TRAVERSE CITY

Sanitary Sewer System
Asset Management Plan

May 2017

OHM Advisors®

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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.

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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.

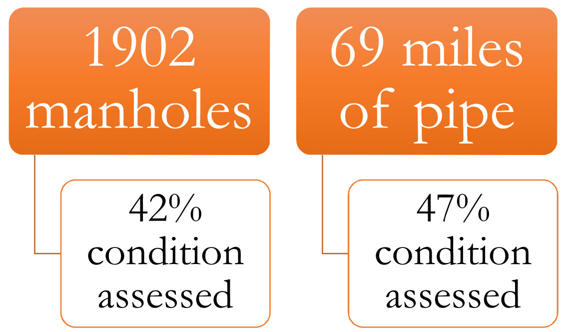

Figure 2 : Portion of Sewer System Assessed

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.

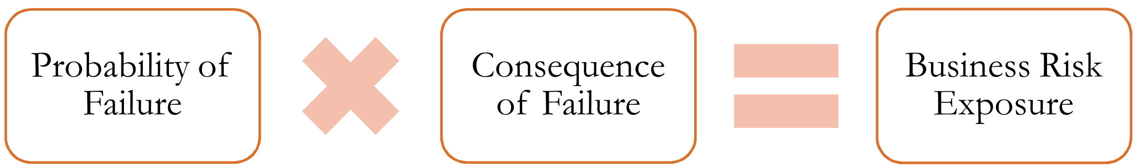

Figure 3 : Risk Equation

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.

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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 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.

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:

- 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.

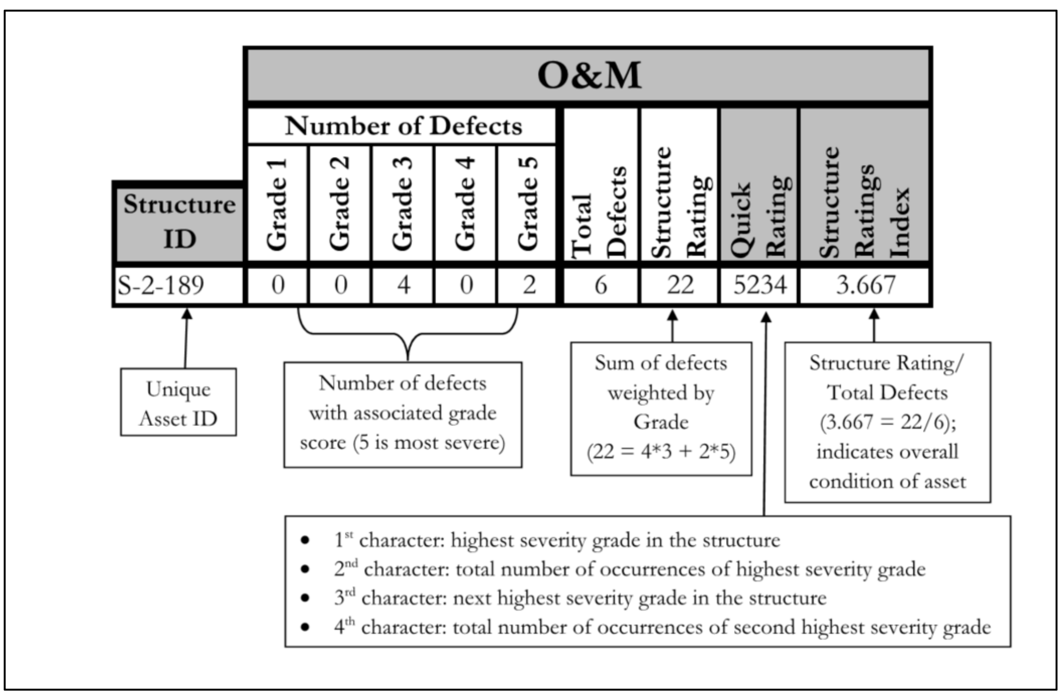


Figure 5: NASSCO Metrics

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.

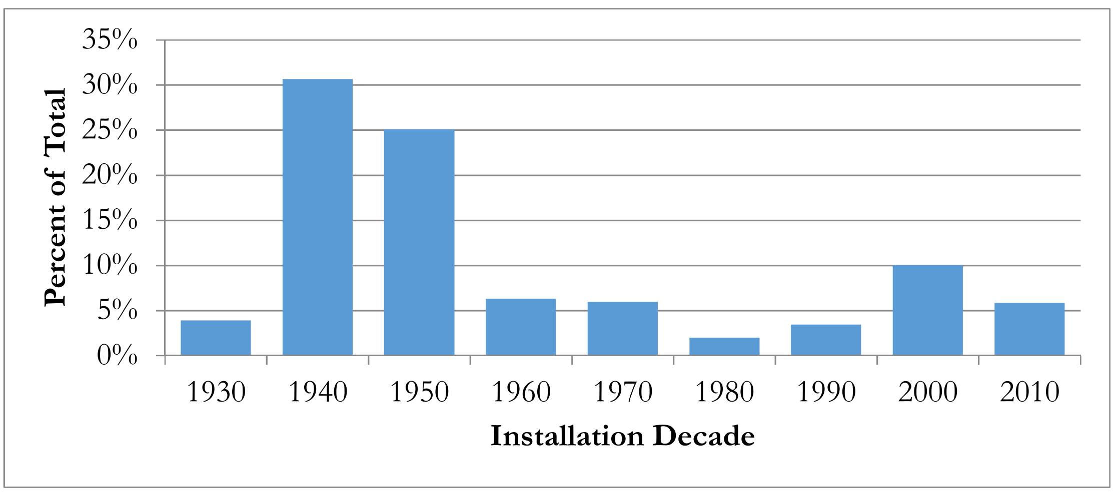


Figure 6: Distribution of Wastewater Manholes Based on Installation Decade

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.

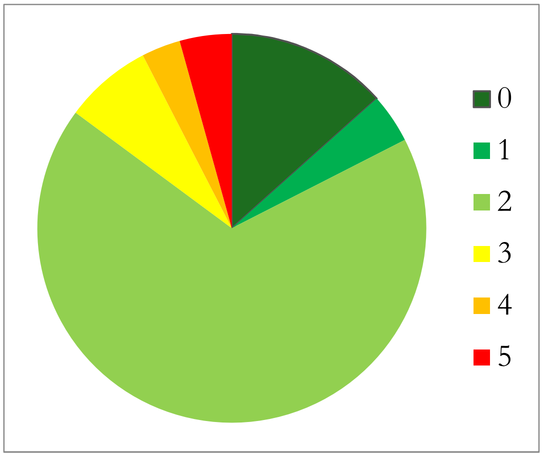


Figure 7: Wastewater Manhole O&M Ratings

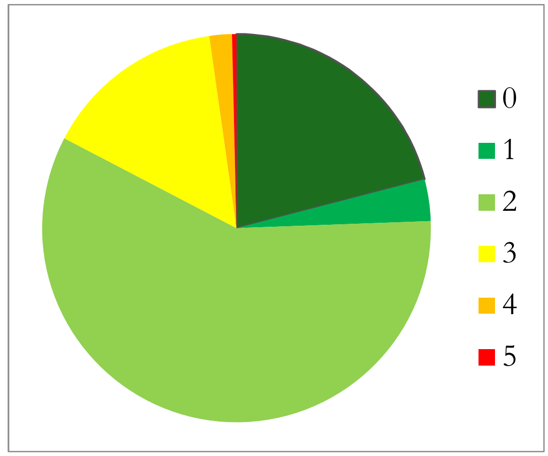


Figure 8: Wastewater Manhole Structural Ratings

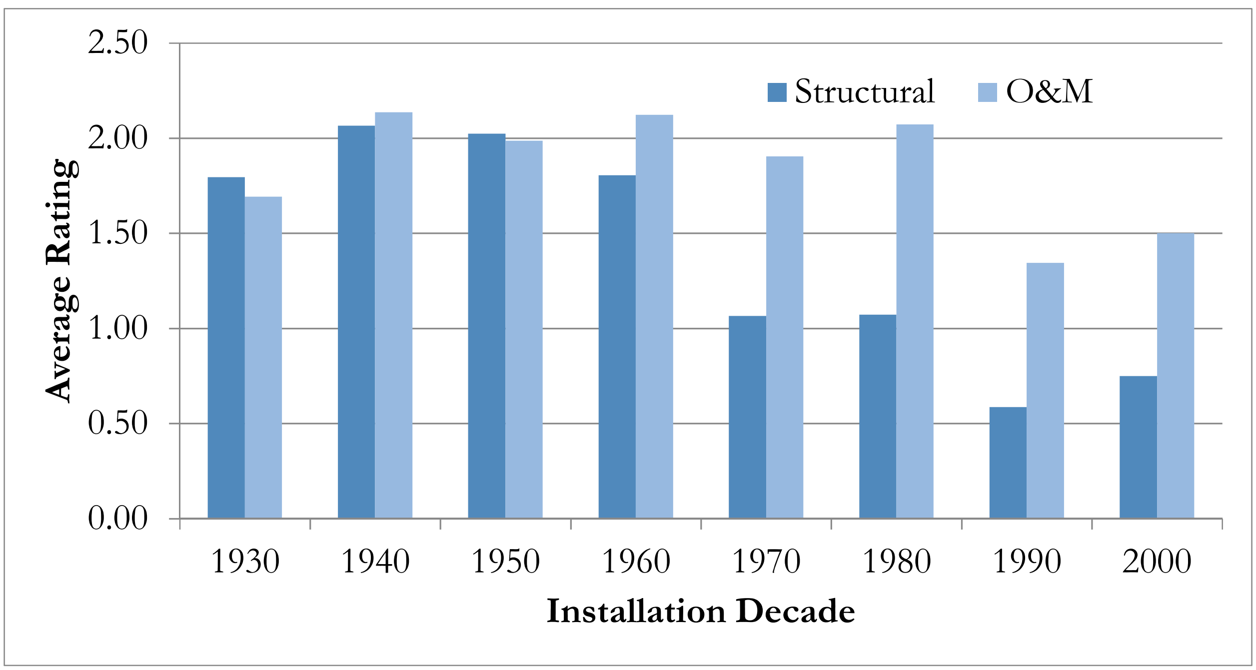


Figure 9: Average Wastewater Manhole Condition Ratings Indices by Installation Decade

* 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.

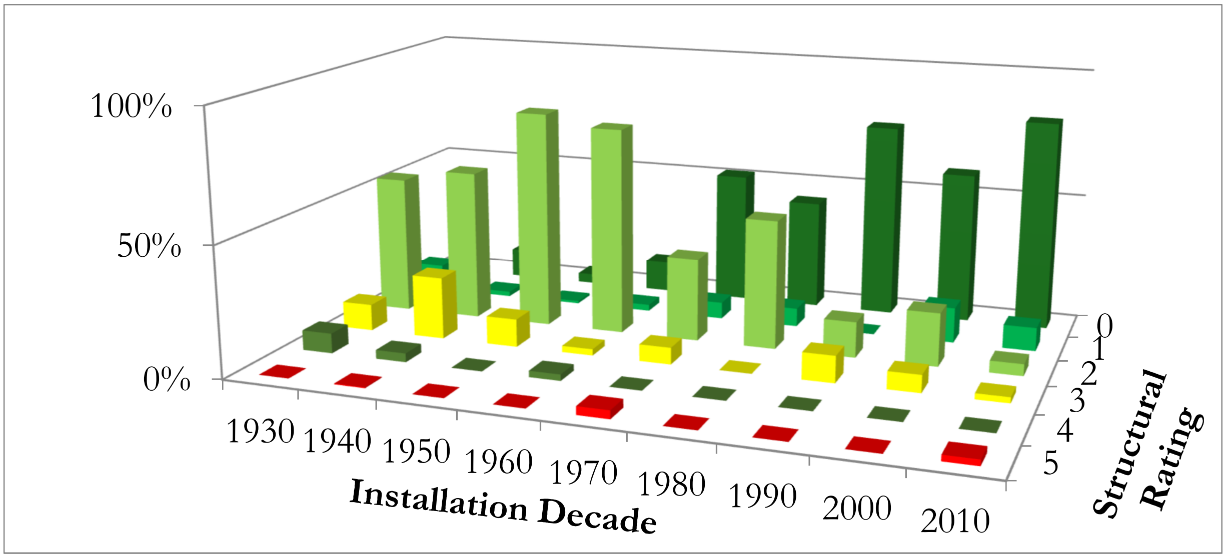


Figure 10: Wastewater Manhole Structural Ratings Indices by Decade

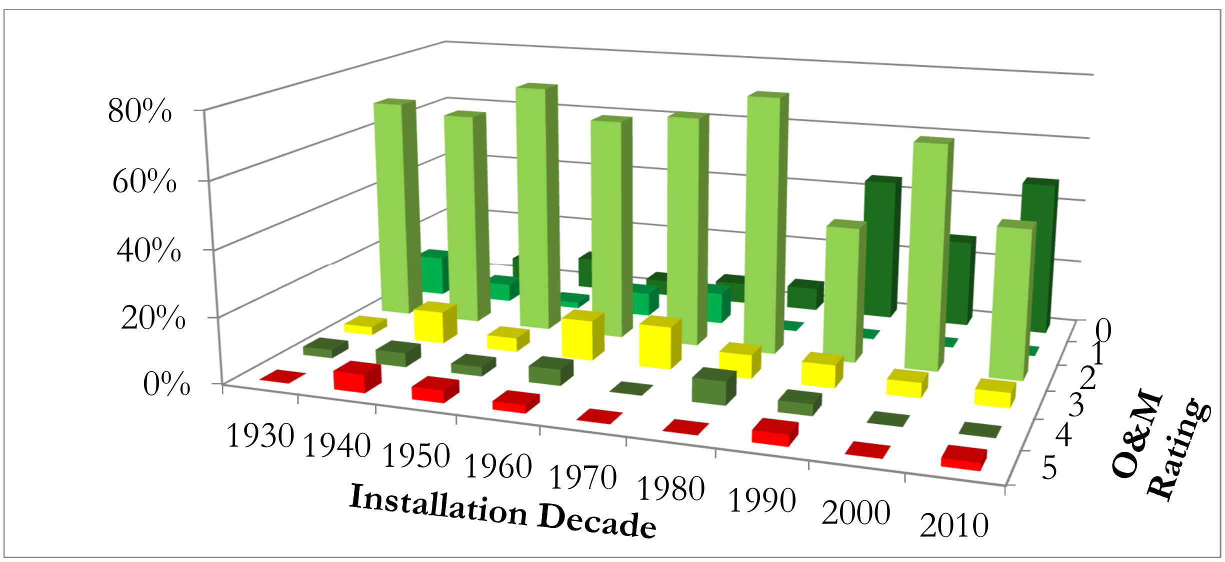


Figure 11: Wastewater Manhole O&M Ratings Indices by Decade

* 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.

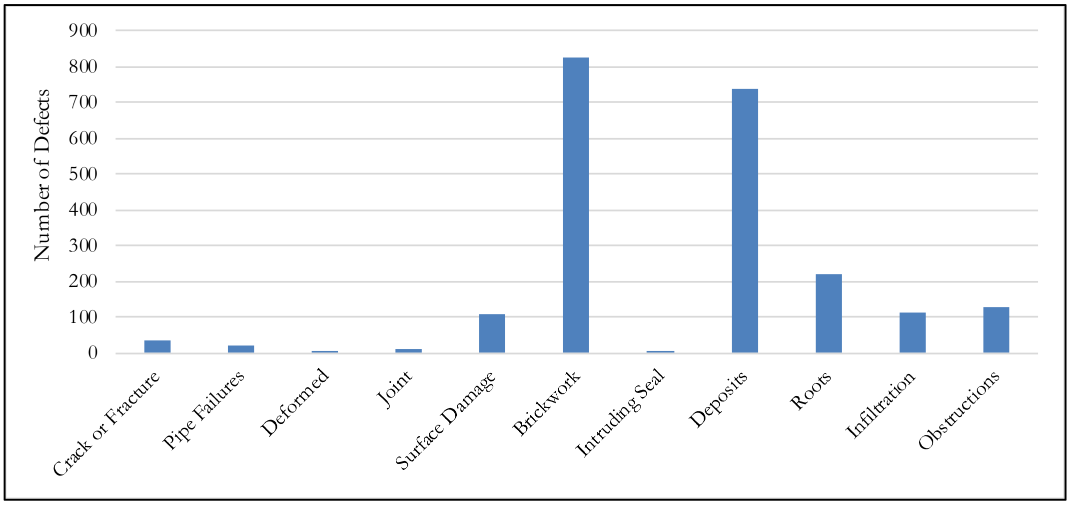


Figure 12: Manhole Defects

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.

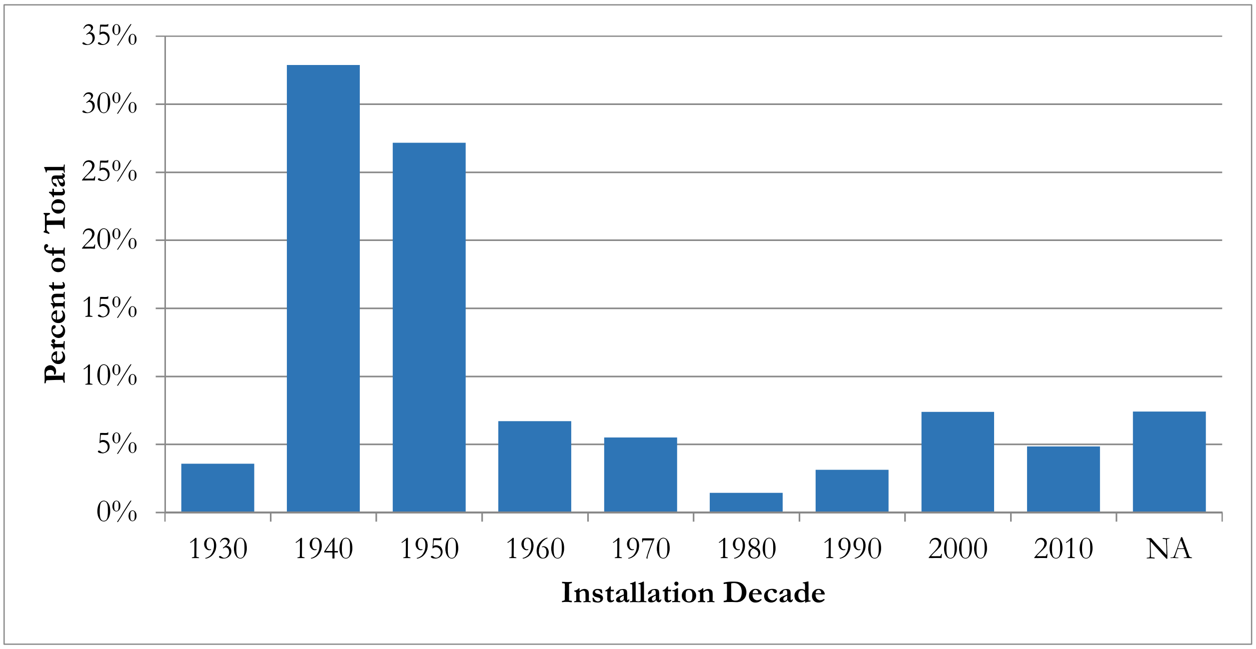


Figure 13: Wastewater Sewer Installation Inventory

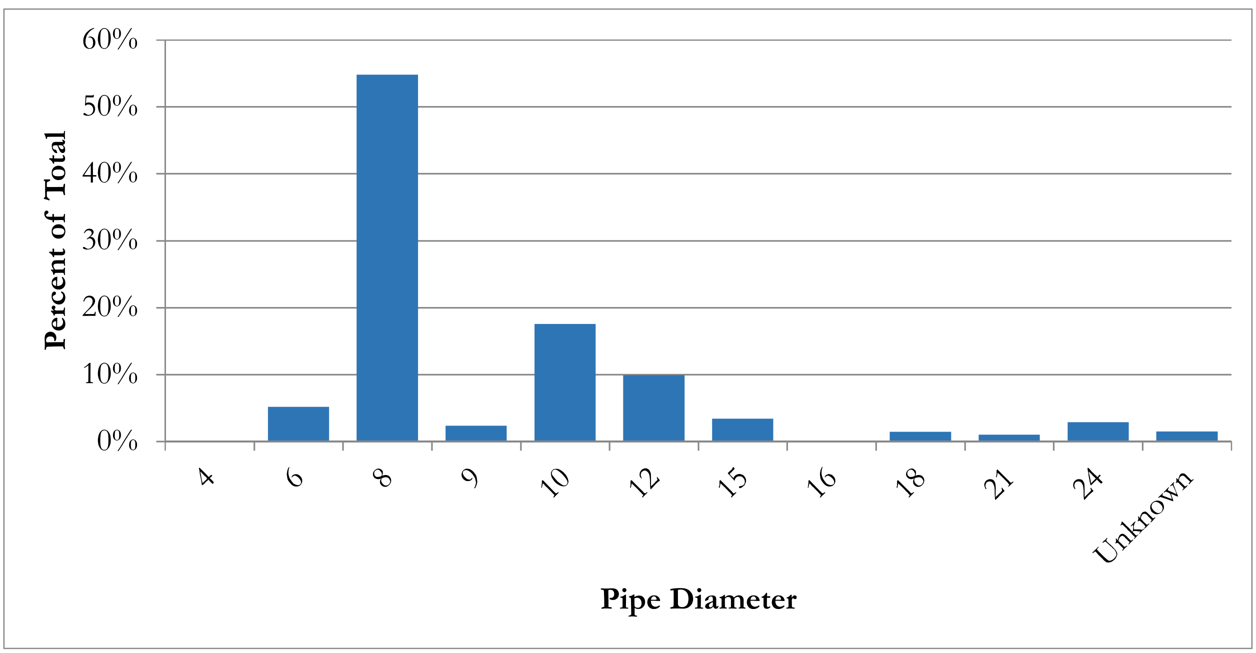


Figure 14: Wastewater Sewer Diameter Inventory

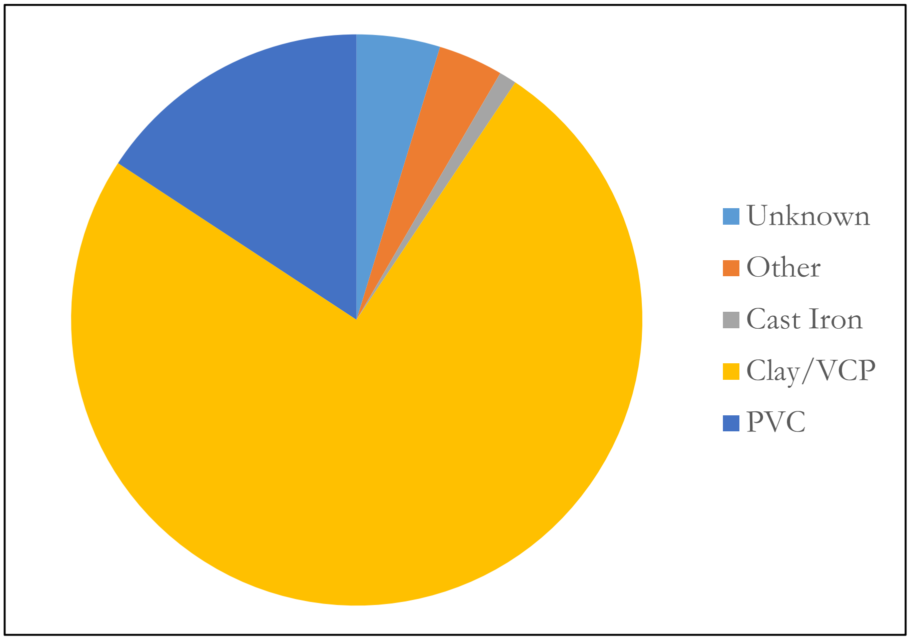


Figure 15: Wastewater Sewer Material Inventory

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.

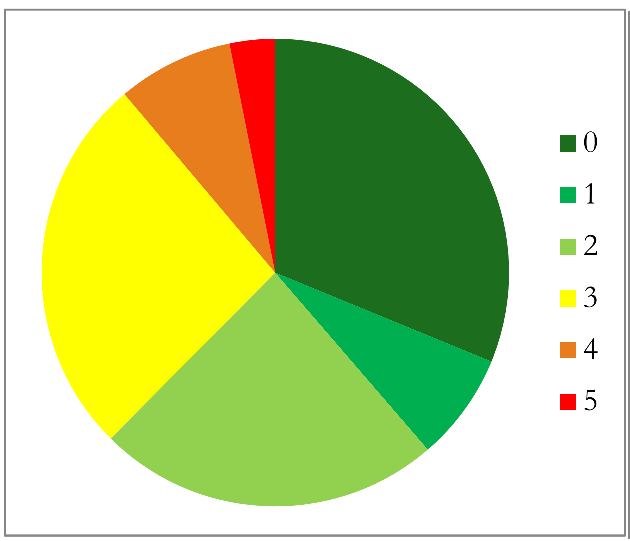


Figure 16: Wastewater Sewer Structural Ratings

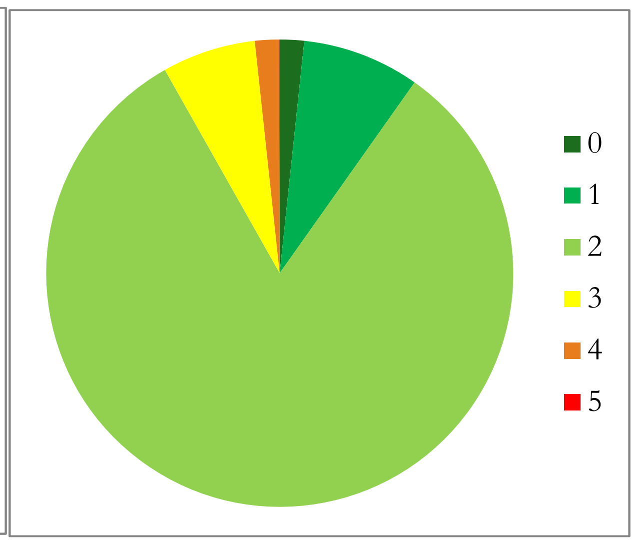


Figure 17: Wastewater Sewer O&M Ratings

Figure 18 shows a breakdown of the average wastewater sewer condition indices by installation decade.

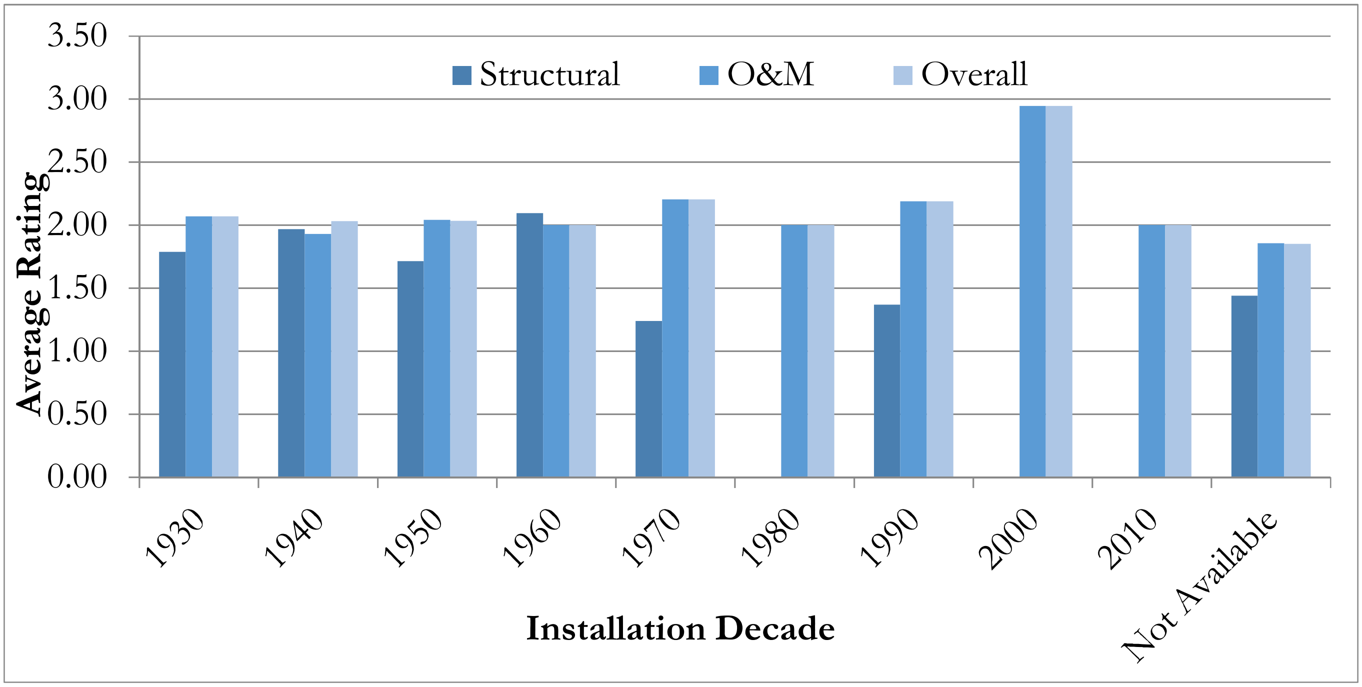


Figure 18: Average Wastewater Sewer Condition Rating Indices by Installation Decade

* 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.

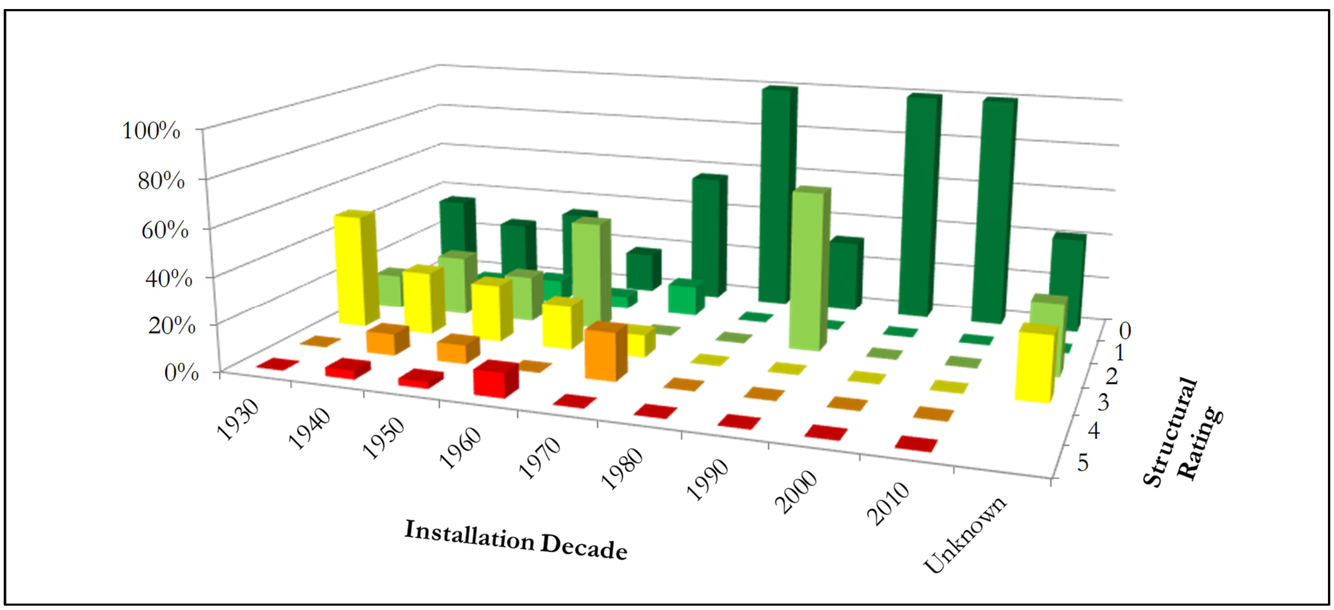


Figure 19: Breakdown of Wastewater Sewer Pipe Structural Scores by Decade

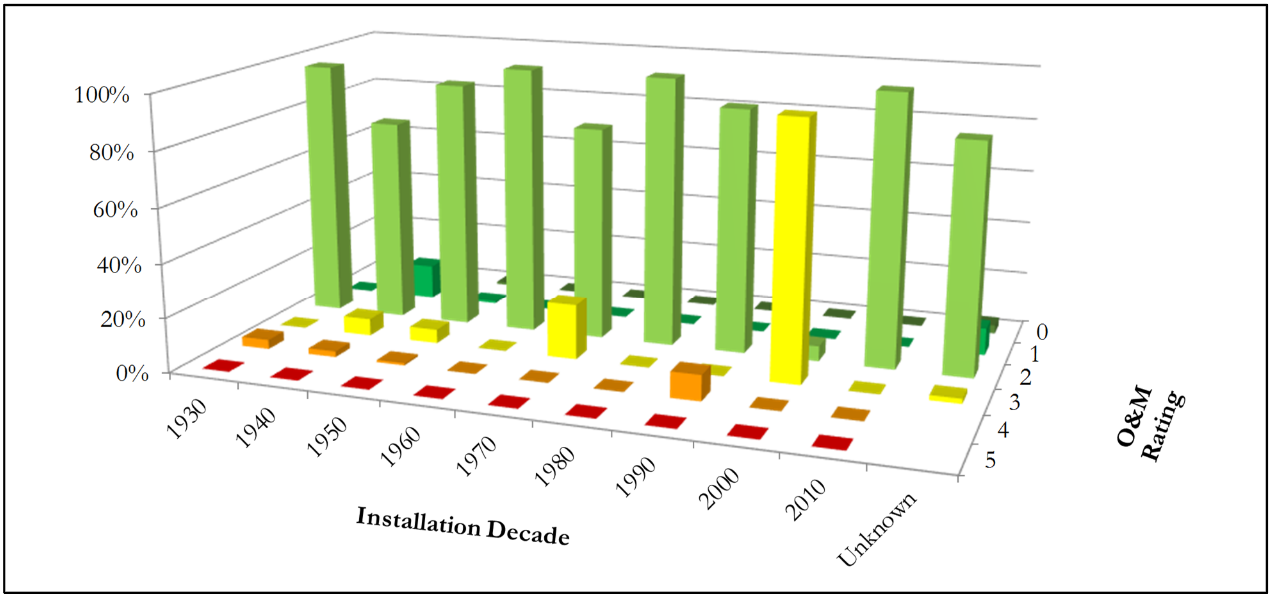


Figure 20: Breakdown of Wastewater Sewer Pipe O&M Scores by Decade

* 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.

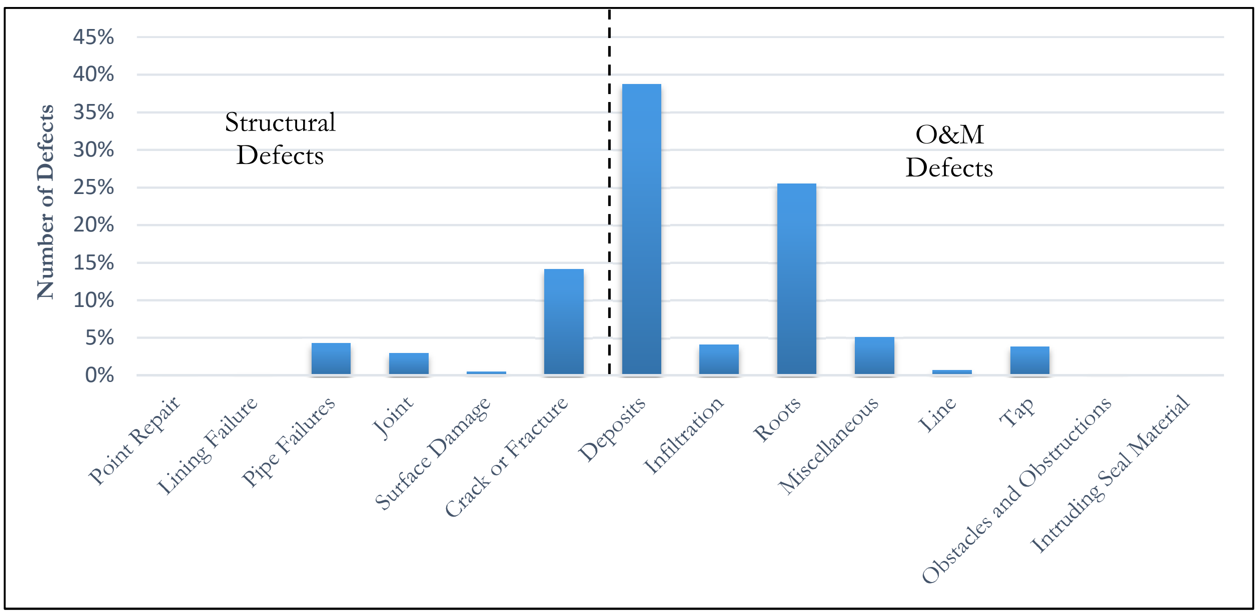


Figure 21: Wastewater Sewer Defects

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.

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.

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.

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.

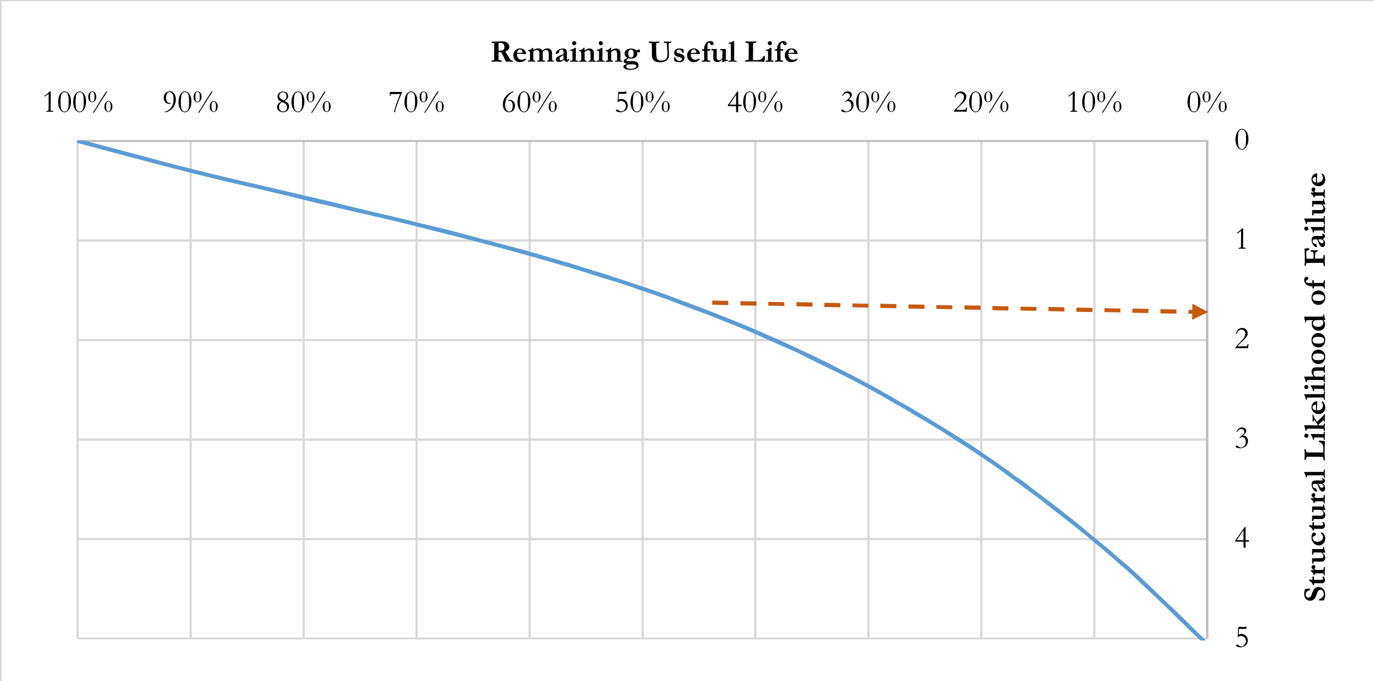


Figure 22: System Deterioration

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.

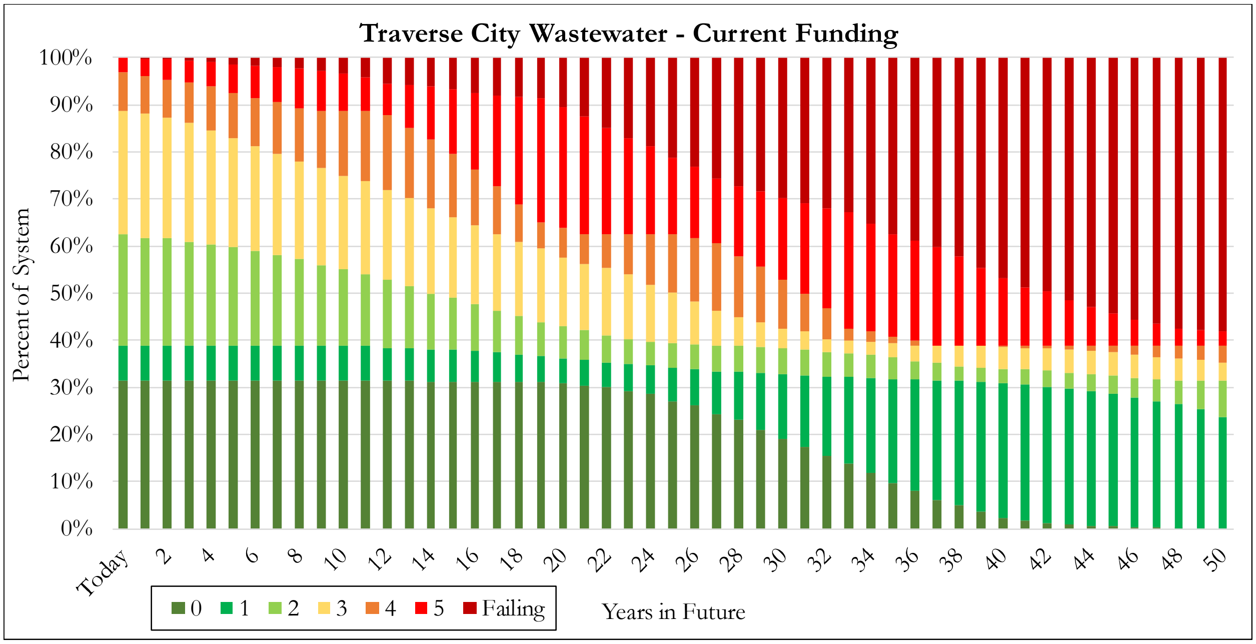


Figure 23: System Deterioration Under Current Funding Level

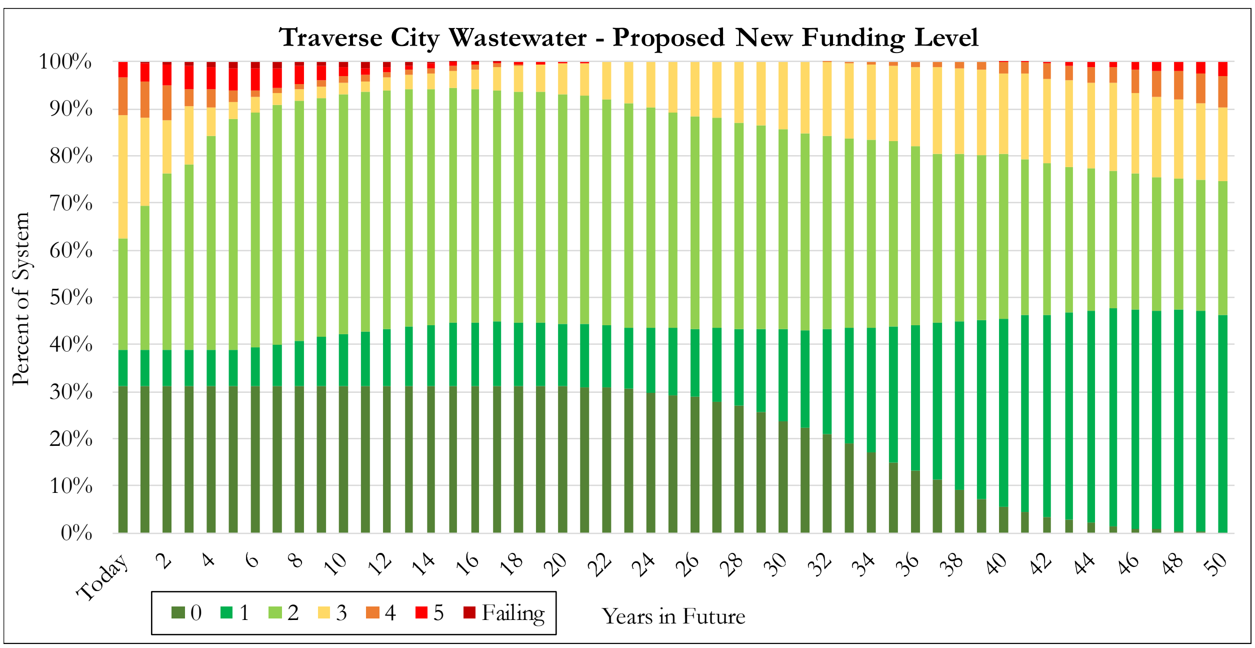


Figure 24: System Deterioration Under Proposed Funding Level

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.

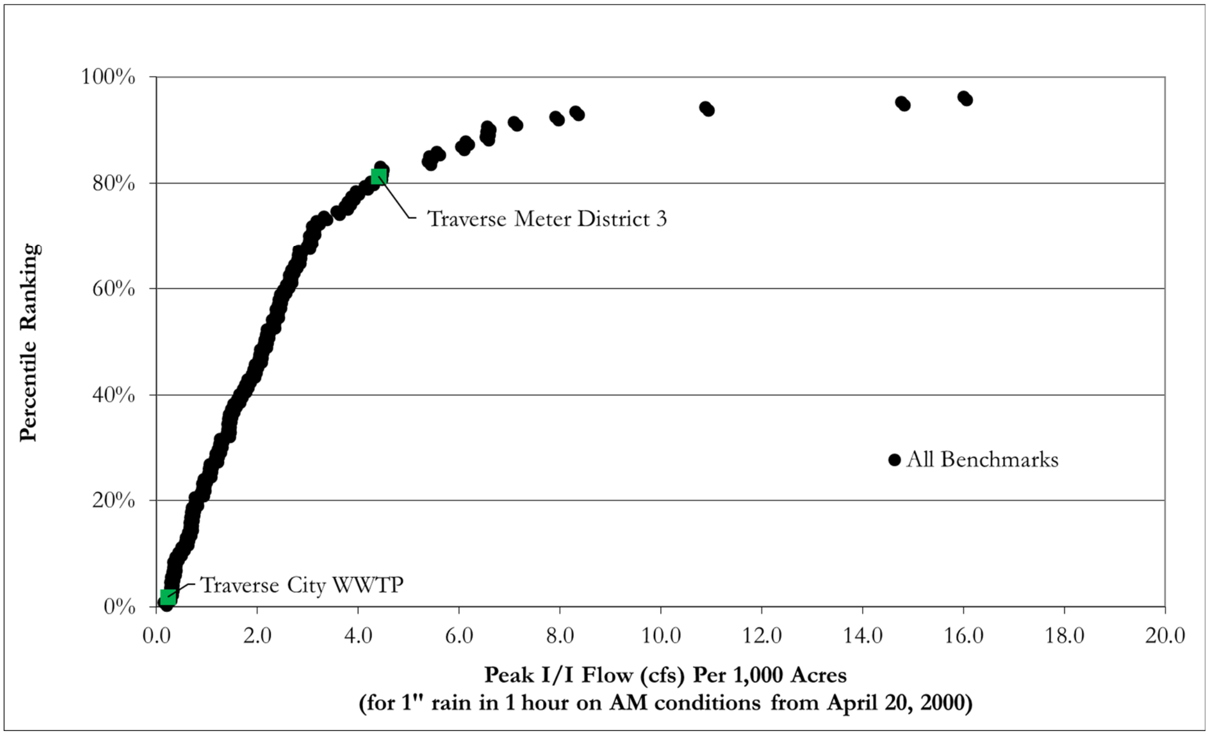


Figure 25: Benchmarked Meter District Wetness

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.

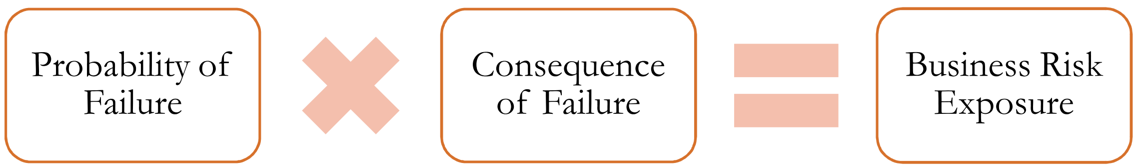


Figure 26: BRE Equation

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.

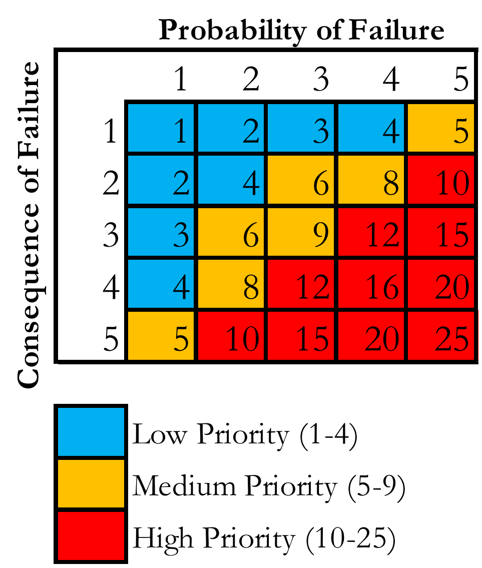


Figure 27 : BRE Matrix

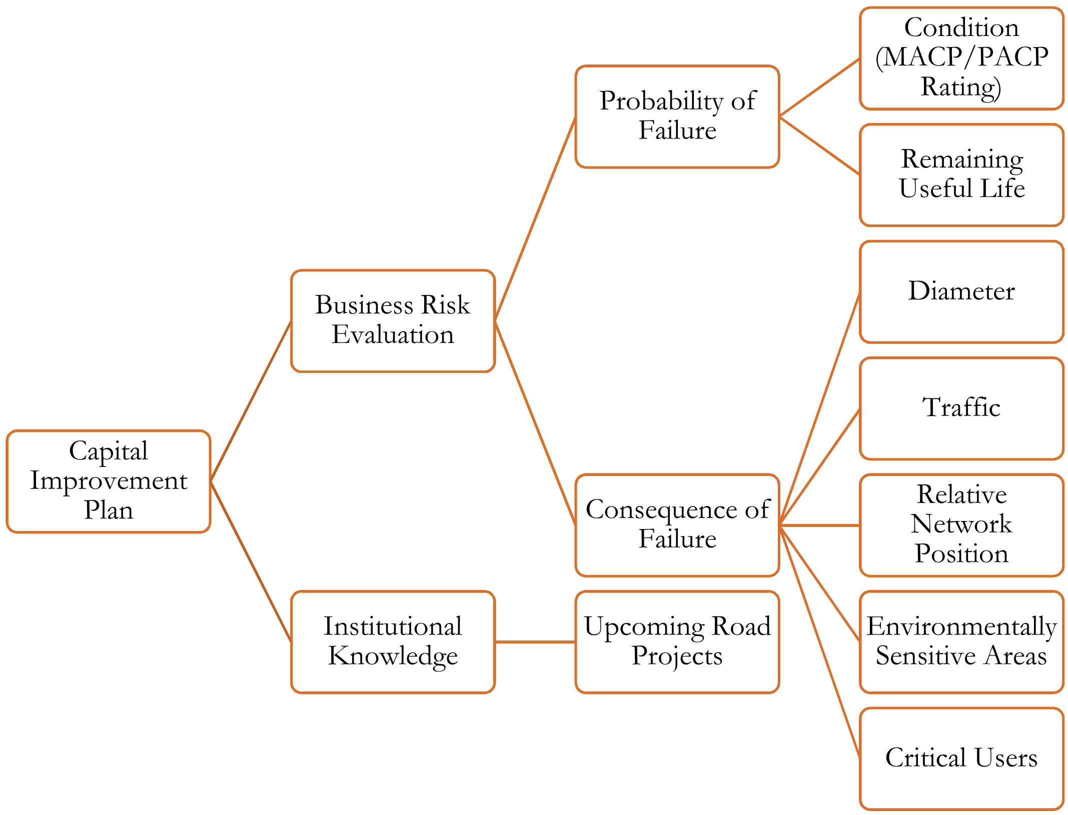


Figure 28: CIP and Risk Flow Chart

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.

- <u>Pipes:</u>
  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.

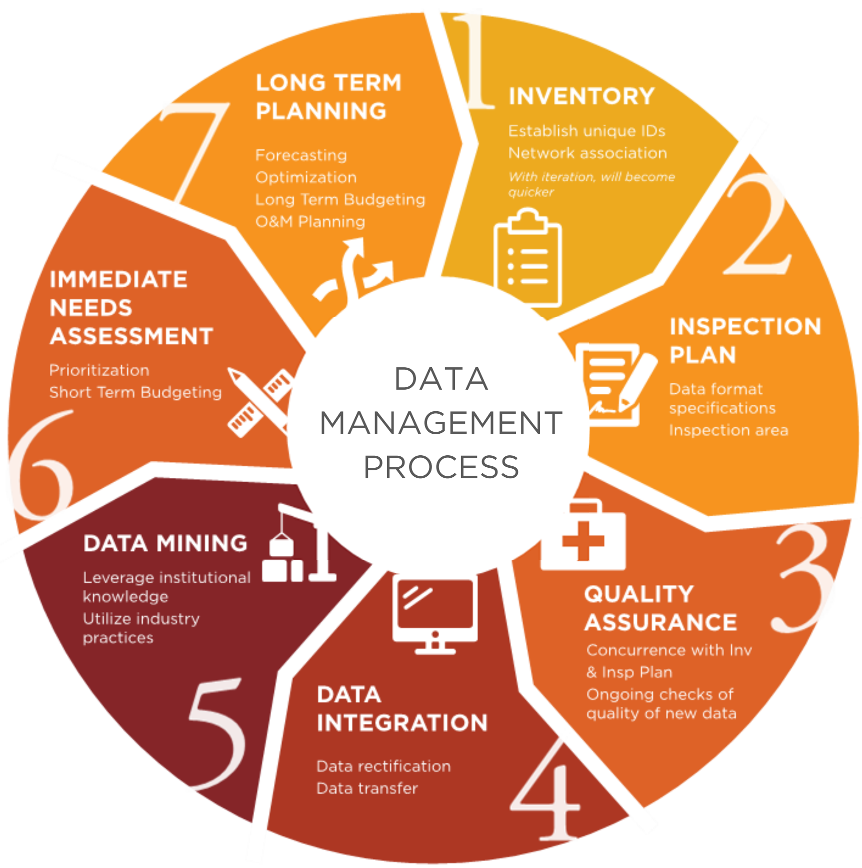


Figure 29: Data Management Process Diagram

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**

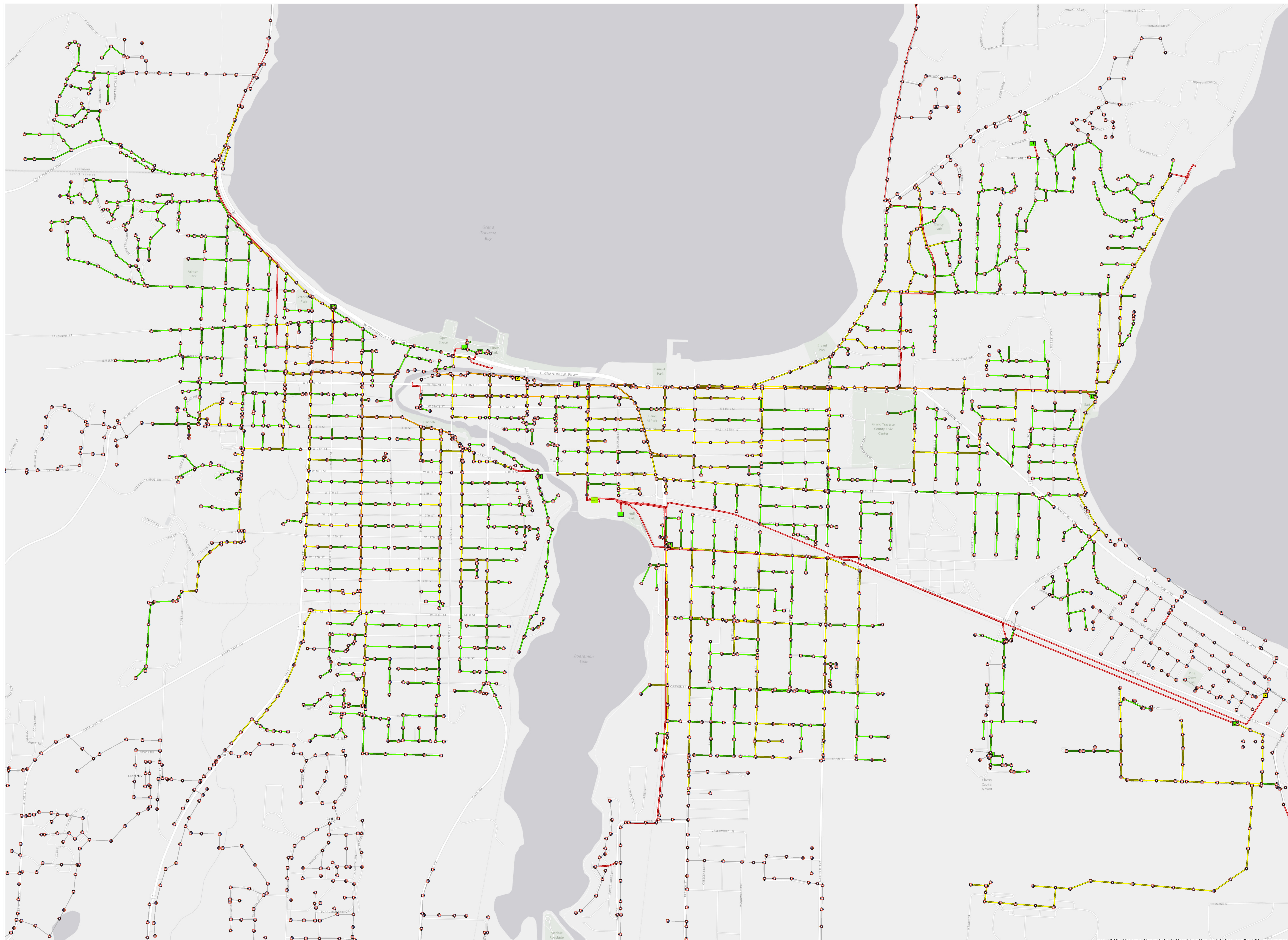
   Use the inspection results to repair/replace assets that are failing and are in need of immediate attention, such as collapsing pipes or other imminent concerns.

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



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

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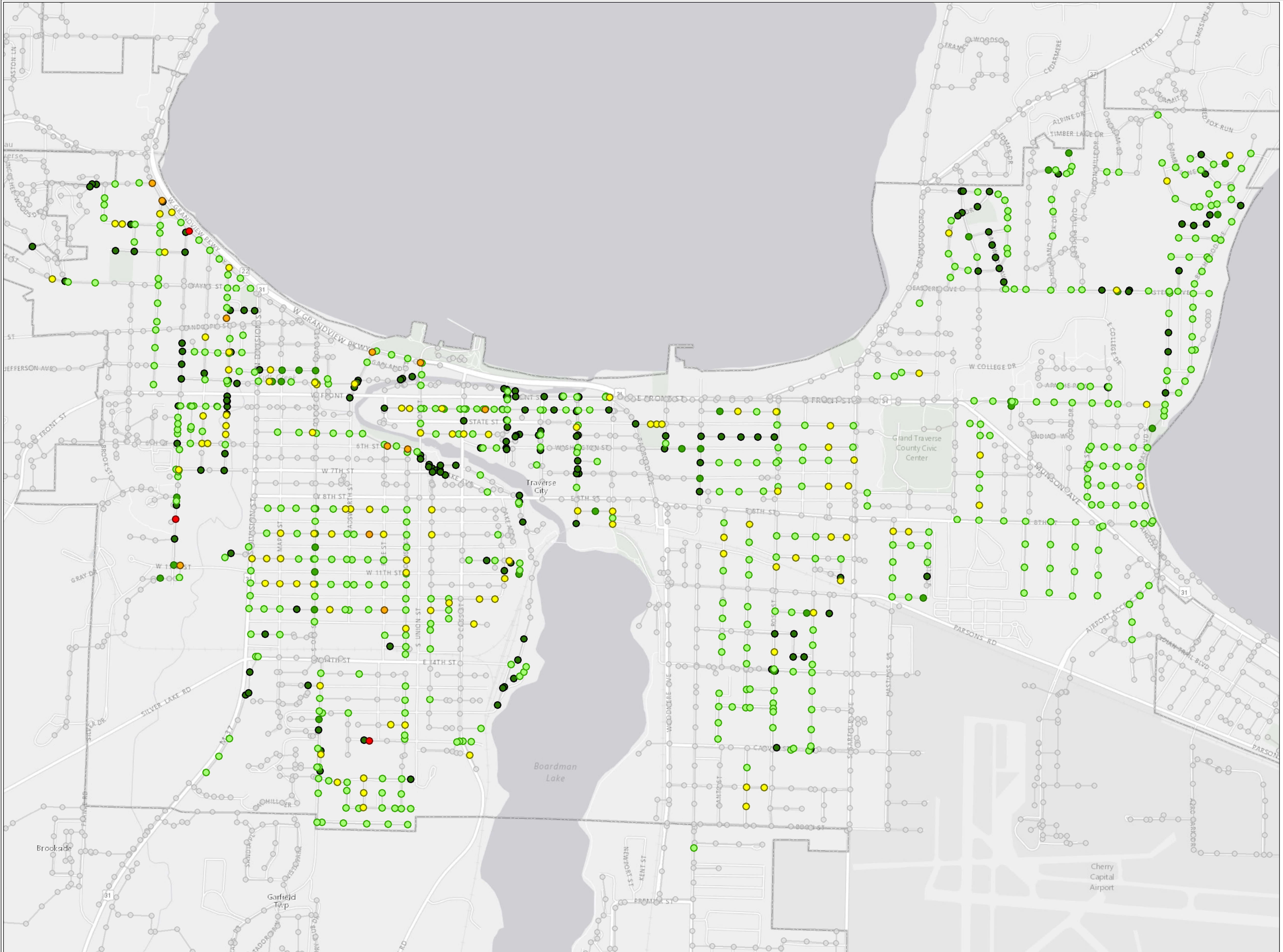

Traverse City SAW

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

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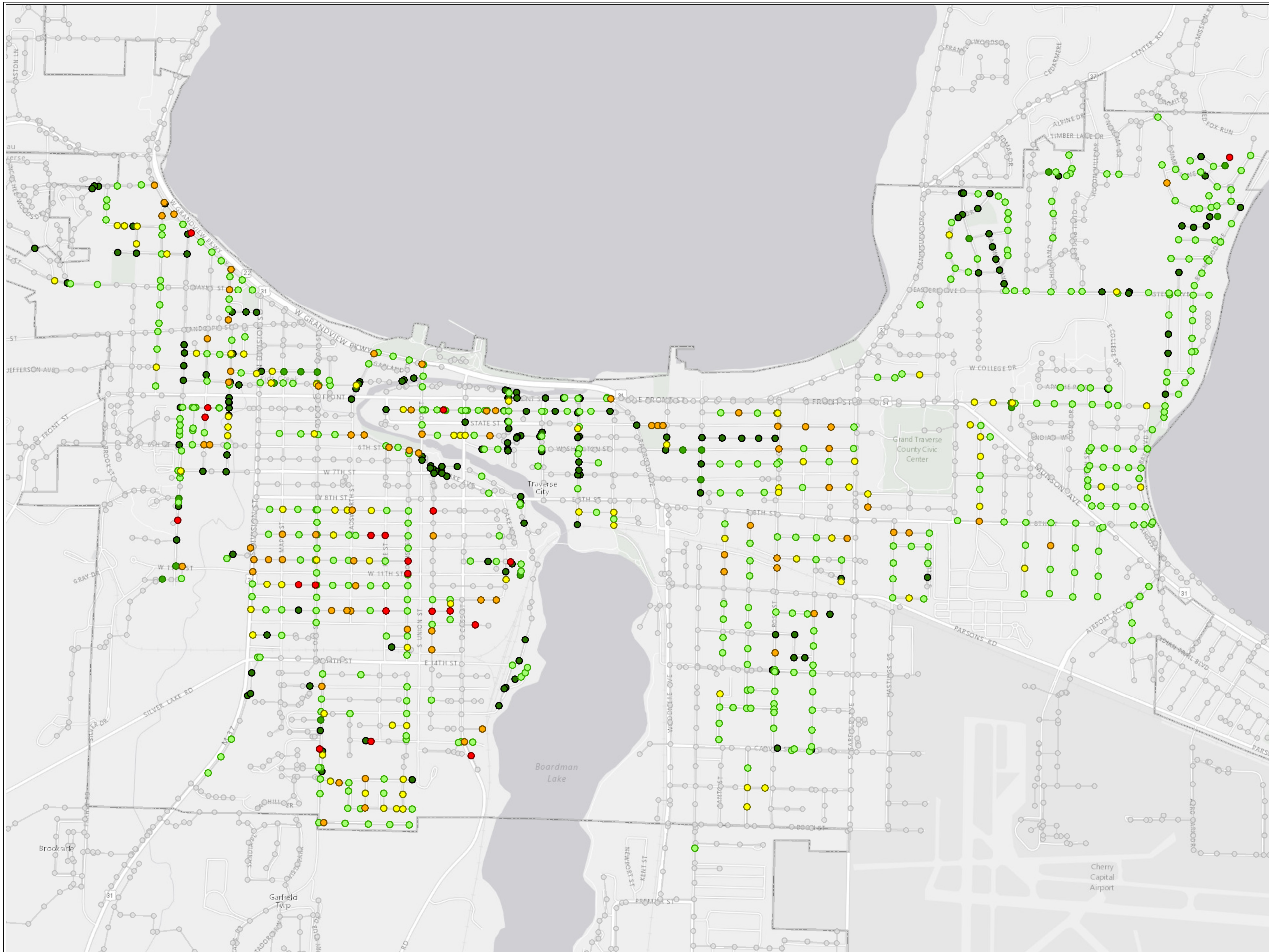
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-1 MACP Structural Index Ratings.mxd



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

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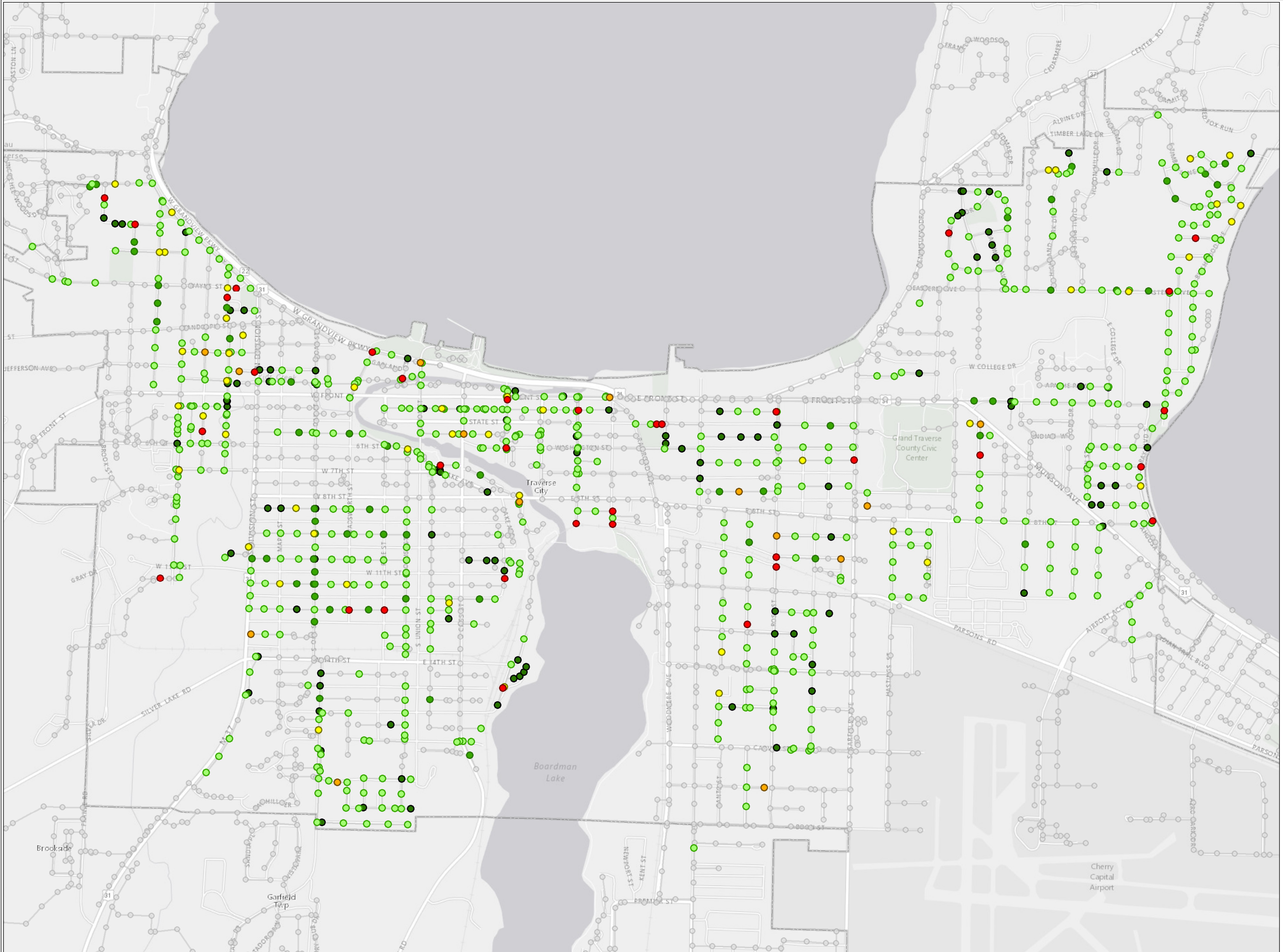
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-2 MACP Highest Rated Structural Defects.mxd



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

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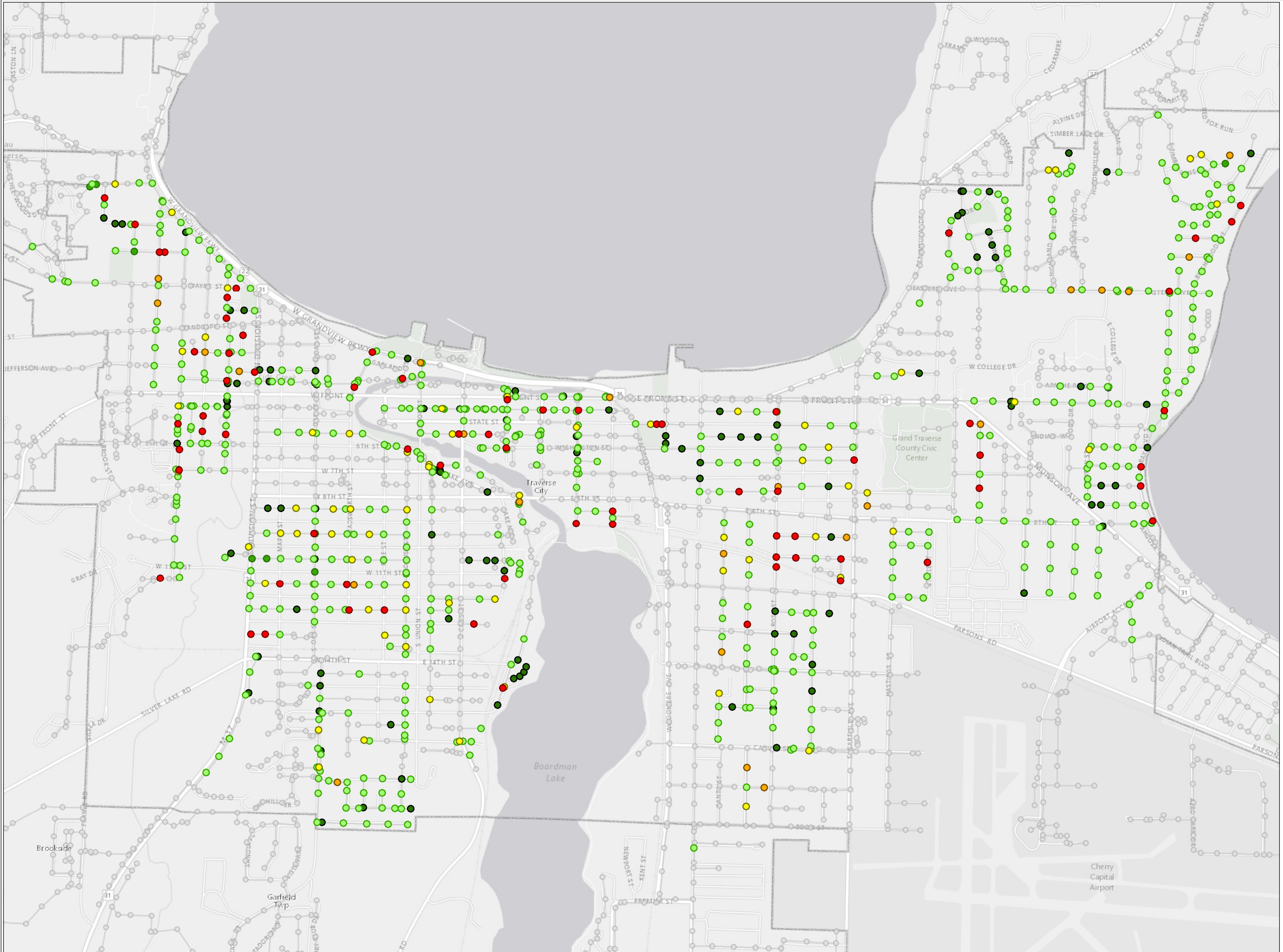
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-3 MACP O&M Index Ratings.mxd



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

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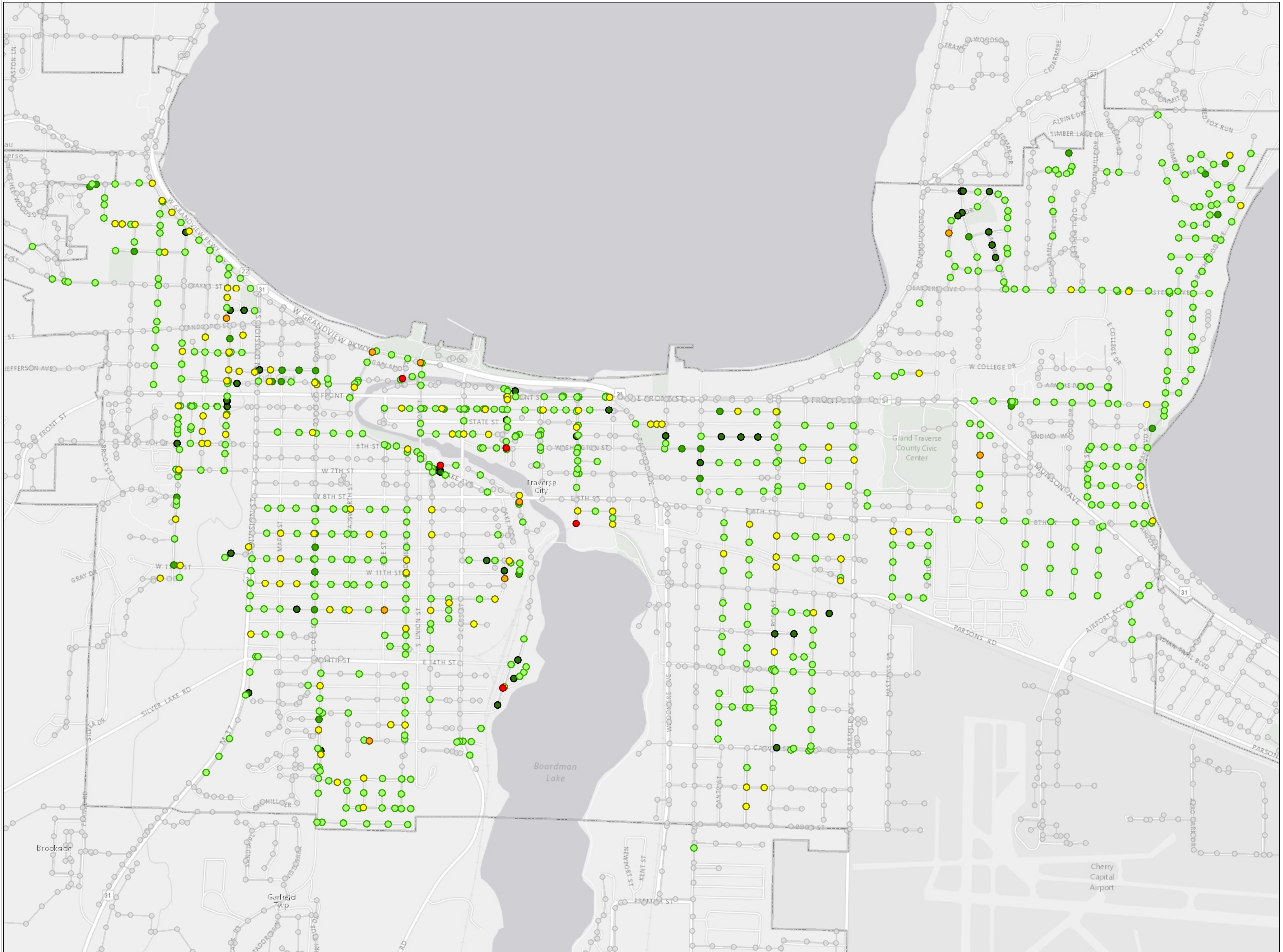
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-4 MACP Highest Rated O&M Defects.mxd



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

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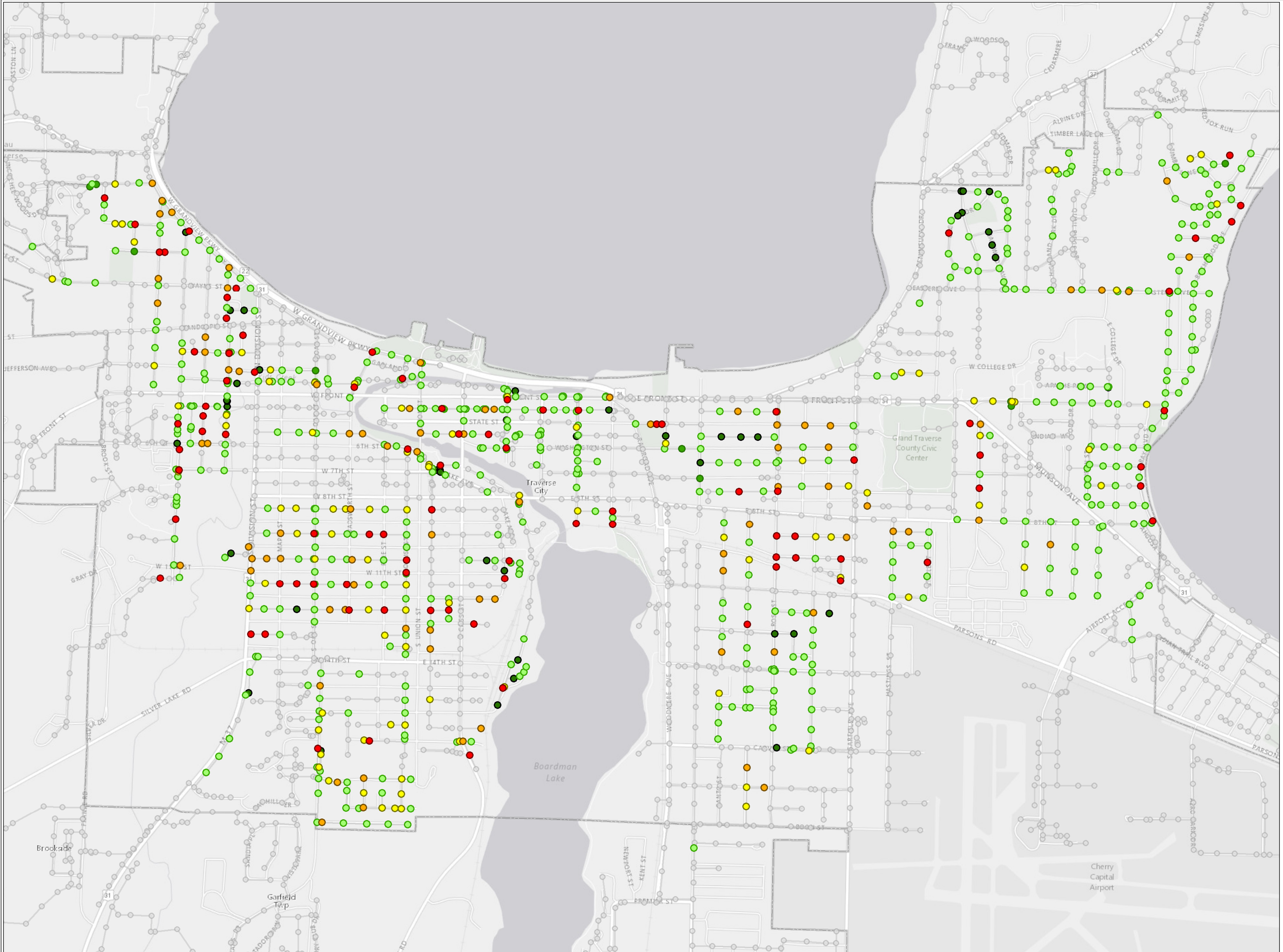
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-5 MACP Overall Index Ratings.mxd



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

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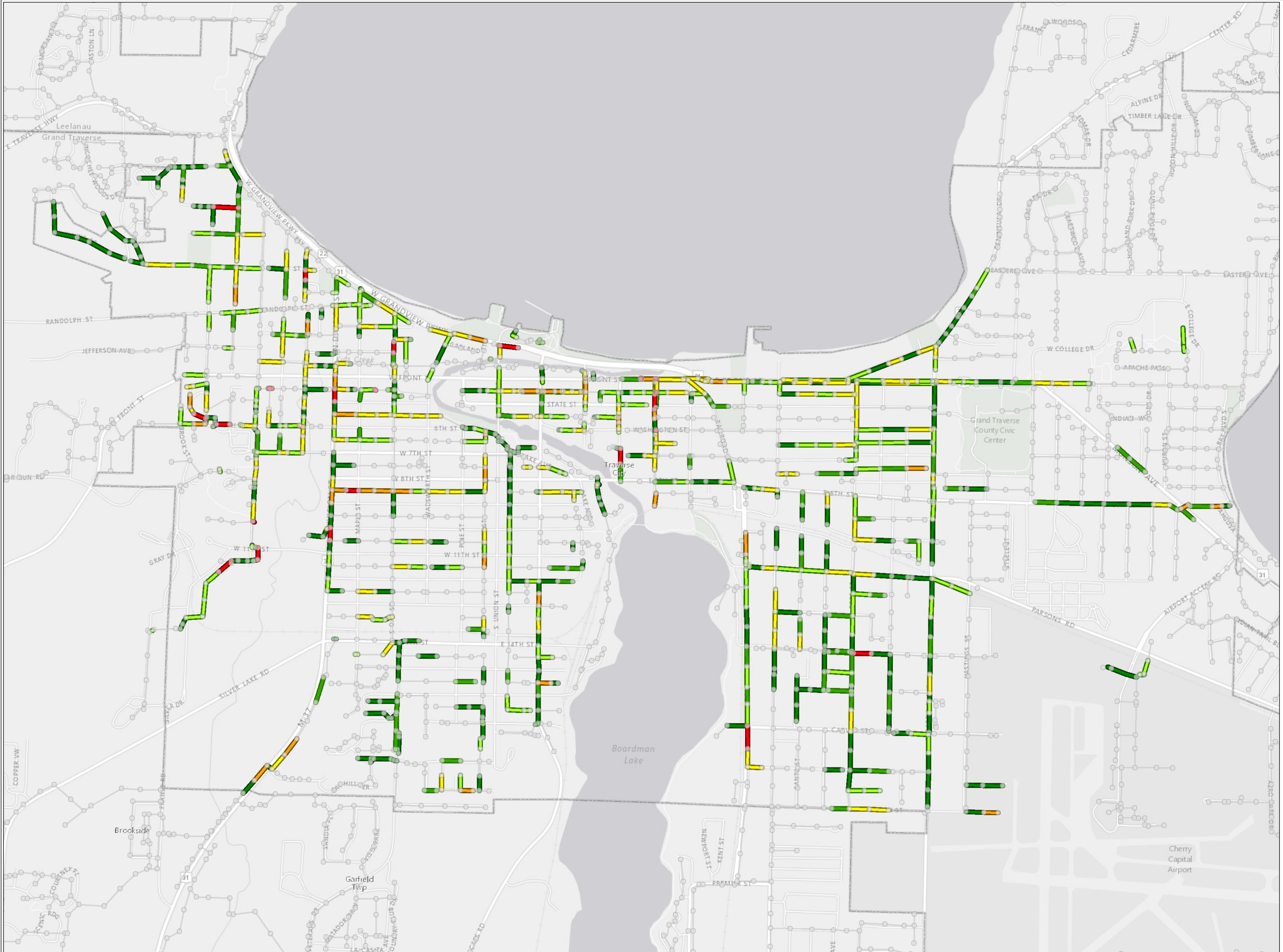

Traverse City SAW

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

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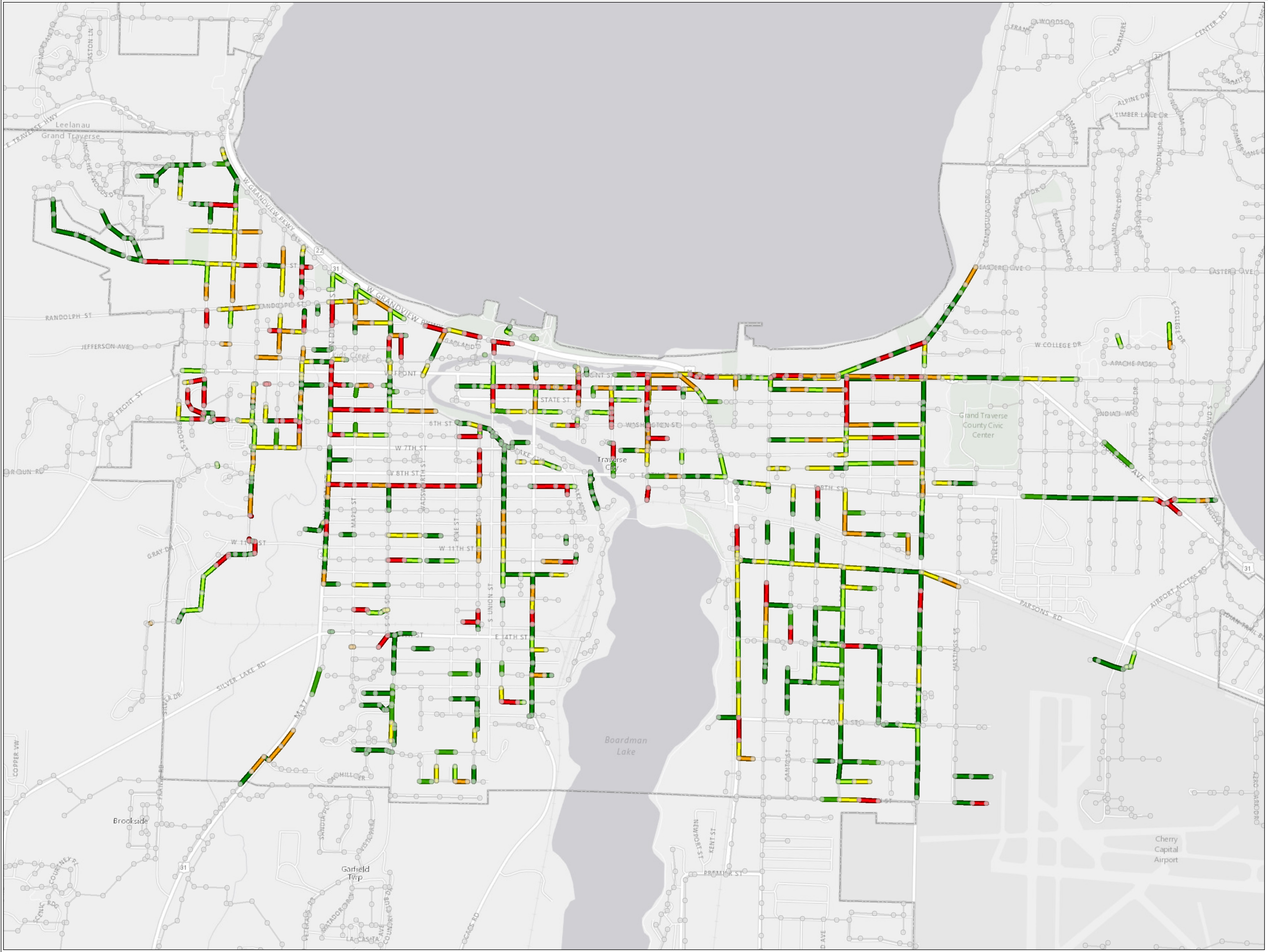
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-7 PACP Structural Index Ratings.mxd



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

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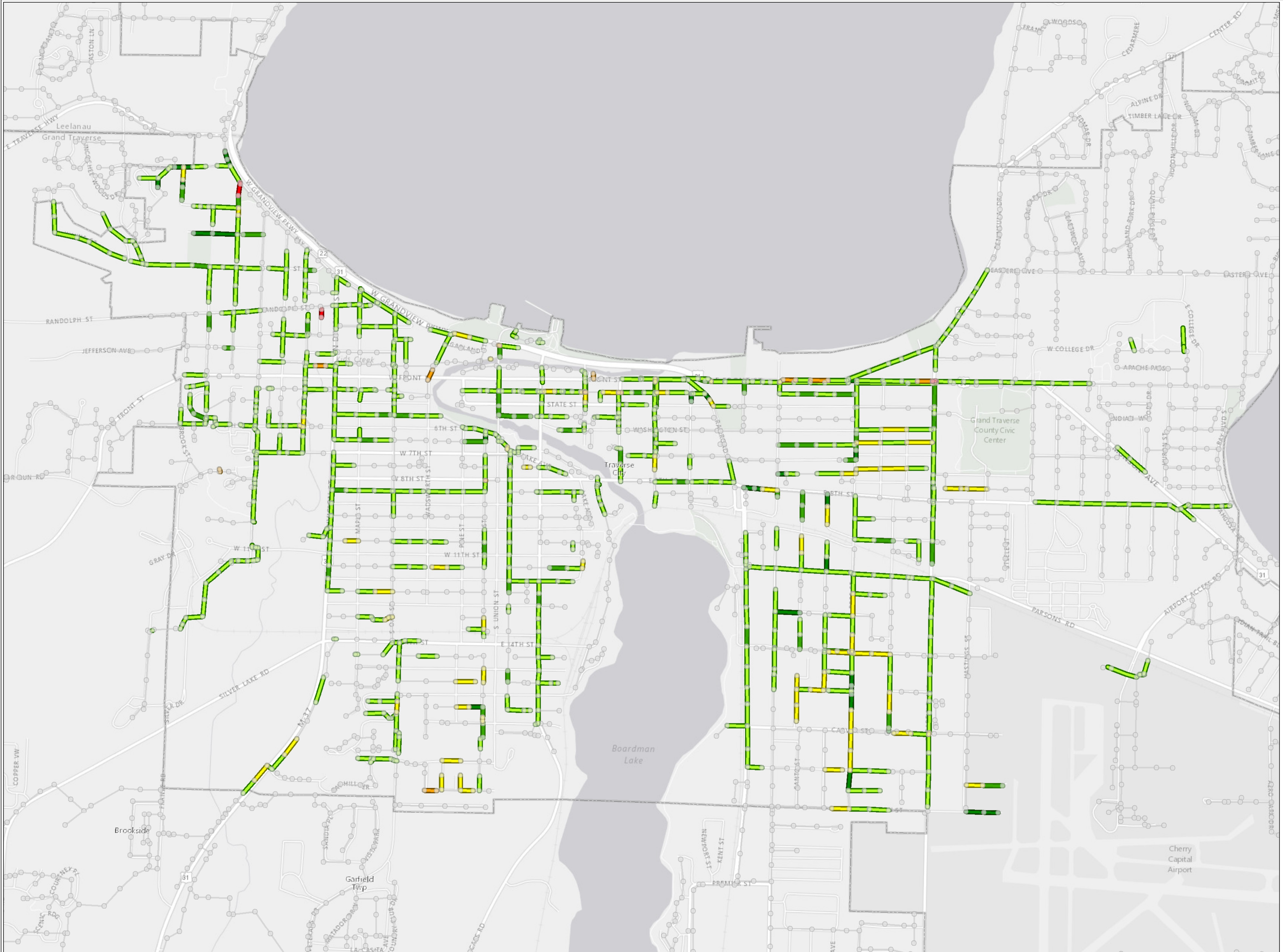
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-8 PACP Highest Rated Structural Defects.mxd



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

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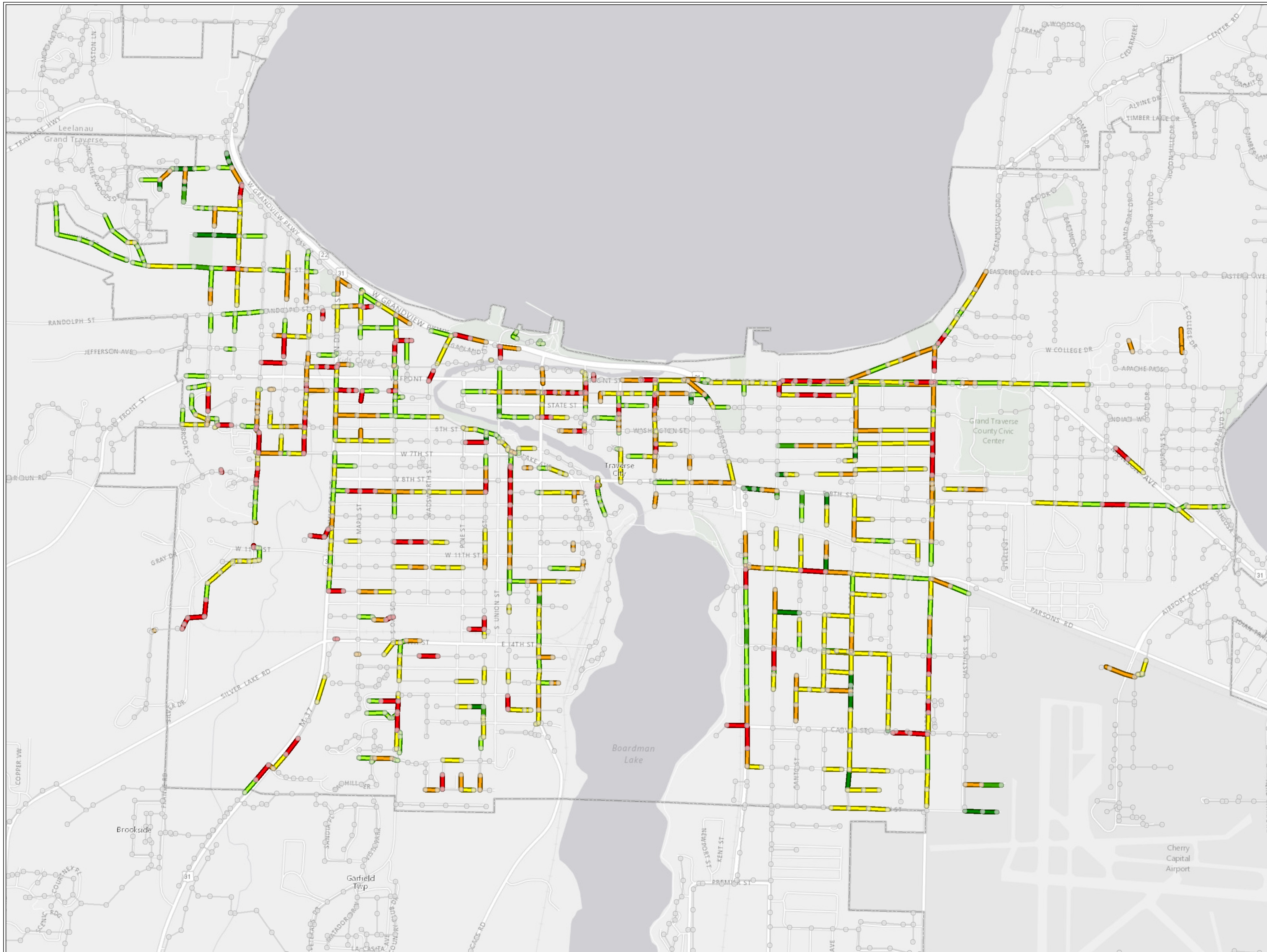
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-9 PACP O&M Index Ratings.mxd



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

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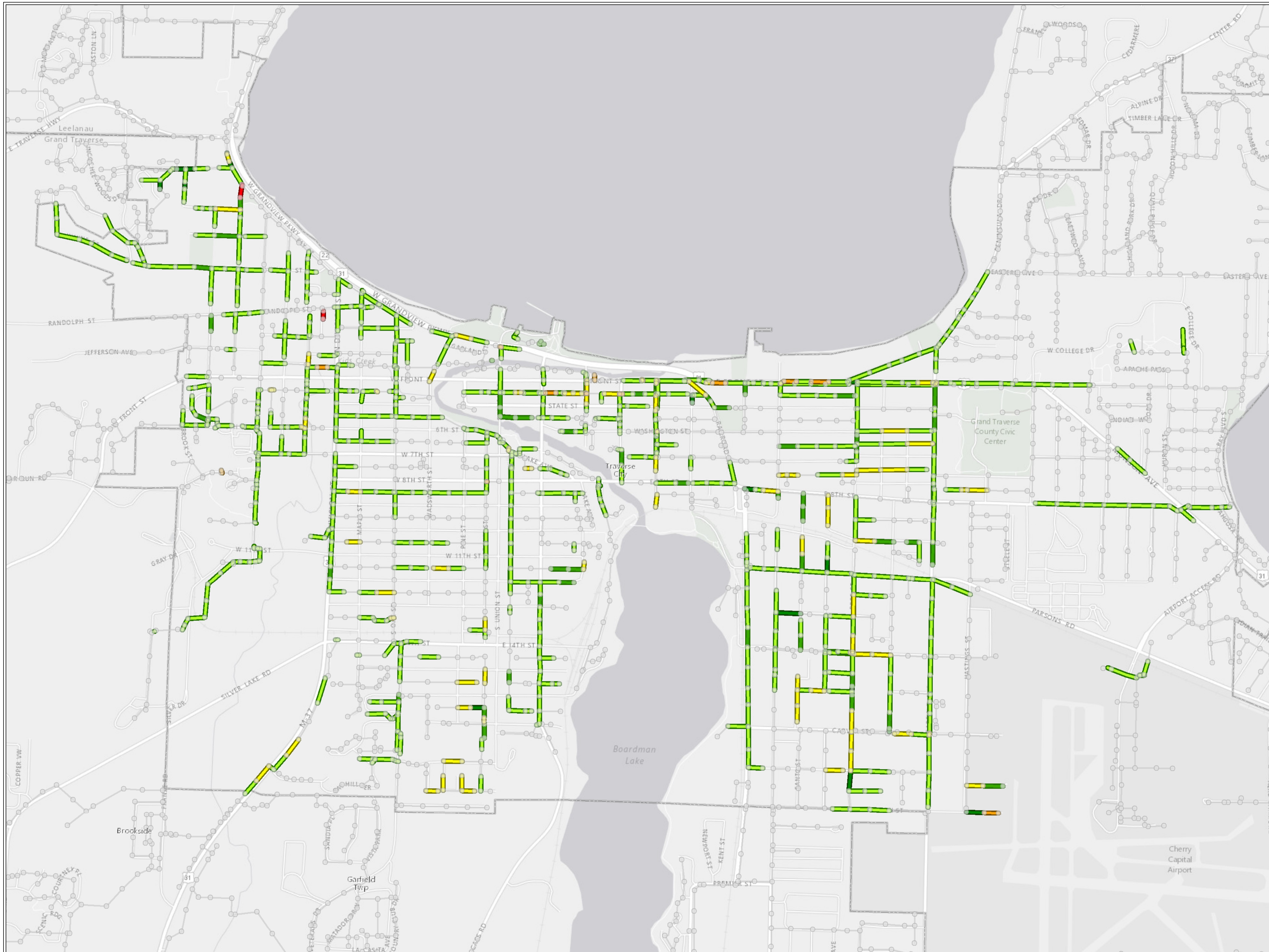
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-10 PACP Highest Rated O&M Defects.mxd



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

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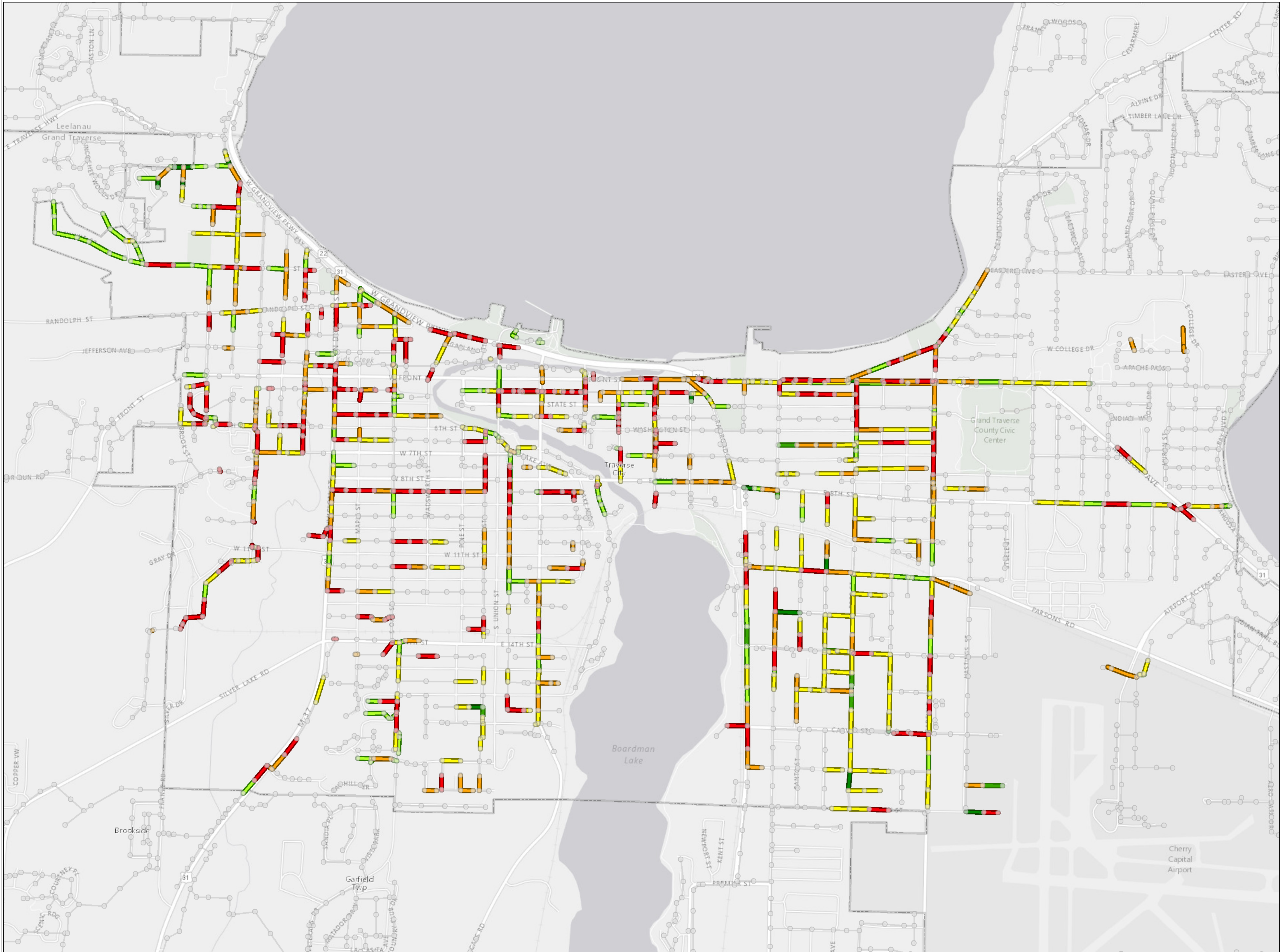
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-11 PACP Overall Index Ratings.mxd



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

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P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170427 Traverse City Wastewater MACP and PACP Figs\Figure A-12 PACP Highest Rated Overall Defects.mxd

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.

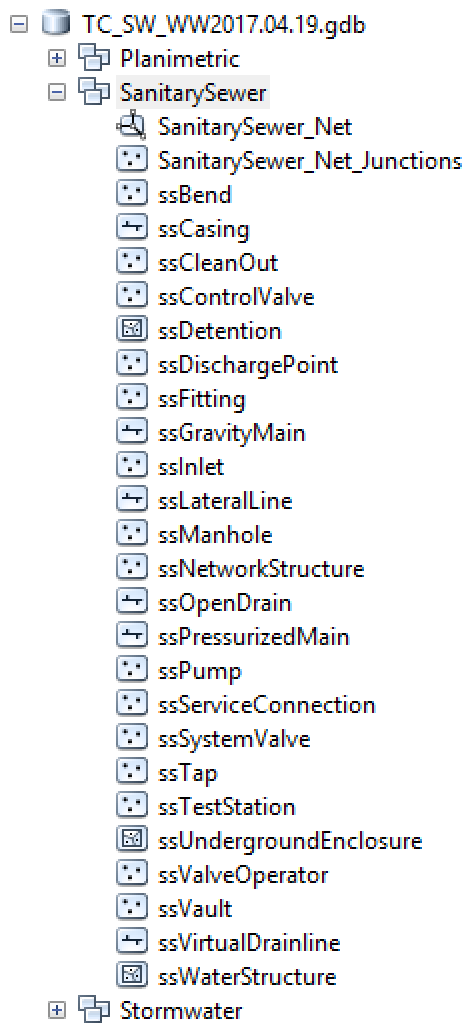

Figure B-1: Wastewater Geodatabase Contents

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.

Table

Sewer Gravity Mains

OBJECTID *	FACILITYID *	Install Date	Material	Diameter	Main Shape	Year Lined	Liner Type	From Manhole	To Manhole	Water Type	Enabled	Active Flag	Owned By	Managed By	Flow Summary	Last Update Date	Last Editor
3664	SSGM-10000	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3665	SSGM-10001	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3666	SSGM-10002	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3667	SSGM-10003	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3668	SSGM-10004	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3669	SSGM-10005	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3670	SSGM-10006	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3671	SSGM-10007	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3672	SSGM-10008	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3673	SSGM-10009	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3674	SSGM-10010	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3675	SSGM-10011	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3676	SSGM-10012	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3677	SSGM-10013	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3678	SSGM-10014	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3679	SSGM-10015	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3680	SSGM-10016	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3681	SSGM-10017	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3682	SSGM-10018	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3683	SSGM-10019	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3684	SSGM-10020	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3685	SSGM-10021	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3686	SSGM-10022	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3687	SSGM-10023	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3688	SSGM-10024	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3689	SSGM-10025	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3690	SSGM-10026	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3691	SSGM-10027	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3692	SSGM-10028	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3693	SSGM-10029	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3694	SSGM-10030	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
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3696	SSGM-10032	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3697	SSGM-10033	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3698	SSGM-10034	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3699	SSGM-10035	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3700	SSGM-10036	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3701	SSGM-10037	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3702	SSGM-10038	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3703	SSGM-10039	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3704	SSGM-10040	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3705	SSGM-10041	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3706	SSGM-10042	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3707	SSGM-10043	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3708	SSGM-10044	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL
3709	SSGM-10045	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Sewage	True	True	Grand Traverse County	Other	<Null>	12/22/2016	LJL

0 (0 out of 4406 Selected)

Sewer Gravity Mains

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

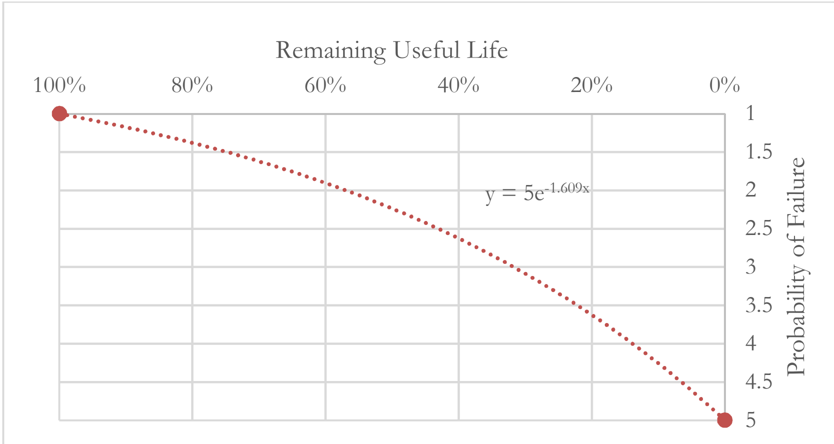

Figure C-1: Probability of Failure for Force Mains

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**

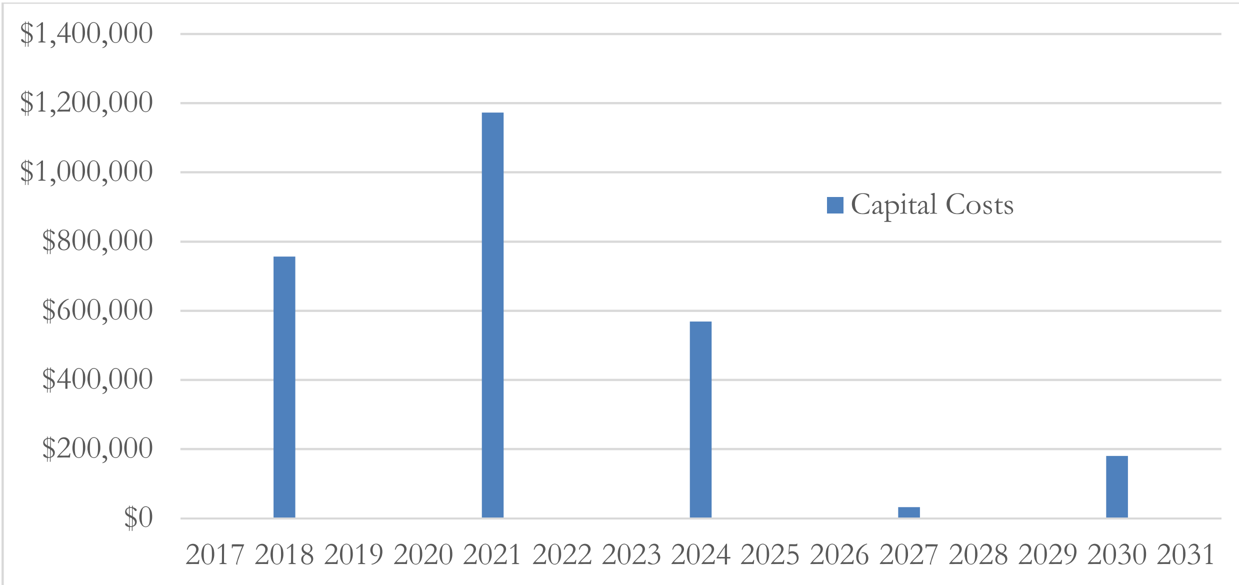

Figure C-2: Funding Necessary over Time at Recommended Replacement Years

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.

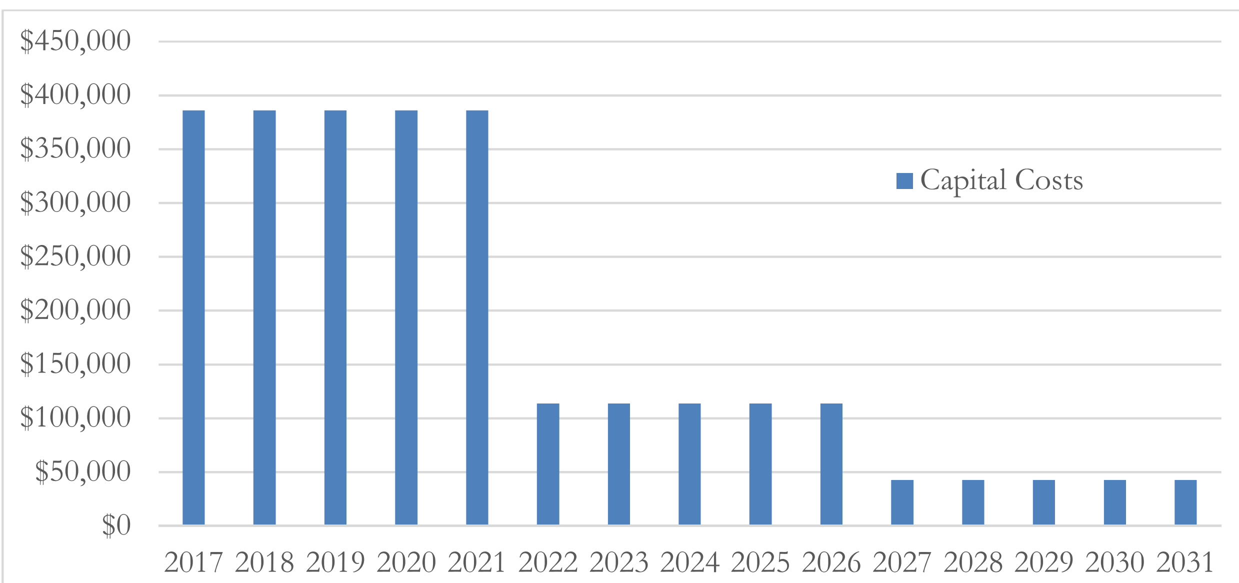

Figure C-3: Funding Spread Out Over Time for Recommended Replacements

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

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

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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

<u>Legend for Table C-C-1 by Column Number Heading:</u>

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

													14	15	16	17	18	19	20	21	22
												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

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.

Appendix C, Table C-C-2: Force Main Criticality Factors

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

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	Funding Source 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

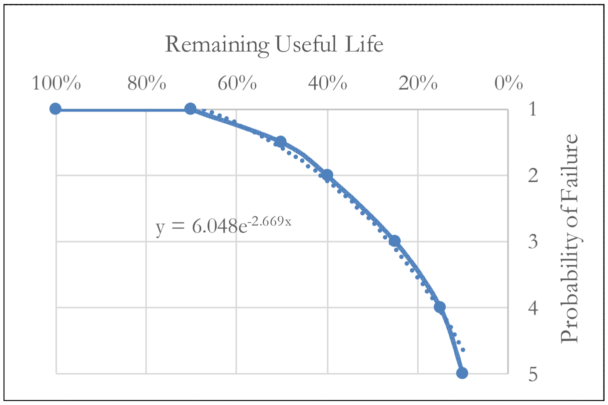


Figure D-1: Probability of Failure for Structural Assets

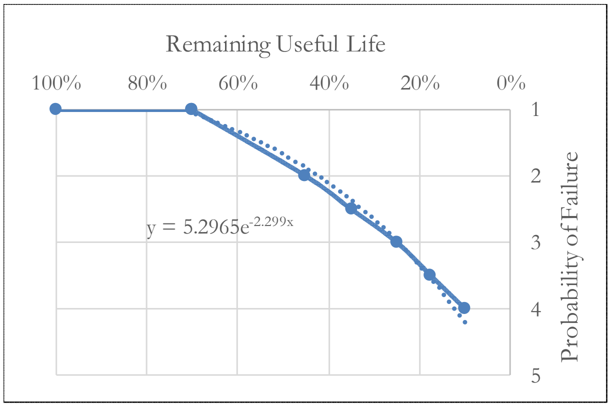


Figure D-2: Probability of Failure for Mechanical and Electrical Assets

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.

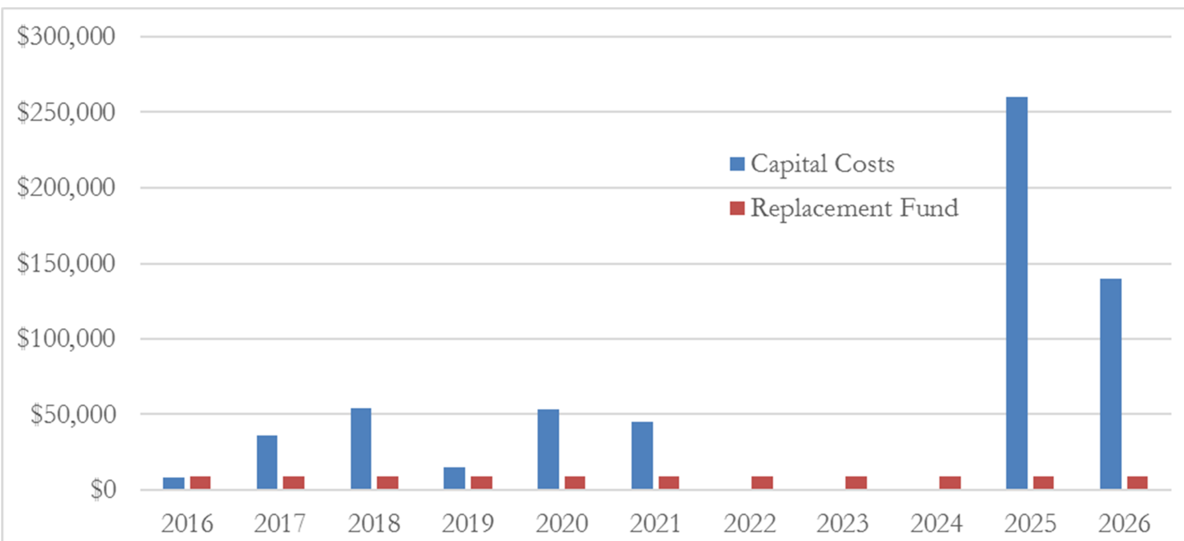


Figure D-3: Funding Necessary over Time

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.

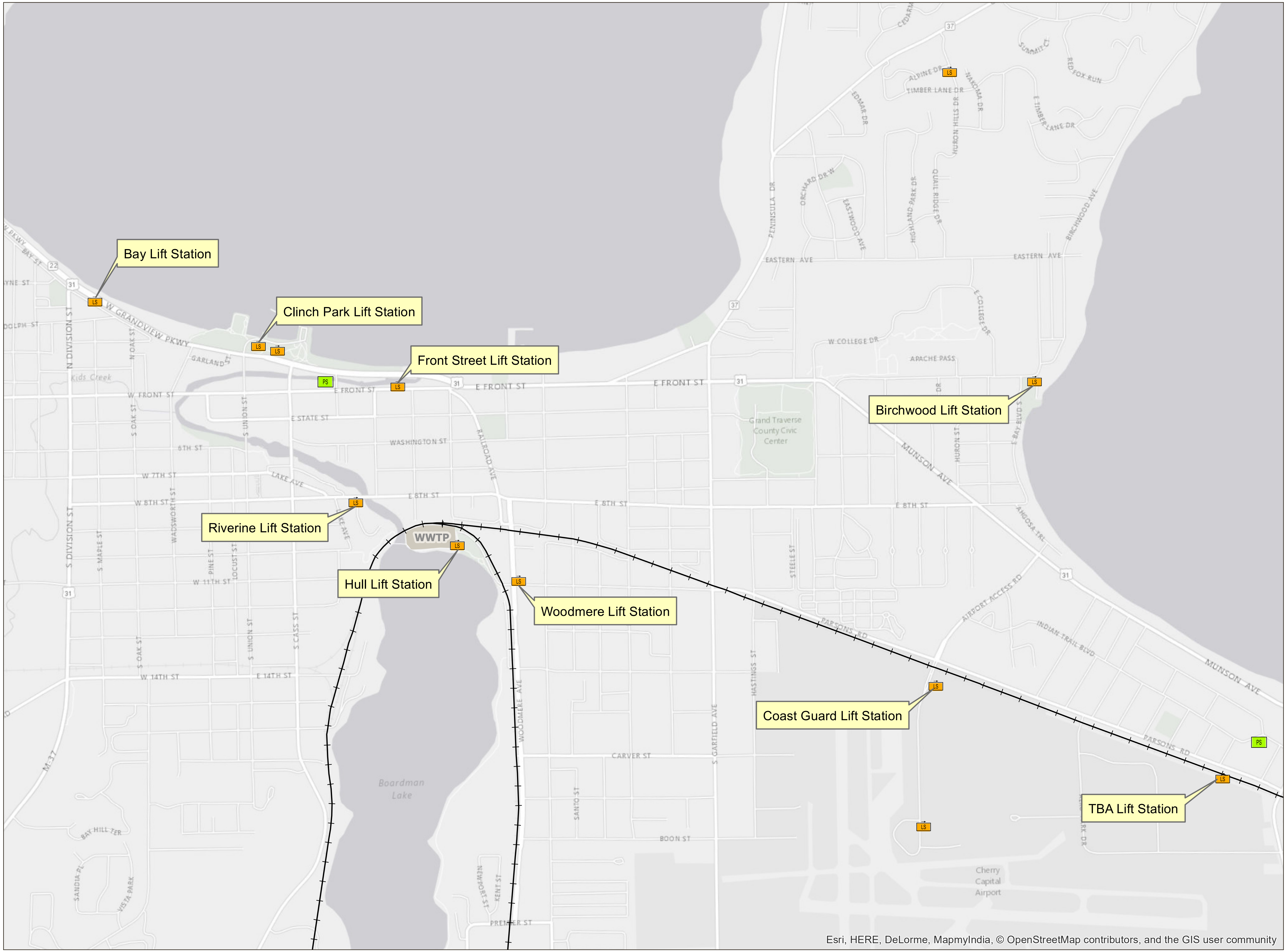
Future work will include a comprehensive capital improvement plan for the system. A holistic approach to future improvements will incorporate results from assessments of the rest of the collection and treatment system.

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

- Lift Station
- 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 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

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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

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

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	Funding Source 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.

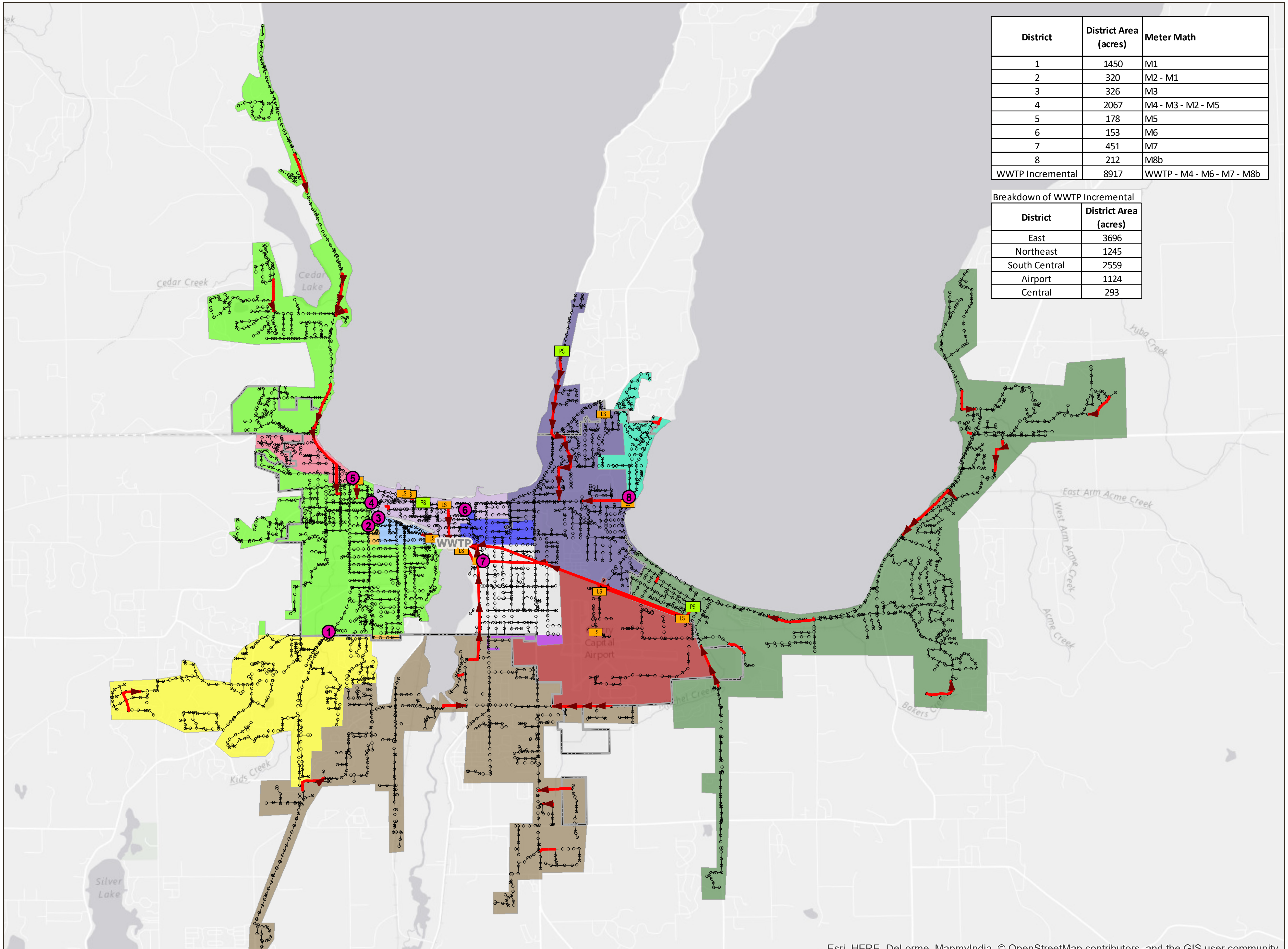
- WWTP
  - This model was developed to measure the wet weather flow response of the entire Traverse City System. Results were used in benchmarking comparisons to other systems and to determine the flow rate during peak flows.

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.

Traverse City

Figure E-1. Meter Districts



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

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

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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%

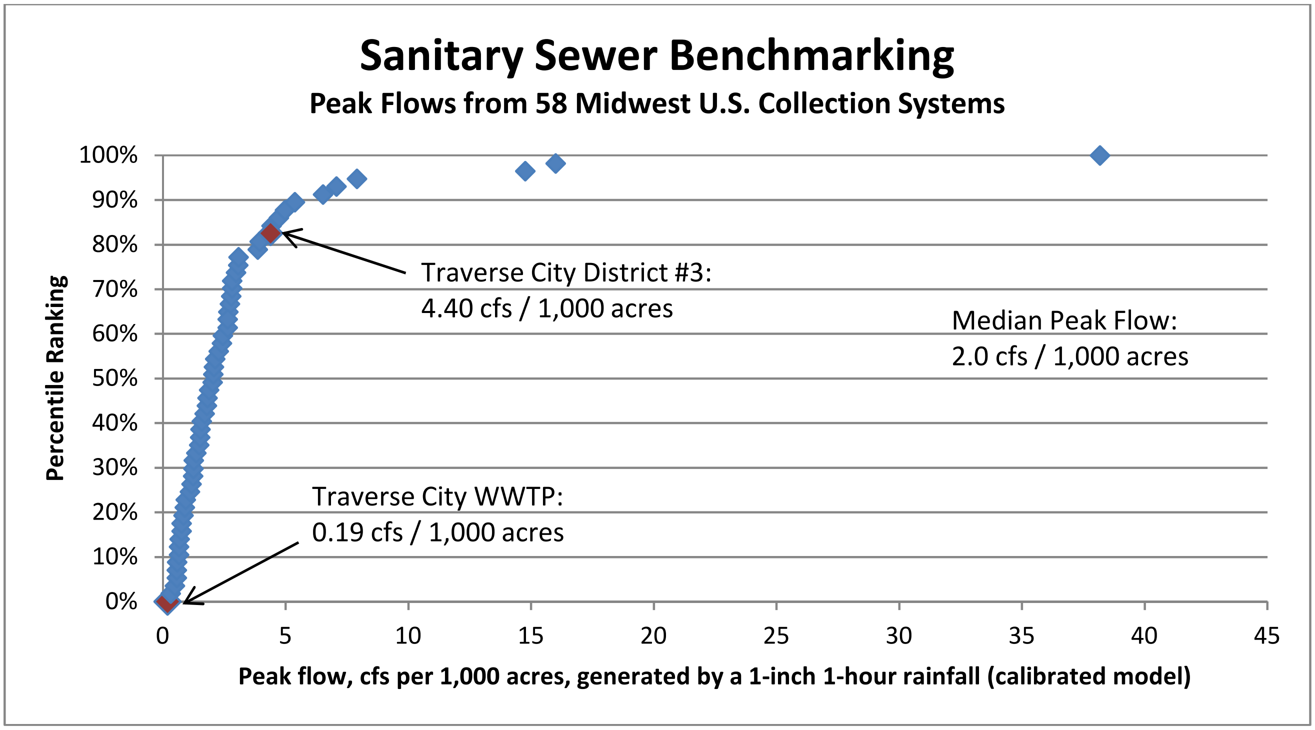


Figure E-2: Peak Flows from 58 Typical Midwest U.S. Collection Systems

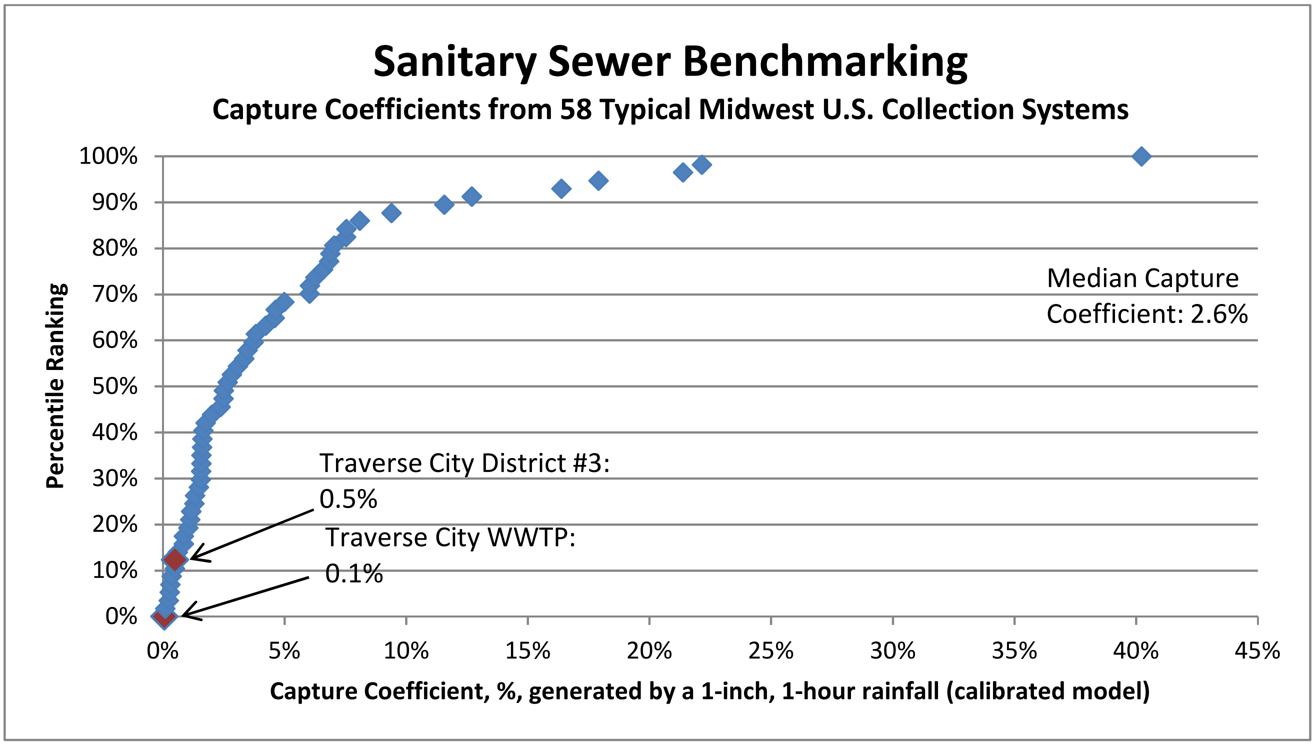


Figure E-3: Capture Coefficients from 58 Typical Midwest U.S. Collection Systems

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.

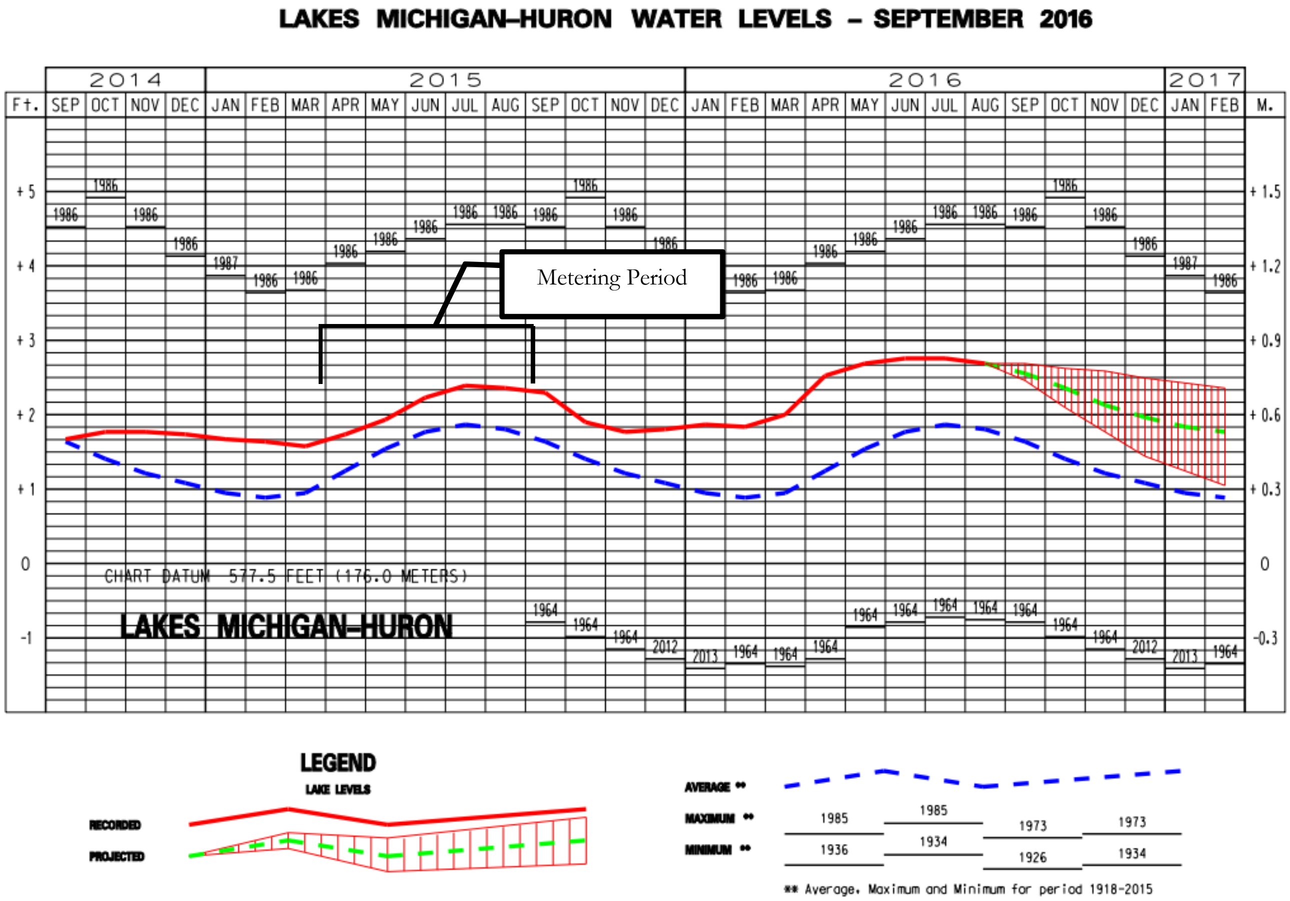


Figure E-4: Lake Michigan and Huron water levels and predictions from US Army Corps of Engineers

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

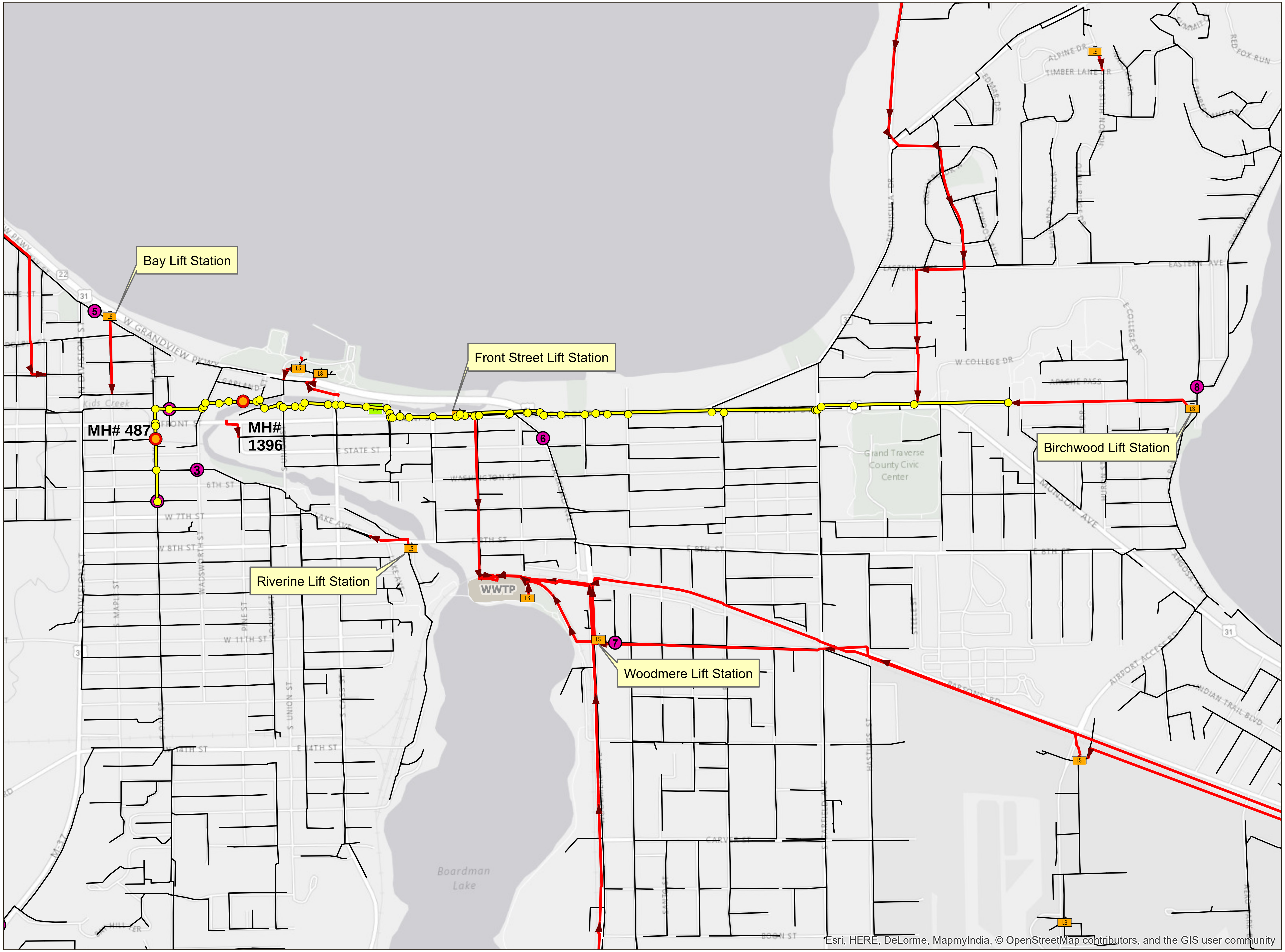
Front Street lift station. Flows for the east side of the city were modeled starting at the downstream end of the Birchwood force main and traveling west along East Front Street until also converging at the Front Street lift station. The modeled sections of the system are illustrated in Figure E-5.

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

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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.

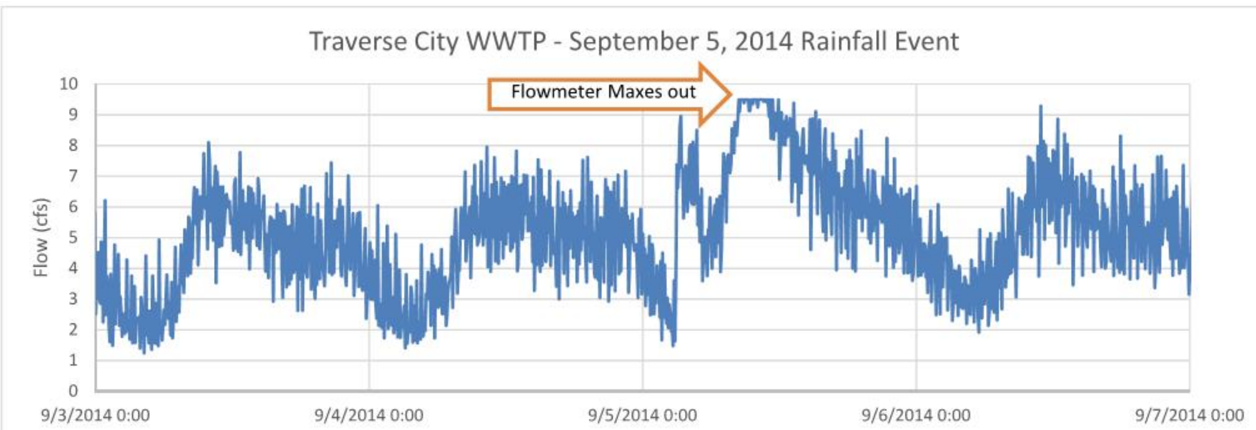


Figure E-6: Flows recorded at WWTP during the September 5, 2014 storm event

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.*

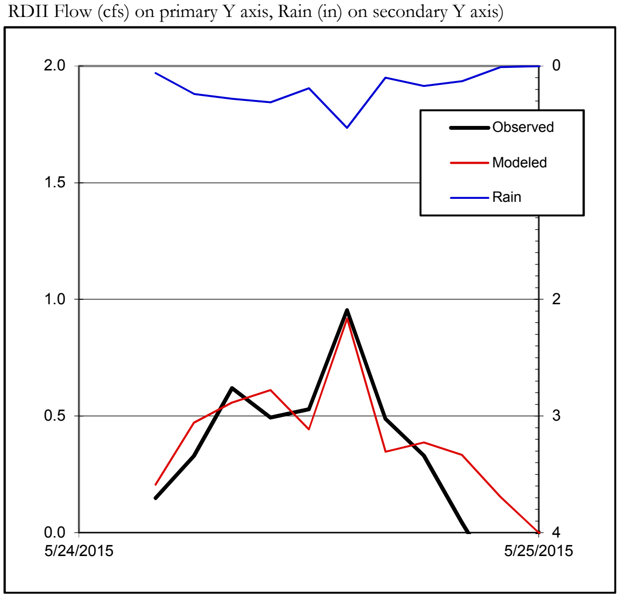
Appendix E-A: AMM Accuracy of Fit Figures

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)

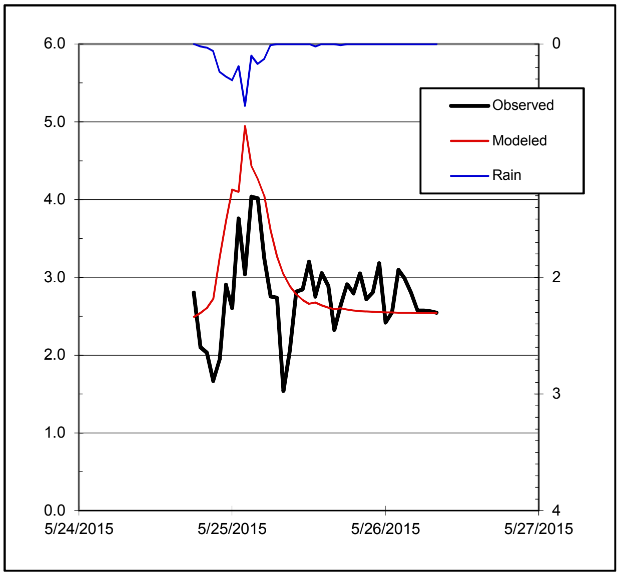


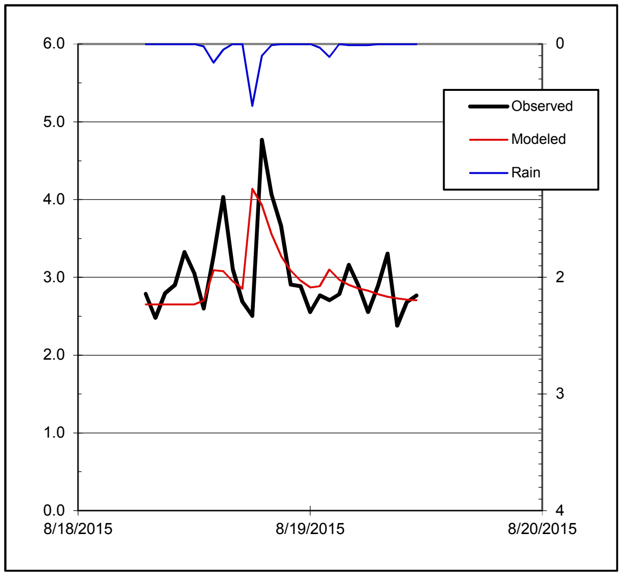
Traverse City Sanitary Sewer Wet Weather Evaluation Project - Antecedent Moisture Model - Accuracy of Fit Analysis
Meters-WWTP - 2015

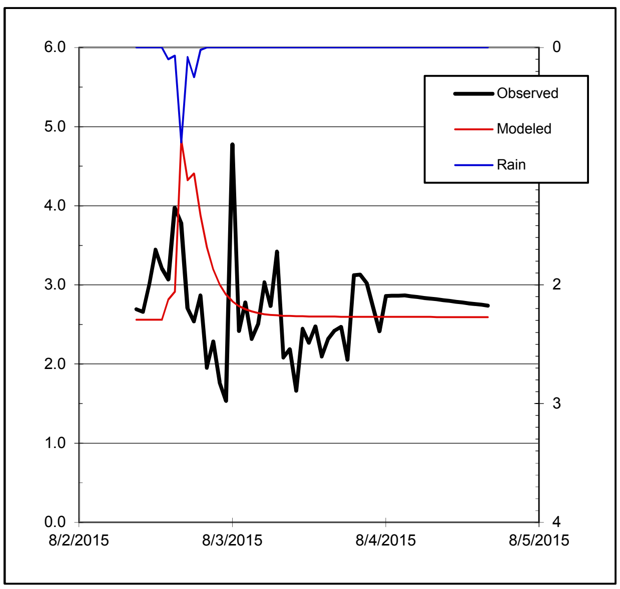
Storm	Rain (in)	Observed Peak (cfs)	Model Peak (cfs)	Peak Flow Error (%)	Observed Vol (1000's cf)	Model Vol (1000's cf)	Volume Error (%)	Notes
05/24/15	2.1	4.04	4.95	22.5%	394	425	7.9%	
08/18/15	1.04	4.77	4.14	-13.2%	324	318	-1.8%	
08/02/15	1.32	4.78	4.83	1.2%	557	569	2.2%	
04/09/15	1.05	3.92	3.36	-14.5%	294	287	-2.3%	

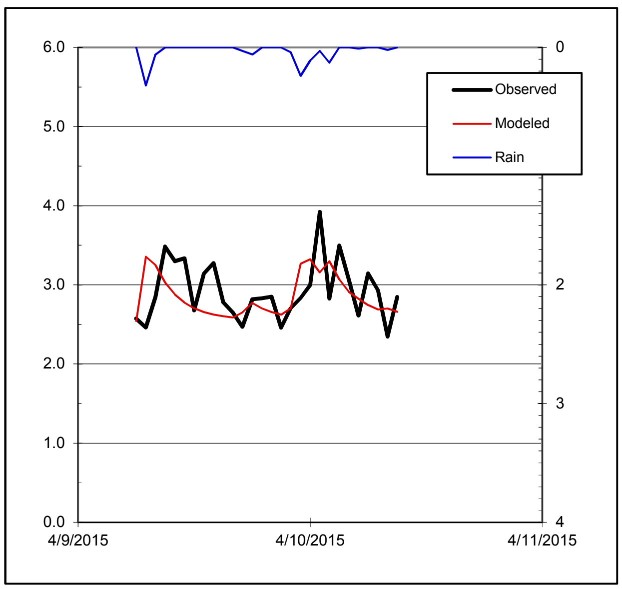
Net Average Error	-1.0%		1.5%
Total Average Error	12.8%		3.6%

RDII Flow (cfs) on primary Y axis, Rain (in) on secondary Y axis)

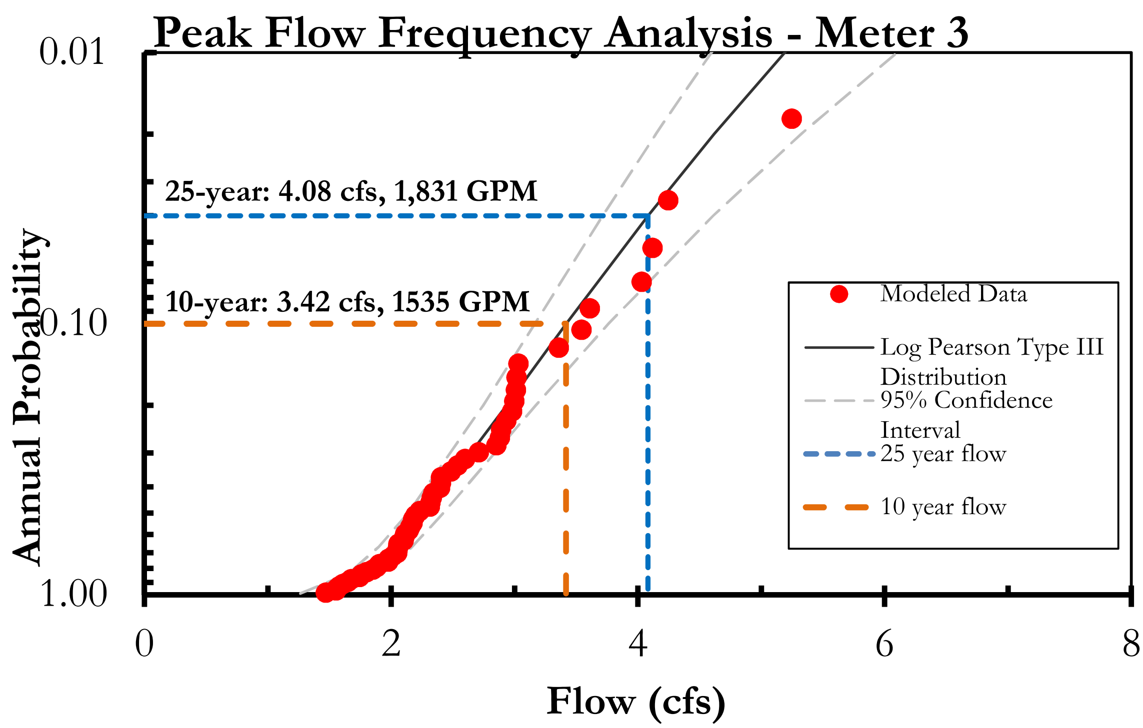


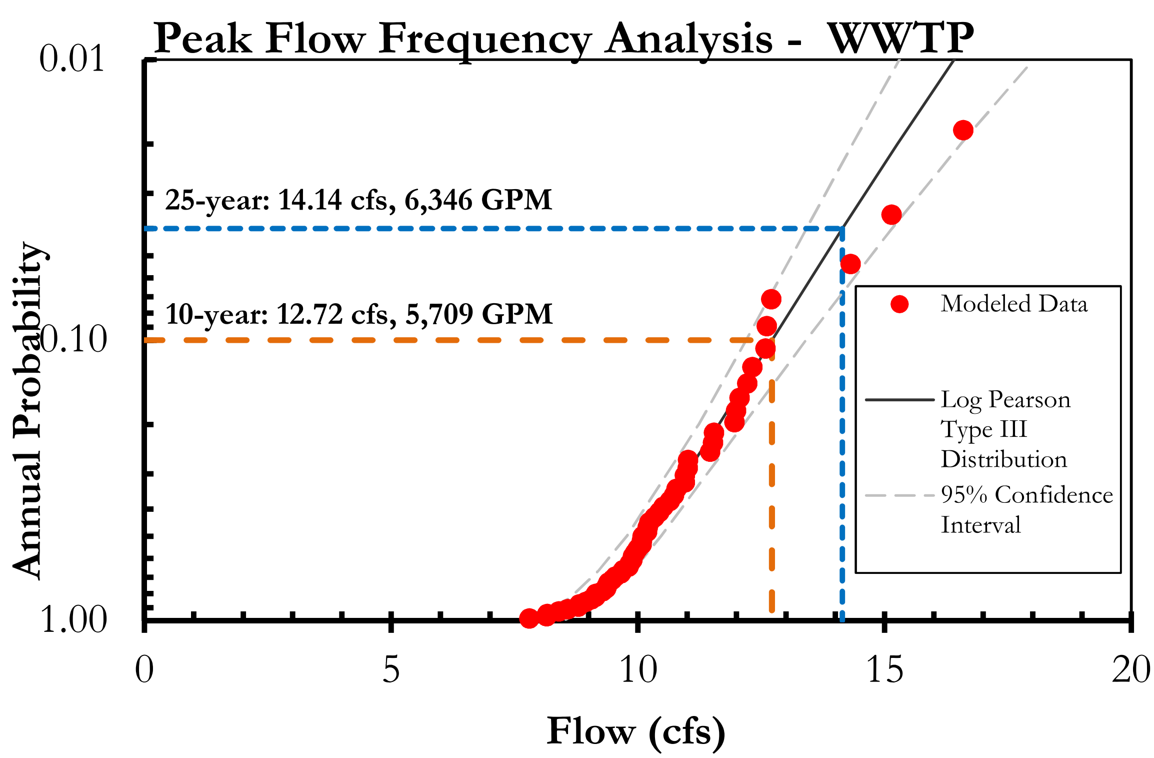






Appendix E-B: AMM Frequency Analysis Figures


Peak Flow Frequency Analysis - Meter 3
25-year: 4.08 cfs, 1,831 GPM
10-year: 3.42 cfs, 1535 GPM
Annual Probability
0.01
0.10
1.00
0
2
4
6
8
Flow (cfs)
Modeled Data
Log Pearson Type III Distribution
95% Confidence Interval
25 year flow
10 year flow


Peak Flow Frequency Analysis - WWTP
25-year: 14.14 cfs, 6,346 GPM
10-year: 12.72 cfs, 5,709 GPM
Annual Probability
0.01
0.10
1.00
0
5
10
15
20
Flow (cfs)
Modeled Data
Log Pearson Type III Distribution
95% Confidence Interval

Appendix E-C: SWMM Model Profiles

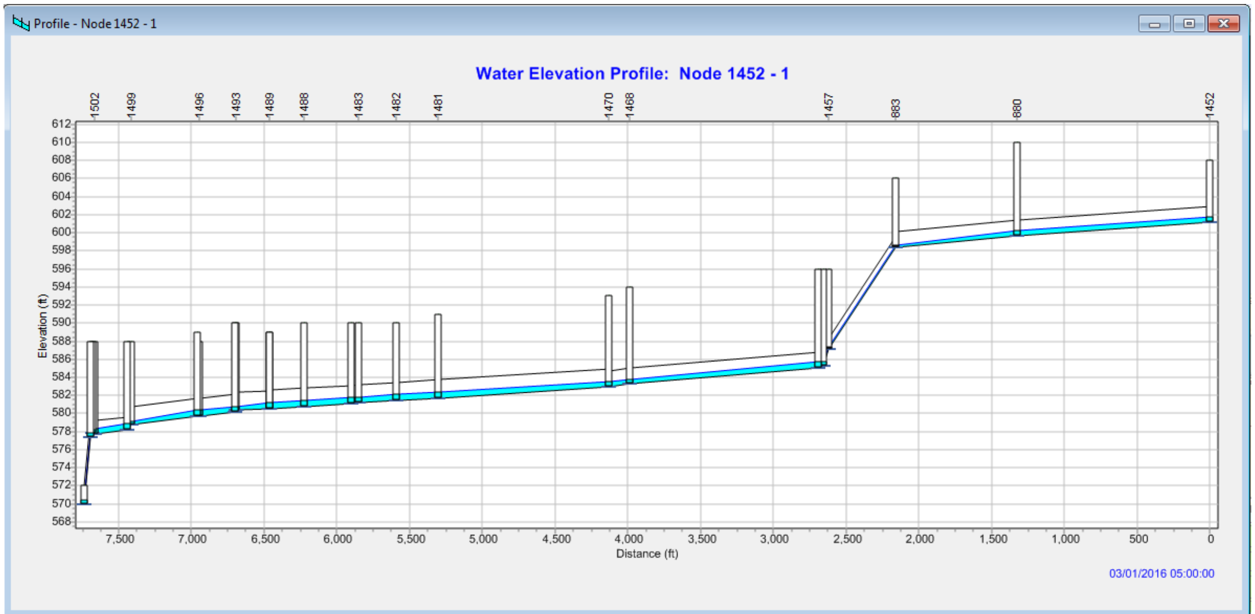


Figure E-C-1: East side during peak hourly flows
No SSOs or surcharging

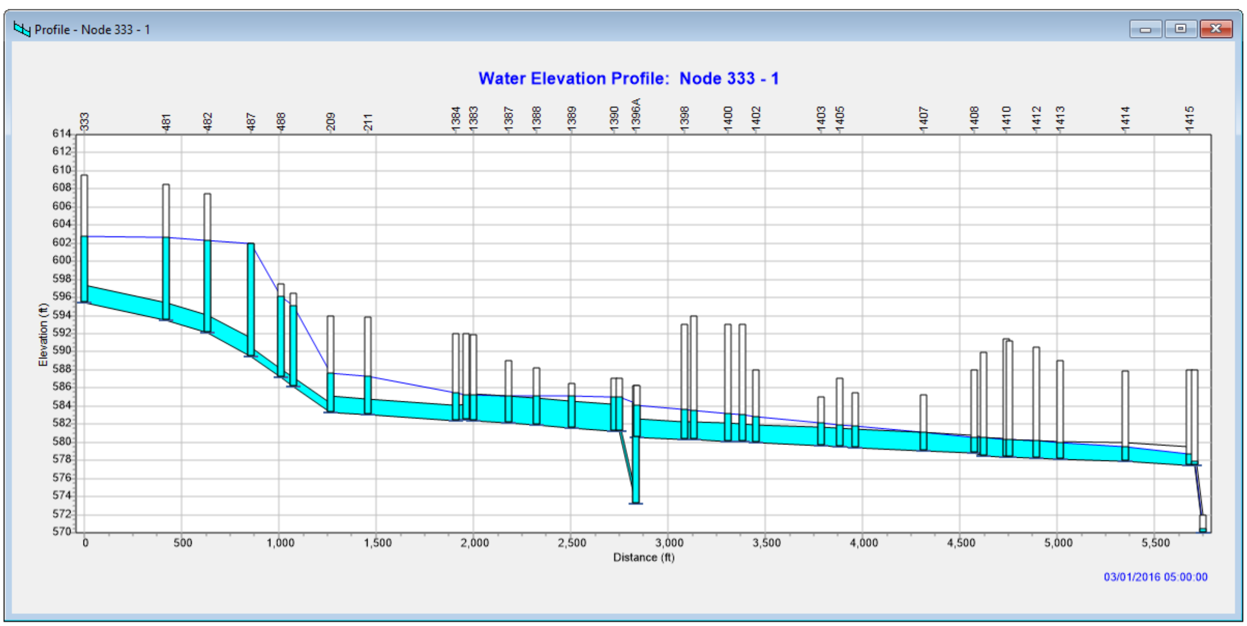


Figure E-C-2: West side during peak hourly flows
Surcharging along line and SSO occurs at MH#487

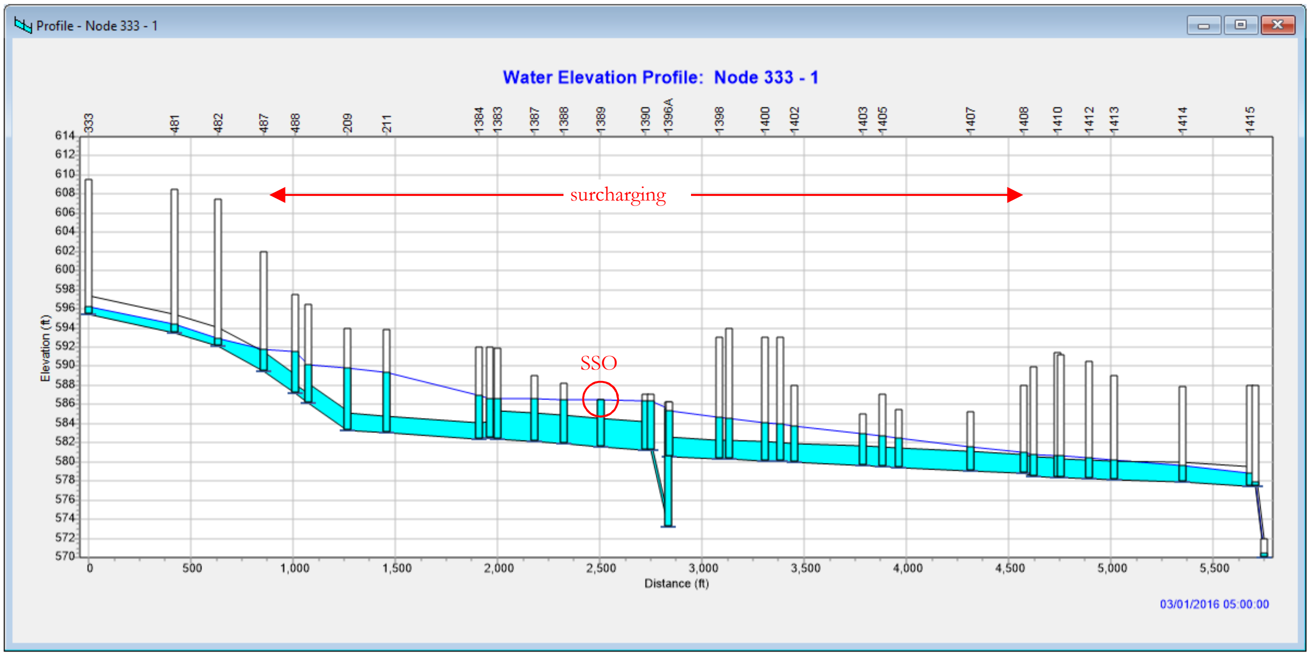


Figure E-C-3: West side during peak hourly flows with 12" lengths upgraded to 24"
Reduced surcharging upstream, increased surcharging downstream, and SSO now at MH#1389

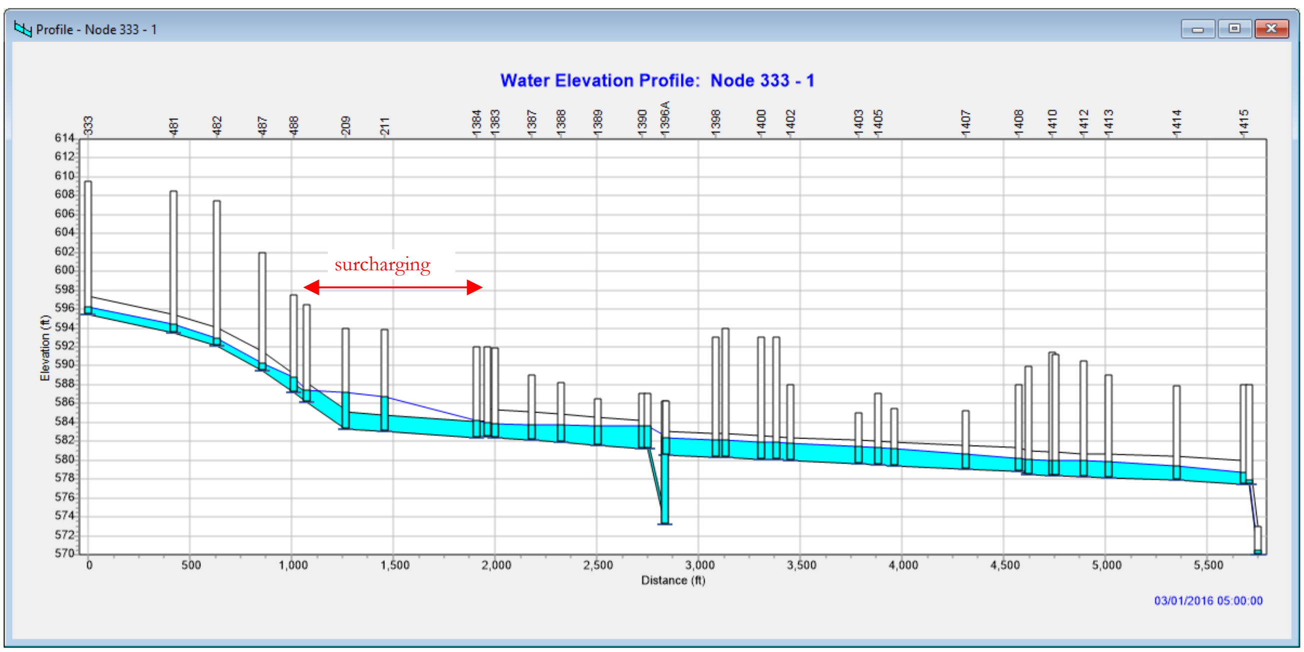


Figure E-C-4: West side during peak hourly flows with all 12" lengths upgraded to 24" and 24" downstream of Boardman Siphon upgraded to 30"
SSO removed and surcharging greatly reduced

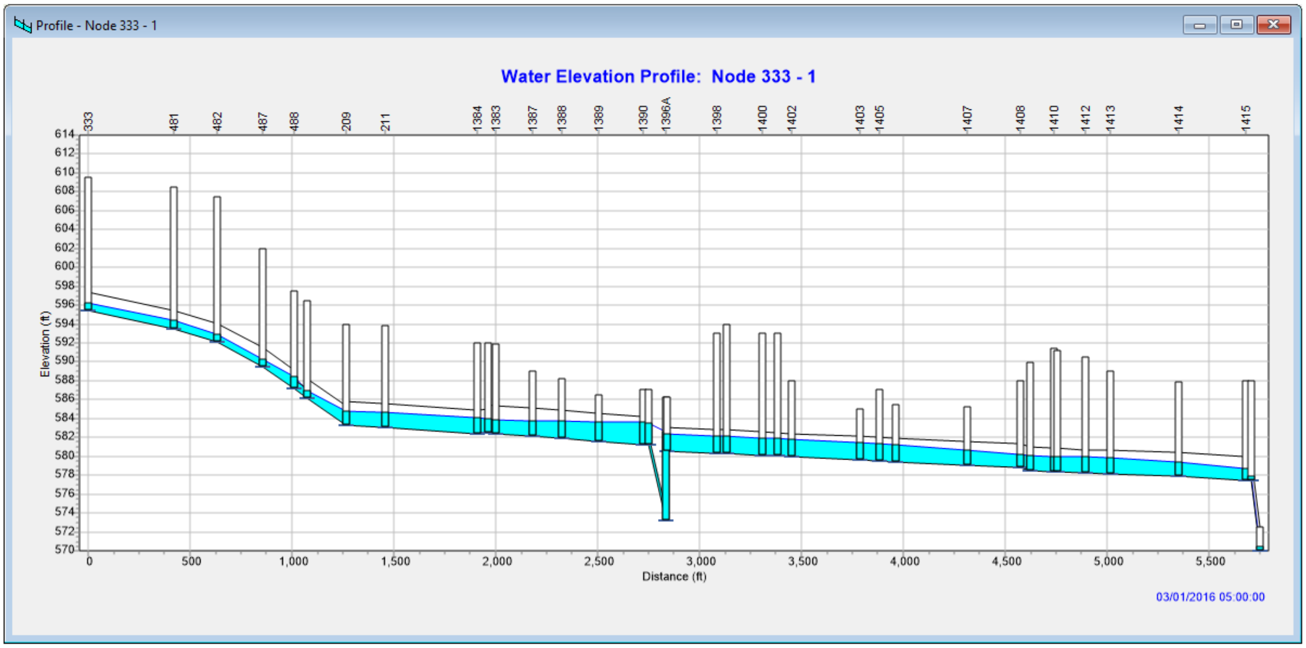


Figure E-C-5: West side during peak hourly flows with all 12" lengths upgraded to 24", all 24" downstream of Boardman Siphon upgraded to 30", and all 21" upgraded to 30"
No SSOs and no surcharging present

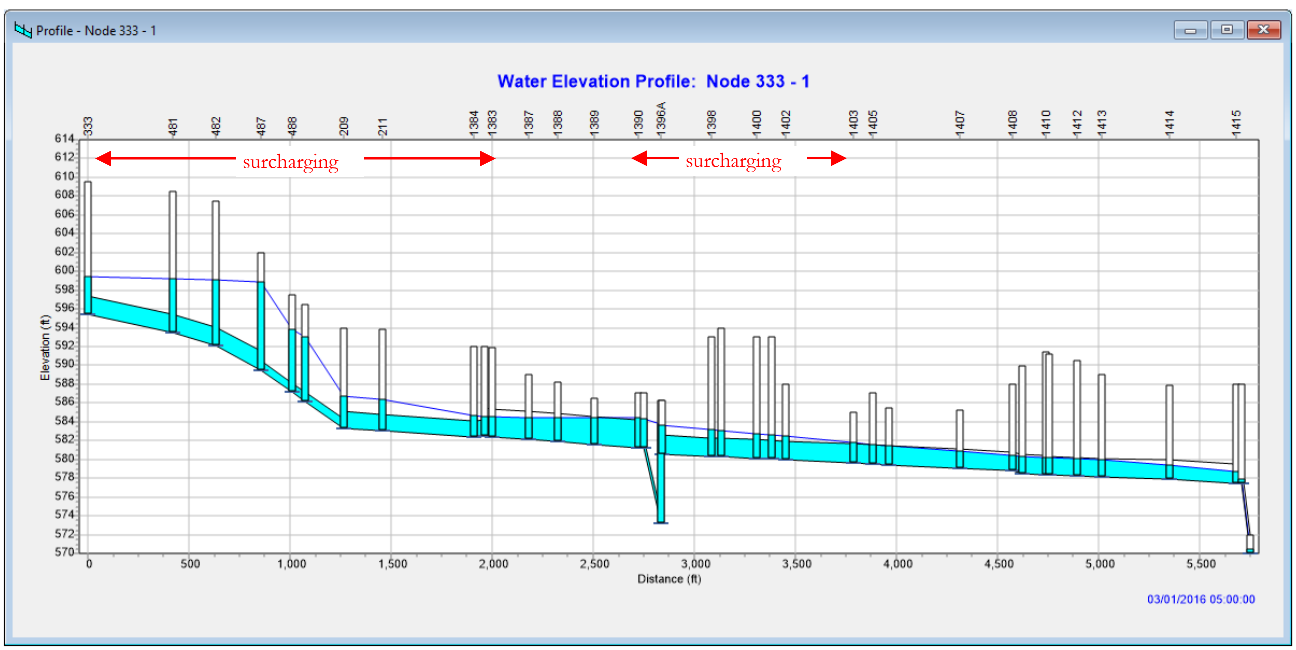


Figure E-C-6: West side during peak hourly flows reduced flows from Meter District 3
Significant surcharging, no SSO

Appendix E-D: Historic WWTP Flows and Lake Levels

Monthly Flow Data
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Inches - MGDx10
Jul-87
Nov-87
Mar-88
Jul-88
Nov-88
Mar-89
Jul-89
Nov-89
Mar-90
Jul-90
Nov-90
Mar-91
Jul-91
Nov-91
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Mar-96
Jul-96
Nov-96
Mar-97
Jul-97
Nov-97
Mar-98
Jul-98
Nov-98
Mar-99
Jul-99
Nov-99
Mar-00
Date
Precip
Plant Flow
City Flow
12.9
11.0 90%
CAPACITY @ 15.5 MGd. MONTH
(60% CAPACITY)
PROJECTED FLOW 10.4 MGD - MONTH
PROJECTED FLOW 8.6 MGD - MONTH

Lake Levels
582
580
578
576
Elevation
Jul-87
Nov-87
Mar-88
Jul-88
Nov-88
Mar-89
Jul-89
Nov-89
Mar-90
Jul-90
Nov-90
Mar-91
Jul-91
Nov-91
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Jul-96
Nov-96
Mar-97
Jul-97
Nov-97
Mar-98
Jul-98
Nov-98
Mar-99
Jul-99
Nov-99
Mar-00
Lake Levels
Date

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.

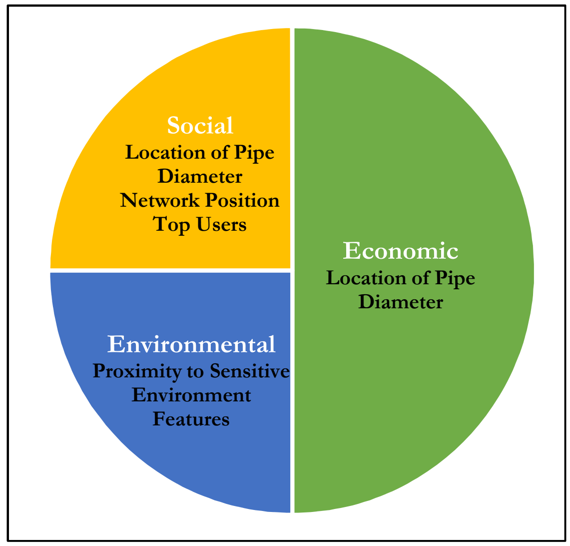


Figure F-1: CoF Community Impacts

<u>Location of Pipe:</u> 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

<u>Top Users:</u> 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

<u>Diameter:</u> 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.

Consequence of Failure \ Probability of Failure	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Low Priority (1-4)
Medium Priority (5-9)
High Priority (10-25)

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:

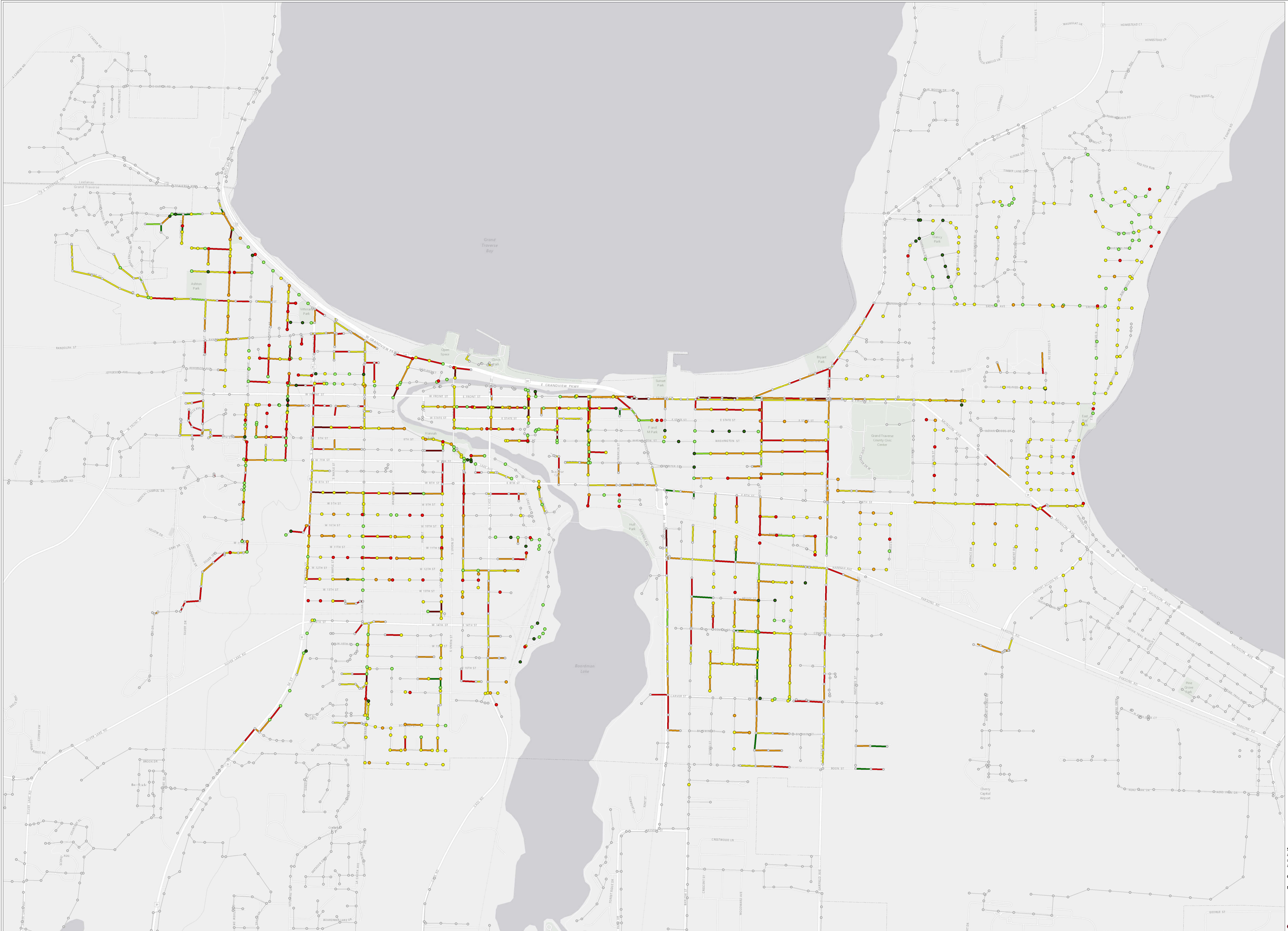
- Assets with a mid-range BRE should be moved up the list if a proposed roadway project coincides with the asset location.
- If assets with mid-range BREs are immediately adjacent to a high BRE, consider adding the mid-range asset to the CIP, as the adjacency may increase cost efficiencies and avoid an unnecessary re-mobilization.

Appendix F-A: Maps

Figures

Figure F-A-1
Probability of Failure

Traverse 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

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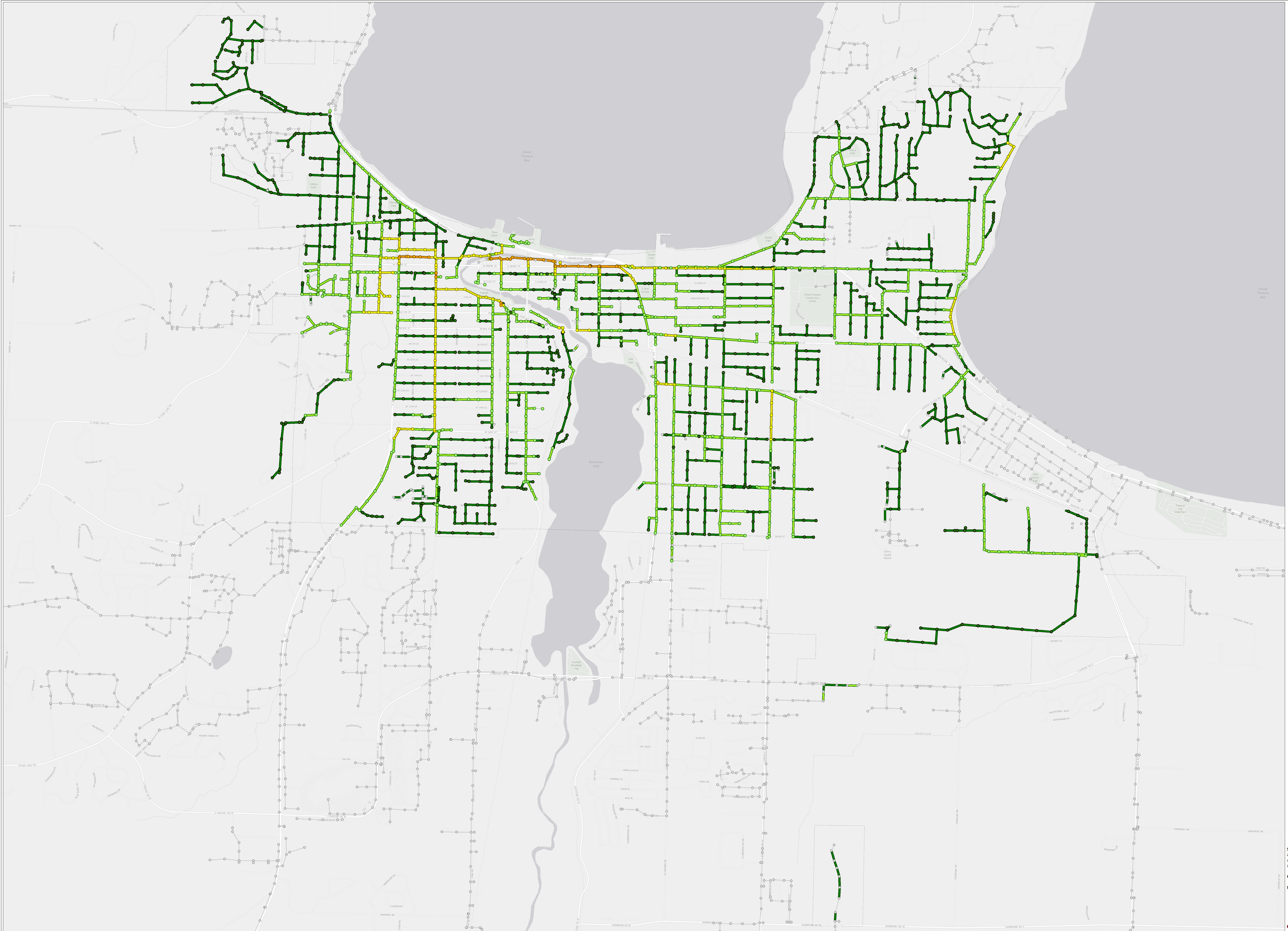
Figure F-A-2
Consequence of Failure

Traverse City, MI



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

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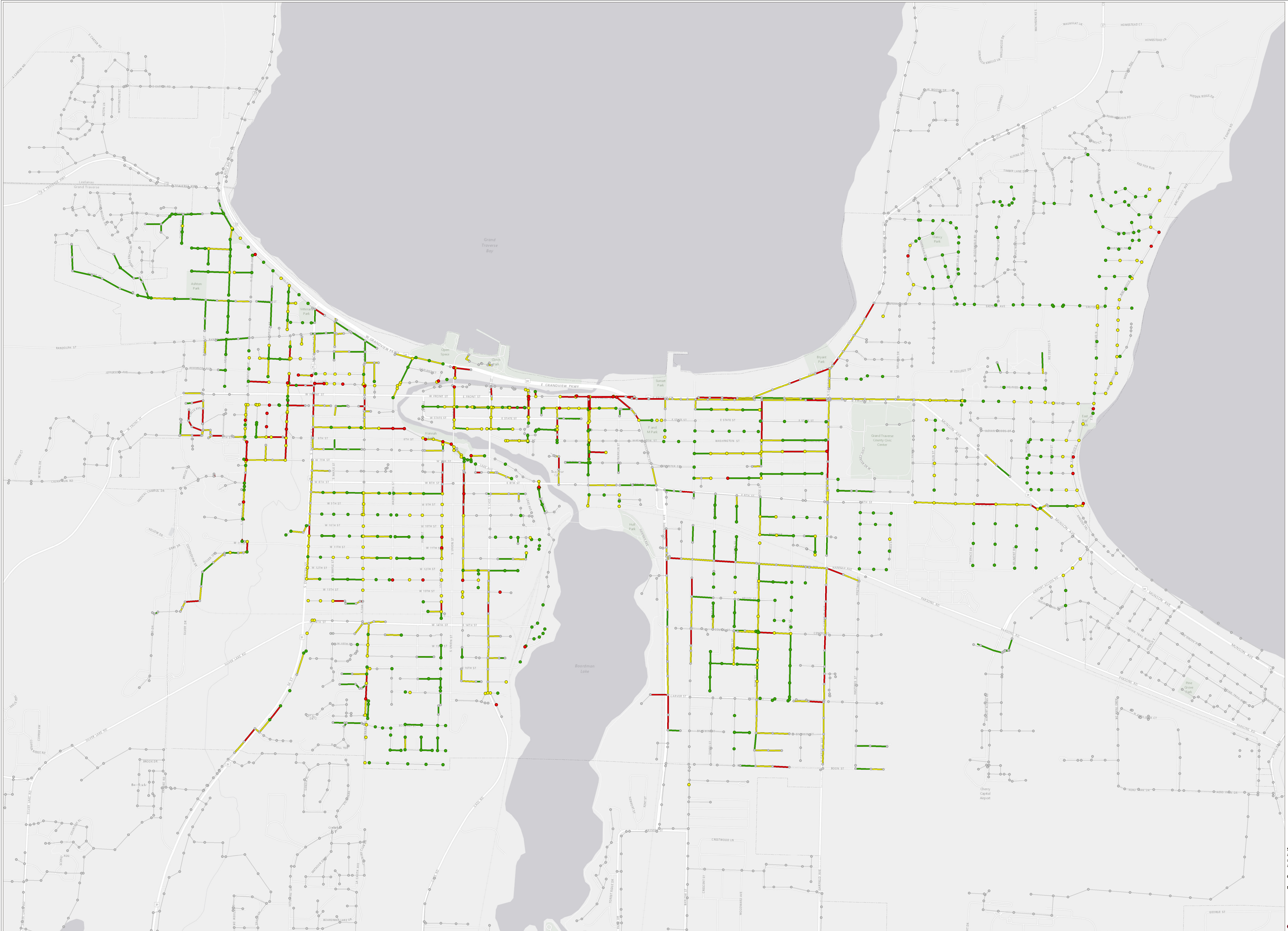
P:\1000_1999\1006140012_Traverse City SAW Wastewater_GIS\ArcLayouts\20170518 Traverse City CIP Maps\20170518 Consequence of Failure.mxd

Figure F-A-3
Business Risk

Traverse 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

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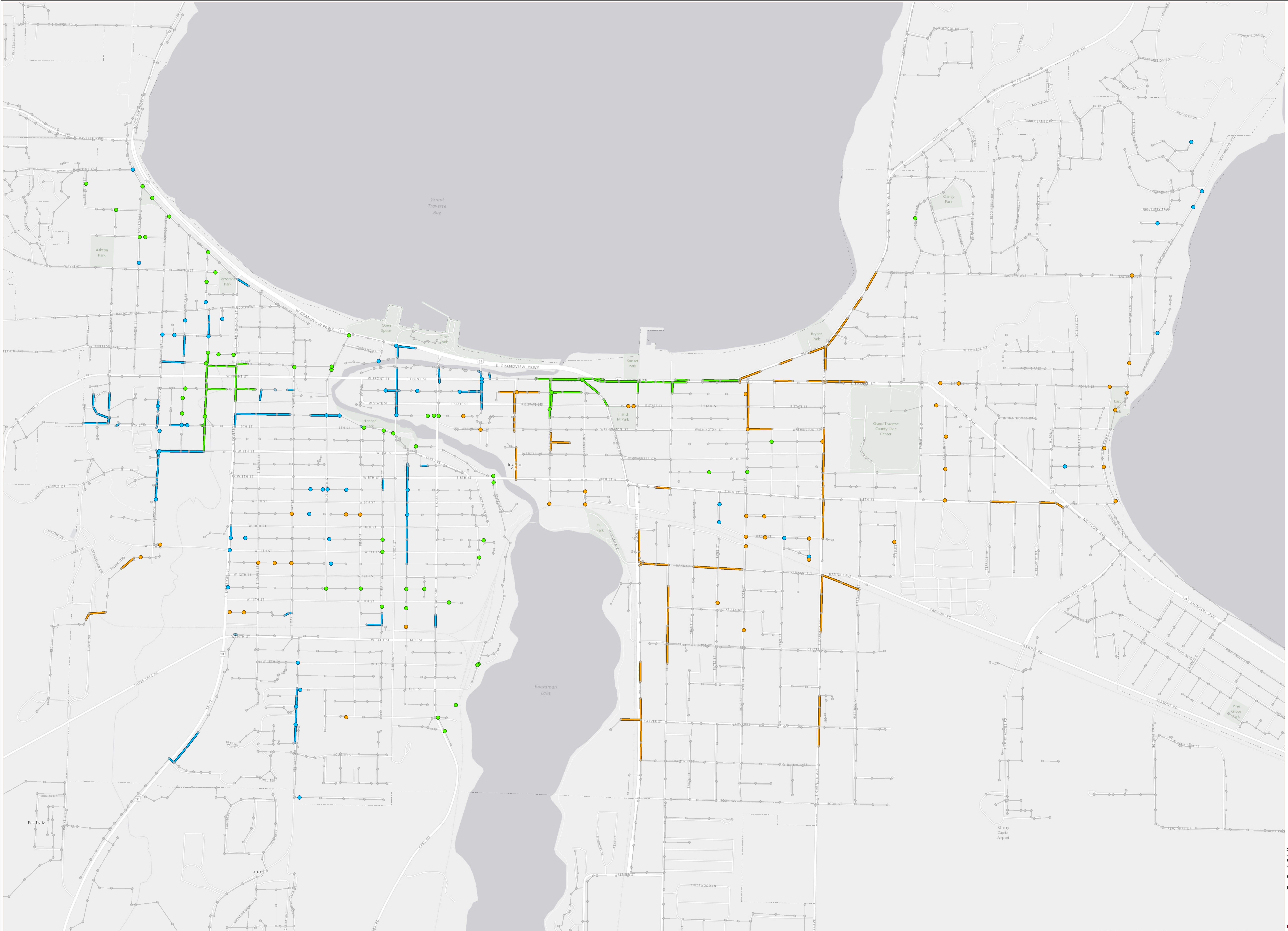
Figure F-A-4
CIP Yearly Projects

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

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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

Contents

Section Page

Exhibits

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

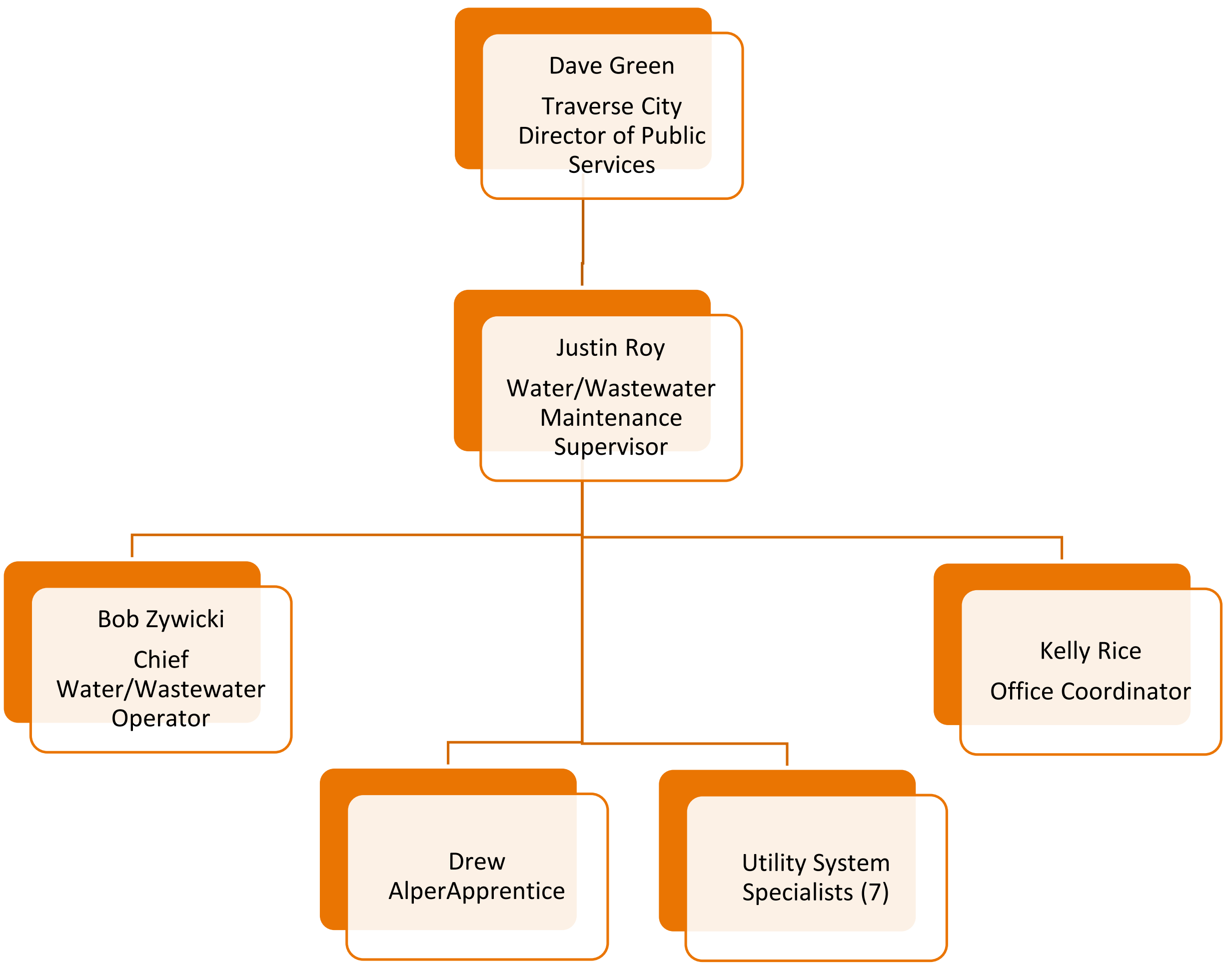
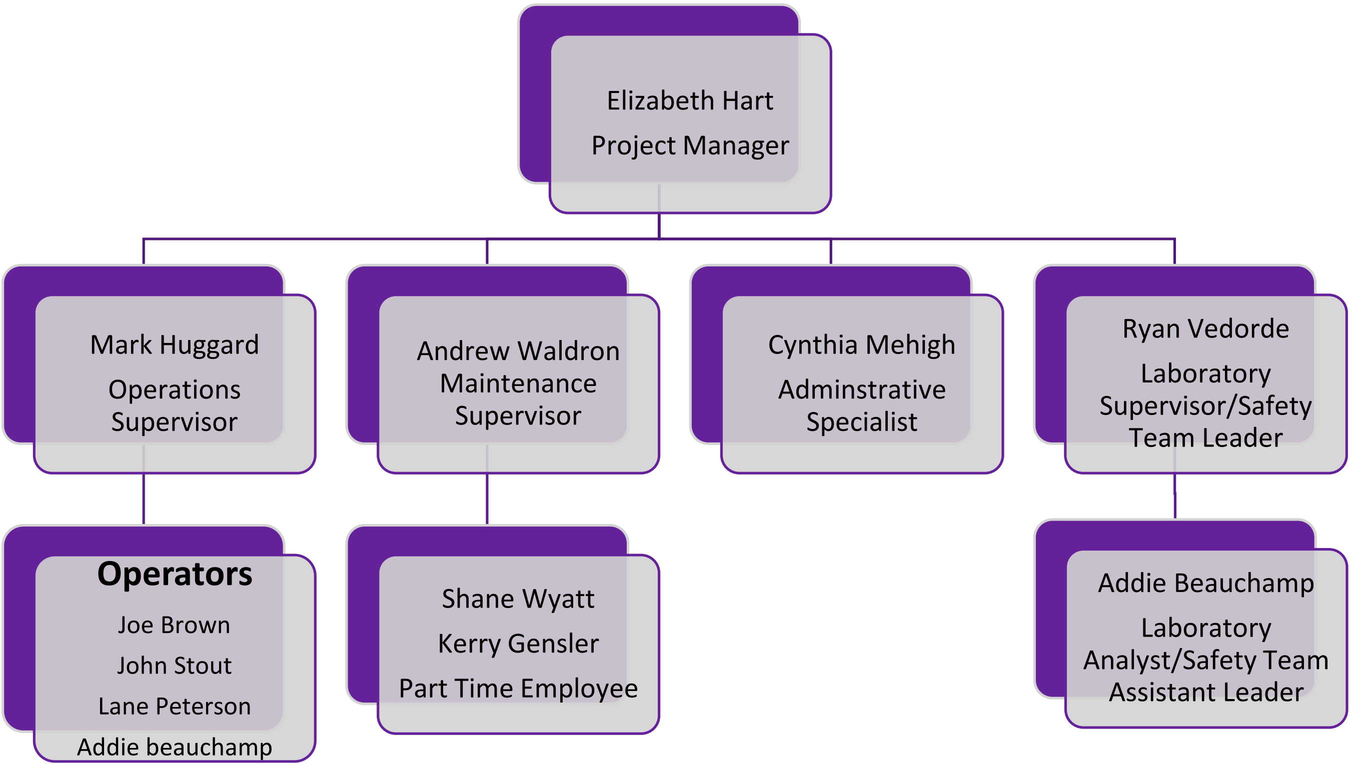


Exhibit 2. CH2M's Staffing for the TCRWWTP and City Lift Stations



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 (°F)**	**Minimum Temperature (°C)**	**Maximum Concentration (mg/L)**
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 Anaerobic Volume Anoxic Volume Aerated Volume Total Volume each Tank	1.885 MG 0.059 MG 0.210 MG <u>0.673 MG</u> 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^{0}F (13^{0}C)
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 Anoxic Zone to Anaerobic Zone Membrane Tanks to Aerated Zone (max.)	 100% or 200% 100% or 200% 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.

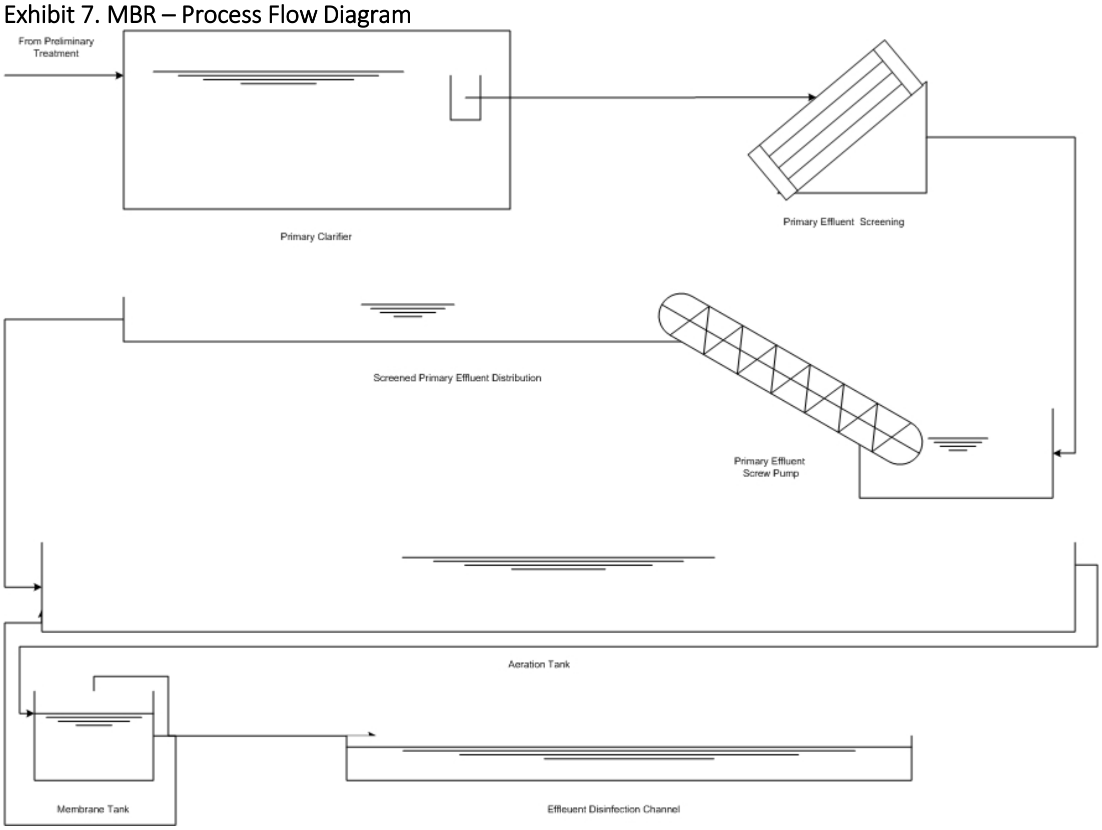
The mixed liquor (ML) from the Aeration Tanks is channeled to the in-service Membrane Tanks. The membrane equipment effectively separates the solids from the liquid phase of the ML by applying suction to the inside of individual membranes with large centrifugal pumps. The separated solids from the ML 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:

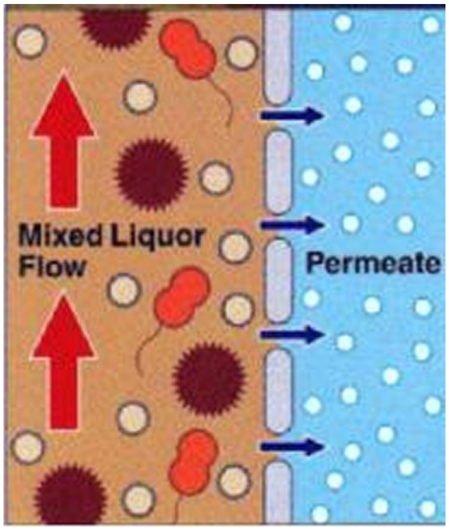
- Biomass to be completely retained; effluent solids concentrations are generally <1 mg/L
- Sufficient solids retention times (SRT) for nitrification;
- SRT to be separate from hydraulic retention time (HRT) allowing independent control of both
- Problems associated with settling and filtration of activated 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

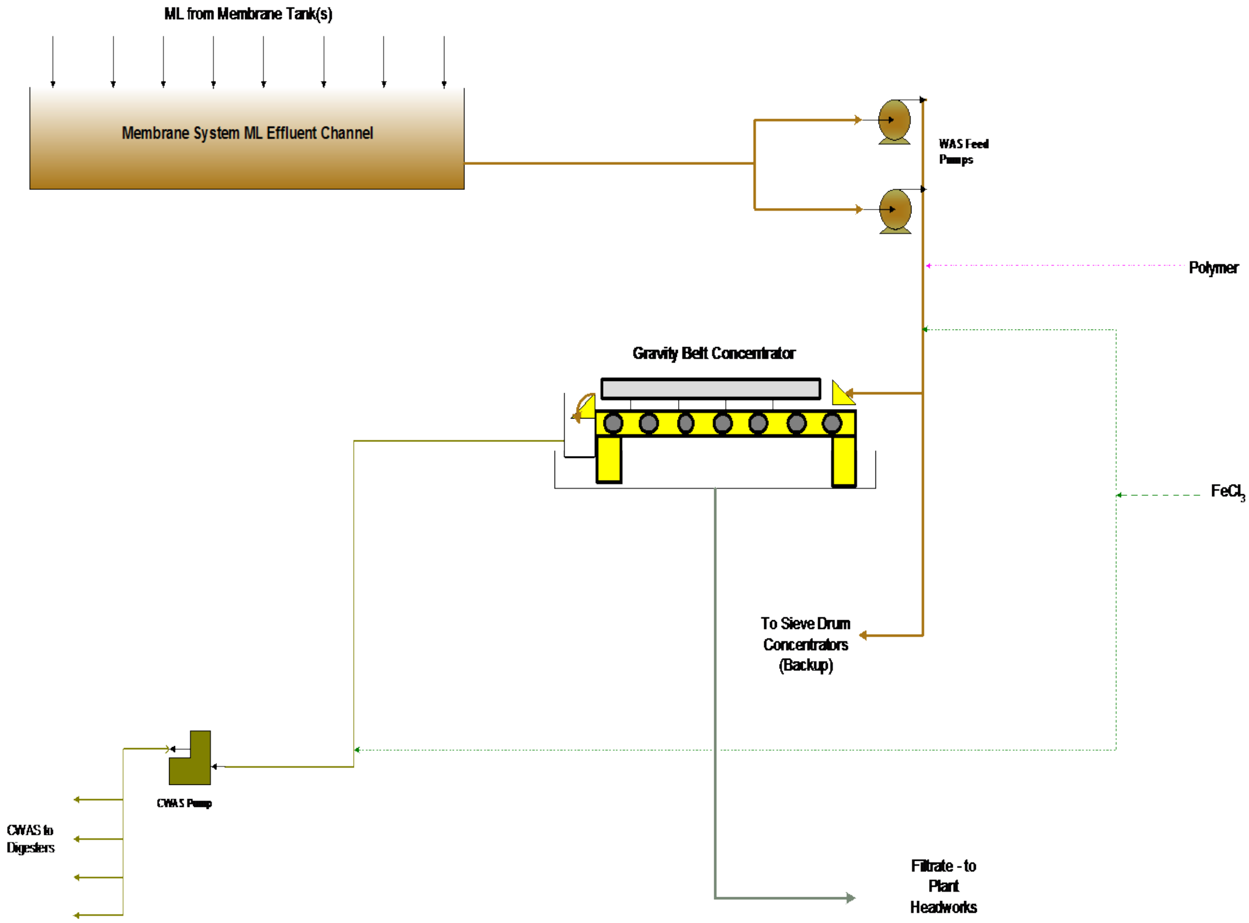
3.16.3 Process Description

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.

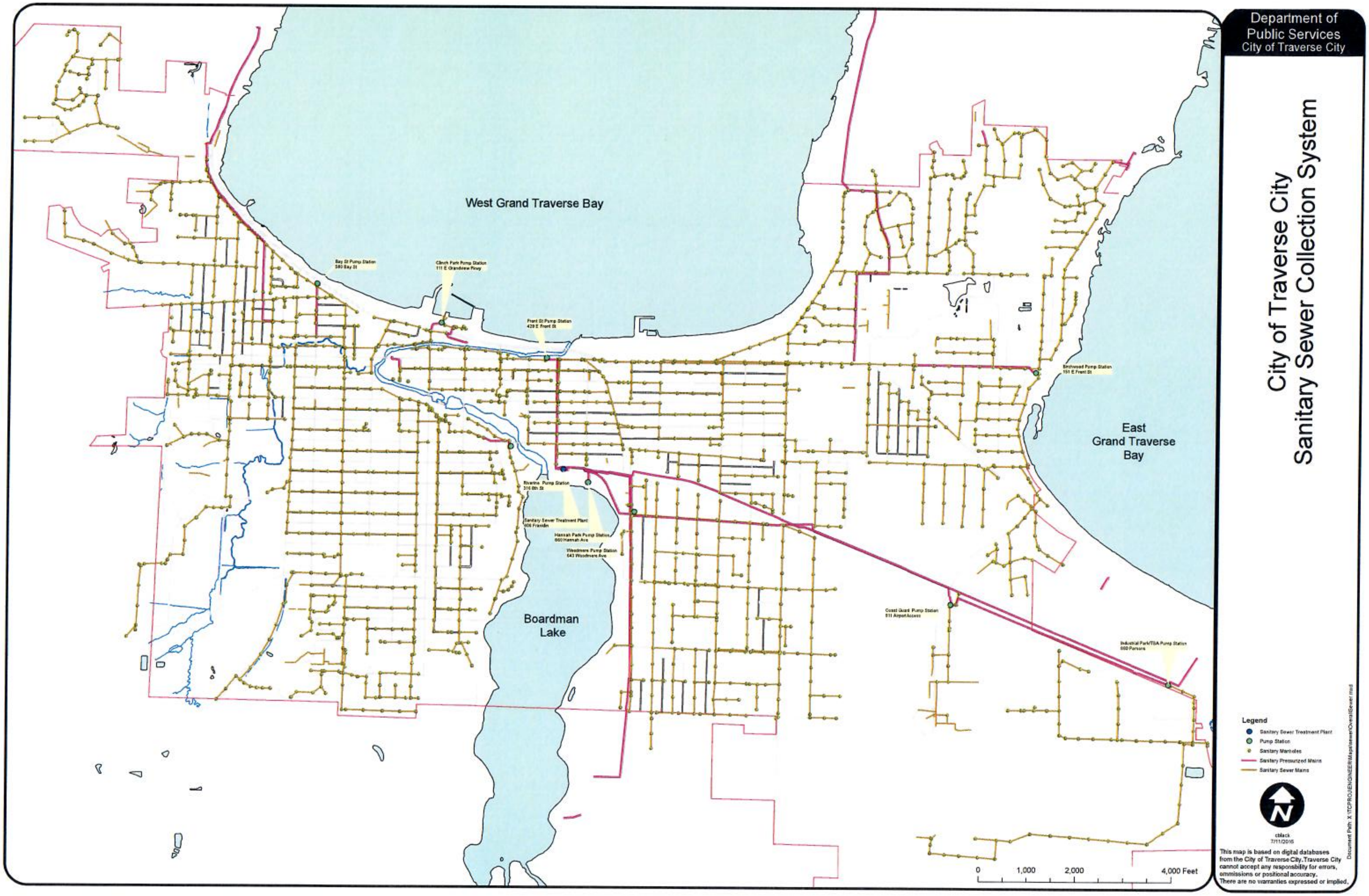
Exhibit 12. TCRWWTP and Lift Stations Improvement Initiatives

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's recommendations, 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
West Grand Traverse Bay
East
Grand Traverse
Bay
Boardman
Lake
Bay St Pump Station
580 Bay St
Clinch Park Pump Station
111 E Grandview Pkwy
Front St Pump Station
429 E Front St
Birchwood Pump Station
151 E Front St
Riverine Pump Station
316 8th St
Sanitary Sewer Treatment Plant
606 Franklin
Hannah Park Pump Station
660 Hannah Ave
Woodmere Pump Station
643 Woodmere Ave
Coast Guard Pump Station
811 Airport Access
Industrial Park/TBA Pump Station
660 Parsons
0
1,000
2,000
4,000 Feet
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
Output	Millions of pounds of BOD treated	3.43M	3.50M	3.37M	3.28M	3.19M
Output	Recordable safety incidents	0	0	1	0	1
Efficiency	Percentage of effluent in compliance with NPDES permit	100%	100%	100%	100%	100%
Efficiency	Kilowatt hours used/pound of BOD treated	1.2980	1.2880	1.3000	1.4100	1.4500
Efficiency	Total recordable rates	0	0	9%	0	5.5%
Efficiency	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

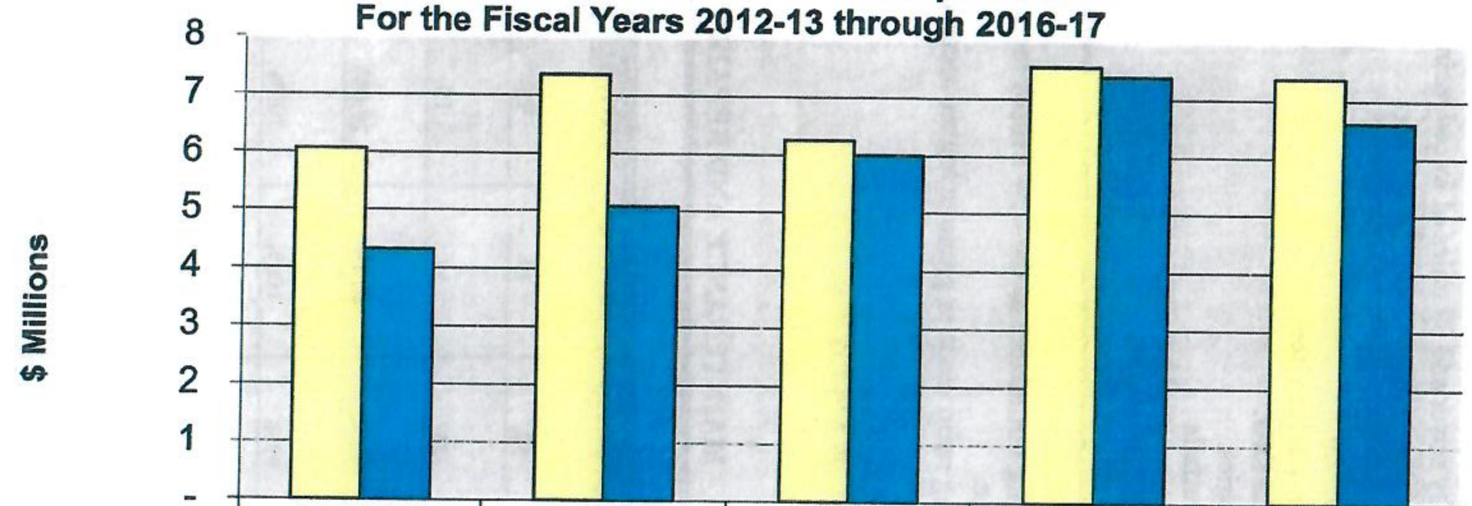
GOALS – MAINTENANCE AND REPAIRS

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	$136,245	$154,747	$156,921	$153,550	$165,969	$164,872	$184,446	$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

All Projects Submitted for 2016/17

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Project ID	Bold -Indicates projects occurring in the first FY of the plan. + -Indicates projects with multiple funding sources. * -Indicates new projects submitted for review.	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

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Bold -Indicates projects occurring in the first FY of the plan.
+ -Indicates projects with multiple funding sources.
*** -Indicates new projects submitted for review.**

WASTE WATER FUND

Sewer Plant & Buildings

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
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

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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

City of TRAVERSE CITY

Six Year Capital Improvement Program

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:

Six Year Capital Improvement Program

City of TRAVERSE CITY

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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:

City of TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of TRAVERSE CITY

Six Year Capital Improvement Program

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

City of
TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of
TRAVERSE CITY

Six Year Capital Improvement Program

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:

City of TRAVERSE CITY **Six Year Capital Improvement Program**

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.

City of
TRAVERSE CITY

Six Year Capital Improvement Program

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:

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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**.

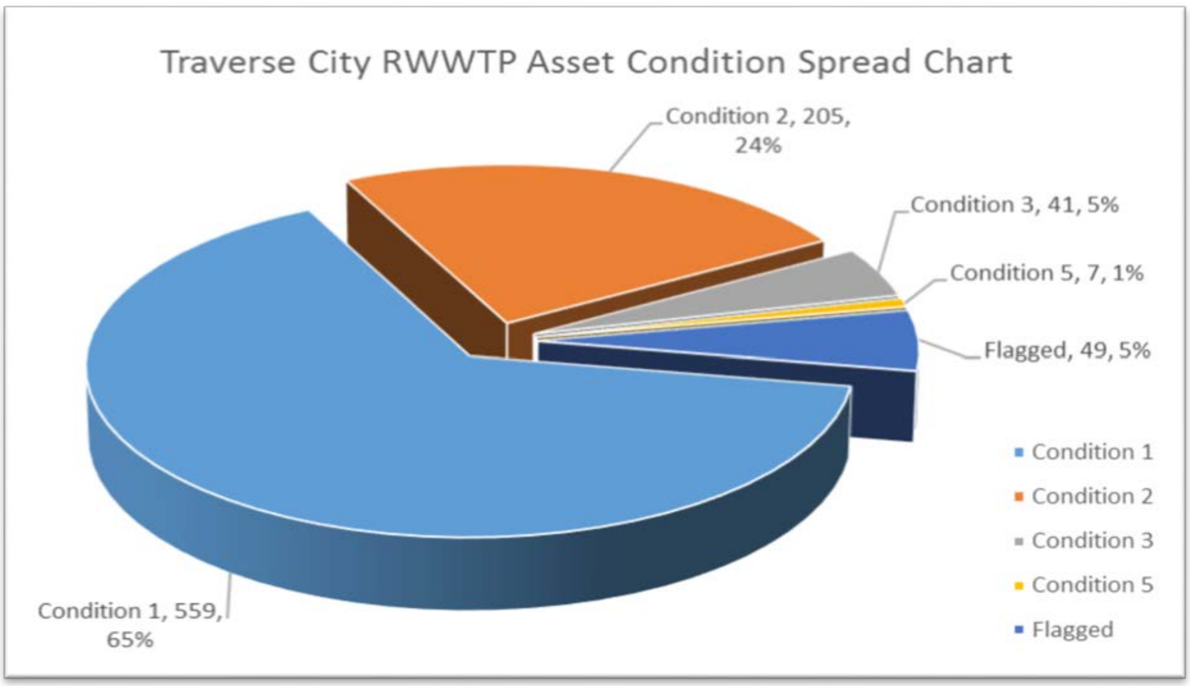


Figure 1. Traverse City RWWTP Asset Condition Spread Chart

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

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:

$$\text{Risk} = \text{Consequence} \times \text{Likelihood}$$

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.

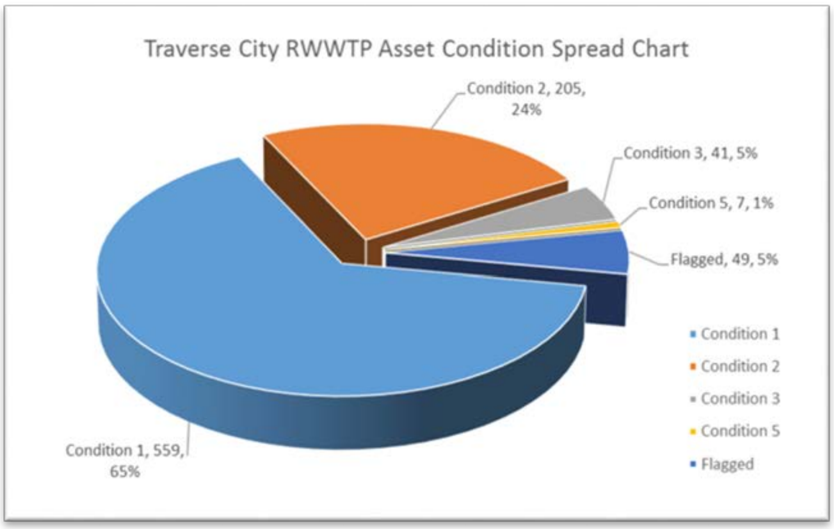


Figure 3. Asset Condition Spread

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.

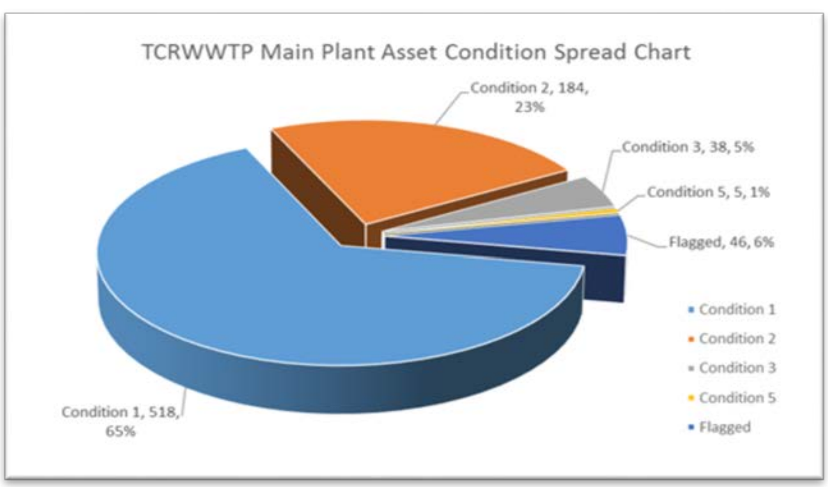


Figure 4. Main Plant Asset Condition Spread

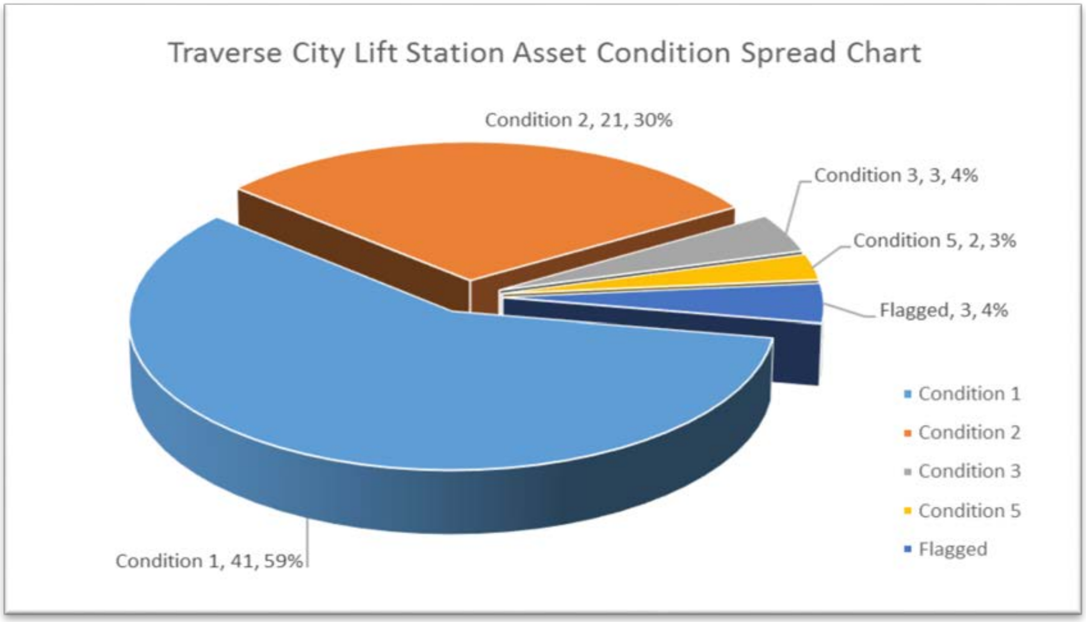


Figure 5. Lift Station Asset Condition Spread

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**).

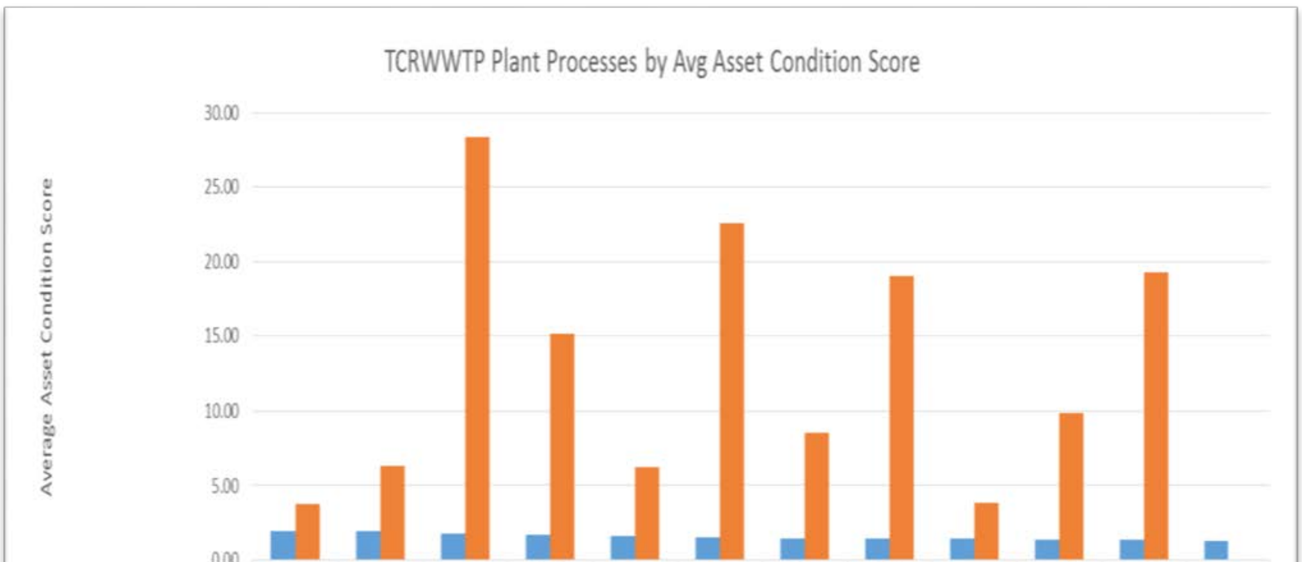
Table 7. Main Plant Process Area Average Condition Score Ranking

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.



	Grit Removal	Preliminary Treatment	Digestion	UV disenfection	Fine Screens	Primary Treatment	Odor Control	Solids Handling	Structures and support	Secondary Treatment	Membrane Filtration	Laboratory
Average Asset Condition Score	1.92	1.90	1.76	1.70	1.60	1.57	1.48	1.47	1.46	1.38	1.32	1.27
Average Total Risk	3.79	6.30	28.40	15.13	6.20	22.57	8.59	19.02	3.87	9.87	19.28	0.00

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

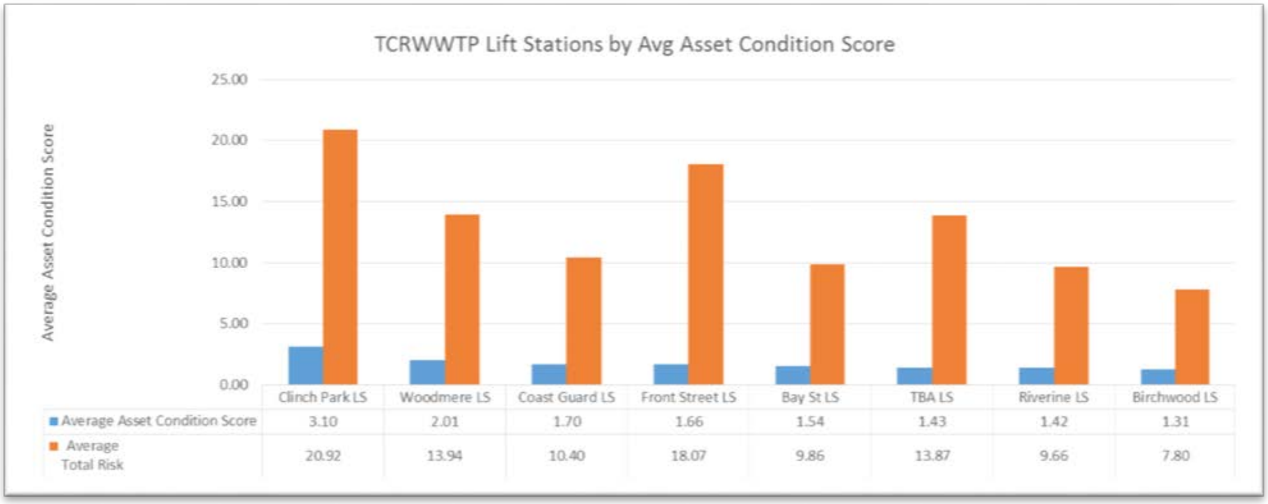


Figure 7. Lift Station Average Scores Ranked by Condition Score

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)