CDS To SST Cell
TRA-0932	Step Stool, SDC Rm, SDC Bldg

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0933	Semblex Room - SDC Bldg
TRA-0934	Semblex Polymer Mixing System
TRA-0935	Panel, Control, SemBlex Polymer Control System
TRA-0937	Pump, Feed, North Polymer Feed
TRA-0938	Motor; North Polymer Pump; SDC
TRA-0939	VFD, North SDC Polymer Pump Dc Motor
TRA-0940	Pump, Feed, South Polymer To SDC'S
TRA-0941	Motor; South Polymer Pump; SDC
TRA-0942	VFD, South SDC Polymer Pump Dc Motor
TRA-0944	Motor, Dry Chemical Feed, Symblex System
TRA-0945	Reducer, Gear, Dry Polymer Feed
TRA-0946	Tank, Symblex Polymer Storage, 1 East
TRA-0947	Tank, Symblex Polymer Storage, 2 West
TRA-0948	Portable Stair, Simplex Rm, SDC Bldg
TRA-0949	Bldg #085, GBC Building
TRA-0950	Bldg 085 GBC Room
TRA-0951	Concentrator, Gravity Belt
TRA-0952	Transmitter, CWAS Flow
TRA-0953	Control, Master, Gravity Belt Concentrator
TRA-0954	Pump, Booster, Wash Water For The GBC
TRA-0955	Pump, Discharge, GBC
TRA-0956	Motor, Pump, GBC Discharge
TRA-0957	Reducer, Gear, GBC Discharge
TRA-0958	VFD, Pump, GBC Discharge
TRA-0959	Pump, Filtrate Return, GBC, 2 in
TRA-0960	Reducer, Gear, GBC Belt
TRA-0961	Switch, Level, GBC Hopper
TRA-0962	GBC Building Motor Control Center
TRA-0963	8' Step Ladder, Yellow Fiberglass, GBC Rm, GBC Bldg
TRA-0964	Control, Pump, East Polymer Injection
TRA-0965	VFD, Pump, East Polymer Feed
TRA-0966	Control, Pump, West Polymer Injection
TRA-0967	VFD, Pump, West Polymer Feed
TRA-0968	Eyewash Station, Bottle - GBC Room
TRA-0969	GBC Building Roll Up Door
TRA-0970	GBC Room Heating Control Panel PLC
TRA-0971	GBC Room Make Up Air Handler And Heater
TRA-0972	Gravity Belt Concentrator Room Overhead Crane
TRA-0973	Portable Stair, GBC Rm, GBC Bldg
TRA-0974	Pressure Switch, Discharge Pump PSI - GBC Room
TRA-0975	Pump, Booster, Glycol - GBC Room
TRA-0976	Pump, Polymer Feed A
TRA-0977	Motor, Polymer Feed Pump A
TRA-0978	Pump, Polymer Feed B, West

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-0979	Motor, Polymer Feed Pump B
TRA-0980	Transmitter, Flow, Poly Feed East
TRA-0981	Transmitter, Flow, Poly Feed West
TRA-0982	Bldg 085 Polymer Room
TRA-0983	Backflow Preventer, GBC Polymer Rm , 1.5 In
TRA-0984	Eyewash/Safety Shower - Bldg 085 Polymer Room
TRA-0985	Fan, Air Supply - Bldg 85 Polymer Room
TRA-0986	Mixer, East Poly Blend Unit
TRA-0987	Mixer, Polymer A East
TRA-0988	Drive, Angle, East Polymer Mixing Tank Mixer
TRA-0989	Valve, Control, Dilution Water Poly Feed A
TRA-0990	Mixer, West Poly Blend Unit
TRA-0991	Mixer, Polymer B West
TRA-0992	Drive, Angle, West Polymer Mixing Tank
TRA-0993	Valve, Control, Dilution Water Poly Feed B
TRA-0994	Portable Stair, US Filter Rm, GBC Bldg
TRA-0995	Pump, Boiler Water Booster - Bldg 85 Polymer Room
TRA-0996	Bldg #090, Digesters 1 and 2 Pipe Gallery Building
TRA-0997	Articulating Ladder, Digester 2 Coupla, Dig 2
TRA-0998	In Ground Pipe For Digester 2S
TRA-0999	Piping, In Ground, Digester 1N
TRA-1000	Pump, Circulating
TRA-1001	Pump, Circulating, Hot Water
TRA-1002	Pump, Circulating, Hot Water
TRA-1003	Pump, Feed
TRA-1004	Transmitter, Level Indicating, Small Digester # 1
TRA-1005	Transmitter, Level Indicating, Small Digester # 2
TRA-1006	Valve, Feed, 6
TRA-1007	No. Small Digester Feed Valve Actuator
TRA-1008	Valve, Feed, 6
TRA-1009	Actuator, Feed
TRA-1010	Bldg #095, Old Locker Rm, Digester 3 and 4 Building
TRA-1011	Bldg 95 Basement - Digesters 3 and 4 Pipe Gallery
TRA-1012	12' Extension Ladder, Orange Fiberglass, HX Rm
TRA-1013	Fixed Ladder, Digester 3 Piping, HX Rm
TRA-1014	Fixed Ladder, Digester 4
TRA-1015	Fixed Ladder, Digester 4 Piping, HX Rm
TRA-1016	Heat Exchanger, Flat Bed (South)
TRA-1017	Heat Exchanger, Spiral (North)
TRA-1018	In Ground Pipe For Digester 3N
TRA-1019	In Ground Pipe For Digester 4S
TRA-1020	Large Digester Transfer Pump - Horizontal. Cornell
TRA-1021	Pump, Circulating, Hot Water
TRA-1022	Pump, Circulating, Hot Water

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1023	Pump, Circulating, Hot Water
TRA-1024	Pump, Circulation, Hot Water For #4 South Digester
TRA-1025	Pump, Circulation, North Spiral Hx Hot Water
TRA-1026	Pump, Circulation, Old Locker Rm
TRA-1027	Pump, Recirculation, Digester 3, Vaughan, Chopper
	Motor, Recirculation, Digester 3, Vaughan
TRA-1028	Pump, Recirculation, Digester 4, Vaughan, Chopper
TRA-1029	Motor, Recirculation, Digester 4, Vaughan
TRA-1030	Transmitter, Level Indicating, Large Digester # 3
TRA-1031	Transmitter, Level Indicating, Large Digester # 4
TRA-1035	Bldg 95 Old Locker Room
TRA-1036	Fan, Exhaust, Heat Exchange Room
TRA-1037	South Digester Cent. Pump Recirc Motor - Vertical Cornell
TRA-1038	South Gas Compressor Motor Digester 4
TRA-1039	Bldg #097, Boiler and Digester 5 Building
TRA-1040	6' Step Ladder, Orange Fiberglass, Stairwell, Dig 5 Bldg
TRA-1041	Bldg 097 Basement - Boiler and Digester 5 Bldg
TRA-1042	Backflow Preventer, Boiler Bldg, 2 In
TRA-1043	Control, Temperature, Sludge Temperature
TRA-1044	Drip Trap Next To Circular Heat Exchange
TRA-1045	Drip Traps On The Methane Mixers & Lines
TRA-1046	Eyewash, Bottle - Bldg 97 Basement
TRA-1047	Flow Meter, Sludge Transfer, Bldg 97 Basement
TRA-1048	Heat Exchanger, Sludge, Digester 5 - Bldg 97 Basement
TRA-1049	Hot Water Heating Piping System
TRA-1050	Motor Control Bucket 3 Hp Hx Circ Pump
TRA-1051	Piping, In Ground And Above Ground For Digester 5
TRA-1052	Pump, Cornell, Vertical, Large Digester Transfer Pump; Hx Room
TRA-1053	Pump, Hot Water Circulating, Bldg 97 Basement
TRA-1054	Pump, Hot Water Circulation Digester 5 Hx
TRA-1055	Motor, Hot Water Circulation Pump
TRA-1056	Pump, Recirculation Digester 5 East (2)
TRA-1057	Motor, Recirculation Pump, Digester 5 (East)
TRA-1058	Pump, Recirculation, Digester 5 West (1)
TRA-1059	Motor, Digester 5 Recirculation Pump 1 (West)
TRA-1060	Pump, Sump, #1, Bldg 97 Basement
TRA-1061	Pump, Sump, #2, Bldg 97 Basement
TRA-1062	Pump, Sump, Duplex Control Panel; Digester 5 Bldg Basement
TRA-1063	Pump, Transfer, Digester 5 East (2)
TRA-1064	Gear Reducer, Digester 5 Transfer Pump
TRA-1065	Motor, Transfer Pump, Digester 5 East (2)
TRA-1066	Switch, Hi Pressure, Transfer Pump 2 (East)
TRA-1067	Pump, Transfer, Digester 5 West (1)
TRA-1068	Gear Reducer, Digester 5 Transfer Pump

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1069	Motor, Digester 5 West (1) Transfer
TRA-1070	Switch, Hi Pressure, Transfer Pump 1 (West)
TRA-1071	South Digester Heat Exchanger
TRA-1072	Step Stool, Pump Rm, Dig 5 Bldg
TRA-1073	Valve, Digester Feed, # 5
TRA-1074	Valve, Relief, Digester #5 Recirculation Line
TRA-1075	Valve, Relief, Digester #5 Recirculation Line
TRA-1076	Bldg 097 Boiler Room - Boiler and Digester 5 Bldg
TRA-1077	#1 Hurst HW Boiler
TRA-1078	Boiler #1 Digester Gas Boiler Valve
TRA-1079	Boiler #1 Digester Gas Isolation Valve
TRA-1080	Boiler #1 Natural / Digester Gas Boiler Valve
TRA-1081	Boiler #1 Natural Gas Isolation Valve
TRA-1082	Digester Gas Fire Control Butterfly Valve Boiler #1
TRA-1083	Hurst Boiler Circulating Pump 1 Mtr
TRA-1084	Natural / Digester Gas Fire Control Butterfly Valve Boiler #1
TRA-1085	Pump, Circulating, Hurst Boiler #1
TRA-1086	#2 Hurst HW Boiler
TRA-1087	Boiler #2 Digester Gas Boiler Valve
TRA-1088	Boiler #2 Digester Gas Isolation Valve
TRA-1089	Boiler #2 Natural / Digester Gas Boiler Valve
TRA-1090	Boiler #2 Natural Gas Isolation Valve
TRA-1091	Digester Gas Fire Control Butterfly Valve Boiler #2
TRA-1092	Hurst Boiler Circulating Pump 2 Mtr
TRA-1093	Natural / Digester Gas Fire Control Butterfly Valve Boiler #2
TRA-1094	Pump, Circulating, Hurst Boiler #2
TRA-1095	8' Step Ladder, Yellow Fiberglass, Boiler Rm
TRA-1096	Boiler Room Heating Control Panel
TRA-1097	Condensate/Sediment Trap
TRA-1098	Controller, Exhaust Fan, Bldg 97 Boiler Room
TRA-1099	Digester Building Boiler Room Exhaust Fan
TRA-1100	Fan, Exhaust, Digester Building Boiler Room
TRA-1101	Motor, Fan, Makeup Air Unit
TRA-1102	Flow Switch, Boiler 1, Bldg 97 Boiler Room
TRA-1103	Flow Switch, Boiler 2, Bldg 97 Boiler Room
TRA-1104	Gas Detector, Bldg 97 Boiler Room
TRA-1105	Micro Iv Lead-Lag Boiler Control Panel
TRA-1106	Pump, Glycol Booster, Bldg 97 Boiler Room
TRA-1107	Pump, Hot Water Booster, Bldg 97 Boiler Room
TRA-1108	Room, Electrical, Boiler and Digester 5 Bldg
TRA-1109	Digester Building PLC
TRA-1110	MCC, Digester 5 Equipment
TRA-1111	Supply Fan Digester Control Power Rm
TRA-1112	UPS For The Digester/Boiler Electrical Room Panel

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1113	VFD, Digester 5 Recirculation
TRA-1114	VFD, Digester 5 Recirculation
TRA-1115	VFD, Digester 5 Transfer Pump East (2)
TRA-1116	VFD, Digester 5 Transfer Pump West (1)
TRA-1117	Room, Explosion Proof, Boiler and Digester 5 Bldg
TRA-1118	Drip Trap, East End Of The Digester Gas Header In The Boiler Room
TRA-1119	Drip Trap, West End Of The Digester Gas Header In The Boiler Room
TRA-1120	Fan, Supply/Exhaust, Explosion Proof Room, Boiler and Digester 5 Bldg
TRA-1121	Gas Monitor, Explosion Proof Room, Boiler and Digester 5 Bldg
TRA-1122	Bldg #100, Administration Building
TRA-1124	Screw Pump # 1
TRA-1125	Motor, Screw Pump #1
TRA-1126	Reducer, Gear, Screw pump # 1
TRA-1127	Coupling, Output, Between The Reduction Gear Output Shaft And The #1 Screw Pump Shaft
TRA-1128	Lower Bearing, Screw Pump #1
TRA-1129	Screw Pump # 2
TRA-1130	Motor, Screw Pump #2
TRA-1131	Reducer, Gear, Screw pump # 2
TRA-1132	Coupling, Output, Between The Reduction Gear Output Shaft And The #2 Screw Pump Shaft
TRA-1133	Lower Bearing, Screw Pump #2
TRA-1134	Screw Pump # 3
TRA-1135	Motor, Screw Pump #3
TRA-1136	Reducer, Gear, Screw pump # 3
TRA-1137	Coupling, Output, Between The Reduction Gear Output Shaft And The #3 Screw Pump Shaft
TRA-1138	Lower Bearing, Screw Pump 3
TRA-1139	10' Step Ladder, Yellow Fiberglass, Upper Hall, Membrane Bldg
TRA-1140	Admin Basement
TRA-1141	Ferric System
TRA-1142	Pump, Ferric Feed #1
TRA-1143	Motor, Ferric Feed Pump 1
TRA-1144	Pump, Ferric Feed #2
TRA-1145	Motor, Ferric Feed Pump 2
TRA-1146	Pump, Ferric Feed #3
TRA-1147	Motor, Ferric Feed Pump 3
TRA-1148	Panel, Control, Ferric Pump #3 Feed Control
TRA-1149	Pump, Ferric Feed #4
TRA-1150	VFD Drive For The #4 Ferric Chloride Pump
TRA-1151	6' Step Ladder, Yellow Fiberglass, Admin Basement
TRA-1152	Admin Bldg Air Line Moisture Separator For Lab Air
TRA-1153	Administration Basement Hot Water Heater
TRA-1154	Administration Bldg Sump Pump #1 North

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1155	Administration Bldg Sump Pump #2 South
TRA-1156	Aeration Flow Transmitter North
TRA-1157	Aeration Flow Transmitter South
TRA-1160	Aeration Header Pressure Transmitter
TRA-1161	Aeration Tank Drain Pump #1 North
TRA-1162	Aeration Tank Drain Pump #2 South
TRA-1163	Air Modulation Valve North
TRA-1165	Air Modulation Valve South
TRA-1166	Backflow Preventer, Lab, Cold Water Supply
TRA-1167	Backflow Preventer, Lab, Hot Water Supply
TRA-1168	Circulating Pump P-15 For Glycol System
TRA-1169	Eyewash/Safety Shower - Admin Basement
TRA-1170	Hot Water Circ Pump HVAC
TRA-1171	Programmable Logic Controller Admin Basement
TRA-1172	Rotary Screw Air Compressor 1 North
TRA-1173	Air Dryer, North, Admin Basement
TRA-1174	Air Receiver, North, Admin Basement
TRA-1175	Rotary Screw Air Compressor 2 South
TRA-1176	Air Dryer, South, Admin Basement
TRA-1177	Air Receiver, South, Admin Basement
TRA-1179	Vacuum Pump For Lab
TRA-1180	Administration Building Elevator
TRA-1181	Administration Building HVAC System
TRA-1182	Admin HVAC Hot Water Circulating Pump Motor
TRA-1183	Handicapped Bathroom Exhaust Fan
TRA-1184	Locker Room Exhaust Fan
TRA-1185	Orange Lab Exhaust Fan
TRA-1186	Window Mounted Ac For The Admin Front Office
TRA-1187	Aeration Blower Room
TRA-1188	Blower, Aeration #1
TRA-1189	#1 Blower Inlet Valve And Actuator
TRA-1190	Aeration Blower Motor No.1
TRA-1191	Blower, Aeration #2
TRA-1192	#2 Blower Inlet Valve And Actuator
TRA-1193	Aeration Blower Motor No.2
TRA-1197	Blower, Aeration #4
TRA-1198	Motor, Aeration Blower #4
TRA-1199	Panel, Control, #4 Blower
TRA-1200	12' Step Ladder, Orange Fiberglass, Blower Rm, Admin Bldg
TRA-1201	Admin Bldg, MCCB
TRA-1202	Main Plant Automatic Transfer Switch
TRA-1203	Fan, Exhaust, Blower Room North
TRA-1204	Fan, Exhaust, Blower Room South
TRA-1205	Fan, Odor Control, Efp-1

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1207	Panel, Lighting, A In Aeration Blower Rm
TRA-1208	Primary Effluent Sampler - Aeration Blower Room
TRA-1209	Step Stool, Blower Rm, Admin Bldg
TRA-1212	GE Rack Out Breaker, Admin Bldg, Screw Pumps, ID#3455
TRA-1213	GE Rack Out Breaker, BGC Bldg, Dig #5 Bldg, ID#7827
TRA-1214	GE Rack Out Breaker, Blower 1, ID#7828
TRA-1215	GE Rack Out Breaker, Blower 2, ID# 3460
TRA-1216	GE Rack Out Breaker, Blower 3, ID#3459
TRA-1217	GE Rack Out Breaker, Blower 4, ID#3457
TRA-1218	GE Rack Out Breaker, East Sludge Loadout, ID#7826
TRA-1219	GE Rack Out Breaker, Main Tie, ID#3456
TRA-1220	GE Rack Out Breaker, North Transformer, ID#3465
TRA-1221	GE Rack Out Breaker, Rotomat, Old Locker Rm ID#3464
TRA-1222	GE Rack Out Breaker, South Transformer, ID#3462
TRA-1223	GE Rack Out Breaker, West SST, ID#3458
TRA-1225	North Transformer, Main Plant, Primary To 480V
TRA-1226	South Transformer, Main Plant, Primary To 480V
TRA-1227	Transmitter, North Flume, Primary Effluent, Miltronics
TRA-1228	Transmitter, South Flume, Primary Effluent, Miltronics
TRA-1229	Fixed Ladder, Admin Bldg, North Hall
TRA-1230	Gas Detection Equipment
TRA-1231	CGM 929 3-Gas Monitor
TRA-1232	Combustible Gas Calibration Kit, Draeger
TRA-1233	Detector, Cgm 900 Ii Autocal
TRA-1234	Detector, CGM Ii Gas
TRA-1235	Detector, CGM Ii Gas
TRA-1236	Generator Room
TRA-1237	10' Step Ladder, Generator RM, Admin Bldg
TRA-1238	4' Step Ladder, Generator Rm, Admin Bldg
TRA-1239	Back Flow Preventer, Portable, 1.5 In Rpz
TRA-1240	Crane - Generator Room
TRA-1241	Eyewash/Safety Shower - Generator Room
TRA-1242	Kohler Emergency Diesel Generator At WWTP
TRA-1243	Lab
TRA-1244	Analytical Balance
TRA-1245	Autoclave
TRA-1246	Autoclave Sterilizer
TRA-1247	Blue Lab Exhaust Fan
TRA-1248	BOD Probe
TRA-1249	Centrifuge
TRA-1250	De-Ionized Water System
TRA-1251	Discrete Analyzer
TRA-1252	Dissolved Oxygen Probe
TRA-1253	Drying Oven

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1254	Fecal Incubator Bath
TRA-1255	Fume Hood
TRA-1256	Fume Hood Exhaust Fan
TRA-1257	Lab Dish Washer
TRA-1258	Magnetic Stirring Hot Plate.#1
TRA-1259	Magnetic Stirring Hot Plate.#2
TRA-1260	Muffle Furnace
TRA-1261	Pan Balance
TRA-1262	Ph Probe
TRA-1263	Precision Low Temperature Incubator 1
TRA-1264	Precision Low Temperature Incubator 2
TRA-1265	Refrigerator, Sample #1
TRA-1266	Refrigerator, Sample #2
TRA-1267	Stove In Lab Area
TRA-1268	TC Plant Alarm Dialer
TRA-1269	Lighting Panel A In Admin Upper Hall North East Corner
TRA-1270	Raven Infrared Blanket Detector A
TRA-1271	RM #120, Maintenance and Assoc. Area
TRA-1272	4 Wheels And 2 Cross Beams And 4 Mounting Plates For Moving Large Motors Pumps And Blowers
TRA-1273	A-frame,. portable, gantry, crane, Aluminum
TRA-1274	Chemix Room Hoist
TRA-1275	Crane, Shop, P&H, 2 tom cap
TRA-1276	Fixed Ladder, Screw Pump Wet Well
TRA-1277	Gas Powered Tools & Equipment
TRA-1278	Cub Cadet Two Stage Snow Thrower
TRA-1279	Gas, Honda, Pressure Washer
TRA-1280	Hotsy, Steam, Pressure Washer
TRA-1281	MTD Push Mower
TRA-1283	Snapper Snow Blower
TRA-1284	Hand, Power Tools
TRA-1285	Ac/Dc Clamp Meter With Ir Temperature
TRA-1286	Ac/Dc Clamp Meter With Ir Temperature
TRA-1287	Don's Tool Bag Multi Meter W/ Clamp Amp Probe
TRA-1288	Dx-460 Power Nailer
TRA-1289	Fluke Model 321 Clamp Meter
TRA-1290	Fluke Model 322 Clamp Meter
TRA-1291	Grinder
TRA-1292	Pm Operators Tool Bag
TRA-1293	Clamp Meter Pm Tool Bag
TRA-1294	Portable Battery Operated Drills And Hammer Drills
TRA-1295	Te 6-S Hammer Drill
TRA-1296	Lights
TRA-1297	Main Pipe Gallery And Shop Basement Heated Make Up Air System

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1298	Maintenance Basement
TRA-1299	12 Ton Shop Press
TRA-1300	Backflow Preventer, WWTP Main, 3 In
TRA-1301	Pallet Jack
TRA-1302	Pallet Jack, Adjustable
TRA-1303	Portable Heating & Cooling
TRA-1304	60,000 BTU, Propane, Portable, Heater
TRA-1305	Free Standing Window Exhaust Ac
TRA-1306	Heater, Oil Core, Portable
TRA-1307	Window Mounted Ac For The Maintenance Office
TRA-1308	Portable Pumps
TRA-1309	2 Portable Submersible Pump W/ Float Sw
TRA-1310	2 Portable Sump Pump
TRA-1311	Pump, Honda, 2 Decant, WMP20X
TRA-1312	Pump, Honda, 2 Decant, WMP20X
TRA-1313	Pump, Honda, 2 Trash, WT20X
TRA-1314	Pump, Honda, 4 Trash, WT40X
TRA-1315	Shop Area Hoist
TRA-1316	Digesters
TRA-1317	Digester, # 3 North
TRA-1318	Compressor, Gas, Digester 3
TRA-1319	Motor, Gas Compressor
TRA-1320	Flame Arrestor, Digester 3
TRA-1321	Digester, #4 South
TRA-1322	Compressor, Gas, Digester 4
TRA-1323	Flame Arrestor, Digester 4
TRA-1324	Digester, #5
TRA-1325	Flame Arrestor, Digester 5 East
TRA-1326	Flame Arrestor, Digester 5 West
TRA-1327	Transmitter, Level, Ultrasonic, Digester #5
TRA-1328	Pump, Gas Driven, Multiquip 3 In. Diaphragm Pump
TRA-1329	Ferric Chloride Storage Area
TRA-1330	Tank, Ferric Chloride Storage Structure
TRA-1331	Ferric Chloride Truck Unloading Piping
TRA-1332	Fixed Ladder, Ferric Tank
TRA-1333	Indicator, Level, Ferric Storage Tank
TRA-1334	Containment, Ferric Chloride
TRA-1335	Eyewash/Safety Shower - Ferric Chloride Storage Area
TRA-1336	General Facility
TRA-1337	Milltronics East Influent Flow Control Panel
TRA-1338	Milltronics West Influent Control Panel
TRA-1339	SCADA And Communications
TRA-1340	56K Phone Modem For Zenon Data Collection Computer
TRA-1341	Acp-5 PLC Panel

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1342	Battery Backup Units
TRA-1343	Apc 1000 Individual Back Up Power Supply
TRA-1344	Apc Dla1500 Smart UPS
TRA-1345	Apc Dla1500 Smart UPS
TRA-1346	Apc Smart UPS 1000
TRA-1347	Back Up Battery Supply For SCADA Computers
TRA-1348	Back Up Power Supply For SCADA Computer In The Orange Lab
TRA-1349	Back Up Power Supply For SCADA Computer In The Orange Lab
TRA-1350	Uninterrupted Power Supply Battery Pack
TRA-1351	Uninterrupted Power Supply Digester #5 BLDG
TRA-1352	Uninterrupted Power Supply WWS02
TRA-1353	Uninterrupted Power WWS01
TRA-1354	UPS Power Supply #1
TRA-1355	UPS Power Supply #2
TRA-1356	UPS Power Supply #3
TRA-1357	UPS Power Supply #4
TRA-1358	UPS Power Supply #5
TRA-1359	UPS Power Supply #6
TRA-1360	UPS Power Supply #7
TRA-1361	Data Communications Switch Admin Basement
TRA-1362	Data Communications Switch In Membrane Electrical Room
TRA-1363	Fiber Optic --> Digital Converter Between Admin Bldg And Membrane Network
TRA-1364	Fiber Optic To Digital Converter Between Admin Building Network And Boiler Room
TRA-1365	Fiber Optic To Digital Converter Between Admin Building Network And The Membrane Building Network Including 24 Port Switch
TRA-1366	GBC Building PLC
TRA-1367	Intellution Software Program
TRA-1368	Membrane Building Back Up CPU
TRA-1369	Modem In The Orange Lab For SCADA Computer To Connect To 8170 Dsl Line
TRA-1370	Monitor; Membrane CPU
TRA-1371	Plant Main CPU
TRA-1372	Plant Slave CPU
TRA-1373	20 Gig Hard Drive And Back Up Drive
TRA-1374	Office Network
TRA-1375	Computer and Networking
TRA-1376	Front Office Desk Top Computer
TRA-1377	Local Back Up Battery 370 W For Maintenance Office Computer
TRA-1378	Local Back Up Battery, 370 W For Ops Computer
TRA-1379	Local Back Up Battery, 370W For Front Office Computer
TRA-1380	Maintenance Department Hand Held Computer
TRA-1381	Maintenance Department Lap Top

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1382	Maintenance Managers Lap Top Computer
TRA-1383	Netopia Dsl Modem And Router
TRA-1384	Networking Switch, Maint, Netgear, S wall
TRA-1385	Networking Switch, Maint,, Netgear, NE corner
TRA-1386	Operations Department Hand Held Computer
TRA-1387	Ops Office Desk Top Computer
TRA-1388	Orange Lab East Wall Desk Top Computer
TRA-1389	Project Managers Lap Top Computer
TRA-1390	Video Projector
TRA-1391	County Samplers Cabinets and Equipment
TRA-1392	Elmwood Twp County Samplers
TRA-1393	Garfield Meter Pit Sampler
TRA-1394	Garfield Twp County Sampler
TRA-1395	Peninsula Dr County Sampler
TRA-1396	Sampler At The 6Th Street Location Sampler
TRA-1397	Sampler, Flow, Acme Township
TRA-1398	Sampler, Flow, Bunker Hill Rd
TRA-1399	Sampler, Flow, Indian Trail
TRA-1400	Sampling Device
TRA-1401	Emergency Lighting At Wwtp
TRA-1402	Facility Ladders
TRA-1403	HVAC Equipment
TRA-1404	Membrane HVAC
TRA-1405	Gas Unit Heater East Stair Well Entrance
TRA-1406	Gas UNIT Heater East Stair Well Entrance
TRA-1407	Gas Unit Heater In Membrane Building Electric Room
TRA-1408	Gas UNIT Heater In Membrane Building Electric Room
TRA-1409	Gas Unit Heater In Membrane Building Upper Hall
TRA-1410	Gas UNIT Heater In Membrane Building Upper Hall
TRA-1411	Gas Unit Heater In Membrane Building West Stair
TRA-1412	Gas UNIT Heater In Membrane Building West Stair
TRA-1413	Membrane Blower Room Heated Make-Up Air
TRA-1414	Membrane Building Electrical Room Heating Control Panel PLC
TRA-1415	Membrane Building Pump Room Heating Control Pannel PLC
TRA-1416	Membrane Chemical Room Heated Make Up Air
TRA-1417	Membrane Pump Room Heated Make-Up Air
TRA-1418	Safety Equipment
TRA-1419	Electrical Protection
TRA-1420	Arc Flash Kit, XLG
TRA-1421	Gloves, Electrical Protection, Class 0, XLG
TRA-1422	Arc Flash Kit, Lg,
TRA-1423	Gloves, Electrical Protection, Class 0, LG
TRA-1424	Arc Flash Kit, Med
TRA-1425	Gloves, Electrical Protection, Class 0, MED

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1426	Arm Protector Set
TRA-1427	Gloves, Electrical Protection, Class 0, XLG, Maintenance
TRA-1428	Rubber Glove Liner Class 00 L/ S7194 R/7194
TRA-1429	Rubber Glove Liner Class 00 L/ S7194 ; R/ S6309
TRA-1430	Rubber Glove Liner, Class 2
TRA-1431	Rubber Glove Liner; Class 0 L/M1155 ; L/ J2755
TRA-1432	Rubber Glove Liner; Class 00 Left S6443 ; Right S7898
TRA-1433	Fire Extinguishers
TRA-1434	Chevrolet S-10 Pick Up, Dr. Green, Behind The Seat; Project Managers
TRA-1435	Fire Extinguisher Bc Ford F-250 Truck
TRA-1436	Room, Electrical, Preliminary Screening Bldg.
TRA-1437	Fire extinguishers - Spare
TRA-1438	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1439	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1440	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1441	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1442	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1443	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1444	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1445	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1446	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1447	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1448	Spare Abc Fire Extinguisher; Admin Basement N.E. Stair Well
TRA-1449	Septic Station Unloading Station Pump
TRA-1450	Vehicles
TRA-1451	2007 Ford Ranger 4X2 White Pick Up
TRA-1452	2008,Ford, F-250, 4x4
TRA-1453	2014, Ford, F150, 4x4
TRA-1454	OOS-2015, Ford, F150, 4X4
TRA-1456	Nissan Forklift
TRA-1457	TCWWTP Lift Stations
TRA-1459	Bay Street Lift Station
TRA-1460	Alarm Dialer At Bay Street Lift Station
TRA-1461	Bay Street LS Pump #1
TRA-1462	Bay Street LS Pump 1 Motor
TRA-1463	Bay Street LS Pump #2
TRA-1464	Bay Street LS Pump 2 Motor
TRA-1465	Bay Street LS Wet Well Mixer (submersible mixer)
TRA-1466	Bay Street LS Wetwell Mixer Motor
TRA-1467	Flow Meter
TRA-1468	Panel, Control, Bay St. Lift Station
TRA-1469	Transducer, Level, Miltronics, Bay St. Lift Station
TRA-1470	Birchwood Lift Station
TRA-1471	15# Abc Fire Extinguisher At The Birchwood LS

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1472	Alarm Dialer At Birchwood Lift Station
TRA-1473	Birchwood Emergency Diesel Generator
TRA-1474	Motor, Diesel, Birchwood LS EDG
TRA-1476	Fan, Exhaust, Birchwood LS
TRA-1477	Panel, Control, Birchwood Lift Station
TRA-1478	Pump, # 1
TRA-1479	Motor, Birchwood LS Pump #1
TRA-1480	Pump, # 2
TRA-1481	Motor, Birchwood LS Pump #2
TRA-1482	Pump, Sump, Birchwood LS
TRA-1483	Transducer, Level, Miltronics, Birchwood Lift Station
TRA-1484	Clinch Park Lift Station
	Control Panel, Clinch Park Lift Station
TRA-1485	Pump, Lift Station, # 1
TRA-1486	Pump, Lift Station, # 2
TRA-1487	Coast Guard Lift Station
TRA-1488	Alarm Dialer At Coast Guard Lift Station
TRA-1489	Chart Recorder At Coast Guard LS
TRA-1490	Flow Meter
TRA-1491	Miltronics Multi Ranger 2 At Coast Guard
TRA-1492	Panel, Control, Coast Guard LS Duplex Pump
TRA-1493	Pump, LS, #1
TRA-1494	Motor, Coast Guard LS Pump 1
TRA-1495	Pump, LS, #2
TRA-1496	Motor, Coast Guard LS Pump 2
TRA-1497	Front Street Lift Station
TRA-1498	Back Up Power Supply For The Front Street Lift Station PLC
TRA-1499	Backflow Preventer, Front St LS, Main Floor, 1 In Rpz
TRA-1500	Backflow Preventer, Front St LS, Basement, 1 In Rpz
TRA-1501	Battery Charger, Front St. Lift Station
TRA-1502	Fan, Exhaust, Front Street LS
TRA-1503	Hoist, Front Street LS
TRA-1504	Main EIM Surge Filter At Front Street
TRA-1505	Miltronics Multi Ranger Plus Telemetry
TRA-1506	PLC, Front Street Lift Station
TRA-1507	Pump Control Panel And PLC Enclosure
TRA-1508	Pump, Centrifical, # 2
TRA-1509	Motor, Front Street LS Pump 2
TRA-1510	Valve, Check, #2 Pump At Front Street
TRA-1511	VFD Front St Pump No.2
TRA-1512	Pump, Centrifical, # 3
TRA-1513	Motor, Front Street LS Pump 3
TRA-1514	Valve, Check, #3 Pump At Front Street
TRA-1515	VFD Front St Pump No. 3

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
TRA-1516	Pump, Centrifical, # 4
TRA-1517	Motor, Front Street LS Pump 4
TRA-1518	Valve, Check, #4 Pump At Front Street
TRA-1519	VFD Front St Pump No.4
TRA-1520	Pump, Sump, Front Street LS
TRA-1521	Standby Generator Front Street LS
TRA-1522	Motor, EDG, Front Street LS
TRA-1523	Hull Park Lift Station
TRA-1524	Pump, Grinder. Hull Park Lift Station
TRA-1525	Portable Generator
TRA-1526	Riverine Lift Station
TRA-1527	Alarm Dialer At Riverine Lift Station
TRA-1528	Control Panel, Pumps
TRA-1529	Pump, Lift Station, # 1
TRA-1530	Motor, Riverine Lift Station Pump 1
TRA-1531	Pump, Lift Station, # 2
TRA-1532	Motor, Riverine Lift Station Pump 2
TRA-1533	Riverine Lift Station Dehumidifier
TRA-1534	Riverine LS Exhaust Fan
TRA-1535	Riverine LS Sump Pump
TRA-1536	TBA Lift Station
TRA-1537	Alarm Dialer At TBA Lift Station
TRA-1538	Panel, Pump Control
TRA-1540	TBA Lift Station Exhaust Fan
TRA-1541	TBA Lift Station Pump #1
TRA-1542	Motor, TBA Lift Station Pump #1 South
TRA-1543	TBA Lift Station Pump #2
TRA-1544	Motor, TBA Lift Station Pump #2 South
TRA-1545	TBA Lift Station Sump Pump
TRA-1546	Woodmere Street Lift Station
TRA-1547	Alarm Dialer At Woodmere LS
TRA-1548	Flow Meter
TRA-1549	Panel, Pump Control, Woodmere Lift Station
TRA-1550	Pump, Woodmere LS #1
TRA-1551	Motor, Woodmere LS Pump #1
TRA-1552	Pump, Woodmere LS #2
TRA-1553	Motor, Woodmere LS Pump 2
TRA-1631	Control Panel, East Fine Screen
TRA-1632	Control Panel, West Fine Screen
TRA-1633	Transformer
TRA--32-600SO1S	South Basin D.O. Meter
TRA-520-600MX1N	North RAS Mixer
TRA-520-600MX1S	Axial Mixer
TRA-9999	South RAS Piping In Pump Room

INSERVICE ASSET LIST FOR TCRWWTP AND LIFT STATIONS AS OF JULY 2016

Asset ID	Asset Name
VEHICLES-TRUCK-36	2007 Ford Ranger 4X2 White Pick Up
VEHICLES-TRUCK-37	2007 Ford Ranger 4X2 White Pick Up
VFD-427	Variable Frequency Drive
VFD-428	Variable Frequency Drive
TRA-1656	Gate Valve, 1N Aeration Basin
TRA-1657	Gate Valve, 2N Aeration Basin
TRA-1658	Gate Valve, 3N Aeration Basin
TRA-1659	Gate Valve, 4N Aeration Basin
TRA-1660	Gate Valve, 5N Aeration Basin
TRA-1661	Gate Valve, 6N Aeration Basin
TRA-1662	Gate Valve, 7N Aeration Basin
TRA-1663	Gate Valve, 8N Aeration Basin
TRA-1647	Gate Valve, 1S Aeration Basin
TRA-1648	Gate Valve, 2S Aeration Basin
TRA-1649	Gate Valve, 3S Aeration Basin
TRA-1650	Gate Valve, 4S Aeration Basin
TRA-1651	Gate Valve, 5S Aeration Basin
TRA-1652	Gate Valve, 6S Aeration Basin
TRA-1654	Gate Valve, 7S Aeration Basin
TRA-1655	Gate Valve, 8S Aeration Basin
TRA-1646	Gate Valve, Membrane Inlet East
TRA-1645	Gate Valve, Membrane Inlet West

Attachment 4
Traverse City's SAW Grant
Scope of Work

ATTACHMENT B – SCOPE OF WORK

Tasks required to complete this project are outlined below.

1. INVENTORY
    a. Review GIS database and identify data needs. Determine key gaps in the wastewater collection system data and use this information to identify locations for sewer survey. Also identify additional attributes required to complete the Asset Management Plan.
    b. Perform a field survey of manhole structures to add critical information such as rim elevations, invert elevations, confirm pipe sizes, and determine system connectivity. Based on GIS data available, additional information is required for about 20% of the sanitary system manholes, or about 390 manholes.
    c. Import the survey data into the GIS database for the sanitary sewer system.
    d. Update the GIS as necessary to include new attributes as deemed necessary to complete the Asset Management Plan.
    e. Research as-built drawings and other historical documents to determine pipe age and confirm pipe material. Enter the data into the GIS.

2. CONDITION ASSESSMENT
    a. Manhole Inventory (MACP): Perform physical inspections of sanitary sewer manholes within the City's wastewater collection system. It is anticipated that approximately 1,000 manholes will be inspected as part of this effort (about 50% of the total sanitary sewer system).
    b. Pump Station Evaluation: The City owns and operates eight (8) pump stations. Each pump station will be physically evaluated to determine the structural condition of the substructure (i.e. wet wells or pits), condition of the pumps/motors, and the condition of control systems.
    c. Forcemain Evaluation: Much of the City's wastewater collection system relies on a network of pump stations and forcemains. Many of the forcemains are aging and the structural condition of these forcemains is unknown. Six (6) locations will be selected to evaluate the internal and external condition of key forcemains. This work will include the following:
        i. Pump station drawdown test: using known wet well volume and a timer, estimate the flow rate during pumping operations. Compare this to the rated pump capacity and note any significant discrepancies (major discrepancies can be attributable to forcemain deterioration).
        ii. Insert a "poly pig" to clean the forcemain prior to inspection (requires temporary shutdown of the pump station).
        iii. Dewater the forcemain to the fullest extent possible.
        iv. Select a forcemain reach for physical inspection. Ideally, this would be a section where air buildup is possible (high point in system), which is generally more susceptible to sulfuric acid corrosion and also more accessible under a partially-dewatered scenario. Excavate to the forcemain and evaluate exterior pipe condition.
        v. Where possible, dewater forcemain and cut a section from the forcemain to allow for internal (CCTV) inspection. This process may require bypass pumping. CCTV inspections will be performed using PACP methodology. Although it is not expected that the entire length of forcemain will be evaluated during this process, the video inspection will provide an adequate sampling of the forcemain condition, and a decision can be made relative to rehabilitation or replacement.
        vi. Where video inspection cannot be performed, cut a section of forcemain and extract it for material analysis. Repair the section of extracted forcemain, backfill, and restore surface.
    d. Asset Management Plan
        i. Import CCTV and manhole inspection data into sanitary sewer GIS database. Use these ratings to establish a Risk of Failure variable to be assigned to each component.

ii. Work with City staff to determine appropriate characteristics to use to establish a Consequence of Failure variable. Characteristics may include: population served, roadway traffic impacted during system repair, potential for basement backup, etc.
iii. Using the Risk/Consequence factors, establish a priority ranking ("Criticality Index") to be used to develop a list of repair/replacement/rehab needs.
iv. Using the roadway (PASER) and sanitary sewer pipe ratings, use GIS to determine where coincidental high priority areas exist and add these to the list of Early Action Projects to be added to the Capital Improvement Plan.
v. Develop a Deterioration Forecasting Model based on current asset condition, depth, material, and age. This will be used to forecast system repair/rehab/replacement needs.
vi. Provide recommendations for future (ongoing) system inspection needs, including CCTV, detention pond inspection, BMP inspection, bridge/culvert inspections, and streambank inventories.

3. METERING / MODELING

a. Temporary Flow Metering: The City of Traverse City experiences higher than normal baseflows, with monthly averages well above the EPA-established level of 120 gpcd which defines excessive baseflow. Since metering is currently limited to the treatment plant and current documented flows are calculated on a monthly basis, it is not known where the key sources of inflow/infiltration are in the City's collection system or how the system flows peak during wet weather. The work under this scope will include the installation and monitoring of flows under varying antecedent moisture conditions, on an hourly (or sub-hourly) basis, so as to determine wet weather response and to develop appropriate hydrologic parameters to model the main components of the collection system under design flow conditions in order to determine Level of Service.
    i. Install 8 temporary flow meters for a duration of 6 months. The meters will be installed at existing pump stations within the City's collection system. This will allow for the capture of local sewer flow response under varying antecedent moisture conditions. Download meter data at a 2-week interval.
b. Develop hydrologic models for each metered district. The Antecedent Moisture Model (AMM) will be used to calibrate the rainfall derived inflow and infiltration (RDII). The calibrated models will be used to calculate 10-year and 25-year recurrence interval peak flows by applying the calibrated models to long-term rainfall and temperature data.
    i. Analyze baseflows and calculate capture coefficients for each metered district to confirm the source(s) of elevated baseflows and higher wet weather flow responses. This will be used to prioritize future sewer investigation and potential rehabilitation efforts.
c. Develop a hydraulic model of the main components of the wastewater collection system, focusing on the trunk system for which flow meter data will be available. The hydraulic model will be run against the 10-year and 25-year recurrence interval flow events as defined in the hydraulic model.
    i. Prepare a Technical Memorandum summarizing the hydrologic responses and hydraulic performance of the wastewater collection system. Note specific problems relating to elevated baseflows and wet weather flows, and identify hydraulic deficiencies under design flow conditions.
d. Upon the completion of the modeling effort, transition the hydrologic/hydraulic model files to City staff and conduct staff training on the model to ensure sufficient local understanding of the model structure and capabilities.

4. PURCHASE GIS AND ASSET MANAGEMENT SOFTWARE AND HARDWARE

a. Specific hardware and software purchases are included as part of the Stormwater Asset Management Plan scope.

5. SEWER CLEANING AND TELEVISING (PACP RATINGS)

a. Based on the City's existing GIS database, the total length of City-owned sanitary sewer is about 420,000 lineal feet. Of this sewer, about 50% has been cleaned and televised within the last 5 years. The cleaning and CCTV effort will focus on the remaining 50% of the system that is older than 20 years old and has not recently been cleaned and televised. This translates to a quantity of about 200,000 lineal feet. Of this, about 110,000 lineal feet will be cleaned/televised by a private contractor and about 90,000 lineal feet will be cleaned/televised by City staff (see details below):

   i. Based on estimates received from a cleaning/televising contractor (contractor estimate included with this grant application), the following costs are assumed for contractor-led sanitary sewer pipe cleaning and televising:

Sewer Size Class	Unit Price	Quantity	Total
All sizes	$2.05	110,000 LF	$225,500
		Total	**$225,500**
		Total (with 10% contingency)	**$248,050**

   ii. In order to better utilize existing City-owned equipment (vactor truck and sewer video equipment), the City will dedicate their equipment to 60 days of full-time use to supplement the contractor-led cleaning/CCTV effort. Based on an assumed cleaning and televising rate of about 1,500 lineal feet per day for City crews, approximately 90,000 lineal feet will be cleaned and televised by the City.

b. Cleaning/CCTV Contract Administration: throughout the duration of the sanitary sewer cleaning and CCTV project, coordinate with the contractor to ensure the following:
   i. Conformance to PACP methodology
   ii. Ensure data is collected, coded, and stored such that it can be transferred to the City's GIS environment
   iii. Review pay requests and provide recommendations for payment
   iv. Provide assistance to identify locations of sewers to be televised
   v. Provide assistance to identify alternate sewer reaches to televise in the event that the contractor encounters sewers that are difficult or impossible to inspect due to debris buildup or structural failure

c. Transfer the MACP sewer condition coding into the City's GIS.

6. LEVEL OF SERVICE EVALUATION

a. Organize 2 public meetings to receive feedback from residents on any areas of concern, focusing on basement backups. These meetings will also be used to discuss appropriate Level of Service for the City's wastewater collection system, including a discussion of the City's regulatory obligations for wastewater collection and treatment.

b. Capital Improvement Plan (CIP)
   i. Using the data from the modeling effort and the initial output from the Asset Management Plan, develop a 5-10 year CIP to address the more critical projects. Prepare planning-level construction cost estimates. Projects to be considered may include:

1. Pump station upgrades
2. Forcemain rehabilitation / replacement
3. Manhole rehabilitation
4. New pumping/storage facilities (if deemed necessary during the modeling effort)
5. Sewer replacement to address hydraulic deficiencies (if identified during the modeling process)

7. RATE STUDY / REVENUE RECOMMENDATIONS

a. Review all existing capital and O&M costs related to the City's sanitary sewer assets. This will result in a comprehensive set of system needs that the City can use to determine total system revenues necessary to address its wastewater infrastructure. This will include a tabulation of costs for the following system components:
   i. High Priority Capital Improvement Needs from the AMP
   ii. Annual maintenance/repair/rehabilitation needs identified in the AMP

b. Identify annual funding needs based on the costs determined above, and prepare a 10-year cash flow plan to address the identified needs.

c. Review the long-term system needs in the context of the existing rate structure, existing debt, and existing fund balances. Determine if a funding gap exists, and, if so, prepare a 5-year plan to adjust sewer rates to meet the needs identified in the Asset Management Plan.

8. OTHER: GRANT APPLICATION / GRANT ADMINISTRATION

a. The consultant will coordinate with City staff to develop a scope of work for Asset Management Planning and will submit the final application to the MDEQ.

b. The City will provide grant administration services, including reimbursement requests and other documentation required by the MDEQ.

Attachment 5a
Traverse City's Wastewater Fund

WASTEWATER FUND

Mission Statement: *To reliably treat the community's wastewater to a level of quality such that it will have no impact on receiving waters and to do so efficiently, minimizing consumption of energy and resources, carbon footprint, and inconvenience to neighbors.*

Traverse City and the surrounding townships are way out in front in environmental leadership and in executing their responsibility to reflect the local environmental ethic in its policies.

The Wastewater Treatment Plant treats sewage from the City of Traverse City and the townships of Acme, East Bay, Elmwood, Garfield, Peninsula, and Blair. All are parties to the Master Sewer Agreement, original adopted in 1987 and revised in 2001. The City has a unique and central role under that agreement; the plant is located in the City, the City is responsible for its operation, and holds the NPDES permit to discharge to the Boardman River. The City is also the entity to which the role of "Control Authority" is delegated by the other parties, that is, the City administers the system-wide Industrial Pretreatment Program and enforces township as well as City sewer use ordinances. The above is accomplished through a management contract with CH2M Hill.

The Traverse City Plant was upon start up, the largest operating plant on the continent using membrane bioreactor technology. It has the capacity to meet area growth needs into the forseeable future and produces an effluent of extraordinary clarity so that it will have no impact on the receiving waters.

SUMMARY OF BUDGET CHANGES – OPERATING REVENUES

Rate Increase – The City Treasurer has recommended a rate increase of $2.00 per the first 600 cubic feet, and $2.00 per each additional thousand cubic feet to take effect in the fiscal year ending June 30, 2017.

GOALS – WWTP and Pump Stations

1. Finalize strategy for membrane replacement and establish funding for implementation.
2. Complete five planned facility sustaining capital projects at the Wastewater Treatment Plant.
3. Establish a plan for Wastewater Treatment Plant staff leadership succession.

PERFORMANCE MEASUREMENTS – WWTP AND PUMP STATIONS

	Performance Indicators	2010/11	2011/12	2012/13	2013/14	2014/15
Output	Billions of gallons treated	1.4619	1.5608	1.5120	1.7200	1.7100
	Millions of pounds of BOD treated	3.43M	3.50M	3.37M	3.28M	3.19M
	Recordable safety incidents	0	0	1	0	1
Efficiency	Percentage of effluent in compliance with NPDES permit	100%	100%	100%	100%	100%
	Kilowatt hours used/pound of BOD treated	1.2980	1.2880	1.3000	1.4100	1.4500
	Total recordable rates	0	0	9%	0	5.5%
	Days away restricted transfer	0	0	0	0	2

WASTEWATER FUND – MAINTENANCE AND REPAIRS

Mission Statement: *To maintain the sanitary sewer collection system, keeping in mind at all times the health and welfare of the public.*

Responsibilities include:

- Cleaning, televising and repairing 79 miles of gravity sewer and 19 miles of forced main sanitary sewer.
- Cleaning and maintaining 1,830 sewer manholes.
- Administering the Cross Connection Inspection Program.
- Identifying illicit roof drain connections to the storm water system.
- Locating all water, sanitary and storm lines for MISS DIG.
- Assisting all DPS Divisions with confined space entries.
- Maintaining 11 storm water treatment systems on outfalls

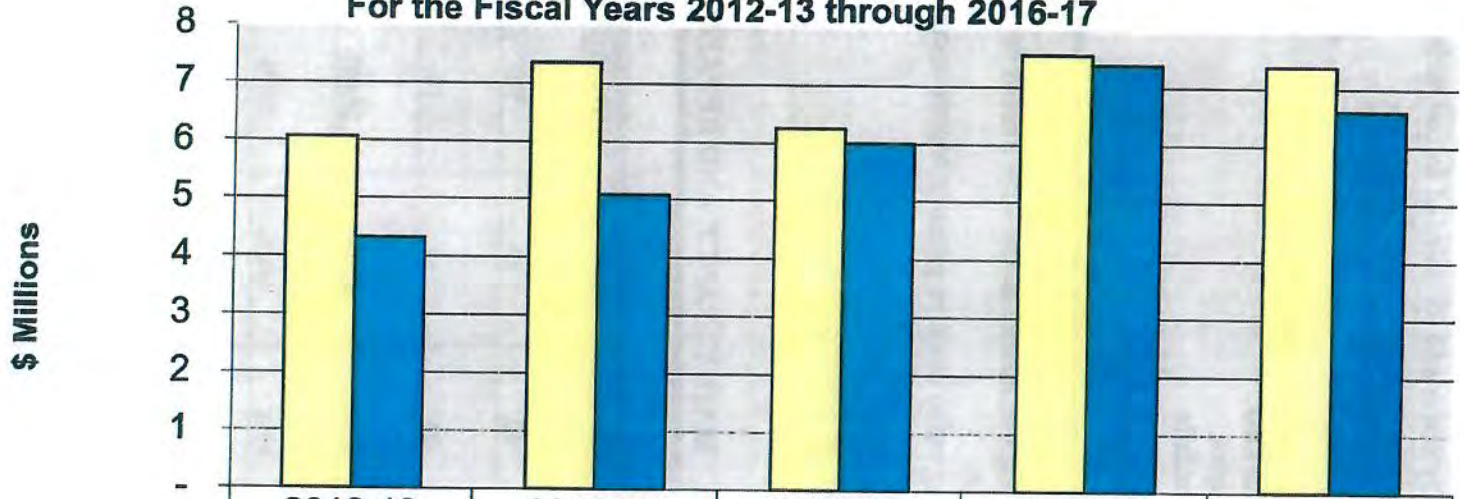
GOALS – MAINTENANCE AND REPAIRS

1. Continue with the implementation plan for changing out meters to the new Sensus meters, which are highly accurate for a longer period of time.
2. Continue with the implementation plan on installing radio reads to promote higher accuracy of reads.
3. Increase efforts to reduce the number of sewer calls.
4. Attempt to clean thirty percent of the sanitary system on a yearly basis.

PERFORMANCE MEASUREMENTS - MAINTENANCE AND REPAIRS

	Performance Indicators	2009/10	2010/11	2011/12	2012/13	2013/14
Output	Sewer maintenance calls	54	58	73	96	84
	Number of storm sewer filters cleaned with vactor	16	25	17	15	15
	Footage of sewers cleaned	98,340	39,681	40,466	29,603	63,422
Efficiency	Percentage of maintenance calls responded to within one hour	100%	99%	100%	100%	100%
	Percentage of sewer backups that were homeowner responsibility	82%	78%	73%	76%	86%
	Average times cleaned per year	1.4	2.3	1.3	1.1	1.1
	Percentage of annual sewers cleaned	24%	10%	10%	7%	15%

City of Traverse City, Michigan
Wastewater Fund Revenues and Expenditures
For the Fiscal Years 2012-13 through 2016-17



	2012-13 Actual	2013-14 Actual	2014-15 Actual	2015-16 Projected	2016-17 Requested
Revenue	$6,067,832	$7,362,225	$6,262,990	$7,555,100	$7,378,300
Expenses	$4,323,077	$5,080,955	$6,007,830	$7,386,900	$6,618,900

Fiscal Years

City of Traverse City, Michigan
ENTERPRISE FUND
WASTEWATER FUND
For the Budget Year 2016-17

	FY 13/14 Actual	FY 14/15 Actual	FY 15/16 Budget	FY 15/16 Projected	FY 16/17 Requested
OPERATING REVENUES					
Sewer Service Charges	$ 4,712,414	4,764,079	$ 4,750,000	$ 4,850,000	$ 5,092,500
Public Authority	2,422,098	1,228,679	1,225,000	1,382,200	1,629,800
Industrial Pretreatment	6,441	3,800	6,000	6,000	6,000
Septage Treatment	11,435	12,359	11,000	11,000	11,000
Forfeited Discounts	13,217	15,291	13,000	13,000	14,000
Interdepartmental Sales	-	87,675	1,000	1,000	1,000
Merchandise and Jobbing	-	500	1,000	1,000	1,000
Miscellaneous	187,787	65,918	135,000	135,000	121,000
TOTAL OPERATING REVENUES	7,353,392	6,178,301	6,142,000	6,399,200	6,876,300
OPERATING EXPENSES					
WWTP AND PUMP STATIONS					
Salaries and Wages	-	-	-	-	25,000
Fringe Benefits	-	-	-	-	9,000
Professional Services	2,747,189	3,326,616	4,821,000	5,011,400	4,199,000
Septage Contract	-	-	-	-	-
Industrial Pretreatment Costs	1,668	-	1,000	1,000	1,000
Insurance and Bonds	41,284	51,893	50,000	60,000	60,000
Total WWTP and Pump Stations	2,790,141	3,378,509	4,872,000	5,072,400	4,294,000
MAINTENANCE AND REPAIRS					
Salaries and Wages	325,453	392,081	328,500	368,000	377,000
Fringe Benefits	129,219	170,408	158,000	143,000	161,000
Office/Operation Supplies	30,250	19,246	30,000	30,000	30,000
Professional Services	148,130	130,722	106,000	96,000	106,000
Communications	-	123			1,200
Transportation	9,679	8,354	12,000	12,000	8,000
Professional Development	7,556	4,513	6,500	6,500	6,500
Public Utilities	3,601	5,033	10,000	10,000	7,500
Insurance and Bonds	5,547	622	1,500	1,500	1,500
Repairs and Maintenance	28,558	300,377	20,000	30,000	20,000
Rentals	78,643	81,596	98,000	98,000	110,000
Total Maintenance and Repairs	766,636	1,113,075	770,500	795,000	828,700
ADMINISTRATIVE AND GENERAL					
Salaries and Wages	138,011	146,384	149,000	133,000	149,000
Fringe Benefits	59,237	72,349	72,300	59,000	72,300

City of Traverse City, Michigan
ENTERPRISE FUND
WASTEWATER FUND
For the Budget Year 2016-17

	FY 13/14 Actual	FY 14/15 Actual	FY 15/16 Budget	FY 15/16 Projected	FY 16/17 Requested
ADMINISTRATIVE AND GENERAL (Continued)					
Office/Operation Supplies	16,061	14,956	17,300	17,300	17,300
Professional Services	15,347	19,999	17,000	17,000	17,000
Communication	116	74	200	200	200
Professional Development	305	1,527	2,500	2,500	2,500
Printing and Publishing	1,020	2,173	3,000	3,000	3,000
Rentals	2,412	4,531	5,000	5,000	5,000
Collection Costs	6,168	(4,631)	2,000	2,000	2,000
Transportation	1,861	1,330	2,500	2,500	2,500
Miscellaneous	2,483	2,651	3,400	3,400	3,400
Depreciation & Amortization	613,449	610,844	636,500	636,500	613,000
Total Administrative and General	856,470	872,187	910,700	881,400	887,200
TOTAL OPERATING EXPENSES	4,413,247	5,363,771	6,553,200	6,748,800	6,009,900
OPERATING INCOME	2,940,145	814,530	(411,200)	(349,600)	866,400
NON OPERATING REVENUES (EXPENSES)					
Federal revenue	-	-	-	-	-
Reimbursements	8,409	84,403	1,183,000	1,153,900	500,000
Interest Revenue	424	286	2,000	2,000	2,000
Gain (Loss) on sale of capital assets	(16,594)	-	-	-	-
Interest/Finance Charges	(347,862)	(338,934)	(370,000)	(319,600)	(279,000)
Total Non-Operating Revenues (Expenses)	(355,623)	(254,245)	815,000	836,300	223,000
Income Before Transfers	2,584,522	560,285	403,800	486,700	1,089,400
Transfers Out - City Fee	(303,252)	(305,125)	(307,000)	(318,500)	(330,000)
CHANGE IN NET POSITION	2,281,270	255,160	96,800	168,200	759,400
Net position, beginning of year	13,334,854	15,616,124	15,871,284	15,871,284	16,039,484
Net position, end of year **	$ 15,616,124	$ 15,871,284	$ 15,968,084	$ 16,039,484	$ 16,798,884
Distribution Personnel Services % F.T.E. Employees = 5.5	59.31%	50.53%	63.14%	64.28%	64.92%
Adminstrative Personnel Services % F.T.E. Employees = 2.75	23.03%	25.08%	24.30%	21.78%	24.94%

** Ending net position represents the difference between total assets (including long-term fixed assets) and total liabilities the cash balance at 6/30/14 was $ 548,662.

This fund was created to account for the costs of collecting and treating wastewater. Revenues are chiefly from service charges to customers. These revenues are also used to pay principal and interest on wastewater revenue bonds which were used to finance improvements.

Attachment 5b
Traverse City's Rate Calculation

CITY OF TRAVERSE CITY

MEMORANDUM

To: Marty Colburn, City Manager
From: William E. Twietmeyer, City Treasurer/Finance Director W.E.T.
Subject: Sewer Fund Projections
Date: April 27, 2016

My annual review of the Sewer Fund is concluded. My communication last year recommended no rate increase in the Sewer Fund for the 2015-2016 fiscal year. **However, this time I am recommending a rate increase for the Sewer Fund for the 2016-2017 fiscal year.**

The last time the City increased its sewer rates it was effective July 1, 2013. At that time the rates were increased to $34.00 for the first 600 cubic feet and $40.00 per thousand for each additional thousand cubic feet. That increase along with previous rate increases were necessitated by the need to pay for the various capital improvement and maintenance projects both to the collection system and to the wastewater treatment plant. This scenario has not changed with regard to the sewer fund. The annual purchase of new replacement membranes at the wastewater treatment plant is ongoing and OMI has added the digester condition assessment and digester 3 and 4 reconditioning to the list of new projects along with the primary header replacement. One new project on the collection side is the automated metering infrastructure project for $750,000 per year for the next two years.

Therefore, I am recommending that the sewer rates be increased to $36.00 for the first 600 cubic feet and $42.00 per thousand for each additional thousand cubic feet of usage. The impact is $242,500 in just the next fiscal year alone. I anticipate that additional rate increases will be necessary both next year and in future years if the various maintenance projects at the plant and in the collection system must proceed forward. Please note that this will not be sufficient to cover the cost of the automated metering infrastructure project. My recommendation if we plan to pursue this project would be to issue revenue bonds to provide the necessary funds because of the enormity of the cost.

Attached for your review is a copy of a spreadsheet showing nine years of historical financial data for the Sewer Fund, along with the current year projected expenses, next year's budget and three future years of projections. Also included is a copy of the proposed rate structure. Please let me know if you desire any additional information.

Encl.

SEWER FUND PROJECTED MULTI YEAR REVENUE AND EXPENSES

FOR YEAR ENDED JUNE 30

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Projected 2016	Budget 2017	2018	2019	2020
OPERATING REVENUE														
Sewer Sales	$3,362,915	$3,413,516	$3,292,019	$3,390,974	$3,697,780	$4,203,540	$4,529,789	$4,712,414	$4,764,079	$4,850,000	$5,092,500	$5,117,963	$5,143,552	$5,169,270
Township Revenue	$1,242,477	$1,374,972	$1,604,479	$1,287,416	$1,151,974	$1,189,726	$1,263,574	$1,256,363	$1,232,479	$1,382,200	$1,629,800	$1,930,016	$2,000,589	$2,087,057
Septage Treatment	$364,284	$474,016	$494,396	$521,016	$461,563	$451,419	$12,434	$11,435	$12,359	$11,000	$11,000	$14,000	$14,000	$14,000
Other Revenue	$141,016	$50,476	$20,655	$29,467	$51,814	$20,846	$56,921	$1,382,014	$215,652	$25,000	$25,000	$25,000	$25,000	$25,000
Total Revenue	$5,110,692	$5,312,980	$5,411,549	$5,228,873	$5,363,131	$5,865,531	$5,862,718	$7,362,226	$6,224,569	$6,268,200	$6,758,300	$7,086,979	$7,183,141	$7,295,327
OPERATING EXPENSES														
Treatment Plant	$2,658,745	$3,003,382	$2,857,372	$2,847,840	$2,753,947	$2,744,145	$2,384,992	$2,790,140	$3,378,509	$5,072,400	$4,294,000	$3,895,032	$4,036,178	$4,209,113
Collection & Maint	$620,361	$614,865	$478,003	$486,166	$564,197	$746,099	$673,263	$766,635	$1,113,075	$795,000	$828,700	$845,274	$862,179	$879,423
Customer Acctg	$344,481	$387,737	$449,979	$454,792	$523,378	$560,785	$525,042	$546,266	$566,468	$563,400	$604,200	$616,284	$628,610	$641,182
Total Expenses	$3,623,587	$4,005,984	$3,785,354	$3,788,798	$3,841,522	$4,051,029	$3,583,297	$4,103,041	$5,058,052	$6,430,800	$5,726,900	$5,356,590	$5,526,967	$5,729,718
DEBT SERVICE														
1971 Bond Prin & Int	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1995 Bond Prin & Int	$136,171	$132,314	$138,245	$154,747	$156,921	$153,550	$165,969	$164,872	$164,446	$0	$0	$0	$0	$0
1998 Bond Prin & Int	$71,640	$61,812	$66,044	$73,885	$71,485	$72,986	$71,734	$0	$0	$0	$0	$0	$0	$0
2002 Bond Prin & Int	$1,186,410	$1,179,927	$1,167,343	$1,184,416	$1,183,224	$1,083,208	$1,150,259	$1,153,929	$1,314,086	$1,397,040	$1,390,560	$1,394,640	$1,402,800	$1,399,800
Total Debt Service	$1,394,221	$1,374,053	$1,371,632	$1,413,048	$1,411,630	$1,309,744	$1,387,962	$1,318,801	$1,498,532	$1,397,040	$1,390,560	$1,394,640	$1,402,800	$1,399,800
SUB NET INCOME	$92,884	($67,057)	$254,563	$27,027	$109,979	$504,758	$891,459	$1,940,384	($332,015)	($1,559,640)	($359,160)	$335,749	$253,374	$165,809
Capital Improvements	$320,271	$562,575	$132,473	$194,844	$568,304	$509,602	$576,965	$297,816	$111,761	$901,000	$1,280,000	$1,503,871	$500,000	$579,860
Township Share Reimbursed										$1,153,900	$500,000			
NET INCOME	($227,387)	($629,632)	$122,090	($167,817)	($458,325)	($4,844)	$314,494	$1,642,568	($443,776)	($1,306,740)	($1,139,160)	($1,168,123)	($246,626)	($414,051)
TOTAL CASH BALANCE	$1,373,527	$743,895	$865,985	$698,168	$239,843	$234,999	$549,493	$2,192,061	$1,748,285	$441,545	($697,615)	($1,865,738)	($2,112,363)	($2,526,414)

Please note the following assumptions:

This projection assumes a change in rates effective july 1, 2016.
The base rate changes from $34.00 to $36.00 and usage over 600 cubic feet increases from $40.00 / thousand cubic feet to $42.00 / thousand cubic feet.

Growth in sales is estimated to increase 1/2% per year.

Growth in Township Revenue is estimated to increase 3% per year.

Treatment Plant Expenses are projected to increase 3.0% per year.
Collection & Maint and Customer Acctg expenses are projected at 2% per year.

The City's portion of debt service is estimated to be 60% of the total debt service.

The Capital Improvements are as provided in the six year public improvements plan.

Analysis Run 4-27-16.

SEWER RATES

Current Rates

Inside City Limits

$34.00 per first 600 cubic feet
$40.00 per thousand for each additional thousand cubic feet

Customers outside City limits are charged 1 1/2 times the City rate.

Proposed Rates

Inside City Limits

$36.00 per first 600 cubic feet
$42.00 per thousand for each additional thousand cubic feet

Customers outside City limits are charged 1 1/2 times the City rate.

Run 4-27-16

Attachment 6a
Summary of Traverse City's CIP

CITY OF TRAVERSE CITY, MICHIGAN

SIX YEAR CAPITAL IMPROVEMENT PLAN

Budget Year 2016-2017 by Fund

All Projects Submitted for 2016/17

Date/Time Printed: 6/20/2016 12:14:49 PM

Bold -Indicates projects occurring in the first FY of the plan.
+ -Indicates projects with multiple funding sources.
*** -Indicates new projects submitted for review.**

Project ID		Cat	Carry Forward 2015-16	Fiscal Year 2016-17	Fiscal Year 2017-18	Fiscal Year 2018-19	Fiscal Year 2019-20	Fiscal Year 2020-21	Fiscal Year 2021-22	Project Cost	City Funds	Non-City Funds
	WASTE WATER FUND											
	Sewer Collection System											
366	**WW-Annual Sewer Rehab/Replace**	**M**	$450,000.00	$450,000.00	$450,000.00	$450,000.00	$450,000.00	$450,000.00	$450,000.00	$3,150,000.00	$3,150,000.00	$0.00
13	**WW-Annual Storm Water Management Program**	**M**	$50,000.00	$50,000.00	$50,000.00	$50,000.00	$50,000.00	$50,000.00	$50,000.00	$350,000.00	$350,000.00	$0.00
987	***WW-Automated Metering Infrastructure (+ Water)**	**C**	$0.00	$750,000.00	$750,000.00	$0.00	$0.00	$0.00	$0.00	$1,500,000.00	$1,500,000.00	$0.00
293	**WW-Catch Basin & Manhole Casting Replacement**	**M**	$0.00	$30,000.00	$30,000.00	$0.00	$0.00	$0.00	$0.00	$60,000.00	$60,000.00	$0.00
968	*WW-Clinch Park Lift Station/Bay Street/Birchwood Upgrade of Control Panels	M	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$117,000.00	$117,000.00	$117,000.00	$0.00
967	*WW-Engineering Evaluation of Clinch Park Lift Station Capacity	M	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$50,000.00	$50,000.00	$50,000.00	$0.00
910	*WW-Front Street Lift Station Pump Around Hookup	M	$0.00	$0.00	$0.00	$0.00	$0.00	$30,000.00	$0.00	$30,000.00	$30,000.00	$0.00
913	*WW-Lift Station Telemetry System	M	$0.00	$0.00	$0.00	$0.00	$0.00	$90,000.00	$0.00	$90,000.00	$90,000.00	$0.00
898	*WW-Riverine Lift Station Equipment Upgrade	M	$0.00	$0.00	$107,865.00	$0.00	$0.00	$0.00	$0.00	$107,865.00	$107,865.00	$0.00
899	*WW-SCADA Upgrade at Front Street Lift Station and the TCRWWTP for PLC 5	M	$0.00	$0.00	$116,006.00	$0.00	$0.00	$0.00	$0.00	$152,639.00	$116,006.00	$36,633.00
892	*WW-TBA LIFT STATION EQUIPMENT UPGRADE	M	$75,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$75,000.00	$75,000.00	$0.00
909	*WW-Woodmere Lift Station Upgrade	M	$0.00	$0.00	$0.00	$0.00	$79,860.00	$0.00	$0.00	$79,860.00	$79,860.00	$0.00
	Total Sewer Collection System		**$575,000.00**	**$1,280,000.00**	**$1,503,871.00**	**$500,000.00**	**$579,860.00**	**$620,000.00**	**$667,000.00**	**$5,762,364.00**	**$5,725,731.00**	**$36,633.00**

CITY OF TRAVERSE CITY, MICHIGAN

SIX YEAR CAPITAL IMPROVEMENT PLAN

Budget Year 2016-2017 by Fund

All Projects Submitted for 2016/17

Date/Time Printed: 6/20/2016 12:14:49 PM

Bold -Indicates projects occurring in the first FY of the plan.
+ -Indicates projects with multiple funding sources.
*** -Indicates new projects submitted for review.**

Project ID		Cat	Carry Forward 2015-16	Fiscal Year 2016-17	Fiscal Year 2017-18	Fiscal Year 2018-19	Fiscal Year 2019-20	Fiscal Year 2020-21	Fiscal Year 2021-22	Project Cost	City Funds	Non-City Funds
	WASTE WATER FUND											
	Sewer Plant & Buildings											
969	*WW-Administration Building Screw Compressor Inspection/Overhaul	M	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,200.00	$10,000.00	$5,200.00	$4,800.00
906	*WW-Arc Flash Evaluation at the Plant	M	$0.00	$0.00	$0.00	$13,000.00	$0.00	$0.00	$0.00	$25,000.00	$13,000.00	$12,000.00
948	***WW-Digester 3 and 4 Reconditioning per 2017/2018 Condition Assessment**	**M**	$0.00	$50,000.00	$0.00	$50,000.00	$0.00	$0.00	$0.00	$200,000.00	$100,000.00	$100,000.00
966	***WW-Digester Condition Assessment**	**M**	$0.00	$13,500.00	$13,500.00	$0.00	$0.00	$0.00	$0.00	$54,000.00	$27,000.00	$27,000.00
971	*WW-Enclose Membrane Trains	C	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$260,000.00	$500,000.00	$260,000.00	$240,000.00
900	*WW-Membrane Distribution and RAS Channel Aeration Line Replacement	M	$0.00	$0.00	$47,700.00	$0.00	$0.00	$0.00	$0.00	$95,400.00	$47,700.00	$47,700.00
786	**WW-Membrane Gate Replacement**	**M**	$25,000.00	$25,000.00	$25,871.00	$29,991.00	$0.00	$0.00	$0.00	$211,724.00	$105,862.00	$105,862.00
970	*WW-Plant PLC Upgrade	M	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$52,000.00	$100,000.00	$52,000.00	$48,000.00
890	***WW-Plant-Membrane Replacement**	**M**	$1,200,000.00	$772,560.00	$772,560.00	$772,560.00	$772,560.00	$0.00	$0.00	$8,212,000.00	$4,290,240.00	$3,921,760.00
904	*WW-Primary Clarifier Supports and Structure	M	$0.00	$0.00	$0.00	$0.00	$52,000.00	$52,000.00	$0.00	$200,000.00	$104,000.00	$96,000.00
902	***WW-Primary Header Replacement**	**M**	$0.00	$250,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$500,000.00	$250,000.00	$250,000.00
912	*WW-Reconditioning Digesters 1 and 2	M	$0.00	$0.00	$0.00	$0.00	$0.00	$40,000.00	$0.00	$80,000.00	$40,000.00	$40,000.00
905	*WW-Replace the Chains and Flights in Primary Clarifiers	M	$0.00	$0.00	$0.00	$0.00	$260,000.00	$260,000.00	$0.00	$1,000,000.00	$520,000.00	$480,000.00
795	WW-SCADA Upgrade	M	$0.00	$0.00	$0.00	$0.00	$47,500.00	$0.00	$0.00	$95,000.00	$47,500.00	$47,500.00
893	*WW-Screw Pump Replacement	M	$100,000.00	$0.00	$115,369.00	$121,138.00	$0.00	$0.00	$0.00	$673,014.00	$336,507.00	$336,507.00
894	*WW-West Biosolids Storage Tank Pump Upgrade	M	$0.00	$0.00	$0.00	$52,206.00	$0.00	$0.00	$0.00	$104,412.00	$52,206.00	$52,206.00
764	**WW-Window Replacement 503 Hannah Ave.**	**M**	$0.00	$30,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$60,000.00	$30,000.00	$0.00
	Total Sewer Plant & Buildings		**$1,325,000.00**	**$1,141,060.00**	**$975,000.00**	**$1,038,895.00**	**$1,132,060.00**	**$352,000.00**	**$317,200.00**	**$12,120,550.00**	**$6,281,215.00**	**$5,809,335.00**
	TOTAL WASTE WATER FUND		**$1,900,000.00**	**$2,421,060.00**	**$2,478,871.00**	**$1,538,895.00**	**$1,711,920.00**	**$972,000.00**	**$984,200.00**	**$17,882,914.00**	**$12,006,946.00**	**$5,845,968.00**

Attachment 6b
Narrative of Traverse City's CIP

943 - SAW-Waste Water Asset Management Plan

PROJECT INFORMATION

Submitted By:	Larry LaCross	*Department:*	Not Specified
Category:	Capital	*Department Head:*	Dave Green
Fund Group:	SAW Grant Fund	*Department Priority:*	Imperitive (must do):
Fund Detail:	Not Specified	*Project Start Date:*	07/01/2014
Date Submitted:	01/15/2015	*Project End Date:*	06/30/2017
Date Last Edited:	01/04/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Federal / State Grant	$0	$231,000	$184,421	$0	$0	$0	$0	$415,421
Inkind	$0	$12,500	$573,023	$0	$0	$0	$0	$585,523
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

This project will create an Asset Management Plan for Sewer and Storm along with creating a Storm Water Management Plan.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$1,000,944
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

June 2014 the City of Traverse City was awarded two SAW Grants from the MDEQ with an overall budget of $2.44 million. The City was awarded the Storm Water Asset Management Plan coupled with the Storm Water Management Plan with a total project cost of $1,443,500.00 and a Waste Water Asset Management Plan with a total project cost of $1,000,944.00.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

969 - WW-Administration Building Screw Compressor Inspection/Overhaul

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2021
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2022
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$0	$5,200	$5,200
Private	$0	$0	$0	$0	$0	$0	$4,800	$4,800
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Inspect screw compressors and replace necessary components to maintain its function.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

366 - WW-Annual Sewer Rehab/Replace

PROJECT INFORMATION

Submitted By:	Justin Roy	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2012
Date Submitted:	01/01/2010	*Project End Date:*	06/30/2018
Date Last Edited:	01/04/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$450,000	$450,000	$450,000	$450,000	$450,000	$450,000	$450,000	$3,150,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Provide $450,000 annually in both the water and wastewater funds to continue systematic improvements (repair and replacement) of our underground infrastructure.

PROJECT JUSTIFICATION:

-Maintains or improves existing infrastructure or facilities

LOCATION DESCRIPTION:

13 - WW-Annual Storm Water Management Program

PROJECT INFORMATION

Submitted By:	Tim Lodge	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Tim Lodge
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2012
Date Submitted:		*Project End Date:*	06/30/2020
Date Last Edited:	01/28/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$350,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

This line item will guarantee funds to construct and repair city storm sewer lines. Funds may be used to disconnect sanitary sewers as well as water quality related infrastructure.

PROJECT JUSTIFICATION:

-Maintains or improves existing infrastructure or facilities

LOCATION DESCRIPTION:

906 - WW-Arc Flash Evaluation at the Plant

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Important (could do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2018
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2019
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$13,000	$0	$0	$0	$13,000
Private	$0	$0	$0	$12,000	$0	$0	$0	$12,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Evaluate motor control centers for ARC flash rating and label appropriately.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

987 - WW-Automated Metering Infrastructure (+ Water)

PROJECT INFORMATION

Submitted By:	Dave Green	*Department:*	Sewer Collection System
Category:	Capital	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2016
Date Submitted:	03/16/2016	*Project End Date:*	06/30/2018
Date Last Edited:	03/22/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$750,000	$750,000	$0	$0	$0	$0	$1,500,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Install water meters and software to accommodate smart metering capabilities that will provide for the migration to electronic advanced meters that will assist utility customers on energy use, reliability and provide reads to utility billing. Will also drive future system engineering and planning as well as provide metrics on completed items to show project results.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

293 - WW-Catch Basin & Manhole Casting Replacement

PROJECT INFORMATION

Submitted By:	Mark Jones	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2010
Date Submitted:	11/09/2009	*Project End Date:*	06/30/2016
Date Last Edited:	01/04/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$30,000	$30,000	$0	$0	$0	$0	$60,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Broken manhole and catch basin castings constitute a hazard to people and vehicles.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Along with street repair the storm sewer (castings) infrastructure is in disrepair.

PROJECT JUSTIFICATION:

-Protects health, safety, lives of citizens -Maintains or improves existing infrastructure or facilities

-Achieves City Commission Goal or Priority along with street repair our storm sewer (castings) infrastructure is in disrepair we used almost 12,000 out of our budget for casting purchases fo the summer of 2009.

LOCATION DESCRIPTION:

Streets

968 - WW-Clinch Park Lift Station/Bay Street/Birchwood Upgrade of Control Panels

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2021
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2022
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$0	$117,000	$117,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Upgrade control panels to replace obsolete equipment and add remote connection capability.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

948 - WW-Digester 3 and 4 Reconditioning per 2017/2018 Condition Assessment

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2016
Date Submitted:	11/24/2015	*Project End Date:*	06/30/2019
Date Last Edited:	02/03/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$50,000	$0	$50,000	$0	$0	$0	$100,000
Private	$0	$50,000	$0	$50,000	$0	$0	$0	$100,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Maintain operability of the Digesters.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Perform actions outlined by third party condition assessment of digesters.Cost is TBD by condition assessment.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

966 - WW-Digester Condition Assessment

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2016
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2018
Date Last Edited:	02/03/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$13,500	$13,500	$0	$0	$0	$0	$27,000
Private	$0	$13,500	$13,500	$0	$0	$0	$0	$27,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Digesters need to be assessed so they can be reconditioned as needed.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

971 - WW-Enclose Membrane Trains

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Capital	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Important (could do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2021
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2022
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$0	$260,000	$260,000
Private	$0	$0	$0	$0	$0	$0	$240,000	$240,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Each train has a value of over $1 million and the enclosure would protect those assets.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Construct a building around membrane trains to keep them out of the elements preventing possible freezing, etc., and making it possible to do recovery cleaning in the winter months.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

967 - WW-Engineering Evaluation of Clinch Park Lift Station Capacity

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2021
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2022
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$0	$50,000	$50,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Evaluate current capacity to assure it can meet the growing need of the Clinch Park vicinity.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

910 - WW-Front Street Lift Station Pump Around Hookup

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2020
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2021
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$30,000	$0	$30,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

In place of pump 1, currently abandoned in place, install pump around hookup

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

913 - WW-Lift Station Telemetry System

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Important (could do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2020
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2021
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$90,000	$0	$90,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Add and or upgrade telemetry at lift stations

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

900 - WW-Membrane Distribution and RAS Channel Aeration Line Replacement

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2017
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2018
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$47,700	$0	$0	$0	$0	$47,700
Private	$0	$0	$47,700	$0	$0	$0	$0	$47,700
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Maintain adequate mixing in the membrane distribution and RAS channels.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Remove and replace aging aeration line in the membrane distribution and RAS channel with SCH 80 PVC.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

786 - WW-Membrane Gate Replacement

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2014
Date Submitted:	12/03/2013	*Project End Date:*	06/01/2019
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$25,000	$25,000	$25,871	$29,991	$0	$0	$0	$105,862
Private	$25,000	$25,000	$25,871	$29,991	$0	$0	$0	$105,862
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

50% of cost covered by Townships

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace the gate valves at the beginning and end of each membrane train.

PROJECT JUSTIFICATION:

Aluminum gates have corroded and need replacement with stainless steal.

LOCATION DESCRIPTION:

WWTP

970 - WW-Plant PLC Upgrade

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2021
Date Submitted:	01/27/2016	*Project End Date:*	06/30/2022
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$0	$52,000	$52,000
Private	$0	$0	$0	$0	$0	$0	$48,000	$48,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Upgrade PLC (Programmable Logic Controls) to maintain current plant functioning.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

890 - WW-Plant-Membrane Replacement

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2015
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2020
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$1,200,000	$772,560	$772,560	$772,560	$772,560	$0	$0	$4,290,240
Private	$1,180,000	$685,440	$685,440	$685,440	$685,440	$0	$0	$3,921,760
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Maintain Plant Capacity

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace 1 Train of Membranes each year until remaining 4 trains of 500C membrane cassettes are replaced.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

904 - WW-Primary Clarifier Supports and Structure

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2019
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2021
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$52,000	$52,000	$0	$104,000
Private	$0	$0	$0	$0	$48,000	$48,000	$0	$96,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

The I-beams support the primary clarifier covers and thus keep orders in. The failing structure can introduce large pieces of cement into the tank damaging the sludge collection system and down stream pumps.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace I-beam supports in Primary Clarifiers on the South side of the Plant. Repair and recoat the concrete in the Primary Clarifiers on the South side of the plant.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

902 - WW-Primary Header Replacement

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2016
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2017
Date Last Edited:	04/06/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$250,000	$0	$0	$0	$0	$0	$250,000
Private	$0	$250,000	$0	$0	$0	$0	$0	$250,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Repair primary header. The top of the Header has some exposed areas. Header has never been full so doesn't leak, but should be repaired. Install two isolation valves, Currently , there is no way of isolating one primary deck from the other which makes maintenance very difficult.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

912 - WW-Reconditioning Digesters 1 and 2

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2020
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2021
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$0	$40,000	$0	$40,000
Private	$0	$0	$0	$0	$0	$40,000	$0	$40,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Would allow for us to operate as Seconday Digesters.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Install flame arrestors, and PRVs. Identify all leaks, and plug. Test vessels for proper functioning.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

905 - WW-Replace the Chains and Flights in Primary Clarifiers

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2019
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2021
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$260,000	$260,000	$0	$520,000
Private	$0	$0	$0	$0	$240,000	$240,000	$0	$480,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

The Chain and Flights in use have been in place for decades. The chain is beginning to elongate, which causes the chain to jump off the sprockets and ultimately keeps us from collect the solids that settle out and float in the clarifiers. The flights are becoming worn and cracked and less efficient in sludge accumulation.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace the chains and flights in the Primary Clarifiers on the South side of the Plant.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

898 - WW-Riverine Lift Station Equipment Upgrade

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2017
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2018
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$107,865	$0	$0	$0	$0	$107,865
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace pumps, check valves,wet well mixer,update controls and reline pump housing

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

795 - WW-SCADA Upgrade

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Important (could do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2019
Date Submitted:	12/03/2013	*Project End Date:*	06/30/2020
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$47,500	$0	$0	$47,500
Private	$0	$0	$0	$0	$47,500	$0	$0	$47,500
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

50% paid for by Townships

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Upgrade SCADA system that controls the plant.

PROJECT JUSTIFICATION:

Last done in 2013. Routine upgrade. If controls fail there is no backup.

LOCATION DESCRIPTION:

WWTP

899 - WW-SCADA Upgrade at Front Street Lift Station and the TCRWWTP for PLC 5

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2016
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2017
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$116,006	$0	$0	$0	$0	$116,006
Private	$0	$0	$36,633	$0	$0	$0	$0	$36,633
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Front Street Lift Station's PLC and the TCRWWTP's PLC 5 are out of date and need to be upgraded to maintain reliable functioning.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Upgrade the PLC at the Front Street Lift Station and the PLC5 at the TCRWWTP-to be performed by a third party.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

893 - WW-Screw Pump Replacement

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2015
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2019
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$100,000	$0	$115,369	$121,138	$0	$0	$0	$336,507
Private	$100,000	$0	$115,369	$121,138	$0	$0	$0	$336,507
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Maintain primary effluent pumping capabilities to meet influent flow demand.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replacement of one screw body,gear box reconditioning and trough reconditioning.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

892 - WW-TBA LIFT STATION EQUIPMENT UPGRADE

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2015
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2016
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$75,000	$0	$0	$0	$0	$0	$0	$75,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace the pumps,check valves and reline pump housing(can)

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

894 - WW-West Biosolids Storage Tank Pump Upgrade

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2018
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2019
Date Last Edited:	02/08/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$52,206	$0	$0	$0	$52,206
Private	$0	$0	$0	$52,206	$0	$0	$0	$52,206
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

Improve biosolids mixing, and biosolids loading capabilities.

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Upgrade West Biosolids Storage Tank Pump.Install a pump rated for a TDH of 52' that can pump 8% solids at a rate of 533gpm. This will allow for suitable mixing of the Storage cells and eliminate the need for separate mixers in each cell.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

764 - WW-Window Replacement 503 Hannah Ave.

PROJECT INFORMATION

Submitted By:	Justin Roy	*Department:*	Sewer Plant & Buildings
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Essential (should do):
Fund Detail:	Sewer Plant & Buildings	*Project Start Date:*	07/01/2013
Date Submitted:	01/07/2013	*Project End Date:*	06/30/2014
Date Last Edited:	01/28/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$30,000	$0	$0	$0	$0	$0	$30,000
Water Fund	$0	$30,000	$0	$0	$0	$0	$0	$30,000
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$60,000
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

Replace original single pane windows and doors with new energy efficient windows and doors.

PROJECT JUSTIFICATION:

New energy efficient windows and garage doors would help reduce heating costs.

Current windows are single pane, original to the building.

LOCATION DESCRIPTION:

503 Hannah Ave.

909 - WW-Woodmere Lift Station Upgrade

PROJECT INFORMATION

Submitted By:	Elizabeth Hart	*Department:*	Sewer Collection System
Category:	Maintenance	*Department Head:*	Dave Green
Fund Group:	Waste Water	*Department Priority:*	Imperitive (must do):
Fund Detail:	Sewer Collection System	*Project Start Date:*	07/01/2019
Date Submitted:	11/24/2014	*Project End Date:*	06/30/2020
Date Last Edited:	01/27/2016	*Project Completed:*	No

FUNDING SOURCES:

Sources:	*Prior Year*	*2016/2017*	*2017/2018*	*2018/2019*	*2019/2020*	*2020/2021*	*2021/2022*	*Total*
Sewer Fund	$0	$0	$0	$0	$79,860	$0	$0	$79,860
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0

SERVICE IMPACT:

COST DETAIL:

Study:	$0
Land Acquisition/ROW:	$0
Engineering/Design:	$0
Construction:	$0
Annual Maint. Cost:	$0
Maint. Year Start:	

PROJECT DESCRIPTION:

New pumps,check valves and controls installed.

PROJECT JUSTIFICATION:

LOCATION DESCRIPTION:

www.ch2m.com
Follow us @ch2m

© 2016 CH2M HILL

2016 ASSET CONDITION ASSESSMENT REPORT

Traverse City Regional Wastewater Treatment Plant and Lift Stations

Prepared for

City of Traverse City
400 Boardman Avenue
Traverse City, MI 49684

February 1, 2017

606 Hannah Ave
Traverse City, MI 49684

Executive Summary

The current City of Traverse City Regional Wastewater Treatment NPDES permit requires an Asset Management Plan (AMP). As part of the AMP, the City is required to have a current assessment of the condition of the critical assets. There have been two previous assessments performed on parts of the facility, one in 2008 and the second in 2010. This is the first complete assessment of all the critical assets at the main plant, as well as the nine lift stations owned and operated by the City of Traverse City.

A series of workshops was held with the plant staff to develop criteria for assessing the assets and identifying risk. A team of four maintenance specialists arrived in Traverse City on Monday, October 10, and worked for 2 weeks assessing the 861 critical assets identified during the previous workshops. A final workshop held on Thursday, November 10, 2016, with representatives from the City of Traverse City, Grand Traverse County, CH2M HILL (CH2M) Traverse City plant staff, and CH2M maintenance and asset management specialists.

The condition assessment and risk data were put into the CH2M Asset Condition Evaluation System (ACES). The overall result of the assessment is shown in **Figure 1**.

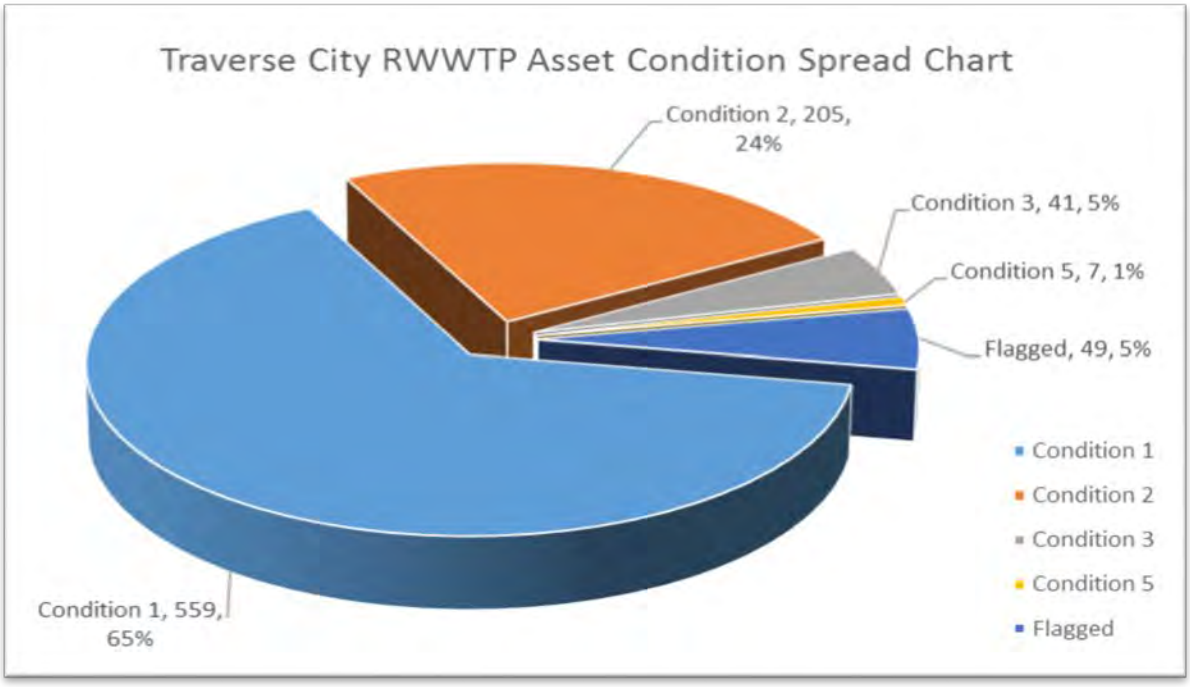


Figure 1. Traverse City RWWTP Asset Condition Spread Chart

The results show that 89 percent of the critical assets at the main plant and lift stations are in very good condition. Only 6 percent of the assets will require some immediate maintenance or repair, and 5 percent could not be accurately assessed at the time of this visit.

Based on the results, 65 percent of the critical assets are in Condition 1, which indicates that these assets are receiving the proper level of maintenance, and up to 95 percent of the assets' normal useful life remains. Another 24 percent of the assets are in Condition 2, which indicates that these assets may require some minimal immediate maintenance, but they still have up to 75 percent of normal useful life remaining.

A more detailed analysis of the process used by CH2M and the results of the assessment are contained in Sections 1 and 2 of this report and the five attached appendixes.

Contents

Section Page

Executive Summary ..... **iii**

Acronyms and Abbreviations ..... **vii**

1 Condition Assessment Process **1-1**
1.1 Risk Based Condition Assessment 1-3
1.2 Consequence of Failure 1-4
1.3 Likelihood of Failure 1-5

2 Condition Assessment Findings **9**

Appendixes

A Asset Type Questions and Answers
B Single Page CA Report
C Main Plant Asset Rollup Report
D Lift Station Asset Roll up Report
E Flagged Inspections

Tables

1. Asset Types 1-1
2. Condition Categories 1-2
3. Condition Category Description 1-3
4. Consequence of Failure Matrix 1-4
5. Likelihood of Failure Matrix 1-5
6. Process Area and Lift Station Risk Scores by Total Risk 1-6
7. Main Plant Process Area Average Condition Score Ranking 10
8. Main Plant Process Area Average Total Risk Score Ranking 11
9. Lift Station Average Condition Score Ranking 12
10. Lift Station Average Total Risk Score Ranking 12

Figures

1. Traverse City RWWTP Asset Condition Spread Chart iii
2. Process and Lift Station Risk Ranking without Considering Risk 1-7
3. Asset Condition Spread 9
4. Main Plant Asset Condition Spread 9
5. Lift Station Asset Condition Spread 10
6. ain Plant Process Area Average Scores Ranked by Condition Score 11
7. Lift Station Average Scores Ranked by Condition Score 13

Acronyms and Abbreviations

ACES®	Asset Condition Evaluation SYSTEM
AMP	Asset Management Plan
CH2M	CH2M HILL
CMMS	Computerized Maintenance Management System
COF	Consequence of Failure
IIMM	International Infrastructure Management Manual
LOF	Likelihood of Failure
TCRWWTP	Traverse City Regional Wastewater Treatment Plant

SECTION 1

Condition Assessment Process

CH2M uses a condition assessment process based on research published in the International Infrastructure Management Manual (IIMM) 2006 edition. The process centers on development of a set of questions and answers that use both observable and measurable data to evaluate the condition of an asset. Since different assets display different observable and measurable characteristics as they deteriorate, it is necessary to group assets that display similar characteristics together. The groups are referred to as asset types. In some cases, asset types can be very general and cover a variety of assets such as motors or generators. In other cases, asset types need to be more specific such as pumps that need to be broken down more. Some examples would be centrifugal pumps and vertical turbine pumps. A list of critical assets was selected from the asset registry in Maintenance Connection, the plant Computerized Maintenance Management System (CMMS), and grouped into asset types.

Table 1 contains a complete list of the asset types used to assess the assets at the Traverse City Regional Wastewater Treatment Plant (TCRWWTP).

Table 1. Asset Types

Asset Types		
ACTUATOR	HVAC	PUMP-VAC
AIR RECEIVER	INSTRUMENT	SAMPLER
ANAEROBIC DIGESTER (S)	INSTRUMENT-FLOW ELEMENT	SCREEN
BAR SCREEN	INSTRUMENT-H2S	SCREEN-ROTARY
BLOWER	INSTRUMENT-LEVEL	SCUM
BOILER	INSTRUMENT-PRESSURE	SOFT START
CHANNEL	INSTRUMENT-TURBIDITY	STRUCTURE
CLARIFIER	MCC	TANK-CHEMICAL
CLASSIFIER	MEMBRANE	TANK-CONCRETE
COMPACTOR	MIXER	TANK-FIBERGLASS
COMPRESSOR-AIR	MIXER-SUBMERSIBLE	TANK-METAL
COMPRESSOR-GAS	MOTOR	UNIT HEATER
CONTROL PANEL	PLC	VACUUM SYSTEM
CRANE	POLYBLEND	VALVE
DOOR-ROLL UP	PUMP	VALVE-ARV
DRYER	PUMP SUMP	VALVE-BACKFLOW
ELECTRICAL DISTRIBUTION	PUMP-CENT	VALVE-BUTTERFLY
ELECTRICAL PANEL	PUMP-DIA	VALVE-CHAIN
EMERGENCY DIESEL GENERATOR SET	PUMP-DRY PIT SUB	VALVE-CHECK
FAN	PUMP-METERING	VALVE-PLUG
FLOW METER	PUMP-PD	VALVE-PRV
GEARBOX	PUMP-PROG CAV	VALVE-SLUICE
GRAVITY BELT	PUMP-SCREW	VFD
HEAT EXCHANGER	PUMP-SUB	WELL-WET WELL

Using a database of asset type questions and answers developed by CH2M and used to assess similar assets for hundreds of clients, the plant staff and maintenance professionals developed a set of asset questions and answers for each asset type in **Table 1**. The answers to each question have scores between 1 and 5, with 1 being the best condition and 5 being the worst condition. The answer score of each question is rolled to an overall condition score for each asset. To adjust for the fact that not all questions have the same level of impact in determining the condition of an asset, each question is weighted. Giving a greater weight to answers for a question about how a valve functions, whether it opens and closes smoothly, than to a question about the condition of the coating on the valve provides a more accurate overall score. A greater accuracy in assessing the condition of assets is possible when measurements can be taken and compared to known standards. An example of a measurement that provides greater insight into the condition of an asset is the measured Insulation resistance of a motor, or the peak vibration reading of a motor bearing. Questions where measurements can be taken and compared to known standards can be set up as overriding questions. The score for an overriding question is set up such that no matter what the scores of the remaining questions, the overall score for the asset can never be less than the score for the overriding question. **Appendix A** contains a complete list of all the asset type questions, answer sets with question weightings, and overriding questions.

The procedure used by CH2M to identify the current condition of an asset is to have two experienced maintenance specialists answer the asset type questions for each critical asset, using both measured and observed data. Observed data included conditions like noise, corrosion, physical damage, missing parts, and non-functional components. The field measurements collected during this assessment include peak vibration measurement, voltage and amperage measurements under load, thermal graphic imaging, and insulation resistance. To be accurately assessed, assets must be operating under normal operating conditions or as close to normal as possible. Equipment that cannot be observed and measured under normal operating conditions is either partially evaluated or not evaluated at the discretion of the field assessment team. The data collected is used to answer question related to the current condition of the asset and calculate an overall asset condition score as discussed above. To facilitate the evaluation of assets, the overall asset scores are grouped into ranges and assigned a condition category. **Table 2** shows the range of overall asset scores that make up each condition category.

Table 2. Condition Categories

Asset Condition Category	Overall Asset Score	
	Minimum Score	Maximum Score
Condition 1	1.00	1.49
Condition 2	1.50	2.49
Condition 3	2.50	3.49
Condition 4	3.50	4.49
Condition 5	4.50	5.00

Based on information from IIMM 2006, general statements about the condition of assets and the future maintenance requirements can be made. As shown in **Table 3**, each condition category has a brief description of the future maintenance requirements of the asset, as well as the likely maximum percentage of the assets' normal service life remaining.

Table 3. Condition Category Description

Condition Category	Description	Estimated % of Remaining Service Life
Condition 1	Indicates the asset is in like new condition. Continuation of the current maintenance and operating procedures is indicated.	95
Condition 2	Indicates asset is in good condition. Some minor additional maintenance may be required along with the current maintenance and operating procedures.	75
Condition 3	Indicates the asset is in fair condition. These assets have one or more issues that require immediate attention. The current maintenance and operating procedures or intervals may need to be modified or adjusted to avoid a reoccurrence of the identified issues.	50
Condition 4	Indicates the asset is in poor condition. Planning for a major overhaul or replacement should begin. A review of current maintenance practices and procedures is needed. If this is a critical asset, a predictive maintenance program should be considered to prevent the asset from reaching this condition in the future.	30
Condition 5	Indicates the asset is in very poor condition. Failure of the asset to provide the desired level of service is likely. Greater than 50% of assets will require replacement. If this is a critical asset, a comprehensive maintenance analysis is recommended to prevent the asset from reaching this condition in the future.	5

1.1 Risk Based Condition Assessment

The approach CH2M used incorporates risk into the condition assessment. In a risk-based condition assessment, the asset condition, as described in the previous section, is only one component of the assessment. While the current condition of an asset is widely accepted as the primary indicator of an asset's likelihood of failing, there are additional risk factors that can more accurately help us define the best repair and replacement strategy. Applying the concept of relative risk ranking provides the ability to make fact-based and defensible decisions for the maintenance, rehabilitation, and replacement of infrastructure assets. Using a relative risk ranking concept is the industry standard for managing infrastructure assets effectively. Understanding the risk of assets failing will enable the City of Traverse City to make better use of these condition assessment results. The City can prioritize capital projects and maintenance actions based upon the extent to which the actions/investments could reduce the relative risk posed by failure of individual assets. This will help to optimize financial resources and mitigate the greatest amount of potential risk.

Risk can be defined as:

> *The potential for realization of unwanted, adverse consequences to organizational and service delivery strategies.*

In the context of utility asset management, the focus is on the risk of asset failure, where failure is not only the physical breakdown of an asset, but also the inability of an asset to meet its intended purpose. The risk that an asset failure will result in the City not meeting its established levels of service can be quantified as a function of the consequence of the asset failure, and the likelihood that the asset will fail, as shown by the following classic risk equation:

Risk = Consequence x Likelihood

Section 1.2, Consequence of Failure, and 1.3, Likelihood of Failure, discuss the scoring system used to quantify the consequence of failure and the likelihood of failure for the City's infrastructure assets. The basis for the scoring system is found in the following sources:

- *International Infrastructure Management Manual*. Version 3.0. Association of Local Government Engineering New Zealand, Inc. and the Institute of Public Works Engineering of Australia. 2006.
- *Implementing Asset Management – A Practical Guide*. National Association of Clean Water Agencies, Association of Metropolitan Water Agencies, and Water Environment Federation. 2007.

1.2 Consequence of Failure

The risk posed by an asset failing is determined by quantifying the consequences that may result from the failure and the likelihood of the failure occurring. The consequence of asset failure focuses on the impact a failure may have on the City's ability to meet its established level of service targets.
The consequences of an asset failing are usually static unless (1) there is a change to the required level of service, (2) major equipment is changed, which results in lower consequence of failure, or (3) there is a redesign of part of the plant. The static nature of the consequence of failure makes the consequence score for a process or asset a potential way of assigning criticality to the assets. A criticality number is often assigned to assets in a Computerized Maintenance Management System (CMMS) to prioritize work orders based on the criticality of the asset being worked on. This works well for routine preventative maintenance or predictive maintenance work orders. Criticality falls short of providing the level of information we need when it comes to capital planning. In capital planning, the likelihood, or how soon an asset will fail, becomes as significant a factor as the criticality (consequence) of the asset failing. **Table 4** shows the Consequence of Failure Matrix, which was developed during the workshop Thursday, November 10, with representatives of the City of Traverse City, Grand Traverse County, and the Traverse City CH2M staff. It lists the level of service categories and the range of consequences (negligible to severe) with scores (1-10).

Table 4. Consequence of Failure Matrix

Consequence of Failure (COF)				City of Traverse City Traverse City RWWTP	
LOS Category	**Weight**	**Negligible = 1**	**Low = 4**	**Moderate = 7**	**Severe = 10**
Public Confidence	25%	No social or economic impact on the community. No reactive media coverage. Any media coverage is a result of proactive announcements by Utility. No complaints.	Minor disruption (e.g., traffic, dust, noise). No adverse media coverage.	Substantial but short-term disruption. Adverse media coverage due to public impact. Localized media coverage.	Long-term impact. Area-wide disruption. Regional media coverage.
Safety of Public and Employees	25%	No Injuries or Adverse Health Effects.	No lost-time injuries or medical attention required beyond first aid.	Lost-time injury or medical attention required.	Loss of life or widespread outbreak of illness.
Regulatory Compliance	20%	No State or County permit violations.	Technical violation	Probable enforcement action, but fines or surcharge unlikely	Regulator consent order.
System Delivery	20%	No impact.	Minor impact to process or out of service less than 4 hours.	Major impact to process, out of service <8 hours.	Major impact to process, out of service >24 hours.
Financial Impact	10%	Can be repaired within Utility budget (<$9,000).	Can be repaired between $9,000 and $50,000.	Can be repaired between $51,000 to $149,000.	Greater than $150,000. Sealed bids.

1.3 Likelihood of Failure

During the same workshop, a similar matrix was developed to score the likelihood of an asset failing. The result is presented in **Table 5**. Each likelihood category was assigned a weighted value based on its contribution to the likelihood of an asset failing to meet its intended purpose over a range of likelihood (negligible to very likely) with scores (1–10). Since the current condition of an asset is widely considered the major factor in predicting the likelihood an asset will fail, a weight of 60 percent was given to the condition rating calculated during the condition assessment. The likelihood that an asset will fail is also the common way to change the total risk that processes and assets pose to the City. While changing the consequence of a failure, as discussed above, usually requires a redesign of a process or complete changes to the assets or systems in use, likelihood can be changed more easily. Likelihood can be changed by rebuilding an asset or improving maintenance procedures. The successful application of predictive technologies to certain assets can also reduce the likelihood of a failure. These are all things that can be done without the need for major asset replacements or plant redesigns.

Table 5. Likelihood of Failure Matrix

Likelihood of Failure (LOF)					City of Traverse City Traverse City RWWTP	
Likelihood Category	**Weight**	**Negligible = 1**	**Unlikely = 3**	**Possible = 5**	**Likely = 7**	**Very Likely = 10**
Physical Condition	60%	Very Good. Condition Grade 1. New or Nearly New. Only Normal Maintenance Required.	Good. Condition Grade 2. Minor Wear.	Fair. Condition Grade 3. Major Wear Affecting Level of Service.	Poor. Condition Grade 4. Unable to Meet Level of Service Life. Failure Imminent.	Very Poor. Grade 5. Requires Complete Rehabilitation or Replacement. Failed.
O and M Protocols	20%	Complete accurate, Up-To-Date, Written, Easily Accessible and Is Being Used.	Complete, Written, Up-To-Date, Being Used but not easily accessible.	Partially Developed.	Written, But Out-Date and Not Used.	No Written Protocols.
Performance	10%	Sufficient capacity to meet average and peak flow requirements. Appropriate utilization and function.	Underutilized or oversized.	Sufficient capacity, but does not meet functional requirements, or over-utilized.	Able to meet current average capacity demand, but not peak demands.	Unable to meet current average capacity needs.
Reliability	10%	No Unscheduled corrective work order events within 12 months.	1 Unscheduled corrective work order events within 12 months.	2 Un scheduled corrective work order events within 12 months.	3 Unscheduled corrective work order events within 12 months.	4 Unscheduled corrective work order events within 12 months.

During the workshop on November 10 with representatives of The City of Traverse City, Grand Traverse County, CH2M plant staff, and CH2M maintenance and asset management specialists, each process area and lift station was scored. The results of the workshop are shown in **Table 6**.

Table 6. Process Area and Lift Station Risk Scores by Total Risk

Ranked by Total Risk	Consequence						Likelihood					
	Safety of Public and Employees	Financial Impact	Public Confidence	Regulatory Compliance	Service Delivery	Consequence of Failure	Physical Condition (1-10)	O&M Protocols (i.e., PMs, SOPs,	Performance	Reliability	Likelihood of Failure	Total Risk
	25%	10%	25%	20%	20%		60%	20%	10%	10%		
Process Area												
Digestion	10	10	10	7	4	8.200	1	5	5	5	2.600	21.320
Primary Treatment	7	10	10	7	10	8.650	1	3	1	7	2.000	17.300
Membrane Filtration	7	10	10	7	4	7.450	1	3	1	10	2.300	17.135
Solids Handling	7	4	7	1	10	6.100	1	5	1	10	2.700	16.470
Front Street LS	7	10	10	7	4	7.450	1	5	1	1	1.800	13.410
UV disinfection	1	4	4	10	4	4.450	1	5	7	5	2.800	12.460
TBA LS	4	4	7	4	4	4.750	1	5	1	5	2.200	10.450
Clinch Park LS	4	1	7	7	1	4.450	1	5	1	3	2.000	8.900
Secondary Treatment	1	10	1	1	10	3.700	1	5	5	3	2.400	8.880
Woodmere LS	4	4	4	4	4	4.000	1	5	1	5	2.200	8.800
Riverine LS	1	4	7	4	7	4.600	1	5	1	1	1.800	8.280
Bay St LS	1	4	7	7	4	4.600	1	5	1	1	1.800	8.280
Hull Park LS	4	1	7	4	4	4.450	1	5	1	1	1.800	8.010
Coast Guard LS	1	4	4	4	4	3.250	1	5	1	7	2.400	7.800
Birchwood LS	4	4	4	4	4	4.000	1	5	1	1	1.800	7.200
Odor Control	7	7	4	1	7	5.050	1	3	1	1	1.400	7.070
Fine Screens	1	10	1	1	4	2.500	1	5	1	1	1.800	4.500
Preliminary Treatment	4	10	1	1	1	2.650	1	3	1	1	1.400	3.710
Structures and support	1	4	1	1	4	1.900	1	3	1	3	1.600	3.040
Grit Removal	1	4	1	1	1	1.300	1	5	1	1	1.800	2.340

Figure 2 shows the ranking of processes and lift stations using the assumption that all the assets were in new or like new condition. The purpose of this graph is to show where risk exists at the plants and lift stations where condition is not a factor.

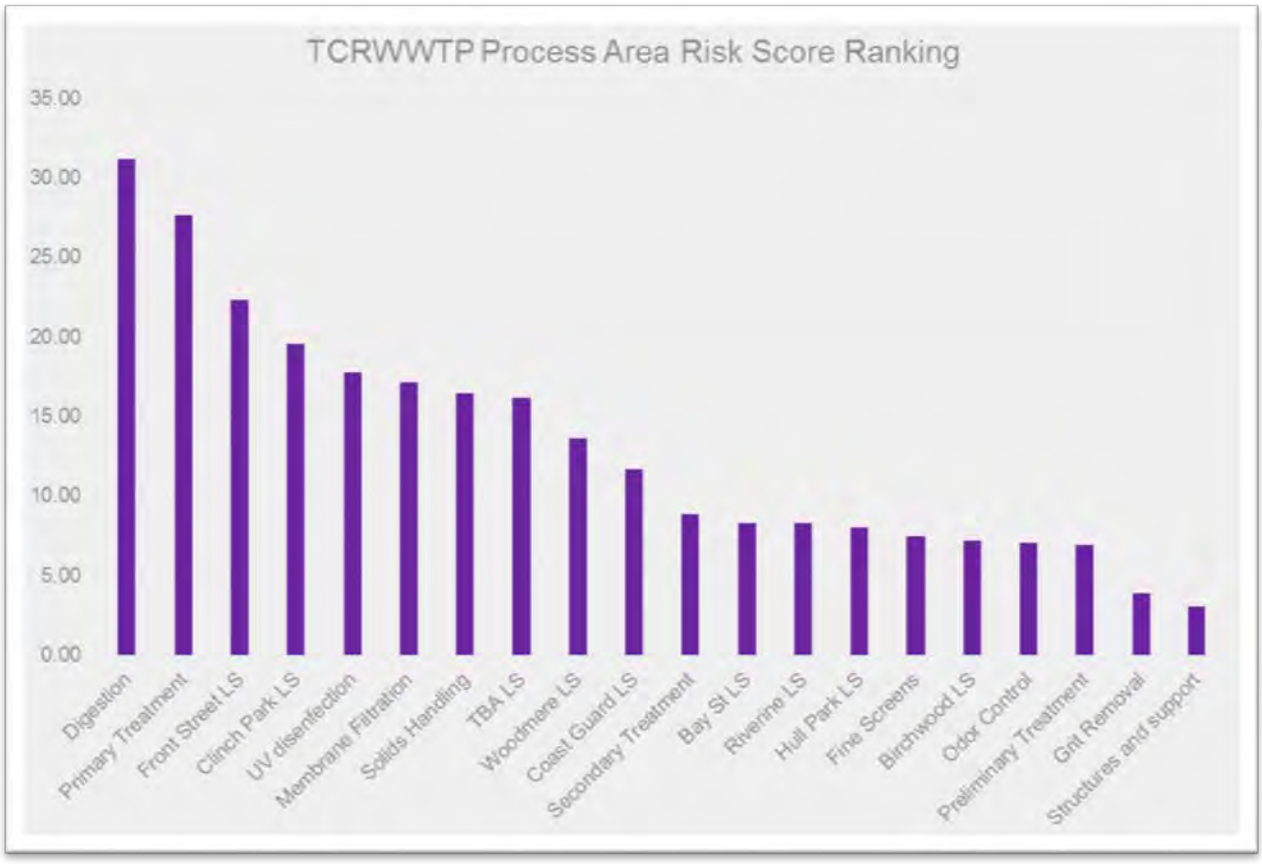


Figure 2. Process and Lift Station Risk Ranking without Considering Risk

Condition Assessment Findings

The results of the condition assessment are shown in the asset condition spread chart, **Figure 3**. The results indicate that 559 (65 percent) of all the critical assets are in Condition 1. This means that the current maintenance plan is effective with up to 95 percent of useful asset life remaining. Another 205 (24 percent) of all critical assets are in Condition Category 2. These assets may require some minor additional maintenance with up to 75 percent of useful life remaining. These two condition categories represent 89 percent of all the critical assets. The remaining 87 (11 percent) of all critical assets may require additional attention in the near future.

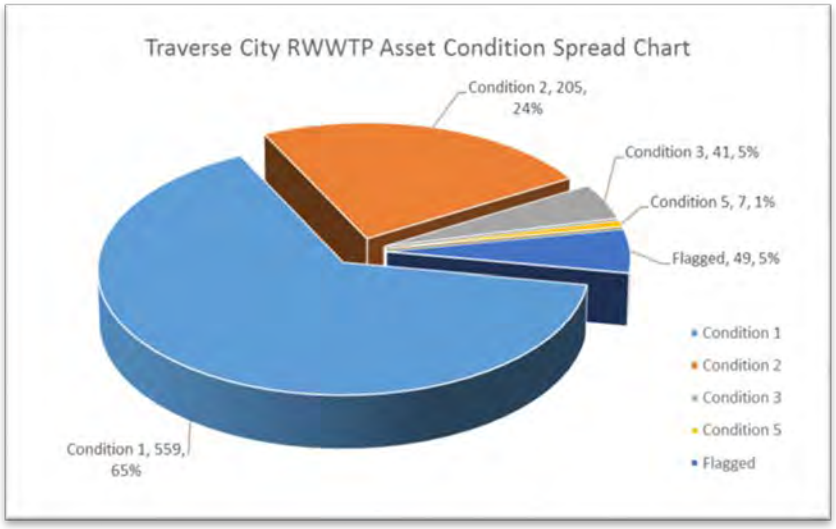


Figure 3. Asset Condition Spread

A report detailing the assessment of each asset, including comments from the assessment team and pictures of concerns identified by the assessment team, can be found in **Appendix B.**

Looking at the assets at the Main Plant and the lift stations separately, the asset condition spread remains very close to the same. **Figure 4** shows the asset condition spread for the Main Plant, and **Figure 5** shows the asset condition spread for the lift stations.

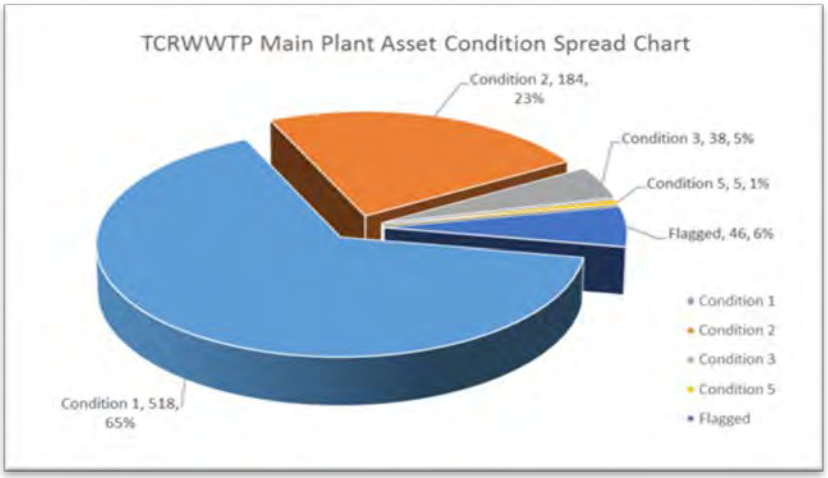


Figure 4. Main Plant Asset Condition Spread

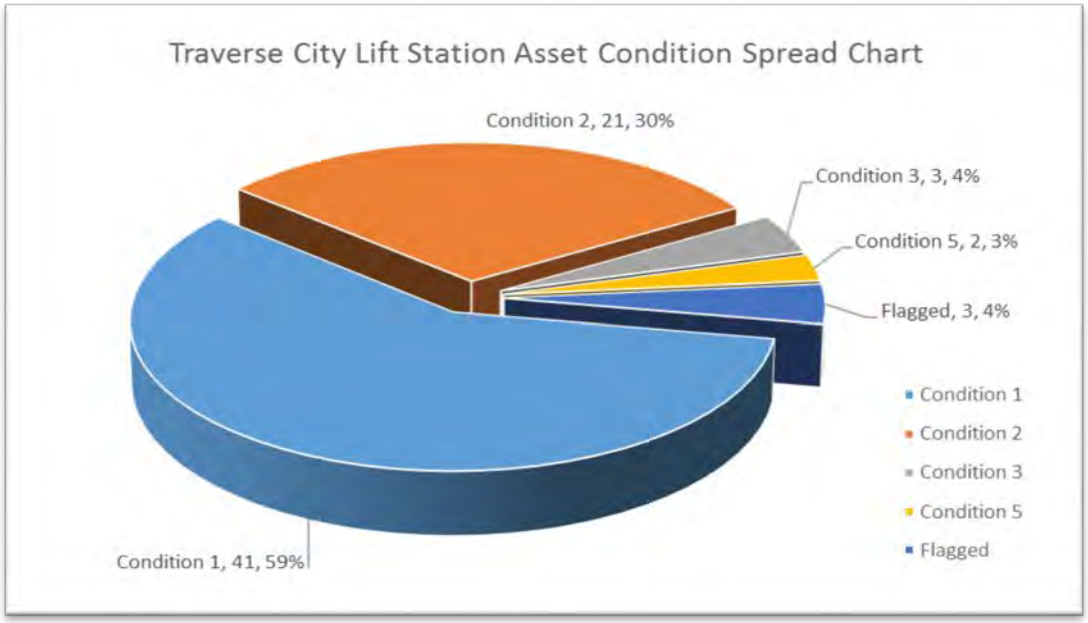


Figure 5. Lift Station Asset Condition Spread

The area's average condition scores for the processes at the main plant show how they rank (**Table 7**). Grit Removal, Preliminary Treatment, and Digestion have the highest average asset condition scores. When risk is factored into the equation, the process ranking changes slightly, with Digestion being the highest average total risk, followed by Primary Treatment and Membrane Filtration (**Table 8**).

Table 7. Main Plant Process Area Average Condition Score Ranking

Plant Process area by Average Condition Score	Number of Assets	Average Asset Condition Score	Average Total Risk	Process Area Consequence	Process Area Likelihood
Grit Removal	14	1.92	3.79	1.30	2.91
Preliminary Treatment	27	1.90	6.30	2.65	2.38
Digestion	50	1.76	28.40	8.20	3.46
UV disinfection	2	1.70	15.13	4.45	3.40
Fine Screens	22	1.60	6.20	2.50	2.48
Primary Treatment	69	1.57	22.57	8.65	2.61
Odor Control	4	1.48	8.59	5.05	1.70
Solids Handling	129	1.47	19.02	6.10	3.12
Structures and support	132	1.46	3.87	1.90	2.04
Secondary Treatment	76	1.38	9.87	3.70	2.67
Membrane Filtration	217	1.32	19.28	7.45	2.59
Laboratory	5	1.27	0.00	0.00	0.00

Table 8. Main Plant Process Area Average Total Risk Score Ranking

Plant Process area by Average Total Risk Score	Number of Assets	Average Asset Condition Score	Average Total Risk	Process Area Consequence	Process Area Likelihood
Digestion	50	1.76	28.40	8.20	3.46
Primary Treatment	69	1.57	22.57	8.65	2.61
Membrane Filtration	217	1.32	19.28	7.45	2.59
Solids Handling	129	1.47	19.02	6.10	3.12
UV disinfection	2	1.70	15.13	4.45	3.40
Secondary Treatment	76	1.38	9.87	3.70	2.67
Odor Control	4	1.48	8.59	5.05	1.70
Preliminary Treatment	27	1.90	6.30	2.65	2.38
Fine Screens	22	1.60	6.20	2.50	2.48
Structures and support	132	1.46	3.87	1.90	2.04
Grit Removal	14	1.92	3.79	1.30	2.91
Laboratory	5	1.27	0.00	0.00	0.00

Tables 7 and **8** we show that the process areas at the main plant with the highest average condition score do not have the highest average total risk. This does not mean there are not individual assets that may require attention. What it does tell us is that after dealing with the individual assets in poor condition with high total risk, processes ranking highest in total risk should be looked at next. The graph in **Figure 6** displays the average condition score and the average total risk for each process area at the main plant. Four processes stand out as requiring attention to mitigate risk to the City.

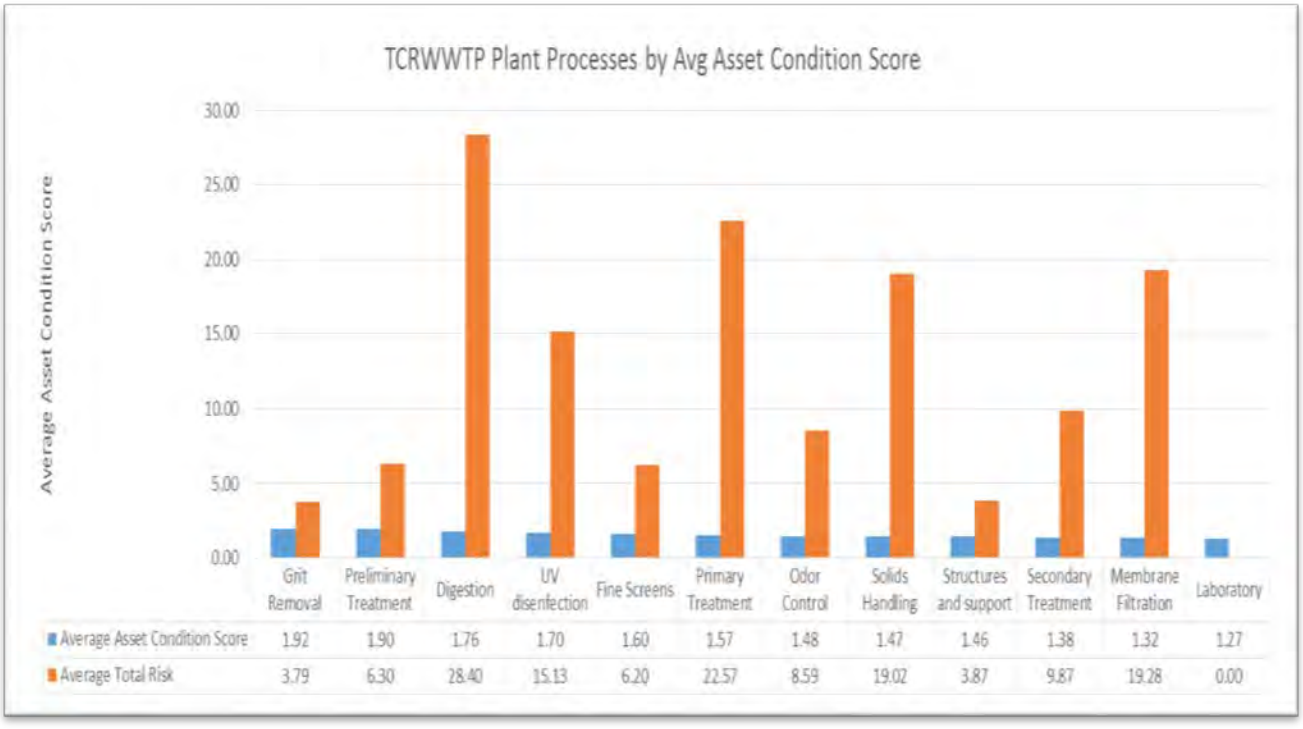


Figure 6. Main Plant Process Area Average Scores Ranked by Condition Score

A detailed report of the asset condition and total risk scores for the main plant is contained in **Appendix C** at the end of this report.

The average condition and risk scores for the lift stations show that, while the asset condition spread for the lift stations and Main Plant is very similar, there are many fewer assets in each lift station than in each process area. The result is that the average condition scores are higher. When the lift stations are ranked by average condition, Clinch Park and Woodmere have the highest average condition scores. When risk is factored into condition, Clinch Park is also the highest average total risk. The Front Street lift station is the fourth highest in average condition score but the second highest in total risk. As with the process areas, after individual high-risk poor condition assets are accounted for, the highest-risk lift stations need to be looked at to lower the City's overall risk. The stations would be Clinch Park, Front Street, Woodmere, and TBA. The ranking of lift stations by average condition score are shown in **Table 9** and by average total risk are shown in **Table 10**. **Figure 7** displays the average condition score and average total risk ranked by average condition score. **Appendix D** contains a detailed report showing all the lift station assets with their individual condition scores and total risk scores.

Table 9. Lift Station Average Condition Score Ranking

Lift Stations by Average Condition Score	Number of Assets	Average Asset Condition Score	Average Total Risk	Process Area Consequence	Process Area Likelihood
Clinch Park LS	2	3.10	20.92	4.45	4.70
Woodmere LS	7	2.01	13.94	4.00	3.49
Coast Guard LS	6	1.70	10.40	3.25	3.20
Front Street LS	23	1.66	18.07	7.45	2.43
Bay St LS	7	1.54	9.86	4.60	2.14
TBA LS	5	1.43	13.87	4.75	2.92
Riverine LS	8	1.42	9.66	4.60	2.10
Birchwood LS	8	1.31	7.80	4.00	1.95

Table 10. Lift Station Average Total Risk Score Ranking

Lift Stations by Average Total Risk Score	Number of Assets	Average Asset Condition Score	Average Total Risk	Process Area Consequence	Process Area Likelihood
Clinch Park LS	2	3.10	20.92	4.45	4.70
Front Street LS	23	1.66	18.07	7.45	2.43
Woodmere LS	7	2.01	13.94	4.00	3.49
TBA LS	5	1.43	13.87	4.75	2.92
Coast Guard LS	6	1.70	10.40	3.25	3.20
Bay St LS	7	1.54	9.86	4.60	2.14
Riverine LS	8	1.42	9.66	4.60	2.10
Birchwood LS	8	1.31	7.80	4.00	1.95

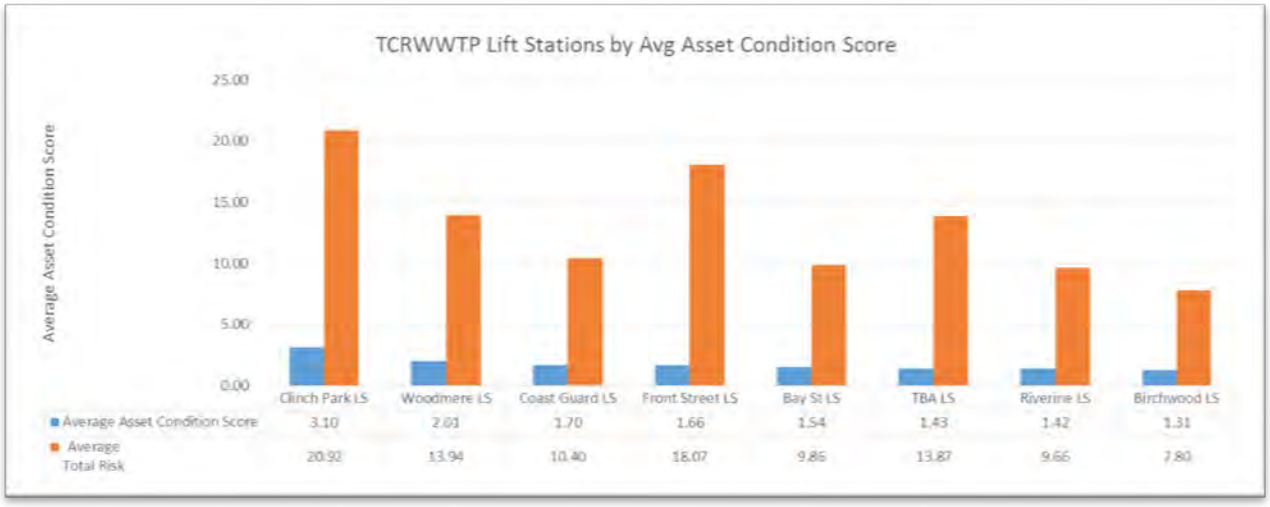


Figure 7. Lift Station Average Scores Ranked by Condition Score

There are 31 assets that were flagged as not functional or partially evaluated. Assets receiving either of these two flags automatically receive an overall score of 3 because these assets could not be observed operating under normal operating condition. The score highlights the assets in the assessment results so that whatever issues existed at the time of the assessment can be addressed, and an accurate assessment can be made by the plant staff. The overall score of 3 moves the assets higher in the ranking, but stops short of listing them as failed assets (overall score of 5). A description of each flag and how many assets are included follows.

- Not Functional—A not functional asset is one that would not operate at the time of the inspection. There are 13 assets flagged as not functional. The following are examples of the reasons assets are flagged as not functional:
  - Assets removed or locked out of service for repair
  - Assets that would not operate at the time of inspection or that operated such that they would not be operated under normal circumstances
- Partially Evaluated—A partially evaluated asset is an asset that could not be operated at the time of the inspection, but the assessment team determined that some of the questions could be answered without operating the asset and still provide valuable information. There are 18 assets flagged partially evaluated. Examples of the reasons assets are flagged partially evaluated are as follows:
  - The asset could not be operated under normal operating conditions, but could be operated sufficiently that the assessment team determined they could evaluate the condition of the asset.
  - Some questions could be answered without operating the asset that would provide valuable information about the asset.

There are also 49 flagged assets that received no score. These assets are flagged Needs Review, Nonexistent, Not Evaluated, or Not Found. A description of each flag and how many assets are included follows.

- Not Evaluated—A not evaluated asset is an asset that could not be operated at the time of the assessment, but there was no indication that the asset was in a failed condition. Since the asset cannot be operated under normal operating condition, the assessment team flagged the asset not

evaluated and gave it a score of 0. There are 35 assets flagged as not evaluated. Examples of the reasons assets are flagged not evaluated are as follows:

  - The asset could not be operated under normal operating conditions.
  - The asset was associated with an out of service or not functional asset, and it could not be operated under normal operating conditions.
  - Operational considerations prohibited the asset from being operated.

- Needs Review—An asset that needs review is an asset that has an asset description that is not complete enough for the field team to be certain which asset it is. By flagging the asset, the asset description can be changed to better identify the asset. There was 1 asset flagged needs review.
- Non-Existent—Assets flagged as nonexistent are assets that the assessment team, working with the plant staff, determined have been permanently removed from service. These assets are flagged so they may be removed from the asset registry. There are 6 assets flagged nonexistent.
- Not Found—Assets flagged as not found are assets that the assessment team, working with the plant staff, could not positively identify, but also could not confirm that they had been permanently removed from service. There are 7 assets flagged not found.

A complete listing of all the flagged inspections is contained in **Appendix E**.

Appendix H: Capital Improvement and Revenue Analysis

Appendix H: Capital Improvement and Revenue Analysis

Traverse City Regional Waste Water Treatment Plant and Collection System Costs (10-year Horizon)

Collection System	Fiscal Year 2017-2018	Fiscal Year 2018-2019	Fiscal Year 2019-2020	2020-2021	Fiscal Year 2021-2022	Fiscal Year 2022-2023	Fiscal Year 2024-2025	Fiscal Year 2025-2026	Fiscal Year 2026-2027	Fiscal Year 2027-2028	Project Cost
Automated Metering Infrastructure	$750,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$750,000.00
Annual pipe and manhole inspection and cleaning program	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$1,600,000.00
Manhole rehabilitation & repair	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$1,500,000.00
Gravity sewer rehabilitation & repair	$680,000	$680,000	$680,000	$680,000	$680,000	$500,000	$500,000	$500,000	$500,000	$500,000	$5,900,000.00
Force Main Replacement	$400,000	$400,000	$400,000	$400,000	$400,000	$78,200	$78,200	$78,200	$78,200	$78,200	$2,391,000.00
Collection System SSES (District 3)	$15,000	$15,000	$0	$0	$0	$0	$0	$0	$0	$0	$30,000.00
Additional Metering - District 3	$0	$0	$15,000	$15,000	$0	$0	$0	$0	$0	$0	$30,000.00
Front Street Lift Station Pump and Valve Replacement/Repair	$40,000	$40,000	$25,000	$0	$0	$0	$0	$0	$0	$0	$105,000.00
Other Lift Stations Pump and Valve Replacement/Repair	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$150,000.00
Lift Station General Maintenance	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$50,000.00
Hydraulic Upgrades - Oak Street Sanitary Sewer	$0	$0	$0	$0	$0	$0	$0	$245,000	$1,460,000	$1,000,000	$2,705,000.00
Clinch Park Lift Station/Bay Street/Birchwood Upgrade of Controls	$0	$0	$0	$117,000	$0	$0	$0	$0	$0	$0	$117,000.00
Engineering Evaluation of Clinch Park Lift Station Capacity	$0	$0	$0	$0	$0	$50,000	$0	$0	$0	$0	$50,000.00
Clinch Park Lift Station Upgrade per Engingeering Study/Condition Assessment and Addition of Flow metering	$0	$0	$0	$0	$0	$0	$0	$160,000			$160,000.00
Front Street Lift Station Pump Around Hookup	$0	$0	$0	$0	$80,000	$0	$0	$0	$0	$0	$80,000.00
Engineering Evaluation/Condition Assessment Birchwood Lift Station	$0	$0	$0	$0	$0	$50,000	$0	$0	$0	$0	$50,000.00
Birchwood Lift Station Upgrade per Engineering Study and Addition of Flow metering	$0	$0	$0	$0	$0	$0	$300,000	$0	$0	$0	$300,000.00
Front Street Lift Station VFD -Pipe and Pump-Wet Well Upgrade and addition of Flow Metering	$0	$0	$0	$0	$598,000	$0	$0	$0	$0	$0	$598,000.00
Front Street Lift Station Engineering Evaluation-To look at Capacity and options for upgrade	$0	$0	$0	$50,000	$0	$0	$0	$0	$0	$0	$50,000.00
Lift Station Telemetry	$0	$0	$0	$90,000	$0	$0	$0	$0	$0	$0	$90,000.00
Riverine Lift Station Engineering Study-Evaluation of Capacity	$0	$0	$0	$0	$0	$50,000	$0	$0	$0	$0	$50,000.00
Riverine Lift Station Upgrade per Engineering Study	$0	$0	$0	$0	$0	$0	$160,000	$0	$0	$0	$160,000.00
Coast Guard Lift Station Engineering Study-Evaluation of Capacity	$0	$0	$0	$0	$0	$0	$0	$50,000	$0	$0	$50,000.00
Coast Guard Lift Station Upgrade per Engineering Study	$0	$0	$0	$0	$0	$0	$0	$0	$300,000	$0	$300,000.00
SCADA upgrade for Front Street Lift Station and the TCWWTP for PLC 5	$152,639	$0	$0	$0	$0	$0	$0	$0	$0	$0	$152,639.00
Pump Station (annual replacement fund)	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$100,000.00
Pump Stations: capital (assets > 25 yrs)	$8,500.00	$36,000.00	$55,000.00	$15,000.00	$54,000.00	$45,000.00	$0.00	$0.00	$0.00	$260,000.00	$473,500.00
Collection System Total (CIP)	$2,386,139	$1,511,000	$1,515,000	$1,707,000	$2,152,000	$1,113,200	$1,378,200	$1,373,200	$2,678,200	$2,178,200	$17,992,139
WWTP	Fiscal Year 2017-2018	Fiscal Year 2018-2019	Fiscal Year 2019-2020	2020-2021	Fiscal Year 2021-2022	Fiscal Year 2022-2023	Fiscal Year 2024-2025	Fiscal Year 2025-2026	Fiscal Year 2026-2027	Fiscal Year 2027-2028	Project Cost
WWTP Flow Meter Upgrade	$10,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,000.00
Plant Pump and Valve replacement/repair	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$500,000.00
Plant General Maintenance	$87,000	$87,000	$87,000	$87,000	$87,000	$87,000	$87,000	$87,000	$87,000	$87,000	$870,000.00
Digester 3&4 Reconditioning per Condition Assessment	$208,000	$208,000	$0	$0	$0	$0	$0	$0	$0	$0	$416,000.00
Digester Condition Assessment	$50,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$50,000.00
Enclose Membrane Trains	$0	$0	$0	$0	$0	$500,000	$0	$0	$0	$0	$500,000.00
Membrane Distribution and RAS Channel Aeration Line Replacement	$0	$95,400	$0	$0	$0	$0	$0	$0	$0	$0	$95,400.00
WW-Membrane Gate Replacement	$51,742	$59,982	$0	$0	$0	$0	$0	$0	$0	$0	$111,724.00
Plant PLC Upgrade	$0	$0	$0	$0	$243,024	$0	$0	$0	$0	$0	$243,024.00
Plant-Membrane Replacement	$860,000	$860,000	$860,000	$860,000	$0	$940,000	$940,000	$940,000	$940,000	$940,000	$8,140,000.00
Primary Clarifier Supports and Structure	$0	$0	$0	$363,654	$0	$0	$0	$0	$0	$0	$363,654.00
Replace the chain and flights in Primary Clarifiers	$0	$0	$0	$1,000,000	$0	$0	$0	$0	$0	$0	$1,000,000.00
Primary Header Replacement	$0	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$500,000.00
Reconditioning Digesters 1 &2	$0	$0	$0	$0	$0	$80,000	$0	$0	$0	$0	$80,000.00
SCADA Upgrade	$0	$0	$95,000	$0	$0	$0	$0	$0	$0	$95,000	$190,000.00
Screw Pump Replacement	$0	$500,000	$500,000	$0	$0	$0	$0	$0	$0	$0	$1,000,000.00
UV System and Structure Modifications	$500,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$500,000.00
Engineering Study Related to Facility's Plan	$200,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200,000.00
Projects Related to Facility Plan Engineering Study(Costs are strictly for budgeting purposes-projects have not yet been indentified nor have related cost estimates been established)	$0.00	$0.00	$0.00	$0.00	$1,000,000.00	$1,000,000.00	$1,000,000.00	$1,000,000.00	$1,000,000.00	$1,000,000.00	$6,000,000.00
West Biosolids Storage Tank Pump Upgrade	$122,512.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$122,512.00
Sewer Plant Total (CIP)	$2,139,254	$2,360,382	$1,592,000	$2,360,654	$1,380,024	$2,657,000	$2,077,000	$2,077,000	$2,077,000	$2,172,000	$20,892,314
Fiscal Year Total (CIP)	$4,525,393	$3,871,382	$3,107,000	$4,067,654	$3,532,024	$3,770,200	$3,455,200	$3,450,200	$4,755,200	$4,350,200	$38,884,453

Operating Expenses (From FY16/17 Budget)		
Maintenance and Repairs - Salaries, Wages, Supplies, Etc.	$467,000	(base assumption: 50% of current $829K budget will be dedicated to CIP budget for rehab, repair, inspection, etc. - remainder is represented in the CIP budget)
WWTP Operating Costs	$2,663,000	(base WWTP operating costs, per CH2M and City Treasurer)
Administrative and General	$273,000	(from current City budget, excluding depreciation expenses)
Debt Service	$1,220,000	(from current City budget, expires in FY21/22)
Transfers Out (City Fee)	$450,000	(5% of revenues, increased to reflect potential increased revenues)
Subtotal: Operating+Finance+Transfers	$5,073,000	
AVERAGE TOTAL CIP (next 10 years)	$3,890,000	(collection system + WWTP + pump stations: no adjustment for inflation - all costs assumed to be 2017 Dollars)
Total Recommended Wastewater Budget	**$9,000,000**	(Recommended budget for FY 17/18 - annual adjustments likely necessary to keep up with inflation)

APPENDIX F: PUBLIC HEARING DOCUMENTATION

APPENDIX G: RESOLUTION

City of Traverse City

Office of the City Clerk

GOVERNMENTAL CENTER
400 Boardman Avenue
Traverse City, MI 49684
(231) 922-4480
tcclerk@traversecitymi.gov

TRAVERSE CITY
CITY COMMISSION RESOLUTION

ADOPTION OF A FINAL PROJECT PLAN FOR WASTEWATER IMPROVEMENTS AND DESIGNATION OF AN AUTHORIZED PROJECT REPRESENTATIVE

WHEREAS, the City of Traverse City recognizes the need to make improvements to its existing wastewater treatment and collection system; and

WHEREAS, the City of Traverse City authorized Hubbell, Roth and Clark to prepare a Project Plan, which recommends the construction of Wastewater Improvements; and

WHEREAS, said Project Plan was presented at Public Hearing April 20, 2026 and all public comments have been considered and addressed;

WHEREAS, adoption of the Project Plan and approval of the loan program does not obligate the City to accept any funding that may be approved through the application process, if approved by the State, it allows the City to be a candidate for SRF loan consideration; and

NOW THEREFORE BE IT RESOLVED, that the City of Traverse City formally approves and adopts said Project Plan and Program Application for the Michigan Department of Environment, Great Lakes and Energy State Revolving Fund Loan.

BE IT FURTHER RESOLVED, that the City Manager, a position currently held by Martin Colburn, is designated as the authorized representative for all activities associated with the project referenced above, including the submittal of said Project Plan as the first step in applying to the State of Michigan for a Clean Water State Revolving Fund (CWSRF) Loan to assist in the implementation of the selected alternative.

I, Sarah Lutz, City Clerk of the City of Traverse City, do hereby certify that the above is a true and correct copy of a resolution adopted at the meeting of the City Commission of the City of Traverse City on April 20, 2026, at which a quorum was present and voted.

_____
Sarah Lutz, Clerk
City of Traverse City, Michigan

APPENDIX H: PROJECT PRIORITY LIST (PPL) SCORING DATA FORM

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Finance Division

PROJECT PRIORITY LIST SCORING DATA FORM

Part 53, Clean Water Assistance, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Instructions

The following information must be completed and submitted alongside a Project Planning Document for the Clean Water State Revolving Fund (CWSRF) or Strategic Water Quality Initiatives Fund (SWQIF). This form should only be completed for items to be included in the upcoming fiscal year project. Include page numbers and appendices of where supporting documentation can be found in the planning document. For traditional wastewater projects, including combined sewer separation, please complete sections 1-4. For projects with only storm water work please complete sections 5-8.

For questions related to wastewater scoring, please contact Charlie Hill at 906-236-3916 or HillC@Michigan.gov. For questions related to storm water scoring, please contact Christe Alwin at 517-420-1501 or AlwinC@Michigan.gov.

Project Information

Applicant: City of Traverse City

Project Location: City of Traverse City

CWSRF/SWQIF Project Number: _____

Applicant Population: _____ Population Served by the Project: _____

Project Type: ☑ Wastewater (including emerging contaminant projects) ☐ Storm Water

1. Compliance – Wastewater Projects

Does the project have an enforceable construction schedule established by an order, permit, enforcement action, or other document issued by EGLE?

☐ Yes ☑ No

If yes, copy of enforcement action, order, permit, notice, or another document. Pages: _____

2. Public Health – Wastewater Projects

Sanitary Sewer Overflow (SSO)/Bypass. Pages: _____

☐ Wet weather related SSOs demonstrated not meeting SSO policy.

☐ Operational-related SSOs demonstrated dry weather SSOs due to structural concerns (incorrect pumps, difficult to maintain siphons, etc.).

Combined Sewer Overflow (CSO). Pages:_____

Based on maximum annual volume reported in the last five years, does the project involve the reduction of annual CSO volumes? Check which volume reduction applies.

☐ Greater than 10MG ☐ 5-10MG ☐ Less than 5MG ☐ N/A

Biosolids scoring for PFOS. Pages:_____

☐ Meets 20 ppb PFOS as expressed in interim biosolids strategy. Must meet EPA public risk level if issued before 3 years. Must meet interim biosolids strategy if revised in next 3 years.

3. Water Quality – Wastewater Projects

Pre-project conditions, including wastewater collection/treatment deficiencies and water quality problems occurring. Pages:_____

☐ Project includes centralized treatment to address failing septic systems in unsewered areas.

Pages:_____

If you selected this option, please identify the following documentation included below.

☐ Documentation of fecal coliform in surface water resulting from failing septic tanks.

☐ Documented illicit discharges of sanitary sewage to surface water resulting from failing septic tanks.

☐ Documentation of impact to surface water resulting from failing septic tanks (visual indicators or other metrics).

☐ No documentation of impacts to surface water is included.

Post-project conditions, including proposed facilities and water quality improvements.

Pages:_____

A. Information on Existing Discharge Pages: _____

i. Discharge Method:
☐Surface Water ☐Groundwater ☐No existing discharge

ii. Discharge Type:
☐Continuous ☐Seasonal ☐Intermittent ☐ No existing discharge

iii. Flow (identify MGD or MGY):_____
For facilities that discharge to regional treatment plants and do not file surface water discharge monitoring reports, provide the average daily metered flow.

iv. Receiving Water and Type:_____

v. Location (township, range, and section): _____

vi. Existing Treatment:
☐Untreated ☐Secondary ☐Tertiary ☐Combined Sewer Overflow
☐Primary (includes septic systems with tile fields or direct surface water discharge)

vii. Existing Disinfection Process:
☐None ☐Chlorination ☐Alternative, other: _____

viii. Nitrate contamination of public or private wells caused by the discharge of effluent/waste from the treatment system or systems. Pages: _____

☐ Public well(s) in vicinity contains nitrates > 10 mg/L
☐ Private well(s) in vicinity contains nitrates > 10 mg/L
☐ Monitoring well(s) in vicinity contains nitrates > 10 mg/L
☐ No evidence of nitrate contamination in local wells

Note: If only the total inorganic nitrogen ("TIN" ammonia + nitrite + nitrate) concentration is available, a separate sampling and nitrate analysis should be performed to document the nitrate concentration.

B. Information on Proposed Discharge Pages: _____

i. Discharge Type:
☐Continuous ☐Seasonal ☐Intermittent

ii. Discharge Points and Receiving Waters:

_____

_____

_____

iii. Average Design Flow (identify MGD or MGY):_____

iv. Identify Receiving Water:_____

v. Location (township, range, and section): _____

vi. Effluent Limits:

Minimum Dissolved Oxygen:_____ $CBOD_5$:_____

Ammonia:_____ Phosphorus:_____

Total Inorganic Nitrogen (TIN) from groundwater permit:_____

vii. Will the proposed facility address documented total residual chlorine (TRC) violations?
☐Yes, proceed to question viii. ☐No

viii. Will the proposed improvements involve either dechlorination or an alternative disinfection technology (e.g., ultraviolet disinfection, ozonation) that eliminates the use of chlorine? ☐Yes ☐No

C. Existing Pre-Project CSO and SSO Discharges

Information must be provided for each outfall directly associated with the proposed project. Note that both tables must be completed for each discharge.

Outfall Number	Receiving Stream	Location (township, range, section)	Estimated Overflow Volume (MG) for 1-year, 1-hour storm event
001			
002			
003			
004			
005			

Outfall Number	Estimated Overflow Duration, in hours	Estimated Annual Overflow Volume (MG)	Tributary Residential Population
001			
002			
003			
004			
005			

D. Future Post-Project CSO and SSO Discharges

List each outfall from Section C. For outfalls which will cease to function as combined sewer outfalls upon the completion of this project, simply enter “Eliminated” under Receiving Stream. List any new outfalls (e.g., for a retention/treatment basin) created by this project and include its associated discharge data. Note that both tables must be completed for each discharge.

Outfall Number	Receiving Stream	Location (township, range, section)	Estimated Overflow Volume (MG) for 1-year, 1-hour storm event
001			
002			
003			
004			
005			

Outfall Number	Estimated Overflow Duration, in hours	Estimated Annual Overflow Volume (MG)	Detention Time Before Discharge for 1-year, 1-hour storm event
001			
002			
003			
004			
005			

4. Improving Infrastructure – Wastewater Projects

Check the following which apply to the proposed project. Pages:_____

☐ Proposed project is part of an approved Asset Management Program.

☐ The purpose of the proposed project is for regionalization of systems.

☐ The proposed project involves resiliency components (e.g., pumping or type of pumps, electrical systems, basement backup protection, etc.)

The following items only apply to storm water projects.

5. Compliance – Storm Water Projects

Is the applicant a Municipal Separate Storm Sewer System (MS4) permittee?

☐ Yes, permit number:_____ ☐ No

Has the applicant received a violation notice identifying violations related to at least one of the following MS4 permit requirements? ☐ Yes, select all that apply below ☐ No

☐ Illicit Discharge Elimination Program

☐ Post-Construction Stormwater Runoff Program

☐ Pollution Prevention and Good Housekeeping Program

☐ Total Maximum Daily Load (TMDL) Implementation Plan

Copy of violation notice. Page:_____

6. Public Health – Storm Water Projects

Does the project result in **all** the following? Pages:_____

☐ Reduced storm water runoff volume for small and large events.

☐ Treatment of the water quality volume.

☐ At least one of the following

- Addresses known flooding issue causing water quality problems or basement backups.
- The design considers projected precipitation for the service life of the project or an increase in precipitation above the current National Oceanic Atmospheric Administration (NOAA) Atlas 14 estimates.

7. Water Quality – Storm Water Projects

Is the project located in an applicable TMDL watershed (i.e., E. coli, biota/sediment, phosphorus, dissolved oxygen, or chloride)?

☐ Yes, TMDL(s) title:_____ ☐ No

Does the project result in a direct reduction of the pollutant(s) causing the TMDL impairment?

☐ Yes ☐ No Pages:_____

Does the project result in reduced storm water runoff volume as a primary focus of the project?

☐ Yes ☐ No Pages:_____

Identify all best management practices (BMPs) and estimate size/quantity of each in the project. Definitions of the BMPs below are included at the end of this document.

Bioretention Basins Pages:_____

Enter the quantity for each size bioretention basin included in the project.

Less than 0.5 acre:_____ 0.5-1.5 acres:_____ Greater than 1.5 acres:_____

Rain Gardens Pages:_____

Enter the quantity for each size rain garden included in the project.

Less than 300ft^2:_____ 300-1000ft^2:_____ Greater than 1000ft^2:_____

Bioswales Pages:_____

Enter the quantity for each size bioswale included in the project.

Less than 1 acre:_____ 1 – 3 acres:_____ Greater than 3 acres:_____

Infiltration Trenches Pages:_____

Enter the quantity for each size infiltration trench included in the project.

Less than 1 acre:_____ 1 – 5 acres:_____ Greater than 5 acres:_____

Pervious Pavement Pages:_____

Select the size of pervious pavement included in the project.

☐ Less than 1 acre ☐ 1 – 5 acres ☐ Greater than 5 acres

Green Roofs Pages:_____

Enter the quantity of green roofs included in the project:_____

Native Revegetation Pages:_____

Select the size area of native revegetation included in the project.

☐ Less than 1 acre ☐ 1 – 5 acres ☐ Greater than 5 acres

Water Storage and Reuse Pages:_____

Select the quantity of water storage and reuse included in the project.

☐ Less than 1,000 gallons ☐ 1,000 – 5,000 gallons ☐ Greater than 5,000 gallons

Tree Cover Pages:_____

Enter the quantity of trees planted as part of the project:_____

Does the project result in increased water quality treatment from an existing discharge?

☐ Yes ☐ No Pages:_____

Does the project result in disconnection of existing impervious surfaces with a quantifiable runoff volume reduction or water quality benefit?

☐ Yes, disconnection area:_____ ☐ No Pages:_____

Does the project result in a new or retrofitted regional BMP(s) to address known local site issues preventing full implementation of the NPDES MS4 post-construction requirements?

☐ Yes ☐ No Pages:_____

Does the regional BMP(s) serve more than one site/parcel?

☐ Yes, number of sites/parcels:_____ ☐ No

8. Improving Infrastructure – Storm Water Projects

Does the project result in implementation of a Stormwater Asset Management Program.

☐ Yes ☐ No Pages:_____

Does the project result in a water quality benefit from the coordination between two or more municipal agencies on stormwater management?

☐ Yes, list municipal entities benefiting from the project ☐ No Pages:_____

_____

_____

_____

BMP Definitions:

Bioretention Basins: Shallow, vegetated basins designed to infiltrate, treat, and temporarily store stormwater. Bioretention basins should be pretreated to optimize water quality performance.

Rain Gardens: Shallow surface depressions planted with native vegetation to capture and treat stormwater runoff. Rain gardens should be pretreated to optimize water quality performance.

Bioswales: Shallow, vegetated stormwater channels designed to slow down runoff and provide infiltration. Check dams may be included to improve performance and maximize infiltration.

Infiltration Trenches: Linear subsurface infiltration structures, typically composed of stone trenches wrapped with geotextile fabric, designed to provide infiltration and conveyance of stormwater.

Green Roof: Rooftops or constructed surfaces that include a thin covering of vegetation or growth media that enables infiltration and evapotranspiration of stormwater.

Native Revegetation: transitioning impervious or previously non-native turfgrass spaces to native plants. Native revegetated spaces may include forest, prairie, meadow, or constructed wetland.

Water Storage and Reuse: structures designed to intercept and store runoff from rooftops and other impervious spaces and allow for its reuse.

Tree Cover: Trees planted specifically for stormwater benefit purposes including stormwater uptake, storage, and evapotranspiration.

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations. Questions or concerns should be directed to the Nondiscrimination Compliance Coordinator at EGLE-NondiscriminationCC@Michigan.gov or 517-249-0906.

This form and its contents are subject to the Freedom of Information Act and may be released to the public.

APPENDIX I: PROJECT PLAN SUBMITTAL FORM

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Finance Division

CLEAN WATER STATE REVOLVING FUNDS (CWSRF/SWQIF)
PROJECT PLANNING DOCUMENT SUBMITTAL FORM

Part 53, Clean Water Assistance, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Project Name: City of Traverse City

Project Description: Wastewater Improvements

Legal Name of Applicant: City of Traverse City
(Name of the applicant municipality bonding for the project. Ex. A county bonding on behalf of a village or township)

Applicant Address: 400 Boardman Avenue, P.O. Box 592, Traverse City, MI 49684

City: Traverse City Zip Code: 49684 County: Grand Traverse

Applicant's Federal Employer Identification Number (EIN): _____

Congressional District: 1st State Senate District: 35, 37 State House District: 101, 104

NPDES Permit Number: MI0027481 Associated SAW Grant Number: 1442-01

Estimated Total Project Cost: _____ Target Construction Start Date: March 2027

Applicant Authorized Representative Name: Benjamin Marentette

Title: City Manager Phone: 231-922-4440 Email: bmarentette@traversecitymi.gov

Authorized Representative Address. If same as applicant address above, check here ☑

Address: _____ City: _____ Zip Code: _____

_____
Signature of Authorized Representative Date

Completed Project Useful Life and Cost Analysis Certification Form. Blank copy included for use.
☑ Attached

Completed PPL Scoring Data Form. Blank copy included for use.
☑ Attached

Joint Resolution of Project Planning Document Adoption/Authorized Representative Designation.
☑ Attached

Did you follow the Qualifications Based Selection (QBS) process for obtaining planning services?
☐Yes ☐No

A final project planning document, prepared and adopted in accordance with EGLE's CWSRF Project Planning Document Preparation Guidance, must be submitted by the annual deadline as indicated on EGLE's CWSRF website for a proposed project to be considered for placement on Michigan's Project Priority List for the upcoming fiscal year.

Please email your final project planning document and attachments with this form to your EGLE Water Infrastructure Funding and Financing Section Project Manager.

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations. Questions or concerns should be directed to the Nondiscrimination Compliance Coordinator at EGLE-NondiscriminationCC@Michigan.gov or 517-249-0906.

This form and its contents are subject to the Freedom of Information Act and may be released to the public.

APPENDIX J: PROJECT COST ANALYSIS CERTIFICATION FORM

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Finance Division

PROJECT USEFUL LIFE AND COST ANALYSIS CERTIFICATION FORM

Per Section 602(b)(13) of the Federal Water Pollution Control Act (FWPCA), all Clean Water State Revolving Fund (CWSRF) assistance recipients must certify that they have conducted the studies and evaluations described in 602(b)(13)(A) and (B), collectively known as a cost and effectiveness analysis.

Applicant Name: City of Traverse City CWSRF Project Number: _____

Project Description: Wastewater Improvements

1) The applicant has studied and evaluated the cost and effectiveness of the processes, materials, techniques, and technologies for carrying out the proposed project or activity for which assistance is sought under the CWSRF; and

2) The applicant has selected, to the maximum extent practicable, a project or activity that maximizes the potential for efficient water use, reuse, recapture, and conservation, and energy conservation, taking into account the cost of:

- constructing the project or activity;
- operating and maintaining the project or activity over the life of the project; and
- replacing the project or activity.

3) The applicant has completed a Project Useful Life analysis for the project or activity and is included in the Project Planning Document or appropriate documentation is attached to this certification.

☐ I certify that requirements (1), (2), and (3) above have been met.

_____

Name of Professional Engineer (Please Print or Type)

_____

Signature of Professional Engineer Date

_____

Name and Title of Authorized Representative (Please Print or Type)

_____

Signature of Authorized Representative Date

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations. Questions or concerns should be directed to the Nondiscrimination Compliance Coordinator at EGLE-NondiscriminationCC@Michigan.gov or 517-249-0906.

This form and its contents are subject to the Freedom of Information Act and may be released to the public.