Water System Reliability Study

City of Traverse City

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EXECUTIVE SUMMARY

This report represents the five year update of the City of Traverse City Water System Reliability Study. Based on the three primary components of the water distribution system (the source water system and water treatment plant, the water distribution system (pipe), and the storage requirements), the following conclusions are made:

- The water supply has met the regulations for microbiological, radioactive, inorganic and volatile organic contaminants for the past 5 years, with one exception. In 2013, the City had a treatment technique violation and has been working to ensure such a violation does not occur again.
- The existing supply capacity is adequate for Year 2014 water demands and further into the future. The projected Fiscal Year 2014 maximum daily demand of 14.8 million gallons per day (mgd) represents less than 74 percent of the firm design supply capacity of 20 mgd. However, there is some concern that the distribution system is restricting the high service pumps to less than their design capacity. Thus, after the filter restoration, the City will be conducting low service and high service pump tests to more accurately identify the firm supply capacity.

  System demands projected through Year 2034 represent approximately 85 percent of the firm design supply capacity. Since the amount of unaccounted-for water in the system is significantly more than desired, the City should implement a water management strategy to conserve water and more efficiently operate the pumps. If not, the projections indicate that the City will need to begin evaluating potential alternatives to increase the supply capacity within 20 years. The water management strategy could include such items as frequent meter change-out and construction of transmission improvements to increase the capacity of the system.
- The City provides adequate water supply for normal (non-emergency) system conditions. The distribution system meets minimum needs with respect to the hydraulic connectivity for this

community; however, some improvements are recommended to improve the system transmission and distribution.

- While supply to customers can be considered adequate, the unbilled water estimated recently is significant and the City should provide more detailed accounting of known non-billed water use to determine whether “lost” water is at unacceptable levels.
- System pressures and available fire flows are adequate. However, high service pumps at the water treatment plant could operate more efficiently and at a higher capacity if additional system transmission were available in the system. As such, a transmission main is recommended through the center of town in the short term. And an existing old 16” transmission main through town is recommended for replacement in the longer term.
- Over the next 20 years, the City is capable of providing storage for fire protection to all residential customers equivalent to 1,000 gpm for 2 hours and to all commercial and industrial customers equivalent to 3,500 gpm for 3 hours. Specific distribution and transmission system improvements have been recommended for improved local fire protection in some areas of the City to generally meet these goals.

I. INTRODUCTION

The City of Traverse City is located in Grand Traverse County in the western, lower peninsula, approximately 130 miles north of Grand Rapids. The City supplies water to all City residents and businesses as well as three neighboring townships. The existing City water system and projected City service area is shown in Figure 1 and 2.

The City is supplied with Lake Michigan surface water from the water intake in the East Arm of Grand Traverse Bay. Water is purified via a Direct Filtration Treatment Plant. Water is then pumped to a City-wide distribution system of more than 120 miles of water main ranging in size from 4 to 30-inches in diameter. The City operates and maintains 5.3 million gallons of storage within the City distribution system between the Wayne Hill Tank and the Barlow Tank.

The purpose of this report is to document the reliability of the water system for the City of Traverse City. This reliability study aims to fulfill the requirements of Part 12, Rule R325.11201 through R325.11207 promulgated under Michigan's Safe Drinking Water Act, 1976, P.A. 399, as amended. A 5- and 20-year projection of water demands and an evaluation of each of the system components on five year intervals are required by the Act.

The City has bulk water agreements with Garfield Township (5 mgd maximum and 3 mgd minimum), Peninsula Township (1 mgd maximum) and Elmwood Township (0.75 mgd maximum). A fourth Township, East Bay, maintains an emergency connection with the City.

This report contains growth projections for the City water system, which at present is considered to be only within the City limits. The report identifies current and projected water demands and includes a computer assisted network analysis of the water distribution system. Recommendations for improvements to the water supply system are made with cost estimates and are presented in a capital improvements plan.

The City has completed the following improvement projects over the past 5 years including:

- 2014 – Alum System upgrades
- 2013 - Fluoride System upgrades
- 2013 – Air Tank / Air Dryer Unit replacement
- 2013 – Construction of 1,530’ of 12” main to Wayne Hill
- 2013 – Construction of 1,800’ of 8” main on Manor and Eastwood
- 2013 – Sheridan/Orchard Street Improvements
- 2012 – Huron Hills Pump Station Upgrade
- 2012 - Chlorine Feed System replacement
- 2012 - Air Compressor System replacement
- 2012 - Construction of 536’ of 12” main on State Street, Pine to Union
- 2012 – Construction of 1,535’ of 8” main – East Bay Boulevard
- 2011 - Construction of 2,882’ of 8” main on Elmwood Avenue
- 2010 – Fitzhugh Drive check valve relocation
- 2010 – Construction of 383’ of 12” main & 1,584’ of 8” main on 8th Street
- 2009 – Construction of 330’ of 12” main on Old Morgan Trail
- 2008 – Construction of 492’ of 8” main on Cypress Street
- 2008 – Construction of 2,124 of 12” main in Grand Traverse Commons (Red Drive)
- 2008 – Construction of 382’ of 12” main & 1,585’ of 8” main on Wayne Street
- 2008 – Central High School Loop

II. WATER DEMANDS

The City of Traverse City water system distributes water to all of the residents and businesses within the City limits, as well as 3 neighboring Townships. The land uses within the City of Traverse City are mixed with a significant amount of residential and commercial areas. It is also noteworthy that the population increases in the area significantly in the summer, raising demands from twice to three times winter use.

Historic water demand data was provided by the City of Traverse City based on metered data and Monthly Operating Reports. The water supply data for the combined City and customer

communities extends back to 1999 as summarized in Table 1. Detailed monthly water use for all customers for Fiscal Years 2007 through 2013 is provided in Appendix C, and City water use alone is shown by removing metered volumes from the total pumped volume. Table 2 shows the water use for each community, and Tables 3 and 4 provide detailed information on the City service connections.

Using this data, the following parameters have been estimated: average day demand, which is the average daily water use for the year; maximum day demand, which is the highest daily use for the year; and peak hour demand, which is the estimated maximum hour of water use during the year. Figure 4 graphically illustrates the historic and projected demands based on this and additional information described further.

The 2008 Grand Traverse Area Water System Master Plan breaks out water demands by district in detail. This considered historic and projected population, potential development and zoning. These demands were applied to the WaterGEMS model for analysis.

Historic and projected populations were reviewed and updated in this study. Table 5 and Figure 3 exhibit the historic population based on Census data, as well as projected community populations and service populations. The data shows that the City of Traverse City population has begun rising slightly after falling for many years. The Townships, conversely, have continued to grow at a slightly diminishing rate. County population projection by the Northwest Michigan Council of Governments also reflect an increase but at a diminishing rate. However, the supplied communities have consistently provided 67 percent of the County growth over the past 30 years.

Population projections were prepared by using the historic data for each community supplied by the City within the past 10 years and adjusting each growth percentage proportionally to

match 67 percent of growth projected for the entire County by the Northwest Michigan Council of Governments.

Water use was estimated for each demand condition with consideration of the population projections and the demand distribution from the 2008 Master Plan. Maximum day demands for 2014 were projected based on the highest recent annual (10-year) maximum day demand with a small increase (0.2 percent). The resulting 2014 maximum day demand was projected at 14.8 mgd.

Maximum day demands for the system have remained consistent relative to average day demands over the past 5 years, ranging from about 2.1 to 2.4 times the average day demand. These are relatively high due to the significant number of seasonal customers in the Traverse City area as well as irrigation system use.

The 2014 average day water use was then approximated based on the 2014 maximum day demand projection of 14.8 mgd divided by the maximum to average ratio of 2.3. The result is a 2014 average day demand of 6.44 mgd for the system.

Data regarding potential future water service areas was limited for estimating the potential (ultimate) future growth. However, the City does not have significant growth potential since most areas have been developed. Population projections from the Northwest Michigan Council of Governments were reviewed and showed a declining County growth rate from approximately 1.3 percent per year to 0.77 percent. This is consistent with the historic growth reduction in each of the Townships. Thus, similar to the 2008 Water System Master Plan, a trendline was used to project populations in each community. However, these projections result in population reduction by 2034, which is not likely. Thus the alternative method of using 67

percent of County population projections was used. Demands can then be projected assuming the same increase as the population increases.

While demands are projected to increase over the next 20 years, we conservatively used the maximum to average demand ratio of 2.3 for all demand projections. Actual peak hour use is not metered and can vary significantly due to weather fluctuations and the commercial customers' operations. Estimates were prepared based on data from similar communities. A peak hour system ratio of 4 was assumed for all projections.

Demands were projected through Year 2034 in five-year increments based on water demands from potential future service areas. Projections are provided in Table 6 for the service population.

III. WATER SUPPLY SOURCE

The City of Traverse City provides water to its customers from a surface water supply. The water source is Lake Michigan obtained from the East Arm of Grand Traverse Bay.

The projected year 2014 maximum daily demand of 14.8 million gallons per day (mgd) represents approximately 74 percent of the firm design supply capacity of 20 mgd. Demands projected through Year 2034 (20 year projection) represent more than 80 percent of the current firm design supply capacity. The actual high service pumping capacity will be determined in 2014 to better assess the needs for meeting future demands.

Once the demand reaches 80 percent of the firm production capacity, the Michigan Department of Environmental Quality (MDEQ) typically recommends that plans for expansion be initiated. Long term demand projections through year 2034 indicate that maximum day demands would reach 80 percent of the firm capacity within the 5-year planning period. However, improvements are recommended to increase the firm pumping capacity and extend the

necessary time-frame to begin an evaluation to obtain additional source capacity. The City should continue to monitor water usage and complete the recommended transmission improvements.

IV. WATER SYSTEM INFRASTRUCTURE

A. Water Treatment Facilities

Water plant operators oversee the water production from the source in the East Bay through treatment followed by pumping into the distribution system. The intake, Low Service Pump Station, and Water Treatment Plant (WTP) were constructed in 1965. In the early 1970s a filter was added to increase plant rated capacity by 5 mgd. Water treatment improvements conducted in the mid-1990s expanded the filter capacity to 20 mgd with the addition of two filters, two flocculators and new low and high service pumps.

1. Intake Facilities

The City has a conventional intake crib in the East Arm of Grand Traverse Bay. The intake is a steel and wood crib approximately 15 feet in diameter and located offshore at a depth of approximately forty (40) feet. Raw water is pumped from a station onshore to the filtration plant, located about 400 yards west.

In 1995, the City installed zebra mussel control at the intake. This control system has been in service during summer months to apply a sodium hypochlorite solution at the crib. However, redundancy is still lacking for the intake and crib.

The intake is periodically inspected and cleaned, including most recently in November 2011. The intake is in excellent condition and provides a quality, low turbidity water supply.

2. Low Lift Pump Station

The station located at the lakeshore receives water from the intake in a 36” diameter line. Valves allow water to be routed to either or both the north and south traveling screens and their associated clear wells. The City has recently refurbished the traveling screens to maintain suitable working condition. Each clear well has two vertical turbine pumps. The locations and capacities of the low service pump are provided in Table 7.

The electrical gear and control panels are located above grade and are protected from flooding. Components to support the 1970s and 1990s expansion were added to the original electrical gear. In the event of loss of utility power, a manual transfer switch is available at the station to power the facility from the permanent standby generator at the water plant.

3. Rapid Mix and Flocculation Basin

Raw water entering the treatment plant may pass through two 24” diameter inline mechanical rapid mixers that are located in parallel. Alum is applied at the mixer. Downstream piping allows use with either flocculator but valve position in normal operation dedicates a mixer to a flocculation basin.

Each of the two flocculation basins has a center inlet feed with mechanical flocculator in the center draft tube. The flocculators provide 27 minutes of detention time at their rated capacity of 19 mgd. The collector ring accepts the water to be applied to the filters. There is little accumulation of precipitated solids, so there are

no provisions for mechanical solids handling. Routine cleaning of the basins is performed.

4. Filtration

Three filter consoles are located on the filter operating level and offer insight on how the plant reached the current five filter capacity. The original console constructed in 1964 serves Filters 1 and 2. Filter 3 is served by the console added in 1973 and Filter 4 and 5 are served by the console added in 1993. Filter construction is unique as is each console. All filters consist of two bays configured for simultaneous normal operation and individual bay washing.

Filters 1, 2 and 3 all have clay block and gravel for media support. The original Filters 1 and 2 have sand and anthracite and were constructed to provide an overall media depth of thirty (30) inches. Filter 3 was constructed with garnet, sand and anthracite for an overall media depth of approximately thirty (30) inches. The original media remains in service and the City periodically adds anthracite to restore the overall media depth. Each bay contains two straight rotating surface wash assemblies. The City is planning for gravel and media replacement in these three filters within the next five years.

Filters 4 and 5 will be rehabilitated during the first quarter of 2014. All filters will have an underdrain. Four layers of gravel with an overall depth of nine (9) inches will provide media support rather than the IMS caps originally installed. The dual media will consist of eighteen (18) inches of sand and twelve (12) inches of anthracite. Each bay contains two “S” shaped rotating surface wash assemblies that will be raised to accommodate the modified gravel and media configuration.

Water production for each filter is monitored and controlled from a dedicated rate of flow controller with circular chart recorder in the Laboratory. Individual filter turbidity is monitored, and each filter console provides monitoring and control for washing of its associated filter(s).

There is a redundant wash water supply system for filter washing. The design wash water rise rate of twenty-five (25) inches per minute is achieved using the controller in the filter consoles with the flow meter and rate of flow control valve located in the lower level of the WTP. The Wash Water Pump and pressure relief valve comprise the primary supply from the clear well beneath the Filters 1, 2 and 3. Finished water from the high service pump discharge is the secondary wash water supply. The Wash Water Pump operating point is 8,000 gpm at 40 feet TDH, providing suitable backpressure to operate successfully. The City periodically exercises the secondary supply.

A surface wash pump provides suitable supply and pressure to rotate the pair of surface washers in each bay. The surface wash pump is rated for 225 gpm at 176' TDH. There is not a redundant supply.

Filter piping is located in the filter gallery in the lower level of the WTP. Each filter is served by a total of nine (9) valves; one modulating valve for filter rate control and eight (8) that are in either the open or closed position. Pneumatic valve actuators serve Filters 1, 2 and 3 and electric valve actuators serve Filters 4 and 5.

All five filters have effluent rate of flow control valves that work in combination with the flow measuring device. Filters 1, 2 and 3 are paced based on the orifice plate flow measurement and Filters 4 and 5 are pace based on magnetic flow meter information.

The rate of flow control system at Filters 1, 2 and 3consisting of the flow control valves and flow measuring devices have reached the end of the reliable service per WTP personnel. Filter-to-waste capability is provided for Filters 4 and 5. There is no filter-to-waste currently available on Filters 1, 2 and 3.

5. Clear Wells and Treated Water Reservoir

Filtered water flows to clear wells located under Filters 1, 2 and 3. Water from the clear wells then exits the WTP, passes through yard piping where fluoride is applied, and then proceeds to the 1.5 million gallon treated water storage reservoir located behind the WTP. Although normally not in use, the plant personnel may also elect to apply chlorine near the fluoride application point. The concrete reservoir is located partially below grade. The reservoir is baffled to provide suitable contact time to achieve satisfactory disinfection. Water exiting the treated water storage reservoir returns to two clear wells located in the WTP; the high service pump suction well and the Huron Hills pump station suction well.

6. High Service Pump Station

The high service pump station is located within the WTP. Water returning from the treated water storage reservoir may be routed to either or both the east or west clear well below the high service pumps. The locations and capacity of the five high service pumps are provided in Table 8. The main electrical gear for the WTP and the control panels are located above grade in the high service pump room and are protected from flooding. Components to support the 1970s and 1990s expansion were added to the original electrical gear. A 750 kW permanent diesel driven standby generator is located at the water plant with an automatic transfer switch so that it is quickly available to power the facility upon loss of utility power.

There is a pressure release valve located in the high service pump room to vent any excessive pressure from the high service pump discharge lines back into the east finished water clear well.

7. Huron Hills Booster Station

The City recently completed upgrades to the Huron Hills booster station located at the west end of the WTP. Upgrades addressed pumping capacity, storage and control system activity. For the purpose of this report, the booster station is considered part of the distribution system, although located in the WTP.

8. Supporting Systems

a. Chemical Feed Systems

1) Alum

Alum is used as a coagulant. The alum system feeds an alum polymer blend that is applied at the inline mixers prior to the flocculation tanks. In early 2014, the City replaced the three alum metering pumps and added a day tank scale. The bulk storage and day tank continue to serve the needs of the WTP.

2) Fluoride

The City completed a fluoride system upgrade in 2013. Fluoride is applied prior to the treated water storage reservoir.

3) Chlorine

In 2012, the City completed a chlorine system upgrade. The sodium hypochlorite feed system consists of a pair of bulk storage tanks, two

transfer pumps, a day tank with scale, and three chemical metering pumps. All components are in excellent condition.

The City adds sodium hexametaphosphate to all the chlorine carrier water to prevent calcification. The sodium hexametaphosphate system consists of a batch tank and chemical metering pump located in the chlorine room.

b. Piping

The majority of the 8-inch and larger diameter piping throughout the WTP is steel. The smaller diameter piping is ductile iron.

Plant dehumidifiers keep the lower pipe gallery dry year round. The majority of the piping and protective coatings appear to be in good condition. The Filter 1 piping, from the 1960s, does have corrosion at the filter wall penetrations.

c. Plant Compressed Air System

The WTP maintains a compressed air system to provide air to the valve pneumatic actuators and a large number of bubbler systems used throughout the plant for level indication. The City recently replaced one of the compressors (2012), the air receiver/air drier (2013), and supporting components to maintain system reliability. Replacement of the original remaining compressor is anticipated within the next three years.

d. Lagoons

There are two lagoons with the associated control facilities that accept filtered wash water and flocculation tank drain water. The two lagoons are located behind the WTP. Water exiting the two lagoons returns to the WTP where a sump and associated pumps in the lower level are used to convey water to the bay. The two

sump pumps are part of the original plant construction in the 1960s and are becoming less reliable.

9. Plant Metering and Controls

The WTP currently has no facility wide monitoring and control system. Further, portions of the plant control system are only capable of manual operation and are not monitored through the WTP Main Control Panel (MCP) located in the laboratory. The plant monitoring and control system has been expanded and upgraded several times since the original plant construction. Most recently, a laboratory computer was added to expand limited monitoring and control. The City is planning to undertake a program to establish a comprehensive Supervisory Control and Data Acquisition (SCADA) system providing the operator improved monitoring and control of the WTP and distribution system. The intent of the SCADA system is to replace the functions currently available at the existing main control panel and laboratory computer, plus expand the functionality. It is anticipated that the expanded functions will be achieved by adding the following:

- Radio communication with two distribution facilities (Wayne Hill and Barlow)
- Low Service Pump Station to WTP fiber optic link
- Filter Console monitoring
- Chemical system monitoring

In addition to providing a SCADA system, there are key elements to the water treatment system plant operation that are reaching the end of their useful life. For example, the raw water flow meter and two finish water flow meters are from the original construction and are no longer serviceable. Reliable operation of these

devices is no longer guaranteed. Implementation of a SCADA system and meter replacement is recommended to assure water plant reliability in the near term.

10. Capacity

The design capacity of the inline mixers and flocculators is 19 mgd, and the filter capacity is 20 mgd. The City is uncertain of the high service and low service pump capacities and plans to complete testing of each in 2014. The WTP rated capacity will be based on the lowest capacity of these elements. That said, there are recommended water main projects in this report that will improve the high service pumping capacity.

B. Storage Facilities

In the entire distribution system (the City and 3 Townships supplied daily), there are five storage tanks plus a ground storage reservoir and clear wells at the treatment plant. The City owns two of the storage tanks, including 5.3 million gallons of ground storage that functions as elevated storage due to the elevation in the system. Data from the two distribution system storage reservoirs is provided in Table 11.

C. Water Distribution Mains

A complex network of water mains provides distribution to City customers. The City limits cover an area of approximately 8.66 square miles, and water customers are supplied through a distribution network consisting of nearly 120 miles of water mains ranging from 4 to 30 inches in diameter. The original system was installed by private parties in 1881 and 1882. The City acquired the system in 1900 and replaced wood mains with iron mains. Currently, the oldest mains were primarily constructed in 1920's and most of the water mains installed in the 1950's and 1960's. The older water main is

nearly all cast iron, while newer water main is ductile iron material. An approximate breakdown of the water mains by size, material and age is presented in Tables 12 through 14.

A network of distribution mains (4-inches and larger) has been constructed throughout the service area. The grid is very well-looped. Transmission is provided to the entire system and to connections with customer communities; however, additional transmission would improve the system efficiency and overall hydraulics.

D. Standby Power

The City of Traverse City owns and maintains permanent standby generators at the WTP and Wayne Hill Booster Station. A 750 KW diesel generator is located at the WTP and is exercised monthly. This generator supports the WTP including the Huron Hills Booster Station plus the Low Lift Pump Station. A 275 KW diesel generator is located at the Wayne Hill Booster Station. This generator powers three 500 gpm booster pumps and is exercised weekly. Details are provided in Table 10.

V. WATER SYSTEM ANALYSIS

A. Water Storage Analysis

1. Existing System

Ten State Standards states in Section 7.01: "Storage facilities should have sufficient capacity, as determined from engineering studies, to meet domestic demands and where fire protection is provided, fire flow demands".

In addition to fire demand, storage tanks must be capable of storing the maximum hour water demand in excess of the maximum day water demand for the period of

time in which the maximum hour water demand occurs. This considers that the water supply system delivers the maximum day water demand.

An analysis was performed with consideration with a conservative estimate of the WWTP capacity during power outage. Storage is more than adequate during higher demand periods. Equalization storage and more than 3,500 gpm of fire flow are available for 3 hour duration from the WTP and elevated storage. Table 15 provides the results of the storage analysis.

2. Future Conditions

The City storage was analyzed for future conditions to determine whether additional storage will be needed. Table 15 projects the recommended storage through Year 2034.

The analysis was completed based on demands and design firm supply capacity. The pumping and storage facilities meet suggested volumes through Year 2034 and beyond. The available fire storage exceeds 3,500 gallons per minute for 3 hours.

B. Distribution System Analysis

Water distribution software, WaterCAD V8i / WaterGEMS, aided the analyzing of the City of Traverse City's water supply system network. Model input data consisted of lengths, sizes, and roughness factors (Hazen-Williams coefficients) for pipes, and ground elevations and demands for nodes, storage tank elevations and volumes, and pump curves and capacities.

1. Model Development

The WATERGEMS model from the 2008 Water System Reliability Study was updated for analysis of the system. Demand data was updated including existing and projected average day, maximum day and fire flow demands. Water mains 4-inch in diameter and greater were included in the model.

Hydrant testing results were used to calibrate the model. A hydrant flow test measures the distribution capabilities of a system by measuring and comparing the static pressure at a given location under typical conditions and the residual pressure at that same location for a given hydrant flow. The test data provides information for model calibration; that is, model parameters can be adjusted so that predicted results compare favorably to measured results. In addition, the test data can provide information to determine locations at which a valve might be partially closed, or locations at which an unknown connection could exist.

Hydrant flow tests were performed by the Insurance Services Office on July 14, 2011. The results of these tests are shown in Table 16. The tests were performed at a variety of locations dispersed throughout the system and provide data to adjust roughness coefficients and demands when necessary to simulate results.

Using the hydrant test data, the model was calibrated as follows:

- Simulate system conditions using initial parameter assumptions from the previous modeling work.
- Adjust water main roughness coefficients and system demand distribution
- Perform a sensitivity analysis on adjusted results
- Fine tune results based on previous steps

Table 17 compares the calibrated model results at the nearest model node to the 10 hydrant test sites. The system operation was simulated for comparison of the test results to the model results. The results for model simulations of the hydrant tests are provided in Table 17.

The hydrant test results are reasonably simulated by the model. Static pressures and residual pressures are within 2 psi and 3 psi, respectively at all test locations, and the results are within 10 percent. Given the limitations in the hydrant test data and fluctuations in system demands, the calibration results can be considered reliable.

Based on the calibration results, the Hazen-Williams coefficient ranges from 40 to 105 for distribution mains (8-inch in diameter or smaller), depending on the age and diameter of the main. This represents the effects of scaling and/or tuberculation. The Hazen-Williams coefficient generally was assumed to be higher but still ranged between 50 and 120 for the larger transmission mains. Recently constructed main throughout the system was assigned a Hazen-Williams coefficient of 130.

2. Existing System

Simulations were performed for various demand conditions using the calibrated model. Resulting pressures were examined to determine the adequacy of the system under high demand. Pressures during maximum day demands and without fires should not fall below 35 psi, nor should pressures in the system exceed approximately 90 to 100 psi.

The available fire flow is generally the standard by which a system is measured since that is typically the highest demand experienced. Typically, the available fire flow represents the flow available at a given location without creating a low pressure

problem anywhere in the system. The minimum system pressure which should be maintained at all times is 20 psi. While recommended fire flows vary based on many factors, the generally suggested fire flows are 1,000 gpm for residential customers, and up to 3,500 gpm for commercial and industrial customers. Based on the available storage and system conveyance, the City provides a 3,500 gpm fire demand to customers.

Results indicate that pressures within the City are adequate throughout the system except for near the Cass Road Booster Station during high demands. The model results show that the system transmission capacity is less than desirable. The high service pumps currently are not operating at their rated capacity due to limitations in the transmission system. A recent transmission improvement on South Cass Road and East Thirteenth Street improved the transmission system; however, additional transmission is recommended.

It is also important to note that high-rise buildings downtown do not always have adequate pressure on top floors. Given the overall pressure to all customers, these buildings must provide booster pumping to maintain pressure. Other nearby communities that also require booster pumps under similar conditions include Grand Haven, Grand Rapids, Ludington, Muskegon and Wyoming.

The 4-inch and 6-inch mains, particularly those with dead ends, restrict the available fire flows to some locations in the system.

As stated above, isolated areas served by older 6-inch diameter and smaller mains cannot achieve the City fire flow demand of 1,000 gpm for residential areas. The

available fire protection could be improved at the selected locations presented in Table 18.

Appendix D includes output of the model results.

3. Future Conditions

Using the model, simulations were performed for future demand conditions to determine where improvements to the existing infrastructure may be needed. All water main Hazen Williams coefficients were reduced for 2019 and 2034 demands to simulate aging. Resulting pressures and available fire flows were reviewed to determine the adequacy of the existing system under future demands.

Table 19 and Table 20 provide a summary of model results for Year 2019 and Year 2034 demands with the existing infrastructure. The results indicate that pressures would again be mostly adequate, but the system transmission capacity would be even more limited due to further aging of water main. Available fire flows will be further reduced from existing fire flow capabilities because of the additional demands on the system from the projected growth of the City over the period. As a result, potential improvements were analyzed to improve the fire protection in the deficient locations.

Appendix D includes output of the model results for Year 2014, 2019 and 2034 simulations.

4. Distribution System Improvement Alternatives

Based on the results of the existing system analysis with future demand projections, improvement alternatives were considered. Many alternatives were considered and then selected and prioritized based on the most cost-effective alternatives to enhance the overall service to the system including fire protection.

Each of the following alternatives provides improved available fire flow to the system, and Figure 7 is a graphic of the potential improvements.

a. Transmission from the Water Treatment Plant (Short Term)

The existing transmission system from the WTP to the City and customer communities is currently a limiting factor for capacity. As shown in Figure 3, the City customer base was relatively flat while the customer communities were growing. However, the increasing demands in customer communities and aging of water main has also caused an increase in energy loss and reduced the high service pumping capacity.

Several routes are available for the transmission main, and these should be reviewed during the design phase. The recommended improvements include the following:

- Construct 16,800 feet of 16" and 24" main on Webster Street, 8th Street, Franklin Street, Lake Street, 7th Street and Spruce Street replacing the existing, older distribution main and providing redundancy of transmission.

- Replace 1,900 feet of aging 6" main on Hannah Avenue with 12" main from Bates Street to South Garfield Avenue.

- Replace 10,000 feet of aging 16" cast iron transmission main on Washington Street, Franklin Street, Front Street, Union Street, West Grandview Parkway and Wayne Street with 24" and 16" main. This project provides redundancy and reliability given the age of the existing transmission main

b. Improved Fire Protection

While the available fire flow for the system is generally adequate, one additional improvement is recommended. The recommended improvements include the following:

- Replace 2,600 feet of 6" and 8" main on Veterans Drive from Georgetown Place to north of 14th Street with 12" main.

One other area with less than desirable fire flows is just west of Madison Street, from Front Street to north of Randolph Street. However, the proposed transmission main crossing the City will improve the available fire flow to desired levels without an additional project. It will also improve pressures in the Commons area.

Model simulations were performed including each of the potential improvements, as well as other alternatives. Simulation results with recommended improvements and Year 2034 demands are summarized in Table 21.

Results show that the pressures and available fire flows throughout the system generally will meet the desired levels for the City of Traverse City. Some multi-floor buildings (3 stories and higher) in the City, however, will continue to need private pumping systems for supply and to meet fire suppression needs.

VI. RELIABILITY ISSUES

A. Redundancy

Redundancy is a critical issue in a complex system such as the City's. Currently, there are several areas that could be improved for better reliability:

- Construction of a new transmission main from the WTP to the west to improve transmission across the system. This will improve suction pressures at the Cass Road Booster Station and will increase the firm capacity of the high service pumps. This main would be parallel to the existing 16" main that crosses the City, which should also be replaced in the longer term since it is rather old.
- Addition of a second transmission main from the low lift pump station to the WTP is recommended to provide redundancy. This would allow for repairs should one be damaged and would increase the potential capacity.
- Similarly, the addition of a second intake provides backup in case of emergency. The existing intake has a greater capacity and is a lower priority.

Otherwise, the system is looped well within the City, providing adequate hydraulics during emergencies.

B. Backup Power

The City of Traverse City owns and operates two permanent standby generators to provide emergency back-up power. The generators are located at the WTP and the Wayne Hill Booster Station. These sites are maintained by City staff and the generators are exercised periodically to assure that the unit is in "ready" condition. Each facility can be operated in an emergency using the generators.

C. Deteriorating Mains

Most of the mains in the City of Traverse City water distribution system were constructed in the 1950's and 1960's. In fact, approximately two-thirds of the system is more than 40-years old, including old 16" cast iron transmission main through the middle of town. In particular, the 6-inch and smaller cast iron mains restrict flow and could potentially be

deteriorating. These older mains and services should be systematically replaced in conjunction with other utility work and whenever possible.

D. Emergency Response (Water Shortage Response) Plan

The City of Traverse City has a Water Shortage Response Plan that addresses water supply needs in an emergency. This plan was originally developed in 1978 and has been updated 9 times since, including in 2013. The cover page and table of contents is provided in Appendix G.

E. Maintenance Programs

The City of Traverse City provides operation and maintenance services on the distribution system. Specific maintenance programs for reliability include:

1. Water Accountability Plan

The City tracks monthly water meter readings in detail, comparing pumping volumes with billing data. This includes detailed accounting of all meters to each of the customer communities. The unbilled volume of water has ranged from 23 percent to 33.5 percent over the past 7 years, as shown in Table 22 and represented graphically in Figure 8. The unbilled water had been relatively steady until the past 2 years when it increased somewhat dramatically to more than 30 percent.

This is a significant volume of water. However, other known unbilled water use such as hydrant flushing, street sweeping, firefighting, and main breaks are not estimated at present. This can represent a substantial volume and should be tracked to better gauge how much water is “lost” since this can have a significant financial impact.

As a result, the City should address this issue to determine whether additional evaluation, such as a leak detection survey, should be completed. We recommend the

City begin estimating unbilled water uses. This is a high priority and should be completed in the short-term.

2. Track Water Use/Evaluate Alternatives to Increase Capacity

The water output is approaching 80 percent of the supply capacity. Once the maximum day exceeds 80 percent, the City should investigate alternatives to increase the supply capacity.

Three actions will likely delay the need for the investigation. Thus, the City can address bullets 1 and 2 in lieu of the investigation until necessary.

- Construction of the short-term proposed water main improvements will increase the water plant capacity. This main will allow high service pumps to provide a higher flow since the system energy losses would be reduced.
- At present, a significant fraction of the output is unaccounted for water. A determination of the water loss and reduction will lessen water output.
- System demands may hold steady or be reduced.

3. Meter Testing/Replacement Program

City customers have Sensus meters which are replaced when they fail. Recently, the City has been replacing approximately 200 to 300 per year, which represents less than 4.0% of the meters in the system. This translates to a changout period of between 25 to 38 years, which is higher than generally recommended but can be considered adequate if believed to be accurate.

Typically, a meter testing and change-out program should consist of testing or replacing all residential meters about every 10 to 15 years. The unbilled water volume

is rather significant; however, known unbilled use should be estimated to determine whether further investigation is needed, which could include an evaluation of the meter accuracy.

Commercial and Industrial meters should be replaced more frequently, and Master meters at interconnects should be checked annually. Additional manpower would likely be required to meet these recommendations.

4. Valve Exercising Program

The City currently exercises valves in advance of operations as time permits. Valve exercising enhances the reliability of the system and improves public protection. Thus, we recommend the City formalize the current program to ensure all valves are operated every other year. This would likely require additional manpower.

5. Flushing Program

The City currently inspects and flushes all hydrants once per year in the fall. The City personnel inspect all hydrants and identify necessary repairs during hydrant flushing.

6. Cross Connection Control Program

The City maintains a Cross-Connection Control Program which must meet MDEQ rules and regulations per Ordinance #1044.13. High priority cross-connections must be inspected annually, medium priority cross-connections must be inspected every 3 years, and low priority cross-connections must be inspected every 5 years.

Device testing must be completed annually. The City has tested cross-connections annually for commercial customers but the cross-connection program for residential

customers must be enhanced. Additional manpower would likely be needed to meet the requirements.

F. Flow into City from the Township

The existing system is designed with the City as the base, low pressure district and booster pumps adding pressure to supply Township customers at higher elevations. There is one location at which flow is pumped to the Township and is bled down through Pressure Relief Valves and eventually returns through a meter back to the City if pressures dictate flow in that direction.

In general, this is not alarming; however, there is one advantage and one disadvantage to note:

Advantage: If there is an emergency and the City High Service Pumps cannot provide the desired flows, the additional stored water in the Township will be available to provide water.

Disadvantage: When water is pumped to the higher pressure district, often to a storage tank, and bled down to a lower pressure district, the water age can be rather significant.

A control valve could be added that only allows flow if pressures drop below 35 psi in the City pressure district. This would not, however, be considered a high priority.

VII. RECOMMENDATIONS FOR IMPROVEMENTS

The following categories of improvements to the City's water system were used to prioritize the recommended system improvements.

A. Recommended Projects

These projects will improve the level of service to City customers by improving system transmission and increasing fire protection in areas that have less than suggested available fire flow.

Short-Term (0-5 Years)

Project 1: Plant Monitoring and Controls Improvements. This includes Supervisory Control and Data Acquisition (SCADA) System Improvements, Flow Meter Replacement for raw water and finished water lines, and Filter 1, 2 & 3 Rate of Flow System Upgrades.

Project 2: Filter 1, 2 & 3 Media Replacement & Surface Wash Upgrades.

Project 3: Replace 11,000 feet of distribution main on Garfield Avenue, Webster Street, 8th Street, Lake Street, 7th Street and Franklin Street with 24" main.

Project 4: Rehabilitate Barlow Reservoir.

Project 5: Electrical Gear Upgrades. The proposed electrical upgrades will include both the WTP and Low Lift Station. Reduced voltage starters are currently used on the four low service pumps and five high service pumps. Besides the benefit of replacing old electrical equipment that is beyond its service life, there are definite energy savings and utility cost reductions to be gained. The merit of upgrading pump control to variable frequency drives (VFD) with compatible motors should be evaluated for each of the nine pumps. Motor replacement on two low service pumps and two high service pumps to accommodate VFD speed adjustment is anticipated.

Project 6: Replace 1,900 feet of aging 6" main on Hannah Avenue with 12" main from Bates Street to South Garfield Avenue.

Long-Term (5-20 years)

Project 7: Chemical System Upgrades (Alum, Chlorine, and Fluoride). The projects address maintaining satisfactory storage and chemical application capabilities.

Project 8: Filter 1, 2 &3 Valve Replacement.

Project 9: Replace 5,800 feet of 12” and 6” main on 7th Street and Spruce Street with 24” main and 16” main.

Project 10: Replace 2,600 feet of 6” and 8” main on Veterans Drive from Georgetown Place to north of 14th Street with 12” main.

Project 11: WTP Standby Generator Replacement. The generator is over 20 years old and is anticipated to reach the end of is useful life within this planning window.

Project 12: Redundant Transmission Main from Low Service Pumps to WTP

Project 13: Replace 10,000 feet of aging 16” cast main on Washington Street, Franklin Street, Front Street, Union Street, W. Grandview Parkway, and Wayne Street with 24” and 16” transmission main.

Project 14: Low Service Pump & High Service Pump Upgrades

Project 15: Construct Second Raw Water Intake

B. General Recommendations

1. Water Accountability Plan (Year 2014-15)

The City should expand the water accountability program, reviewing all potential sources of unbilled (and billed) water use. Tracking the unbilled water will enable the City to confirm whether a significant source of lost revenue exists and must ultimately be identified (potentially with additional action). More specifically, we recommend the City check finished water meters periodically, and consider using only one of these during winter months (low flow periods) due to potential low flow accuracy concerns.

The accountability plan includes estimating all water system usage including water used during emergencies, system flushing and street sweeping, among others. Once these have been estimated and documented over several years, the City should

investigate potential sources of water loss as long if the annual loss is greater than approximately 10 percent. This plan should be part of a system-wide water management strategy.

2. Water Use/Evaluate Alternatives to Increase Capacity (Year 2016-17)

The water supplied is approaching 80 percent of the overall supply capacity. Once the maximum day exceeds 80 percent, the City should investigate alternatives to increase the supply capacity.

Three actions will likely delay the need for the investigation:

- Construction of the short-term proposed transmission main will increase the water plant capacity.
- At present, a significant fraction of the output is unaccounted for water. A determination of the water loss and reduction will provide a reduction in water output.
- System demands may hold steady or be reduced.

We recommend the City address bullets 1 and 2 in lieu of the investigation until necessary.

3. Replace Older, Deteriorating Mains (Year 2014-2034)

Some older, deteriorating mains were addressed with specific recommended Project #12. At present, the remaining older 4- and 6-inch mains are either still able to pass the minimum desired flow for fire protection or can be sufficiently served by nearby hydrants. These small diameter mains are therefore not considered deficient under

current conditions. However, the City should continue its effort to replace all old distribution mains, as well as any other deteriorating mains, with 8-inch mains.

Replacement of other old, small-diameter main should be done in conjunction with other street and utility projects. Significant tuberculation may have occurred on some of these distribution mains; therefore, these should be replaced when other construction is completed in these areas.

4. Meter Testing/Change-out Program (2014-2034)

Given the unaccounted water volume in the system, the City should consider bolstering the meter testing/change-out program. While the City identifies non-billed usage for better water accountability, we recommend determining an appropriate period for meter change-out. For many systems, the testing/change-out period is 3 years for commercial and industrial meters and is 10 years for residential meters. This will help maintain accurate customer billing and could provide a significant increase in system revenue.

5. Valve Exercising Program (2014-2034)

The City currently exercises valves in advance of operations as time permits. We recommend the City formalize the current program to ensure all valves are operated every other year.

6. Flushing Program (2014-2034)

The City currently inspects and flushes all hydrants once per year in the fall. We recommend the City continue to flush annually and consider flushing bi-annually in areas of potential need.

7. Acquire Additional Assistance for Maintenance Activities (2014-2019)

The City currently is not meeting the MDEQ requirements for some maintenance activities. Specifically, the cross-connections inspections have not been completed annual as required, valve turning has not been performed throughout the system on a frequent basis, and meter replacements are needed which could potentially increase the City income substantially. Therefore, we recommend additional manpower be acquired to adequately perform all maintenance activities.

8. Dead End Mains (2014-2034)

Dead end mains should be looped whenever possible. Water tends to become stagnant in dead end mains; this affects the quality of water provided to customers served by the main. Therefore, whenever feasible, dead end mains should be removed by closing loops to improve the circulation of water and increase fire protection capability. Some locations of dead end mains include Centre Place, Fairlane Drive, Medical Campus Drive, Randolph Street and Red Drive.

9. Emergency Response Plan (2014-2034)

The City emergency response plan was updated in 2013 to better ensure proper response in an emergency. The plan, shown in Appendix G, allows for a response to emergencies but should be expanded to include systematic approach to an outbreak or other emergency.

10. Reliability Study (2019)

This report represents the 5-year update of the Water System Reliability Study. Given the uncertainty of growth, demand projections should be reviewed periodically. In

addition, infrastructure and system operation should be evaluated as needed to ensure efficient and cost effective operation.

11. Other Maintenance Programs (2014-2034)

The City should continue current maintenance programs including hydrant flushing, valve exercising and tank maintenance.

12. Obtain Some Level Of Control of Township Systems (Year 2014-2019)

The Traverse City water system is very complex with numerous pressure districts and customer communities. As a result, it is critical that future changes to the customer community systems are reviewed by the City to ensure the supply remains adequate. This can be accomplished many different ways including the development of an authority or requiring plan review in future service agreements.

VIII. COST ESTIMATES

An Opinion of Project Costs has been prepared for each recommended project. Costs for projects of similar size and scope that have been constructed in western Michigan were reviewed for relevant information.

The water main cost estimates have been prepared including an allowance of approximately 25% above the estimated construction cost. This allowance is intended to include the cost of construction contingencies (issues which are presently unknown), legal fees, engineering design and construction services (including preliminary and final design, soil borings, topographic survey, bidding assistance, construction staking, compaction testing, construction observation and project administration during the entire project) and administrative expenses related to the project.

It has been assumed that land is available for construction of the described improvements. No provision has been made in the cost estimate for extraordinary cost of land or right-of-way purchase or easements.

Cost estimates are included in Table 23.

Appendix A

Tables

City of Traverse City
Water System Reliability Study

Table 1
Historic Water Supply Data

Fiscal Year	Average Day Pumpage (mgd)	Maximum Day Pumpage (mgd)	Max/Avg Ratio
2000	4.689	10.499	2.24
2001	4.598	11.200	2.44
2002	4.703	13.006	2.77
2003	4.931	13.336	2.70
2004	4.887	12.160	2.49
2005	4.842	11.394	2.35
2006	5.447	13.655	2.51
2007	5.298	13.696	2.59
2008	5.797	14.771	2.55
2009	5.131	12.056	2.35
2010	4.806	11.652	2.42
2011	5.379	11.122	2.07
2012	6.116	12.290	2.01
2013	6.224	14.060	2.26
5-year Avg.	5.531	12.236	2.22
5-year Max.	6.224	14.060	2.42
10-year Max.	6.224	14.771	2.59
5-year Min.	4.806	11.122	2.01

1. Data based on Traverse City Annual Water Output and & Financial History Report.
2. Water Supply includes water to customer communities as well as the City.
3. Year shown is fiscal year (2013 is 2012-13 fiscal year).

City of Traverse City
Water System Reliability Study

Table 2
Historic Water Billing By Community

Fiscal Year	Total Supplied (mgd)	Traverse City (mgd)	Garfield Township (mgd)	Peninsula Township (mgd)	Elmwood Township (mgd)	Unaccounted For (mgd)
2007	5.298	2.486	1.894	0.124	0.018	0.776
2008	5.797	2.535	1.818	0.116	0.014	1.314
2009	5.131	2.437	1.717	0.14	0.013	0.824
2010	4.806	2.169	1.578	0.134	0.019	0.907
2011	5.379	2.145	1.636	0.127	0.017	1.453
2012	5.887	2.299	1.708	0.159	0.02	1.701
2013	5.995	2.333	1.553	0.16	0.031	1.917
5-year Avg.	5.440	2.277	1.638	0.144	0.02	1.36
5-year Max.	5.995	2.437	1.717	0.16	0.031	1.917
5-year Min.	4.806	2.145	1.553	0.127	0.013	0.824

1. Data based on Traverse City Annual Water Output and & Financial History Report.
2. Water Supply to customer communities based on meter readings.
3. Year shown is fiscal year (2013 is 2012-13 fiscal year).

Table 3
Existing Service Connections and Equivalent Residential Units

Fiscal Year	Service Connections	Residential Equivalent Units
Residential	5,420	5,420
Commercial	1,367	6,872
Total	6,787	12,292

Note: Service Connection data provided by the City for 2013.

City of Traverse City
Water System Reliability Study

Table 4
Usage Totals by Customer Class

Fiscal Year	Commercial (mgd)	Residential (mgd)	Total (mgd)
2009	1.37	1.06	2.43
2010	1.22	0.95	2.17
2011	1.21	0.93	2.14
2012	1.27	1.01	2.28
2013	1.28	1.05	2.32
5-year Avg.	1.27	1.00	2.27
5-year Max.	1.37	1.06	2.43
5-year Min.	1.21	0.93	2.17

1. Data based on Traverse City Revenue Reports
2. Year shown is fiscal year (2013 is 2012-13 fiscal year).

City of Traverse City
Water System Reliability Study

Table 5

Historic and Projected Populations

Year	Grand Traverse County	City of Traverse City		Garfield Twp		Elmwood Twp		Peninsula Township		Total Service Population
		Total	Service	Total	Service	Total	Service	Total	Service	
1970 [1]	39,175	18,048	18,048	4,917		2,240		2,642		
1980 [1]	54,899	15,516	15,516	8,747		3,004		3,833		
1990 [1]	64,273	15,155	15,155	10,516		3,427		4,340		
2000 [1]	77,654	14,532	14,532	13,840		4,264		5,265		
2010 [1]	86,986	14,674	14,674	16,256		4,503		5,433		
2014 [2,3]	91,701	14,736	14,736	17,480	12,899	4,612	256	5,508	1,312	29,185
2019 [2,3]	97,380	14,805	14,805	18,949	13,434	4,736	267	5,593	1,367	30,395
2024 [2,3]	103,121	14,870	14,870	20,426	13,964	4,855	278	5,672	1,421	31,595
2029 [2,3]	108,314	14,924	14,924	21,756	14,438	4,957	287	5,740	1,469	32,666
2034 [2,3]	112,734	14,968	14,968	22,883	14,836	5,039	295	5,794	1,509	33,567

Notes:
1. Population through 2010 based on United States Census data.
2. County population projections based on North Michigan Regional Planning Commission and historic growth.
3. Community population projections based on the recent 10 year growth adjusted to match the historic ratio of growth to the growth rate of the entire County (67%). See Figure 3.
4. See Figure 2 for the location the future service area.

City of Traverse City
Water System Reliability Study

Table 6
Water Use Projections

Year	Demand Projections, mgd		
	Average Day	Maximum Day	Peak Hour
2014	6.44	14.80	25.7
2019	6.70	15.41	26.8
2024	6.97	16.02	27.9
2029	7.20	16.56	28.8
2034	7.40	17.02	29.6

Note: Projections based on historical water use and population growth projections.

Table 7
Low Service Pump Station Pump Data

Pump No.	Year Installed	Location	Type	Nominal Capacity (mgd)	Motor (hp)
1	1965	South Clear Well	Vertical Turbine	5.7	75
2	1965	North Clear Well	Vertical Turbine	5.7	75
3	1993	North Clear Well	Vertical Turbine	8.0	125
4	1973	South Clear Well	Vertical Turbine	8.0	100

Notes: 1. The WTP personnel compiled the equipment inventory on which this table is based.

2. The City intends to have pump tests performed in 2014, therefore nominal capacity listed.

Table 8
High Service Pump Station Pump Data

Pump No.	Year Installed	Location	Type	Nominal Capacity (mgd)	Motor (hp)
1	1964	West Clear Well	Vertical Turbine	3.0	125
2	1964	East Clear Well	Vertical Turbine	5.0	200
3	1964	West Clear Well	Vertical Turbine	5.0	200
4	1964	East Clear Well	Vertical Turbine	7.5	300
5	1993	West Clear Well	Vertical Turbine	7.0	300
6	Future	Space at East Clear Well			

Notes: 1. The WTP personnel compiled the equipment inventory on which this table is based.

2. The City intends to have pump tests performed in 2014, therefore nominal capacity listed.

City of Traverse City
Water System Reliability Study

Table 9
Treatment Plant Element Capacities

Element	Number of Units	Rated Capacity (mgd)
Intake	1	> 20
Low Service Pumps	4	19.4
Rapid Mix	2	19.0
Flocculator Basins	2	19.0
Filters	5	20.0
High Service Pumps	5	20.0

Note: 1. High Service Pumps have a design capacity of 20 mgd; actual capacity is unknown at present but will be tested.
2. Current High and Low Service Pump Capacities to be determined in the field in 2014. Recommended Transmission Capacity Improvements will increase the High Service Pump Capacity.

City of Traverse City
Water System Reliability Study

Table 10
Existing Pump Stations

Site / Location	Huron Hills Booster at WTP	Wayne Hill Booster
Pumps	3	3
Year Installed	1983 (2) 2012 (1)	2005
Type	Vertical Turbine	Centrifugal
Permit Capacity	3 @ 500 gpm	3 @ 500 gpm
Horsepower	60 hp each	75 hp each
Auxiliary Power Type	WTP Generator	Generator
Auxiliary Power Rating	750 KW	275 KW
Auxiliary Power Fuel Type	Diesel	Diesel
Auxiliary Power Capacity	1000 gpm (2 pumps)	1000 gpm (2 pumps)
Auxiliary Power Starting Freq.	Monthly	Weekly

City of Traverse City
Water System Reliability Study

Table 11
Existing Storage Facility Data

Tank Site / Location	Storage at WTP	Wayne Hill Reservoir	Barlow Reservoir
Volume, Gallons	1,500,000	1,300,000	4,000,000
Type	Ground	Ground	Ground
Material	Concrete	Concrete	Steel
Date Constructed	1964	1948	1972
Last Inspection	2002	2006	2002
Last Painted Interior	NA	NA	1972
Last Painted Exterior	NA	NA	1981
Tank Drain	Pump	Hydrant	Hydrant
Cathodic Protection	No	No	Yes
Altitude Valve	No	Yes	No

City of Traverse City
Water System Reliability Study

Table 12
Water Main Sizes and Lengths

Water Main Diameter (inches)	Approximate Length of Water Main (feet)	Approximate Length of Water Main (miles)	Percentage of Total (%)
< 6	7,176	1.4	1.1
6	340,602	64.5	53.5
8	77,728	14.7	12.2
10	28,959	5.5	4.6
12	115,395	21.9	18.1
16	23,385	4.4	3.7
18	1,279	0.2	0.2
20	6,768	1.3	1.1
24	20,059	3.8	3.2
30	14,801	2.8	2.3
Total	636,152	120.5	100

Source: City of Traverse City GIS

Table 13
Water Main Materials

Type Distribution	Approximate Length of Water Main (feet)	Approximate Length of Water Main (miles)	Percentage of Total (%)
Cast Iron	441,230	83.6	69.4
Ductile Iron	190,622	36.1	30.0
Steel	3,393	0.6	0.5
Other	587	0.1	0.09
HDPE	320	0.06	0.05
Total	636,152	120.5	100

Source: City of Traverse City GIS

City of Traverse City
Water System Reliability Study

Table 14
Approximate Water Main Age

Year Installed	Approximate Length of Water Main (feet)	Approximate Length of Water Main (miles)	Percentage of Total (%)
1881-1929	3,608	0.7	0.6
1930-1939	6,171	1.2	1.0
1940-1949	24,734	4,7	3.9
1950-1959	127,625	24.2	20.1
1960-1969	234,583	44.4	36.9
1970-1979	36,766	7.0	5.8
1980-1989	13,223	2.5	2.1
1990-1999	48,477	9.2	7.6
2000-2009	80,933	15.3	12.7
2010-2013	9,484	1.8	1.5
Unknown	50,548	9.6	7.9
Total	636,152	120.5	100

Source: City of Traverse City GIS

City of Traverse City
Water System Reliability Study

Table 15
Storage Analysis Summary

Year	Firm Pump Capacity (gpm)	Maximum Day Demand (gpm)	Peak Hour Demand (gpm)	Suggested Fire-Flow[1] (gpm)	Duration[1] (hours)	Water Supplied[2] (gallons)	Typical Customer Demand[3] (gallons)	Fire Demand[4] (gallons)	Recommended Storage Vol. (gallons)	Storage Volume Provided (gallons)	Recommended Additional Storage Vol. (gallons)
2014	5,565	10,278	17,875	1,000	2	668,000	1,689,000	120,000	1,141,000	5,300,000	0
2014	5,565	10,278	17,875	2,500	2	668,000	1,689,000	300,000	1,321,000	5,300,000	0
2014	5,565	10,278	17,875	3,500	3	1,002,000	2,306,000	630,000	1,934,000	5,300,000	0
2019	5,565	10,722	18,613	1,000	2	668,000	1,760,000	120,000	1,212,000	5,300,000	0
2019	5,565	10,722	18,613	2,500	2	668,000	1,760,000	300,000	1,392,000	5,300,000	0
2019	5,565	10,722	18,613	3,500	3	1,002,000	2,403,000	630,000	2,031,000	5,300,000	0
2024	5,565	11,145	19,348	1,000	2	668,000	1,830,000	120,000	1,282,000	5,300,000	0
2024	5,565	11,145	19,348	2,500	2	668,000	1,830,000	300,000	1,462000	5,300,000	0
2024	5,565	11,145	19,348	3,500	3	1,002,000	2,498,000	630,000	2,126,000	5,300,000	0
2029	5,565	11,523	20,004	1,000	2	668,000	1,892,000	120,000	1,344,000	5,300,000	0
2029	5,565	11,523	20,004	2,500	2	668,000	1,892,000	300,000	1,524,000	5,300,000	0
2029	5,565	11,523	20,004	3,500	3	1,002,000	2,583,000	630,000	2,211,000	5,300,000	0
2034	5,565	11,841	20,556	1,000	2	668,000	1,944,000	120,000	1,396,000	5,300,000	0
2034	5,565	11,841	20,556	2,500	2	668,000	1,944,000	300,000	1,576,000	5,300,000	0
2034	5,565	11,841	20,556	3,500	3	1,002,000	2,654,000	630,000	2,282,000	5,300,000	0

Notes:
1. Fire demand and duration based on Table 1-1 of AWWA M-31 Manual
2. Water Supply Volume based on firm capacity for the given duration
3. Customer Demand Volume based on one hour of peak demand and maximum day demands for the remaining duration.
4. Emergency Storage based on Fire Flow Demand over the duration.
5. Example Calculation: Year 2034

   Firm Pump Capacity = 5,565gpm (Conservative estimate of the High Service Pump Capacity during a power outage)
   Maximum Day Demand = 2034 projected max day demand (17.0 mgd) ÷ 24hrs/day ÷ 60min/hr = 11,841 gpm
   Peak Hour Demand = 2034 projected peak hour demand (29.5 mgd) ÷ 24 ÷ 60 = 20,556 gpm
   Water Supplied = limited pump capacity x duration = 5,565 gpm x 2hrs x 60min/hr = 668,000 gal
   Typ Customer Demand=1hr of peak hour demand+1hr of max day demand=1hr x 20,515 gpm + 1hr x 11,817gpm = 1,944,000 gal
   Fire Demand = standard fire flow x duration = 1000gpm x 2hr x 60min/hr = 120,000gal
   Recommended Stor Vol = Typ. Customer Demand + Fire Demand - Water Supplied = 1,944,000 + 120,000 – 668,000 = 1,396,000gal
   Storage Volume Provided = total of two storage tanks = 5,300,000 gallons
   Recommended Additional Storage Volume = Recommended Storage Volume - Storage Volume Provided = 0

City of Traverse City
Water System Reliability Study

Table 16
Hydrant Test Results

Hydrant Test No.	Static Hydrant Location(s)	Hydrant Flow (gpm)	Static Pressure (psi)	Residual Pressure (psi)
1	Seventh St & Union St	1850	55	47
2	M-72 & Bay Street	2890	62	44
3	Fourteenth St & Maple St	2660	53	41
4	Front St & Barlow St	1670	72	38
5	Garfield Ave & Kinross St	1330	60	50
6	Munson Ave & Davis St	2010	67	40
7	Huron Hills Dr, 2nd N of Timber Ln	920	87	68
8	Cass St & Eleventh St	950	54	49
9	Avenue B, 1st N of Indian Trails Blvd	930	54	46
10	Airport Access Rd, 1st S of Parsons	1020	52	46

Notes: ISO hydrant test results from July 14, 2011

City of Traverse City
Water System Reliability Study

Table 17
Comparison of Calibrated Model to Field Test Pressures

Hydrant Test No.	Test Location Node	Hydrant Test Location(s)	Hydrant Test Flow (gpm)	Static Pressure (psi)		Residual pressure (psi)	
				Field Results	Model Results	Field Results	Model Results
1	T272	Seventh St & Union St	1850	55	55	47	50
2	T022	M-72 & Bay Street	2890	62	61	44	47
3	T244	Fourteenth St & Maple St	2660	53	52	41	40
4	T041	Front St & Barlow St	1670	72	72	38	39
5	T357	Garfield Ave & Kinross St	1330	60	59	50	53
6	T414	Munson Ave & Davis St	2010	67	67	40	41
7	T568	Huron Hills Dr, 2nd N of Timber Ln	920	87	85	68	70
8	T303 (e)	Cass St & Eleventh St	950	54	54	49	49
9	T190	Avenue B, 1st N of Indian Trails Blvd	930	54	54	46	47
10	T322 (s)	Airport Access Rd, 1st S of Parsons	1020	52	52	46	45

Notes: 1. Hydrant tests were performed on July 14, 2011.

2. Simulations assume 2 pumps operating at WTP

City of Traverse City
Water System Reliability Study

Table 18
Model Results for Existing Conditions

Jct Number	Location	Pressure (psi)			Available Fire Flow (gpm)
		Average Day Demands	Maximum Day Demands	Peak Hour Demands	
J-T063	N. Cedar & Randolph	69	64	59	3,500+
J-T147	S. Cedar & Seventh	65	60	55	3,500+
J-T051	Third & Oak	70	65	60	2,560
J-T281	Wadsworth & Ninth	62	56	51	3,500+
J-T321	Tenth & Lake	60	55	49	1,350
J-T216	Eleventh & Division	62	57	52	1,270
J-T283	Union & Thirteenth	60	55	50	3,500+
J-T480	Sixteenth & Veterans	96	93	88	1,540
J-T024	Wellington & Front	76	70	63	3,500+
J-T074	Hope & State	74	67	61	1,940
J-T072	Front & State	71	64	59	3,070
J-T229	Washington & Michigan	68	62	55	3,500+
J-G759	19th & Center Lane	72	69	64	1,180
J-T271	Eighth & Fair	80	74	67	3,500+
J-T414	Davis & Munson	81	75	68	3,320
J-T291	Lincoln & Rose	71	65	57	2,690
J-T439	Baldwin & Barlow	74	68	62	3,500+
J-T380	Garfield & Baldwin	68	62	55	3,500+
J-T350	Hastings & Centre	70	63	56	2,060
J-T488	Randolph & Fulton	47	43	38	600
J-T269	Front & Miliken	87	80	73	3,330
J-T464	Cass, south of Seventeenth	53	47	42	3,500+
J-T348	Cherokee & Ramsdell	61	56	52	1,240

Notes:
1. Average Day and Max Day Demand Pressures are based on Barlow 25' in summer, Wayne Hill at 15' and pumps meeting demand.
2. Available Fire Flow is the highest expected flow during maximum day demands while maintaining 20 psi residual pressure in the pressure district. Simulations also assume all but the largest pump is operating at WTP.
3. ISO typically suggests an available fire flow 1,000-1,500 gpm for Residential Areas. The recommended available fire flows represents that necessary for full credit toward insurance rating, but is not required.
4. Locations represent the extremities of the system plus other important locations within the City.

City of Traverse City
Water System Reliability Study

Table 19
Model Results for Year 2019 Demands with Existing Infrastructure

Jct Number	Location	Pressure (psi)			Available Fire Flow (gpm)
		Average Day Demands	Maximum Day Demands	Peak Hour Demands	
J-T063	N. Cedar & Randolph	74	64	59	3,500+
J-T147	S. Cedar & Seventh	70	60	54	3,500+
J-T051	Third & Oak	75	64	59	2,550
J-T281	Wadsworth & Ninth	67	56	50	3,500+
J-T321	Tenth & Lake	65	55	48	1,340
J-T216	Eleventh & Division	67	57	51	1,270
J-T283	Union & Thirteenth	65	55	49	3,500+
J-T480	Sixteenth & Veterans	97	93	87	1,530
J-T024	Wellington & Front	82	69	63	3,500+
J-T074	Hope & State	79	67	60	1,940
J-T072	Front & State	76	64	58	3,050
J-T229	Washington & Michigan	74	61	54	3,500+
J-G759	19th & Center Lane	73	70	69	1,170
J-T271	Eighth & Fair	85	74	66	3,500+
J-T414	Davis & Munson	85	75	67	3,310
J-T291	Lincoln & Rose	77	64	56	2,670
J-T439	Baldwin & Barlow	78	68	61	3,500+
J-T380	Garfield & Baldwin	73	61	54	3,500+
J-T350	Hastings & Centre	75	63	55	2,050
J-T488	Randolph & Fulton	51	42	37	600
J-T269	Front & Miliken	91	80	72	3,320
J-T464	Cass, south of Seventeenth	57	47	41	3,500+
J-T348	Cherokee & Ramsdell	66	56	51	1,230

Notes:
1. Average Day and Max Day Demand Pressures are based on Barlow 25' in summer, Wayne Hill at 15' and pumps meeting demand
2. Available Fire Flow is the highest expected flow during maximum day demands while maintaining 20 psi residual pressure in the pressure district. Simulations also assume all but the largest pump is operating at WTP.
3. ISO typically suggests an available fire flow 1,000-1,500 gpm for Residential Areas. The recommended available fire flows represents that necessary for full credit toward insurance rating, but is not required.
4. Locations represent the extremities of the system plus other important locations within the City.

City of Traverse City
Water System Reliability Study

Table 20
Model Results for Year 2034 Demands with Existing Infrastructure

Jct Number	Location	Pressure (psi)			Available Fire Flow (gpm)
		Average Day Demands	Maximum Day Demands	Peak Hour Demands	
J-T063	N. Cedar & Randolph	68	63	56	3,500+
J-T147	S. Cedar & Seventh	65	59	52	3,500+
J-T051	Third & Oak	69	64	57	2,510
J-T281	Wadsworth & Ninth	61	55	48	3,500+
J-T321	Tenth & Lake	60	54	46	1,320
J-T216	Eleventh & Division	62	56	48	1,250
J-T283	Union & Thirteenth	60	54	47	3,500+
J-T480	Sixteenth & Veterans	96	92	85	1,510
J-T024	Wellington & Front	75	69	60	3,500+
J-T074	Hope & State	73	66	57	1,910
J-T072	Front & State	70	63	55	2,990
J-T229	Washington & Michigan	68	61	52	3,500+
J-G759	19th & Center Lane	73	68	67	1,150
J-T271	Eighth & Fair	80	73	64	3,500+
J-T414	Davis & Munson	80	74	65	3,270
J-T291	Lincoln & Rose	71	63	54	2,630
J-T439	Baldwin & Barlow	73	67	59	3,500+
J-T380	Garfield & Baldwin	67	60	51	3,500+
J-T350	Hastings & Centre	69	62	53	2,030
J-T488	Randolph & Fulton	47	42	35	590
J-T269	Front & Miliken	86	79	70	3,280
J-T464	Cass, south of Seventeenth	52	47	39	3,500+
J-T348	Cherokee & Ramsdell	61	55	49	1,220

Notes:
1. Average Day and Max Day Demand Pressures are based on Barlow 25' in summer, Wayne Hill at 15' and pumps meeting demand
2. Available Fire Flow is the highest expected flow during maximum day demands while maintaining 20 psi residual pressure in the pressure district. Simulations also assume all but the largest pump is operating at WTP.
3. ISO typically suggests an available fire flow 1,000-1,500 gpm for Residential Areas. The recommended available fire flows represents that necessary for full credit toward insurance rating, but is not required.
4. Locations represent the extremities of the system plus other important locations within the City.

City of Traverse City
Water System Reliability Study

Table 21
Model Results for Year 2034 Demands with Recommended Projects

Jct Number	Location	Pressure (psi)			Available Fire Flow (gpm)
		Average Day Demands	Maximum Day Demands	Peak Hour Demands	
J-T063	N. Cedar & Randolph	68	63	57	3,500+
J-T147	S. Cedar & Seventh	65	59	53	3,500+
J-T051	Third & Oak	69	64	57	2,510
J-T281	Wadsworth & Ninth	61	55	48	3,500+
J-T321	Tenth & Lake	60	54	47	1,330
J-T216	Eleventh & Division	62	56	49	1,250
J-T283	Union & Thirteenth	60	54	47	3,500+
J-T480	Sixteenth & Veterans	96	92	86	3,500+
J-T024	Wellington & Front	75	68	60	3,500+
J-T074	Hope & State	72	66	58	1,910
J-T072	Front & State	70	63	56	2,990
J-T229	Washington & Michigan	67	60	52	3,500+
J-G759	19th & Center Lane	70	68	62	1,770
J-T271	Eighth & Fair	79	73	64	3,500+
J-T414	Davis & Munson	80	74	66	3,260
J-T291	Lincoln & Rose	70	63	54	2,620
J-T439	Baldwin & Barlow	73	67	59	3,500+
J-T380	Garfield & Baldwin	67	60	52	3,500+
J-T350	Hastings & Centre	69	62	53	2,020
J-T488	Randolph & Fulton	47	42	36	1,510
J-T269	Front & Miliken	86	79	71	3,270
J-T464	Cass, south of Seventeenth	52	46	40	3,500+
J-T348	Cherokee & Ramsdell	61	55	49	1,220

Notes:
1. Average Day and Max Day Demand Pressures are based on Barlow 25' in summer, Wayne Hill at 15' and pumps meeting demand
2. Available Fire Flows are based on maximum day demands and with all but largest pumps operating at WTP
3. ISO typically suggests an available fire flow 1,000-1,500 gpm for Residential Areas. The recommended available fire flows represents that necessary for full credit toward insurance rating, but is not required.
4. Locations represent the extremities of the system plus other important locations within the City.

City of Traverse City
Water System Reliability Study

Table 22
History of Total Unaccounted-For Water

Year	Total Pumped, million gallons	Billed Volume, million gallons	Percent Unbilled Water
2006-07	2,193.769	1,666.528	24.0%
2007-08	2,151.748	1,655.805	23.1%
2008-09	2,083.219	1,588,799	23.7%
2009-10	1,935.628	1,439.048	25.7%
2010-11	1,963.266	1,452.225	26.0%
2011-12	2,232.310	1,554.534	30.4%
2012-13	2,271.942	1,510.961	33.5%

Note: Of the unbilled portion shown, up to 0.04% has been used at the WTP.

City of Traverse City
Water System Reliability Study

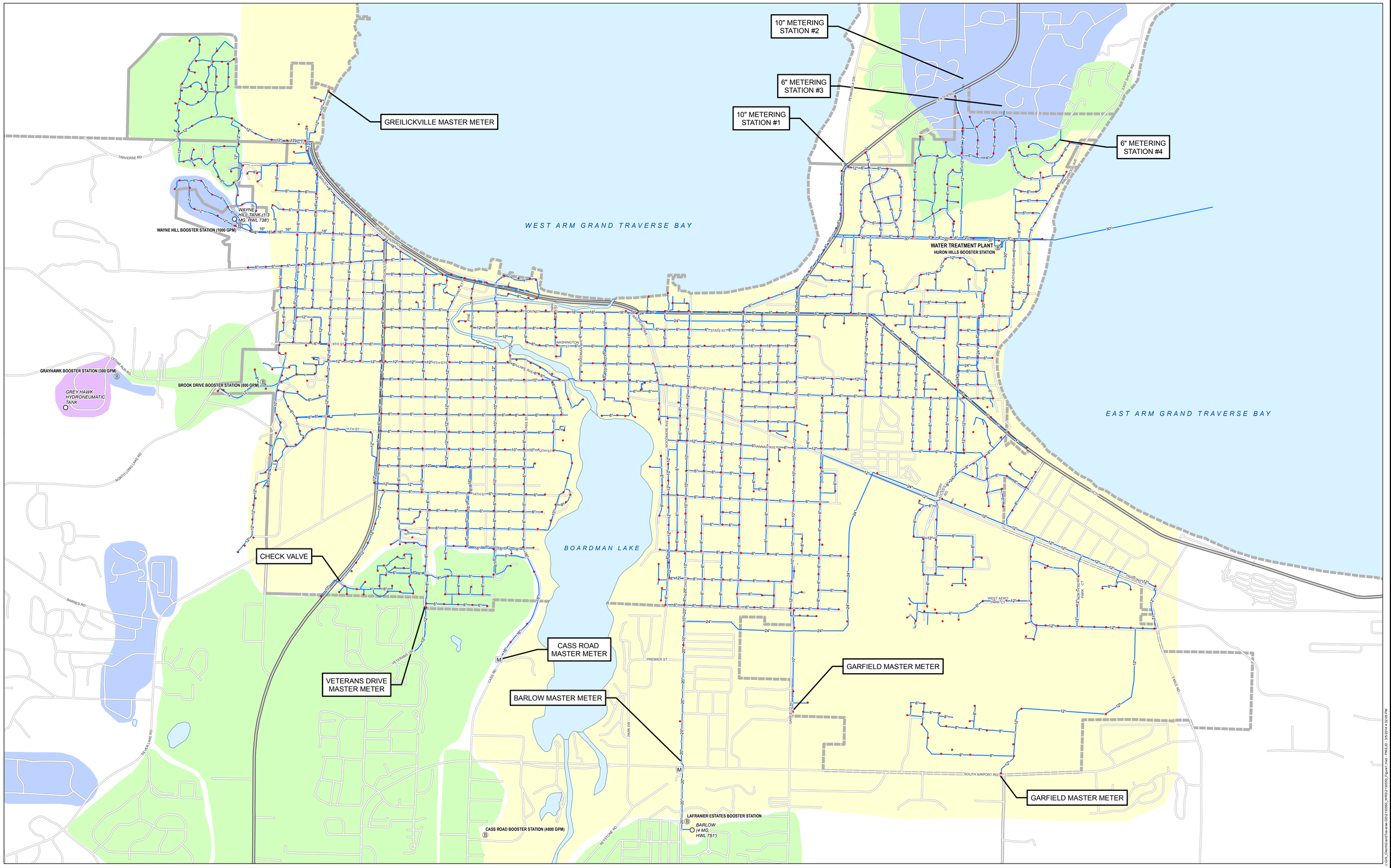
Table 23
Cost Opinions for Recommended Improvements

Improvement Project	Opinion of Probable Project Cost	Time Frame (Years)
P-1 Plant Monitoring and Controls Improvements	$ 800,000	2014-15
P-2 Filter 1, 2 & 3 Media Replacement & Surface Wash Upgrades	$ 350,000	2014-15
P-3 Construct 11,000 feet of 24" Transmission Main Across the City (Phase 1)	$ 2,400,000[4]	2014-18
P-4 Rehabilitate Barlow Reservoir	$ 1,000,000	2014-15
P-5 Electrical Gear Upgrades at WTP and Low Lift Station	$ 850,000	2014-16
P-6 Replace 1,900 feet of aging 6" main on Hannah Avenue with 12" main from Bates Street to South Garfield Avenue.	$ 310,000	2017
P-7 Chemical System Upgrades (Alum, Chlorine, and Fluoride)	$ 250,000	2019-24
P-8 Filter 1, 2 & 3 Valve Replacement	$ 400,000	2019-24
P-9 Construct 5,800 feet of 24"and 16" Transmission Main Across the City (Phase 2)	$ 1,090,000[4]	2019-24
P-10 Construct 2,600 feet of 12" Transmission Main on Veterans Drive, from Georgetown Place to north of 14th Street	$ 400,000	2019-24
P-11 WTP Standby Generator Replacement	$ 250,000	2024-29
P-12 Redundant Transmission Main from Low Lift Pumps to WTP	$ 500,000	2024-29
P-13 Replace 10,000 feet of aging 16" cast main on Washington Street, Franklin Street, Front Street, Union Street, W. Grandview Parkway, and Wayne Street with 24" and 16" transmission main.	$ 2,000,000[4]	2029-34
P-14 Low Service Pump & High Service Pump Upgrades	$ 2,000,000	2029-34
P-15 Construct Second Raw Water Intake	$ 4,000,000	2029-34
Grand Total	$ 16,600,000	

Notes: 1. Opinion of Cost includes 25 percent allowance for legal and administrative costs, engineering & contingencies.
2. The Opinion of Cost is based on current dollars.
3. Water Treatment Projects less than $100,000 not included.
4. Opinion of Cost dependent on route of transmission.

Appendix B

Figures



CITY OF TRAVERSE CITY
WATER RELIABILITY STUDY

WATER DISTRIBUTION SYSTEM

FIGURE 1

Prein&Newhof
2130550

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PENINSULA TOWNSHIP

GARFIELD TOWNSHIP

TRAVERSE CITY

1100

1000

875

750

1200

10" METERING STATION #2

6" METERING STATION #3

10" METERING STATION #1

6" METERING STATION #4

CHECK VALVE (TYP.)

WATER TREATMENT PLANT

GREILICKVILLE MASTER METER

VETERANS DRIVE MASTER METER

CASS ROAD MASTER METER

BARLOW MASTER METER

GARFIELD MASTER METER

BARLOW GROUND STORAGE TANK
4.0 MG
HWL 750.0

750 375 0 750 1,500
1 " = 1,500 '

LEGEND

- PRESSURE REDUCING VALVE
- STORAGE TANK
- BOOSTER STATION
- EXISTING SERVICE AREA

WATER MAIN: 6", 8", 10", 12", 14", 16", 18", 20", 24", 30"

PROPOSED PRESSURE DISTRICTS: 750, 875, 1000, 1100

EX. PRESSURE DISTRICTS: 740, 850-875, 1000, 1090, 1150

CITY OF TRAVERSE CITY
WATER RELIABILITY STUDY

SERVICE AREA BOUNDARY & PRESSURE DISTRICTS

FIGURE 2

Prein&Newhof

2130550

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FIGURE 3

City of Traverse City
Population Data and Projection

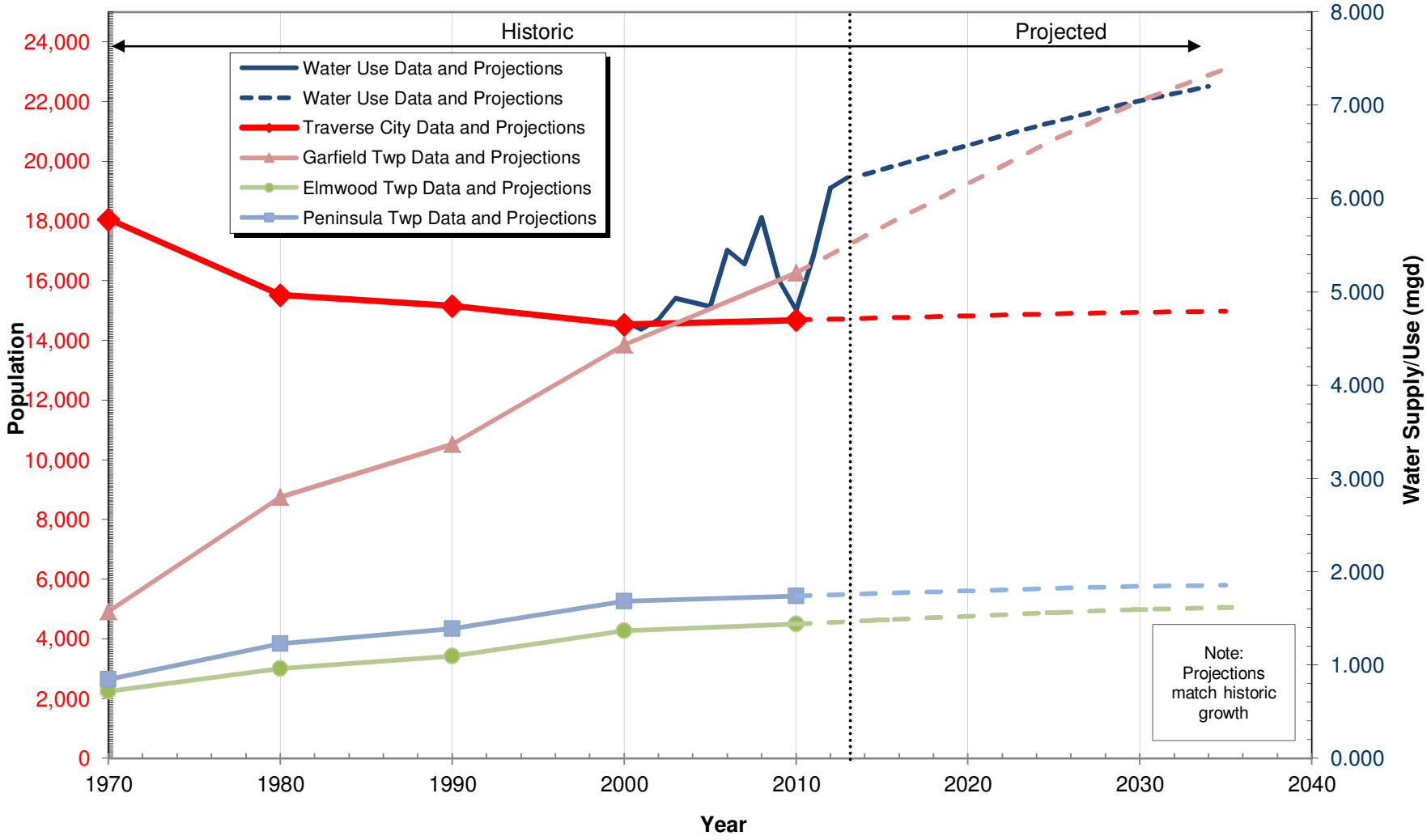
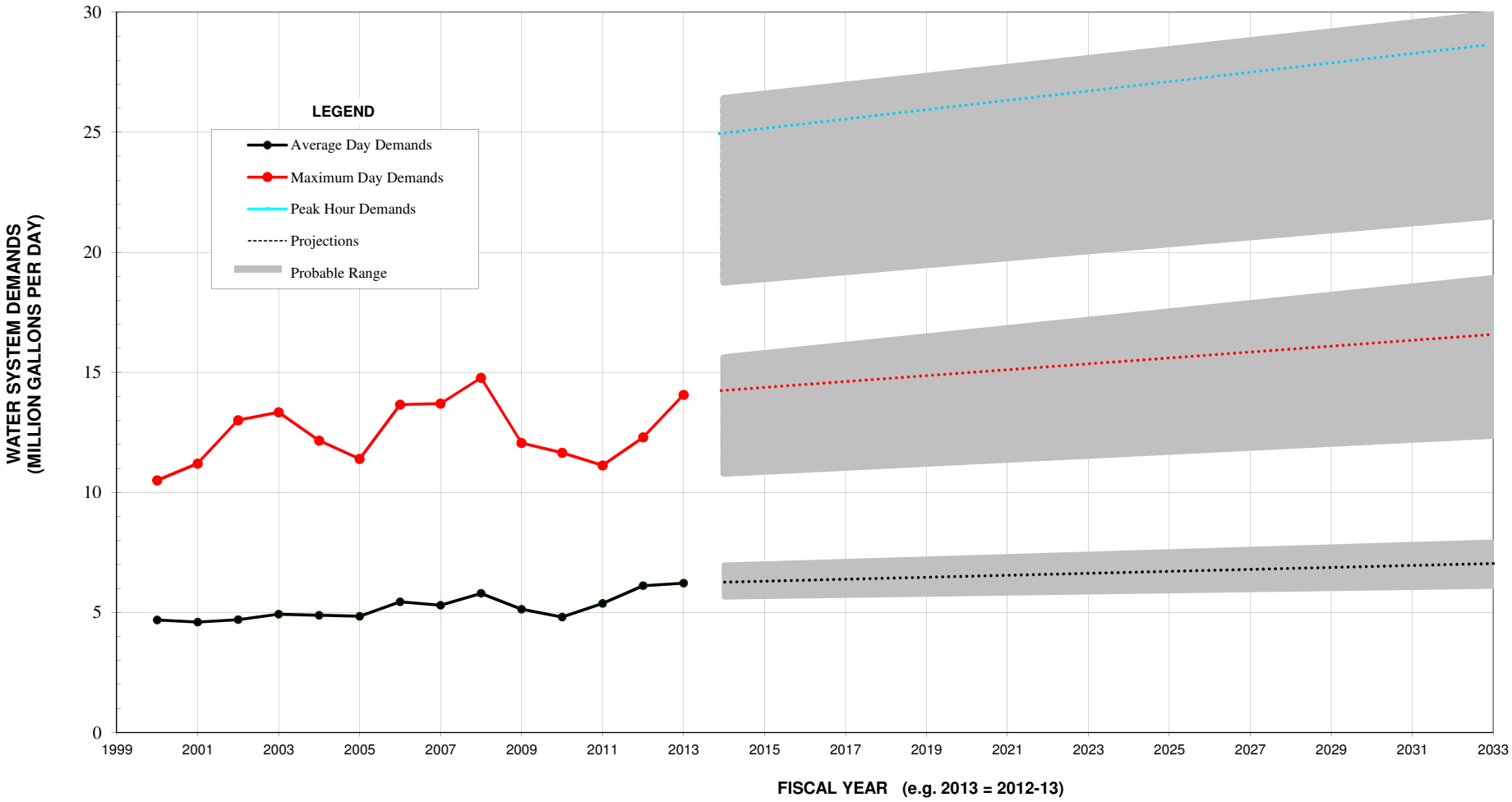
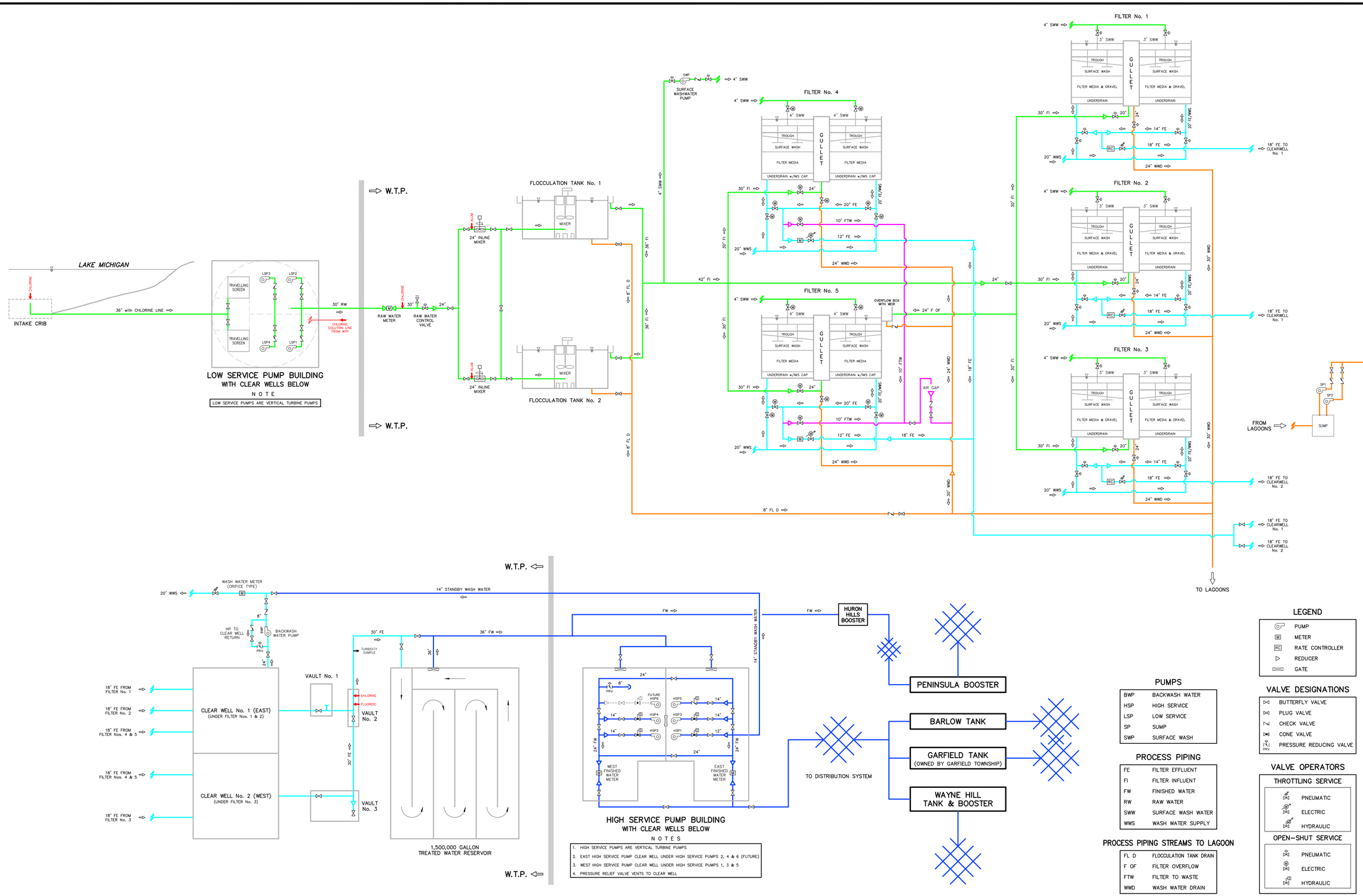


FIGURE 4

City of Traverse City
Historic And Projected Water System Demands





NO.	R E V I S I O N S	BY	DATE

DRAWN: SMYTH
DATE: JAN. '14
CHECKED: C.A.P.
DATE: JAN. '14

Prein&Newhof
Engineers ▪ Surveyors ▪ Environmental ▪ Laboratory

TRAVERSE CITY WATER SYSTEM RELIABILITY
TRAVERSE CITY, MICHIGAN

WATER TREATMENT PLANT

FLOW SCHEMATIC

PROJECT NO. 2130550

FIGURE NO. 5

PENINSULA TOWNSHIP | TRAVERSE CITY | GARFIELD TOWNSHIP

HYDRAULIC GRADE LINE

9 PRV's NOT ALL SHOWN

PRV 873 845 | PRV 873 840 | PRV 873 781 | PRV 873 794

PRV 1087 981

PRV 1007 INCOCHEE #1

PRV #2 708

PRV 1007 MORGAN FARMS #1 708

875 | 738

879 879 895 | 751

PRV 980 950 CASS RD. | PRV 950 McRAE HILLS 858 804 | 708

1170 | 940

PRV 1090 SILVER FALLS PRV 890

PRV 1090 SUMMIER HILL PRV 975

PRV 1090 SURGE SUPPRESSOR 975

PRV 1090 #2 COPPER RIDGE #2 995

1090 | 1153

GRD 850 850

GRD 800

GRD 600–750

ELEVATION (FEET)

1200 1100 1000 900 800 700 600 500 400

0 5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000 60,000 65,000 70,000 75,000

DISTANCE (FEET)

WATER TREATMENT PLANT (EL. 600'+/-)

HURON HILLS BOOSTER STATION

BROOKS DRIVE BOOSTER STATION

GRAYHAWK BOOSTER STATION

WAYNE HILL TANK (1.30 MG)

WAYNE HILL BOOSTER (2,200 GAL. HYDROPNEUMATIC TANK)

BARLOW TANK (4.00 MG)

LaFRANIER BOOSTER STATION

BIRMLEY ELEVATED STORAGE TANK (0.3 MG)

TRADITIONS BOOSTER STATION

CASS ROAD (EL. 620'+/-)

CASS ROAD BOOSTER STATION

McRAE TANK (2.25 MG, BURIED)

SILVER PINES BOOSTER STATION

HERITAGE ESTATES STANDPIPE (0.30 MG)

HERKNER BOOSTER STATION

TRAVERSE CITY WATER SYSTEM RELIABILITY

TRAVERSE CITY, MICHIGAN

HYDRAULIC GRADIENT

FIGURE 6

Prein&Newhof

2130550

500 250 0 500 1,000

1 " = 1,000 '

LEGEND

- STORAGE TANK
- BOOSTER STATION
- HYDRANT
- MAINLINE VALVE
- MASTER METER VALVE
- EXISTING SERVICE AREA
- DISTRIBUTION MAIN
- PROPOSED IMPROVEMENT PROJECT
- FIRE PROTECTION DEFICIENCIES

CITY OF TRAVERSE CITY

WATER RELIABILITY STUDY

WATER DISTRIBUTION SYSTEM GENERAL PLAN

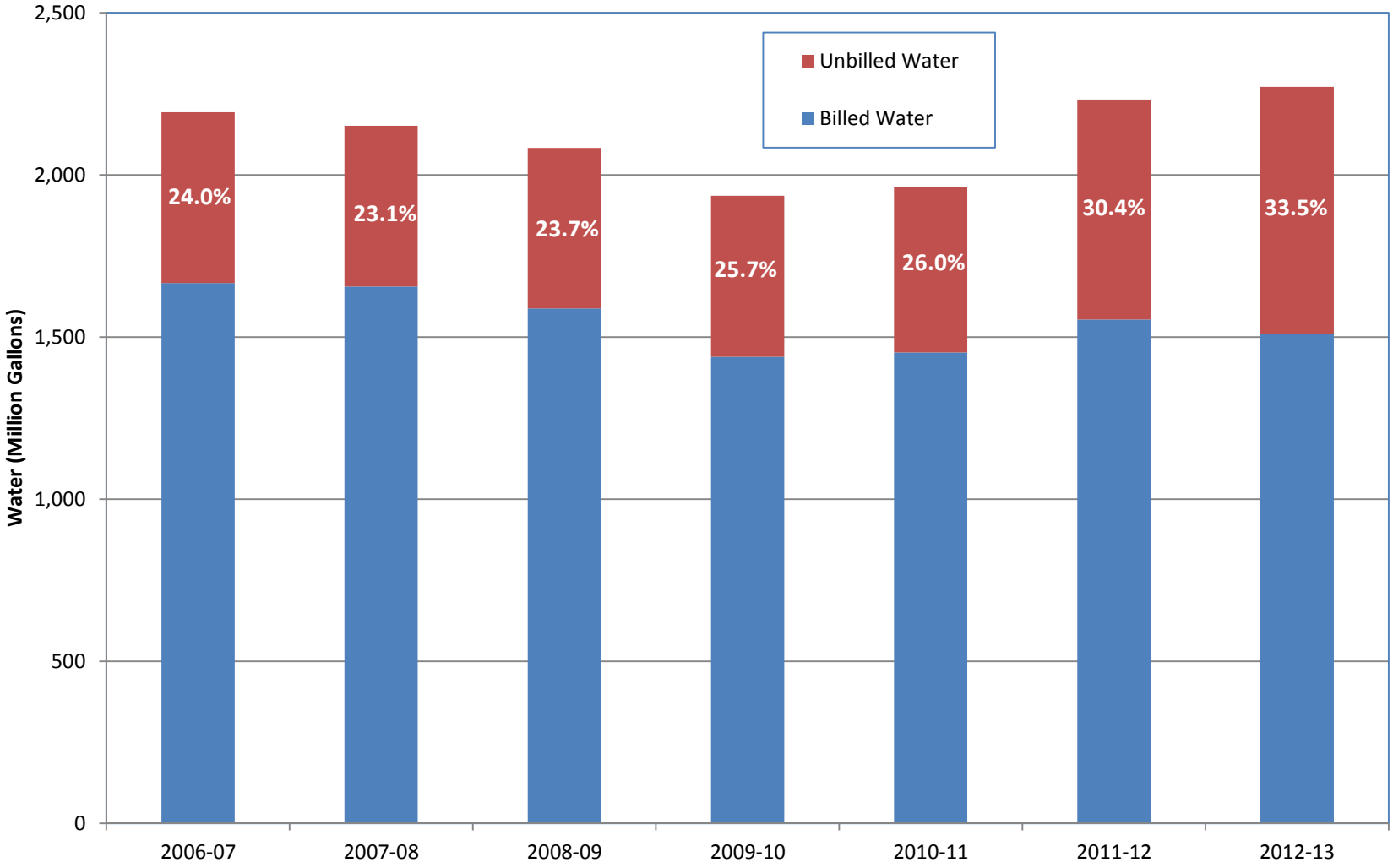
FIGURE 7

Prein&Newhof

2130550

FIGURE 8

City of Traverse City
Historic Water Loss Data

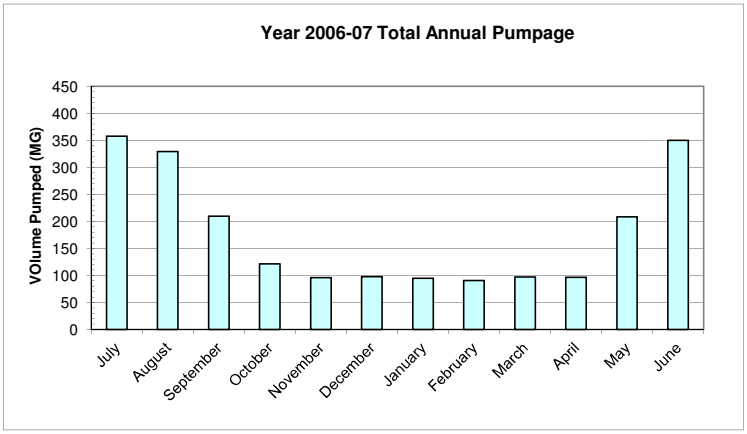


Appendix C

Monthly Water Supply Data

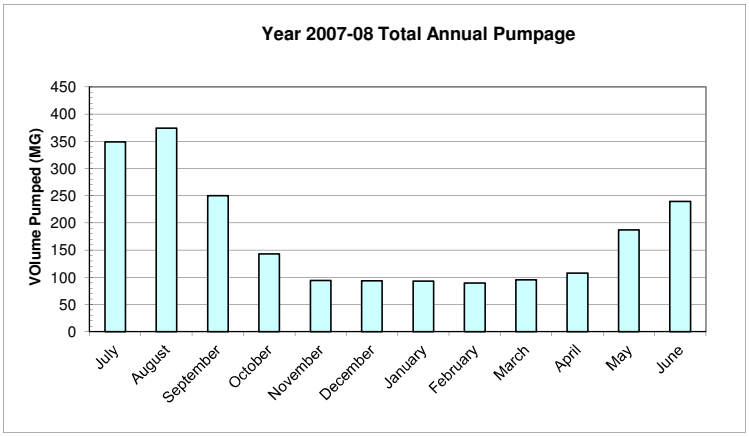
Annual Pumpage 2006-07

Month	Trav. City (mg billed)	Total Output (mg)
July	107.508	357.947
August	130.481	329.247
September	118.219	209.908
October	80.435	121.411
November	63.121	96.099
December	50.248	97.770
January	56.304	94.813
February	45.113	90.360
March	46.401	97.116
April	49.686	96.729
May	54.167	208.655
June	105.621	350.114
Annual Huron Hills Booster Pumpage (mg)		43.142
Annual Water Plant Metered Usage (mg)		0.458
Total Yearly Volume (mg)		2193.77
Average Daily Pumpage (mgd)		6.010



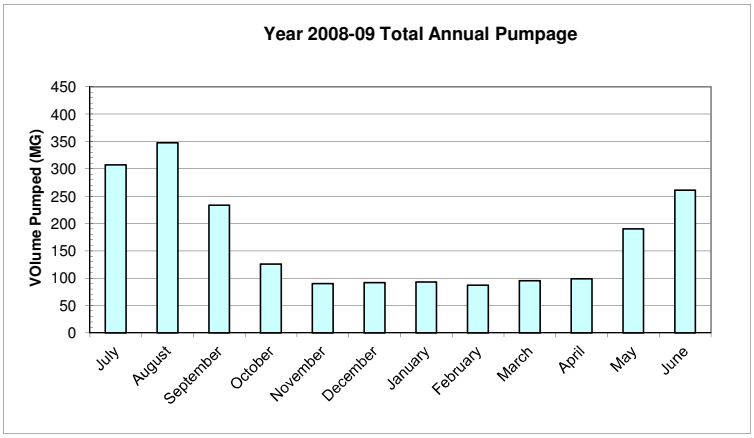
Annual Pumpage 2007-08

Month	Trav. City (mg billed)	Total Output (mg)
July	121.455	348.601
August	144.260	373.928
September	131.759	250.093
October	97.562	142.843
November	61.661	93.813
December	43.887	93.250
January	51.217	92.635
February	47.720	89.545
March	47.227	95.187
April	48.508	107.520
May	56.110	187.081
June	76.379	239.163
Annual Huron Hills Booster Pumpage (mg)		37.495
Annual Water Plant Metered Usage (mg)		0.594
Total Yearly Volume (mg)		2151.75
Average Daily Pumpage (mgd)		5.895



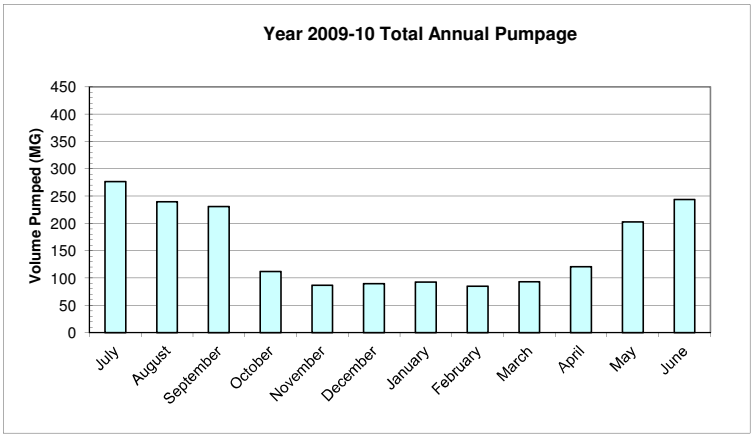
Annual Pumpage 2008-09

Month	Trav. City (mg billed)	Total Output (mg)
July	103.525	307.379
August	138.735	347.435
September	117.616	233.703
October	95.711	125.760
November	58.621	90.030
December	45.268	91.840
January	47.078	93.225
February	44.066	86.975
March	46.045	95.553
April	42.847	98.999
May	53.667	189.853
June	96.412	260.950
Annual Huron Hills Booster Pumpage (mg)		61.087
Annual Water Plant Metered Usage (mg)		0.430
Total Yearly Volume (mg)		2083.22
Average Daily Pumpage (mgd)		5.707



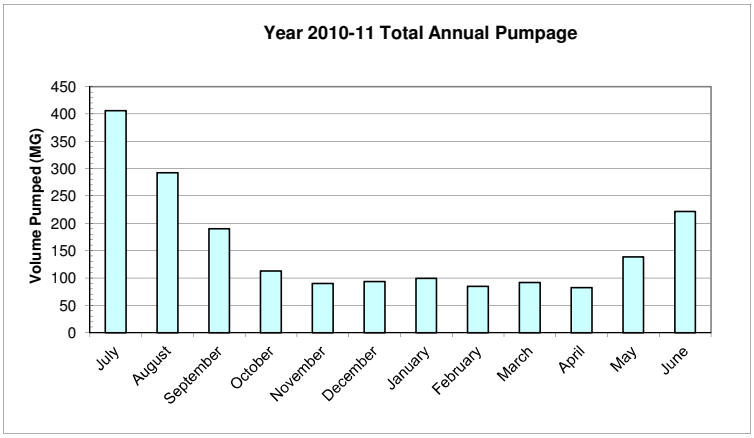
Annual Pumpage 2009-10

Month	Trav. City (mg billed)	Total Output (mg)
July	96.943	276.156
August	92.430	239.613
September	99.324	230.887
October	83.646	111.831
November	38.957	86.727
December	55.965	89.650
January	45.022	92.284
February	42.474	84.688
March	41.973	93.168
April	51.526	120.348
May	55.134	202.730
June	88.117	243.876
Annual Huron Hills Booster Pumpage (mg)		62.920
Annual Water Plant Metered Usage (mg)		0.752
Total Yearly Volume (mg)		1935.63
Average Daily Pumpage (mgd)		5.303



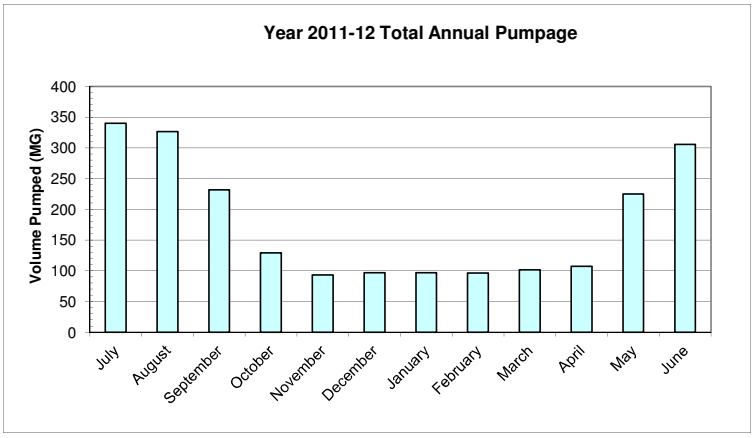
Annual Pumpage 2010-11

Month	Trav. City (mg billed)	Total Output (mg)
July	103.056	406.011
August	109.199	292.139
September	101.512	189.706
October	64.675	112.930
November	45.618	89.838
December	51.248	93.380
January	46.508	99.380
February	34.700	84.472
March	53.970	91.838
April	43.247	82.070
May	50.194	138.686
June	78.866	221.512
Annual Huron Hills Booster Pumpage (mg)		60.991
Annual Water Plant Metered Usage (mg)		0.313
Total Yearly Volume (mg)		1963.27
Average Daily Pumpage (mgd)		5.379



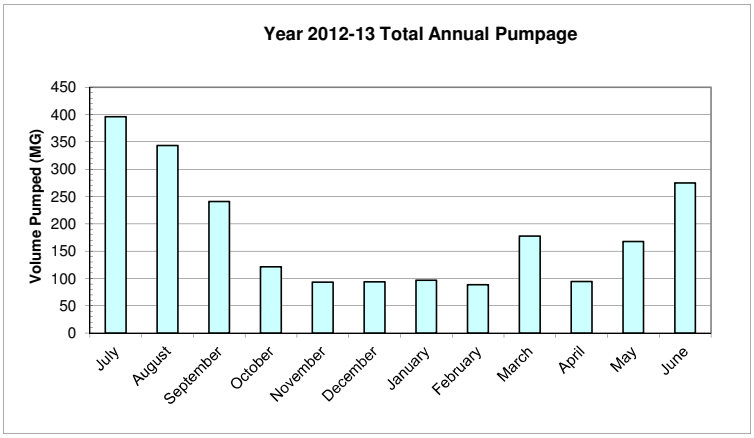
Annual Pumpage 2011-12

Month	Trav. City (mg billed)	Total Output (mg)
July	107.508	339.867
August	130.481	326.557
September	118.219	231.407
October	80.435	128.831
November	63.121	93.267
December	50.248	96.774
January	56.304	96.911
February	45.113	96.093
March	46.401	101.386
April	49.686	107.365
May	54.167	224.746
June	105.621	305.572
Annual Huron Hills Booster Pumpage (mg)		83.184
Annual Water Plant Metered Usage (mg)		0.350
Total Yearly Volume (mg)		2148.78
Average Daily Pumpage (mgd)		5.887



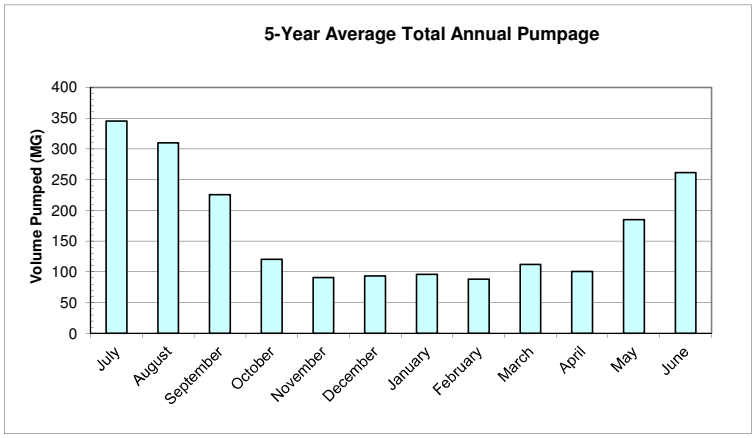
Annual Pumpage 2012-13

Month	Trav. City (mg billed)	Total Output (mg)
July	107.508	396.192
August	130.481	343.168
September	118.219	240.748
October	80.435	121.377
November	63.121	93.342
December	50.248	93.683
January	56.304	96.523
February	45.113	88.725
March	46.401	177.574
April	49.686	94.380
May	54.167	167.509
June	105.621	274.990
Annual Huron Hills Booster Pumpage (mg)		83.409
Annual Water Plant Metered Usage (mg)		0.321
Total Yearly Volume (mg)		2188.21
Average Daily Pumpage (mgd)		5.995



5-Year Average Annual Pumping

Month	Trav. City (mg billed)	Total Output (mg)
July	103.708	345.121
August	120.265	309.782
September	110.978	225.290
October	80.981	120.146
November	53.888	90.641
December	50.595	93.065
January	50.243	95.664
February	42.293	88.191
March	46.958	111.904
April	47.398	100.632
May	53.466	184.705
June	94.927	261.380
Annual Huron Hills Booster Pumpage (mg)		70.318
Annual Water Plant Metered Usage (mg)		0.433
Total Yearly Volume (mg)		2063.82
Average Daily Pumpage (mgd)		5.654



Appendix D

Model Input / Output

500 250 0 500 1,000
1 " = 1,000 '

LEGEND

- STORAGE TANK
- BOOSTER STATION
- HYDRANT
- MAINLINE VALVE
- MASTER METER VALVE
- DISTRIBUTION MAIN
- CITY LIMITS
- 2014 PEAK HOUR PRESSURE CONTOURS

CITY OF TRAVERSE CITY
WATER RELIABILITY STUDY

2014 PEAK HOUR PRESSURE CONTOURS

FIGURE A

Prein&Newhof
2130550

10" METERING STATION #2

6" METERING STATION #3

10" METERING STATION #1

6" METERING STATION #4

GREILICKVILLE MASTER METER

VETERANS DRIVE MASTER METER

CASS ROAD MASTER METER

BARLOW MASTER METER

GARFIELD MASTER METER

WEST ARM GRAND TRAVERSE BAY

EAST ARM GRAND TRAVERSE BAY

BOARDMAN LAKE

WAYNE HILL TANK (1.5 MG, HWL 751')

WAYNE HILL BOOSTER STATION (1000 GPM)

GRAYHAWK BOOSTER STATION (300 GPM)

GREY HAWK HYDRONEUMATIC TANK

BROOK DRIVE BOOSTER STATION (800 GPM)

CASS ROAD BOOSTER STATION (4800 GPM)

WATER TREATMENT PLANT HURON HILLS BOOSTER STATION

LAFRANIER ESTATES BOOSTER STATION

BARLOW (4 MG, HWL 751')

TRAVERSE RD

CEDAR RUN RD

NORTH LONG LAKE RD

BARNES RD

SILVER LAKE RD

VETERANS DR

CASS RD

PREMIER ST

PARK DR

KEYSTONE RD

GARFIELD AVE

SOUTH AIRPORT RD

JAKE RD

EAST SHORE RD

WEST AERO PARK CT

500 250 0 500 1,000

1 " = 1,000 '

LEGEND

- STORAGE TANK
- BOOSTER STATION
- HYDRANT
- MAINLINE VALVE
- MASTER METER VALVE
- DISTRIBUTION MAIN
- CITY LIMITS
- 2014 MAXIMUM DAY DEMANDS PLUS 1000 GPM FIRE FLOW

CITY OF TRAVERSE CITY

WATER RELIABILITY STUDY

2014 MAXIMUM DAY DEMANDS PLUS 1000 GPM FIRE FLOW PRESSURE CONTOURS

FIGURE B

Prein&Newhof

2130550

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CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T002	584	75.3	69.5	64.8	3,000
J-T004	585	110.2	106.7	102.4	3,770
J-T005	585	75.3	69.4	64.6	2,720
J-T006	585	74.8	69.0	64.2	2,780
J-T007	585	74.7	69.0	64.4	3,260
J-T008	585	110.1	106.7	102.3	2,110
J-T009	587	72.3	67.3	63.1	2,080
J-T010	587	74.0	68.2	63.6	3,000
J-T011	587	72.6	67.4	62.9	5,010
J-T012	587	73.9	67.9	62.9	2,060
J-T013	587	72.4	67.5	63.4	1,950
J-T014	587	72.6	67.4	62.9	5,010
J-T015	587	72.4	67.3	62.9	5,010
J-T016	587	73.9	67.9	62.9	2,060
J-T017	587	72.4	67.3	62.8	5,010
J-T018	587	72.5	67.5	63.4	5,010
J-T019	588	71.7	67.0	63.0	3,830
J-T020	588	72.9	67.6	63.4	1,860
J-T021	588	71.9	66.9	62.6	2,420
J-T022	588	72.9	67.5	63.2	5,000
J-T023	589	73.1	67.1	62.0	2,020
J-T024	589	76.0	69.6	63.4	5,010
J-T025	589	73.1	67.1	62.0	2,060
J-T026	589	71.8	66.6	62.0	5,010
J-T027	589	71.4	66.4	62.1	5,010
J-T028	589	75.1	68.8	62.9	5,030
J-T029	590	71.2	66.1	61.6	3,210
J-T030	590	72.5	66.8	61.8	5,030
J-T031	590	72.1	66.6	61.7	5,010
J-T032	590	98.7	91.2	82.8	1,260
J-T033	590	72.6	66.6	61.6	1,900
J-T034	590	72.2	66.6	61.6	5,010
J-T035	590	99.0	93.7	87.2	2,300
J-T036	590	71.6	66.2	61.6	5,010
J-T037	590	76.2	69.7	63.4	5,080
J-T038	590	71.3	65.9	61.1	2,710
J-T039	591	72.2	66.2	61.2	1,990
J-T040	592	70.2	65.3	61.0	5,010
J-T041	592	76.2	69.5	62.9	2,250
J-T042	592	91.6	84.5	76.7	1,850
J-T043	592	69.9	65.1	61.2	1,850
J-T044	592	73.2	67.0	61.3	5,010
J-T045	592	81.2	74.1	66.7	1,550
J-T046	593	70.5	65.0	60.1	5,020
J-T047	593	75.0	68.5	62.1	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T048	593	71.3	65.3	60.3	1,830
J-T049	593	73.6	67.2	61.1	2,530
J-T050	593	90.8	83.9	76.0	2,130
J-T051	593	70.0	64.6	59.7	2,560
J-T052	593	96.3	90.8	84.0	2,930
J-T053	594	70.7	65.0	60.0	5,030
J-T054	594	68.9	64.2	60.2	4,740
J-T055	594	71.5	65.5	60.1	5,010
J-T056	594	96.4	91.0	84.2	2,190
J-T057	595	97.6	92.4	86.0	3,770
J-T058	595	79.0	72.0	64.7	2,090
J-T059	595	98.1	93.0	86.7	3,810
J-T060	595	102.4	98.5	93.7	5,010
J-T061	595	96.9	91.7	85.2	3,250
J-T062	595	68.8	63.8	59.3	2,750
J-T063	595	68.8	63.8	59.3	5,010
J-T064	595	69.0	63.8	59.1	2,160
J-T065	595	71.5	65.0	59.1	2,870
J-T066	595	79.6	72.6	65.2	1,820
J-T067	595	68.7	63.6	59.2	4,880
J-T068	595	97.0	91.8	85.3	3,660
J-T069	596	99.2	94.4	88.5	4,300
J-T071	596	69.9	64.1	59.0	5,060
J-T072	596	70.6	64.4	58.8	3,070
J-T073	597	103.4	99.8	95.3	5,010
J-T074	597	73.5	67.0	60.5	1,940
J-T075	597	72.7	66.3	60.0	5,010
J-T076	597	67.5	62.9	59.1	2,430
J-T077	597	73.8	67.1	60.6	3,340
J-T078	597	68.0	62.8	57.9	1,910
J-T079	597	84.8	77.9	70.4	2,470
J-T080	598	69.0	63.4	58.3	5,010
J-T081	598	96.5	91.4	85.0	5,010
J-T082	598	109.6	102.0	93.1	1,620
J-T083	598	68.0	62.6	57.7	3,090
J-T084	598	72.9	66.3	59.9	740
J-T086	598	67.5	62.5	58.1	5,010
J-T087	598	96.0	90.9	84.5	5,010
J-T088	598	68.8	63.1	58.0	5,010
J-T089	598	67.0	62.3	58.3	5,010
J-T090	599	72.7	66.2	59.8	5,010
J-T091	599	67.2	62.4	58.5	1,590
J-T092	599	96.3	91.2	84.9	5,010
J-T093	599	81.8	71.9	57.7	1,510
J-T094	599	75.2	68.3	61.3	2,370

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T095	599	78.4	71.6	64.2	3,100
J-T096	599	72.4	65.9	59.5	5,010
J-T097	600	77.1	70.3	62.9	5,010
J-T098	600	76.8	69.9	62.6	1,780
J-T099	600	95.2	90.0	83.5	5,010
J-T100	600	77.1	70.2	62.9	5,010
J-T101	600	67.0	61.7	56.9	2,240
J-T102	600	70.7	64.3	58.3	2,450
J-T103	600	67.4	62.0	57.0	5,010
J-T104	600	70.8	64.6	58.5	5,010
J-T105	600	66.8	61.6	56.8	2,120
J-T106	600	66.8	61.6	56.8	1,620
J-T107	600	102.6	99.0	94.7	5,010
J-T108	600	68.3	62.3	57.3	1,730
J-T109	600	68.3	62.3	57.2	1,760
J-T110	600	99.2	95.1	90.0	5,010
J-T111	600	73.4	66.6	59.8	1,160
J-T112	600	74.2	67.4	60.5	1,660
J-T113	600	93.4	87.9	80.9	2,070
J-T114	600	75.5	68.7	61.6	5,010
J-T115	600	81.1	71.2	57.0	1,500
J-T116	600	100.9	97.0	92.2	5,010
J-T117	600	67.8	62.2	57.0	5,010
J-T118	600	66.7	61.5	56.7	1,840
J-T119	601	94.3	89.0	82.5	4,370
J-T120	601	120.0	112.7	104.3	2,850
J-T121	601	66.4	61.2	56.5	1,930
J-T122	601	71.6	65.1	58.7	5,010
J-T123	601	71.8	65.2	58.8	5,010
J-T124	601	70.3	64.0	58.0	5,010
J-T125	601	73.1	66.4	59.6	2,390
J-T126	601	71.8	65.3	58.9	5,010
J-T127	601	80.7	70.8	56.6	1,490
J-T128	602	68.4	62.1	56.4	1,280
J-T130	602	115.2	107.7	99.3	2,760
J-T131	602	115.3	107.9	99.5	2,770
J-T132	603	102.9	99.5	95.2	1,710
J-T133	603	102.8	99.5	95.2	3,550
J-T134	603	80.0	70.1	55.9	1,490
J-T135	603	77.3	70.6	63.1	1,030
J-T136	603	103.1	99.9	96.0	2,400
J-T137	603	103.1	99.9	96.0	5,010
J-T139	603	102.7	99.3	95.1	4,990
J-T140	603	77.3	70.5	63.1	1,930
J-T141	603	77.2	70.5	63.0	4,690

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T142	603	69.3	63.0	56.9	2,050
J-T143	603	76.3	69.5	62.1	4,690
J-T144	604	102.7	99.6	95.6	5,010
J-T145	604	70.5	64.0	57.6	5,010
J-T146	604	67.9	61.4	55.5	1,660
J-T147	604	65.3	60.0	55.1	5,010
J-T148	604	69.7	63.3	57.0	5,010
J-T149	604	96.9	92.7	87.6	5,010
J-T150	604	70.3	63.8	57.4	5,010
J-T151	605	123.1	116.2	108.0	3,080
J-T152	605	79.3	69.3	55.2	1,480
J-T153	605	64.4	59.6	55.3	5,010
J-T154	605	64.9	59.6	54.8	1,890
J-T155	605	92.4	87.1	80.7	5,010
J-T156	605	65.3	59.8	54.8	5,010
J-T157	605	94.7	90.2	84.7	5,010
J-T158	605	113.0	105.5	97.0	2,050
J-T159	605	113.2	105.8	97.4	2,720
J-T160	606	64.4	59.2	54.4	2,100
J-T161	606	110.0	102.4	93.7	2,190
J-T162	606	106.8	99.2	90.4	2,060
J-T163	606	64.2	59.1	54.3	1,800
J-T164	606	90.8	85.3	78.4	3,920
J-T165	606	78.6	68.7	54.5	1,500
J-T166	606	78.6	68.7	54.5	1,480
J-T167	606	101.4	98.0	93.7	1,330
J-T168	606	90.8	85.4	78.6	5,010
J-T169	606	78.5	68.6	54.4	1,480
J-T170	607	112.3	104.8	96.4	2,410
J-T171	607	79.4	70.8	58.5	1,570
J-T172	607	64.9	59.5	55.2	4,920
J-T173	607	112.6	105.1	96.7	2,580
J-T174	607	117.8	110.5	102.1	2,010
J-T175	607	91.6	86.4	79.9	5,010
J-T176	607	63.5	58.3	53.1	1,110
J-T177	607	63.8	58.6	53.8	2,030
J-T178	607	62.9	58.5	54.9	5,010
J-T179	607	63.9	58.6	53.8	1,440
J-T180	607	112.0	104.6	96.3	2,680
J-T182	607	63.9	58.6	53.7	2,210
J-T183	607	73.7	66.8	59.7	2,010
J-T184	608	90.5	85.0	78.3	3,300
J-T185	608	74.5	67.7	60.3	3,640
J-T186	608	103.4	99.0	94.0	2,850
J-T187	608	63.7	58.3	53.3	2,100

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T188	608	77.9	68.0	53.8	1,490
J-T189	608	63.5	58.3	53.5	5,010
J-T190	608	75.5	66.0	52.0	1,510
J-T191	608	62.8	57.6	52.6	5,010
J-T192	608	63.6	58.3	53.4	5,010
J-T193	608	62.6	58.1	54.5	1,760
J-T194	608	77.8	67.8	53.7	1,550
J-T195	608	63.2	57.8	52.6	1,510
J-T196	608	63.0	57.5	52.2	1,390
J-T197	608	63.4	58.1	53.3	5,010
J-T198	608	93.6	88.7	82.8	2,420
J-T199	608	92.5	87.5	81.5	3,470
J-T200	608	96.0	91.8	86.7	5,010
J-T201	608	86.5	80.2	72.3	3,920
J-T202	608	68.7	62.1	55.6	5,010
J-T203	608	68.7	62.1	55.7	5,010
J-T204	609	90.4	85.3	78.9	5,010
J-T205	609	93.4	88.6	82.9	5,010
J-T206	609	77.6	67.6	53.5	1,490
J-T207	609	63.0	57.9	53.2	5,010
J-T208	609	73.0	66.7	59.9	1,520
J-T209	609	68.5	62.0	55.5	5,010
J-T210	609	89.7	84.3	77.6	2,850
J-T211	609	77.3	67.4	53.3	1,510
J-T212	609	68.5	62.0	55.5	5,010
J-T213	609	90.5	85.3	78.9	5,010
J-T214	609	90.3	85.2	78.9	5,010
J-T215	609	62.3	56.8	51.4	1,060
J-T216	609	62.4	56.9	51.5	1,270
J-T217	609	97.8	90.4	81.9	1,270
J-T218	609	90.3	85.2	78.8	5,010
J-T219	609	73.2	66.4	59.0	5,010
J-T220	609	77.3	67.3	53.2	1,460
J-T221	609	88.7	83.1	76.1	2,820
J-T222	609	93.6	88.9	83.2	3,330
J-T223	609	63.1	57.7	52.8	3,390
J-T224	610	87.0	81.1	74.0	3,960
J-T225	610	95.1	90.8	85.5	3,210
J-T226	610	91.9	86.9	80.9	5,020
J-T227	610	115.9	108.5	99.8	1,220
J-T228	610	63.0	57.6	52.7	2,670
J-T229	610	68.3	61.7	55.2	5,010
J-T230	610	62.9	57.6	52.7	5,010
J-T231	610	68.2	61.7	55.2	5,010
J-T232	610	69.3	62.7	55.9	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T233	610	87.9	82.1	75.2	3,670
J-T234	610	62.1	57.1	52.4	2,050
J-T235	610	87.1	81.3	74.3	3,040
J-T236	610	63.0	57.5	52.6	5,010
J-T237	610	62.9	57.5	52.6	5,010
J-T238	610	61.9	56.6	51.2	1,870
J-T239	610	96.1	92.1	87.1	2,650
J-T240	610	62.7	57.3	52.3	2,750
J-T241	610	61.8	56.4	51.0	1,390
J-T242	610	62.8	58.0	53.1	4,640
J-T243	610	62.1	57.0	51.9	5,010
J-T244	610	62.0	56.8	51.7	5,010
J-T245	610	90.3	85.5	79.5	5,010
J-T246	610	85.9	79.9	72.8	4,740
J-T247	610	87.2	81.3	74.3	3,280
J-T248	610	68.0	61.4	54.9	5,010
J-T249	610	76.7	66.8	52.7	1,460
J-T250	611	67.8	61.3	54.8	5,010
J-T251	611	62.8	57.4	52.4	5,010
J-T252	611	84.5	78.4	71.3	5,010
J-T253	611	86.9	80.7	73.5	2,160
J-T254	611	91.3	86.2	80.1	2,870
J-T255	611	76.6	66.7	52.7	1,550
J-T256	611	67.7	61.2	54.7	5,010
J-T257	611	62.6	57.2	52.2	5,010
J-T258	611	62.2	56.8	51.7	5,010
J-T259	611	83.6	77.4	70.3	3,140
J-T260	611	85.4	79.4	72.3	3,000
J-T261	611	61.4	56.3	51.3	1,600
J-T262	611	87.1	81.4	74.7	5,010
J-T263	611	63.1	57.5	52.4	5,010
J-T264	611	65.9	59.6	53.6	5,010
J-T265	611	65.9	59.6	53.6	5,010
J-T266	611	60.9	55.5	50.0	1,670
J-T267	611	60.7	55.1	49.5	1,570
J-T268	611	61.0	55.6	50.1	1,550
J-T269	611	86.5	80.4	73.2	3,330
J-T270	611	82.6	76.4	69.3	5,010
J-T271	611	80.4	74.1	67.0	5,010
J-T272	611	62.4	57.0	52.0	5,010
J-T273	611	80.4	74.1	66.9	5,010
J-T274	611	67.5	61.0	54.5	5,010
J-T275	612	60.6	56.5	53.1	5,010
J-T276	612	86.4	80.5	73.6	3,670
J-T277	612	88.0	82.3	75.4	2,350

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T278	612	76.7	70.0	62.7	2,820
J-T279	612	62.0	56.6	51.5	5,010
J-T280	612	60.6	55.3	49.8	1,100
J-T281	612	61.5	56.0	50.9	5,010
J-T282	612	59.7	54.1	48.3	1,400
J-T283	612	60.3	54.9	49.6	5,010
J-T284	612	61.7	56.2	50.9	1,490
J-T285	612	60.9	55.7	50.5	4,240
J-T286	612	87.3	81.6	74.6	1,750
J-T287	612	110.9	103.5	95.0	2,550
J-T288	612	71.8	65.2	58.1	5,010
J-T289	612	69.7	62.9	55.8	1,600
J-T290	612	70.2	63.4	56.2	3,210
J-T291	613	71.3	64.5	57.2	2,690
J-T292	613	104.9	98.7	92.0	2,440
J-T293	613	60.7	55.2	49.9	5,010
J-T294	613	70.1	63.3	56.2	3,480
J-T295	613	61.0	55.5	50.2	5,010
J-T296	613	73.5	66.7	59.3	2,770
J-T297	613	84.6	78.3	70.4	4,670
J-T298	613	75.2	68.5	61.2	3,210
J-T299	613	70.0	63.2	56.0	3,570
J-T300	613	75.6	69.1	61.9	5,010
J-T301	613	71.8	65.0	57.6	5,010
J-T302	613	61.2	55.7	50.5	4,330
J-T303	613	60.8	55.3	49.9	3,790
J-T304	613	60.2	54.8	49.4	5,010
J-T305	613	56.6	50.9	44.8	750
J-T306	613	69.9	63.1	55.9	1,900
J-T307	613	71.3	64.5	57.2	2,580
J-T308	614	71.4	64.5	57.2	5,010
J-T309	614	60.3	55.6	51.4	2,250
J-T310	614	71.5	64.8	57.5	5,010
J-T311	614	86.9	82.0	76.0	5,010
J-T312	614	87.4	82.4	76.4	5,010
J-T313	614	57.2	51.4	45.1	770
J-T314	614	59.6	54.1	48.5	1,940
J-T315	614	59.7	54.1	48.5	2,920
J-T316	614	58.9	53.3	47.5	1,550
J-T317	614	60.1	54.5	49.0	3,510
J-T318	614	59.9	54.3	48.7	3,380
J-T319	614	60.1	54.4	48.8	1,500
J-T320	614	59.4	53.8	48.1	1,690
J-T321	614	60.3	54.7	49.3	1,350
J-T322	614	76.5	69.2	60.7	4,810

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MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T323	614	73.4	66.6	59.0	1,630
J-T324	614	72.5	65.6	58.1	5,010
J-T325	615	59.1	53.5	47.8	2,400
J-T326	615	59.6	54.0	48.4	1,470
J-T327	615	59.5	53.9	48.3	2,200
J-T328	615	59.5	53.9	48.3	2,680
J-T329	615	76.1	68.8	60.2	3,090
J-T330	615	59.3	53.8	48.2	1,610
J-T331	615	59.5	53.9	48.3	1,370
J-T332	615	74.7	64.8	50.7	1,370
J-T333	615	71.1	64.4	57.0	5,010
J-T334	615	71.1	64.3	56.9	3,420
J-T335	615	105.6	98.7	91.4	2,270
J-T336	616	70.7	64.0	56.7	5,010
J-T337	616	70.9	64.1	56.7	5,010
J-T338	616	59.4	54.5	49.7	1,230
J-T339	616	71.0	64.1	56.7	3,160
J-T340	616	57.9	52.3	46.5	1,420
J-T341	616	58.8	53.2	47.6	1,440
J-T342	616	58.2	52.6	46.8	1,650
J-T343	616	57.6	52.0	46.0	1,260
J-T344	617	70.5	63.8	56.5	5,010
J-T345	617	70.8	64.0	56.6	3,130
J-T346	617	58.2	54.0	50.4	3,210
J-T347	617	57.8	52.2	46.5	1,380
J-T348	617	61.3	56.2	51.7	1,240
J-T349	617	70.2	63.4	56.1	2,550
J-T350	618	70.0	63.3	56.1	2,060
J-T351	618	57.3	51.8	46.2	770
J-T352	618	57.7	52.1	46.4	1,330
J-T353	618	69.9	63.1	55.8	3,250
J-T354	618	57.0	51.5	46.0	1,590
J-T355	618	70.3	63.4	56.0	3,180
J-T356	619	56.9	53.2	50.1	5,010
J-T357	619	69.3	62.6	55.4	4,720
J-T358	620	69.0	62.4	55.3	1,910
J-T359	620	57.5	52.4	47.3	3,910
J-T360	620	57.1	52.4	47.7	900
J-T361	620	56.6	51.2	45.7	1,600
J-T362	620	57.4	52.3	47.3	4,250
J-T363	620	57.4	52.3	47.2	1,800
J-T364	620	57.5	52.3	47.2	4,920
J-T365	620	59.2	53.8	49.7	4,360
J-T366	621	102.6	95.8	88.7	1,350
J-T367	621	70.0	63.3	55.8	2,290

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T368	621	71.4	65.0	57.6	3,930
J-T369	621	69.9	63.2	55.7	2,430
J-T370	621	70.6	64.0	56.7	4,170
J-T371	621	68.9	62.2	54.9	2,460
J-T372	621	68.5	61.9	54.8	4,920
J-T373	621	71.7	65.2	57.8	3,830
J-T374	621	69.2	62.6	55.4	3,700
J-T375	621	56.5	52.1	47.9	1,030
J-T376	621	56.5	52.3	48.6	2,840
J-T377	621	57.0	51.9	46.9	3,980
J-T378	621	56.9	52.0	47.2	1,230
J-T379	621	70.4	63.7	56.2	1,760
J-T380	621	67.8	61.6	54.7	4,530
J-T381	621	72.4	66.1	58.8	4,690
J-T382	622	73.7	67.4	60.2	2,100
J-T383	623	70.5	64.2	57.0	3,930
J-T384	623	72.9	66.7	59.4	2,060
J-T385	624	57.6	52.2	48.0	4,360
J-T386	624	71.1	64.9	57.7	4,270
J-T387	624	72.6	66.6	59.6	4,940
J-T388	624	76.0	70.8	64.7	5,010
J-T389	624	74.5	68.8	62.2	5,010
J-T390	624	75.3	70.2	64.1	5,020
J-T391	624	75.8	70.5	64.3	5,010
J-T392	624	66.2	60.1	53.4	4,180
J-T393	624	75.0	69.4	62.9	1,320
J-T394	625	70.4	64.1	56.9	1,800
J-T395	625	70.9	64.7	57.6	2,400
J-T396	625	62.2	60.2	58.1	3,990
J-T397	625	93.2	89.8	85.5	1,910
J-T398	625	55.4	50.2	45.2	5,010
J-T399	625	72.3	66.4	59.5	2,840
J-T400	626	56.8	51.3	47.2	4,290
J-T401	626	103.0	92.1	71.6	1,770
J-T402	626	103.0	92.1	71.6	1,380
J-T403	626	61.8	56.7	51.7	1,600
J-T404	626	62.0	56.9	51.9	1,610
J-T405	626	54.7	49.4	44.2	3,600
J-T406	626	54.4	49.1	43.8	3,810
J-T407	626	56.6	51.2	47.1	4,220
J-T408	626	56.7	51.3	47.4	4,270
J-T409	626	112.3	109.2	103.2	5,010
J-T410	626	112.3	109.1	103.0	2,830
J-T411	626	110.5	106.1	97.4	4,980
J-T412	626	61.1	54.5	48.1	5,010

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T413	626	89.8	85.9	81.2	5,010
J-T414	626	80.9	75.2	68.2	3,320
J-T415	626	60.6	54.1	47.7	5,010
J-T416	626	55.3	50.2	45.1	4,540
J-T417	626	82.1	76.6	69.7	1,180
J-T418	626	106.6	99.0	84.8	3,570
J-T419	626	56.4	51.0	46.8	4,590
J-T420	626	102.6	91.3	70.4	2,800
J-T421	626	112.1	108.9	102.6	5,010
J-T422	626	56.8	51.3	47.6	4,320
J-T423	626	61.8	56.8	51.6	1,260
J-T424	698	70.6	58.5	36.6	1,480
J-T425	626	58.2	52.8	48.7	1,860
J-T426	626	63.0	58.2	53.0	1,740
J-T427	626	103.0	92.1	71.6	1,050
J-T428	626	102.9	91.9	71.4	2,890
J-T429	626	66.7	62.4	56.8	800
J-T430	626	70.2	60.4	46.6	1,420
J-T431	626	56.4	51.0	46.7	3,090
J-T432	626	80.8	75.0	67.7	3,870
J-T433	626	111.2	107.2	99.5	5,010
J-T435	626	52.6	50.0	47.8	5,010
J-T436	626	103.3	92.8	72.7	3,020
J-T437	626	112.3	109.1	102.8	1,180
J-T438	626	51.5	49.9	48.4	5,010
J-T439	626	73.8	68.3	61.8	5,010
J-T440	626	112.3	109.2	103.1	5,010
J-T441	626	101.8	89.7	67.9	2,460
J-T442	626	112.3	109.2	103.1	5,010
J-T443	626	49.3	48.9	48.2	5,010
J-T444	626	55.3	50.2	45.1	2,680
J-T445	626	60.7	54.2	47.8	5,010
J-T446	626	110.0	105.0	95.6	4,700
J-T447	626	73.3	67.6	60.8	1,730
J-T448	626	112.3	109.1	102.8	970
J-T449	626	65.8	59.0	51.6	5,010
J-T450	626	69.7	63.2	55.9	2,910
J-T451	626	69.5	63.0	55.6	3,770
J-T452	626	72.6	66.7	59.9	5,010
J-T453	626	74.5	69.2	62.8	5,010
J-T454	626	73.5	67.8	61.2	5,010
J-T455	626	65.6	58.8	51.5	5,010
J-T456	626	72.9	65.7	56.9	4,450
J-T457	626	82.1	76.6	69.8	5,010
J-T458	626	72.9	65.6	56.9	4,590

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MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T459	626	48.8	48.0	46.4	5,010
J-T460	626	73.7	66.5	57.9	4,050
J-T461	626	71.8	65.6	58.3	1,800
J-T462	626	95.3	87.2	64.0	2,280
J-T463	626	71.8	65.6	58.3	990
J-T464	628	52.5	47.3	42.1	4,150
J-T465	628	52.5	47.3	42.1	2,950
J-T466	629	55.2	50.1	45.9	890
J-T467	629	52.1	46.6	40.7	840
J-T468	630	52.7	48.1	43.4	720
J-T469	630	51.6	46.0	40.0	740
J-T471	634	49.6	44.5	39.3	3,840
J-T472	630	50.9	46.0	41.0	3,630
J-T473	636	62.4	58.2	52.7	1,580
J-T474	638	51.4	45.9	41.8	3,940
J-T475	638	64.9	58.4	51.0	1,260
J-T476	638	65.4	59.0	51.7	1,990
J-T479	642	88.2	80.1	56.9	1,240
J-T480	642	96.1	92.9	87.5	1,540
J-T481	643	87.8	79.7	56.5	1,250
J-T482	644	87.3	79.2	56.0	1,240
J-T483	644	44.2	38.4	32.1	370
J-T484	645	91.7	85.0	78.0	1,810
J-T485	647	86.1	77.9	54.7	1,250
J-T486	648	85.6	77.5	54.3	1,240
J-T488	650	47.0	42.5	38.0	600
J-T489	650	47.4	42.1	37.0	2,820
J-T490	652	83.9	75.8	52.6	1,250
J-T491	652	88.3	81.6	74.7	1,860
J-T492	653	84.4	76.9	54.3	1,310
J-T493	653	84.4	76.9	54.3	3,320
J-T494	654	83.0	74.9	51.7	1,240
J-T495	655	82.7	74.5	51.4	1,250
J-T496	655	82.6	74.5	51.3	1,250
J-T497	656	83.1	75.6	53.0	3,320
J-T498	656	43.7	38.2	34.3	3,410
J-T499	660	81.3	73.8	51.3	2,410
J-T501	660	39.2	33.9	28.7	2,260
J-T502	660	81.0	73.2	50.3	1,280
J-T504	660	80.5	72.4	49.2	1,250
J-T505	660	99.3	99.0	98.4	1,470
J-T506	662	84.3	77.6	70.5	1,140
J-T507	662	79.6	71.4	48.2	1,240
J-T508	664	78.7	70.6	47.4	1,240
J-T509	664	78.8	70.7	47.5	1,250

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MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T510	665	78.4	70.3	47.2	1,250
J-T511	666	77.8	69.7	46.5	1,240
J-T512	666	52.1	48.5	43.3	1,310
J-T513	668	77.0	68.8	45.7	1,240
J-T514	669	76.6	68.5	45.3	1,250
J-T515	669	76.7	68.6	45.4	1,250
J-T516	670	71.3	63.3	42.4	1,090
J-T517	670	76.2	68.1	44.9	1,250
J-T518	676	73.7	65.6	42.4	1,250
J-T519	678	72.7	64.6	41.4	1,230
J-T520	680	72.0	63.9	40.7	1,250
J-T521	682	75.6	68.8	61.8	1,120
J-T522	684	70.3	62.2	39.1	1,250
J-T523	690	67.7	59.6	36.5	1,250
J-T524	692	67.6	60.2	37.7	1,470
J-T526	693	63.6	60.3	55.9	1,240
J-T527	694	65.8	57.6	34.5	1,230
J-T528	696	65.1	57.2	34.0	1,170
J-T529	698	65.0	57.6	35.2	1,330
J-T530	699	68.1	61.4	54.3	730
J-T531	700	71.9	62.0	42.7	1,950
J-T532	700	63.4	55.5	32.4	1,130
J-T533	700	82.1	82.0	81.8	1,580
J-T535	702	62.8	55.1	32.3	1,220
J-T536	702	62.3	54.2	31.0	1,160
J-T537	703	61.9	53.8	30.5	980
J-T538	704	61.5	53.4	30.2	1,130
J-T539	705	61.1	53.1	29.9	1,100
J-T540	706	60.8	52.8	29.7	980
J-T542	709	59.4	51.3	28.2	1,050
J-T543	710	59.2	51.4	28.4	1,070
J-T544	712	68.1	59.5	43.5	2,180
J-T546	714	57.4	49.5	26.4	990
J-T548	716	56.4	48.4	25.2	940
J-T549	718	55.6	47.7	24.6	930
J-T551	718	105.5	103.0	99.5	4,310
J-T552	719	55.4	47.4	24.3	910
J-T555	721	71.2	68.0	61.9	1,470
J-T556	721	71.2	68.0	61.9	3,380
J-T557	723	70.3	67.2	61.0	1,390
J-T558	724	69.9	66.7	60.6	2,840
J-T560	725	69.4	66.3	60.1	2,650
J-T561	626	51.2	49.9	48.6	5,010
J-T565	751	88.8	85.1	80.1	1,560
J-T566	759	86.4	83.5	79.5	3,010

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MODEL OUTPUT - 2014 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T568	761	85.4	82.4	78.3	2,920
J-T569	766	83.9	81.0	76.9	1,450
J-T570	767	82.6	79.3	74.8	1,670
J-T572	626	103.0	92.1	71.7	2,920
J-T573	650	101.9	98.7	92.6	3,690
J-T573	650	95.6	95.6	67.4	4,140

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T002	584	80.1	69.2	64.1	2,970
J-T004	585	112.6	106.5	101.8	3,760
J-T005	585	80.0	69.1	63.8	2,690
J-T006	585	79.6	68.7	63.4	2,760
J-T007	585	79.4	68.7	63.7	3,230
J-T008	585	112.6	106.4	101.7	2,110
J-T009	587	76.8	67.1	62.2	2,080
J-T010	587	78.8	67.9	62.8	2,970
J-T011	587	77.4	67.2	62.1	5,010
J-T012	587	78.8	67.6	62.1	2,040
J-T013	587	76.8	67.2	62.7	1,940
J-T014	587	77.4	67.2	62.1	5,010
J-T015	587	77.1	67.1	62.1	5,010
J-T016	587	78.8	67.6	62.1	2,050
J-T017	587	77.1	67.0	62.0	5,010
J-T018	587	76.9	67.2	62.7	5,010
J-T019	588	76.1	66.8	62.2	3,820
J-T020	588	77.4	67.4	62.7	1,850
J-T021	588	76.6	66.7	61.8	2,410
J-T022	588	77.5	67.2	62.5	4,940
J-T023	589	77.9	66.8	61.2	2,000
J-T024	589	81.6	69.3	62.5	5,010
J-T025	589	77.9	66.8	61.3	2,050
J-T026	589	76.7	66.4	61.2	5,010
J-T027	589	76.1	66.2	61.2	5,010
J-T028	589	80.6	68.5	61.9	5,030
J-T029	590	76.0	65.9	60.8	3,190
J-T030	590	77.6	66.6	60.9	5,030
J-T031	590	77.2	66.3	60.9	5,010
J-T032	590	104.0	90.8	81.7	1,260
J-T033	590	77.5	66.3	60.8	1,890
J-T034	590	77.3	66.3	60.7	5,010
J-T035	590	102.8	93.4	86.3	2,300
J-T036	590	76.5	66.0	60.7	5,010
J-T037	590	81.8	69.4	62.4	5,090
J-T038	590	76.2	65.7	60.2	2,700
J-T039	591	77.1	65.9	60.4	1,980
J-T040	592	74.8	65.0	60.2	5,010
J-T041	592	81.9	69.1	61.9	2,240
J-T042	592	96.8	84.1	75.6	1,840
J-T043	592	74.2	64.9	60.5	1,840
J-T044	592	78.6	66.7	60.4	5,010
J-T045	592	86.9	73.7	65.6	1,540
J-T046	593	75.5	64.7	59.2	5,020
J-T047	593	80.5	68.1	61.1	5,010

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T048	593	76.2	65.0	59.5	1,820
J-T049	593	79.1	66.9	60.1	2,520
J-T050	593	96.1	83.4	74.9	2,120
J-T051	593	74.9	64.4	58.8	2,550
J-T052	593	100.3	90.5	83.0	2,920
J-T053	594	75.8	64.8	59.1	5,030
J-T054	594	73.2	64.0	59.4	4,720
J-T055	594	76.8	65.2	59.2	5,010
J-T056	594	100.3	90.6	83.3	2,180
J-T057	595	101.4	92.1	85.1	3,750
J-T058	595	84.7	71.6	63.6	2,080
J-T059	595	101.8	92.7	85.8	3,800
J-T060	595	105.3	98.2	93.0	5,010
J-T061	595	100.7	91.3	84.3	3,240
J-T062	595	73.5	63.6	58.5	2,740
J-T063	595	73.5	63.6	58.5	5,010
J-T064	595	73.8	63.6	58.2	2,150
J-T065	595	77.2	64.7	58.1	2,850
J-T066	595	85.2	72.1	64.1	1,810
J-T067	595	73.3	63.4	58.3	4,850
J-T068	595	100.8	91.4	84.4	3,640
J-T069	596	102.6	94.1	87.7	4,280
J-T071	596	75.1	63.8	58.1	5,060
J-T072	596	76.0	64.1	57.8	3,050
J-T073	597	106.1	99.6	94.7	5,010
J-T074	597	79.1	66.6	59.5	1,940
J-T075	597	78.2	65.9	59.0	5,010
J-T076	597	71.7	62.7	58.4	2,420
J-T077	597	79.4	66.8	59.6	3,320
J-T078	597	72.9	62.5	57.0	1,900
J-T079	597	90.1	77.5	69.3	2,460
J-T080	598	74.2	63.1	57.4	5,010
J-T081	598	100.2	91.1	84.2	5,010
J-T082	598	114.6	101.5	92.1	1,620
J-T083	598	72.9	62.4	56.8	3,070
J-T084	598	78.4	66.0	58.8	740
J-T086	598	72.1	62.3	57.2	5,010
J-T087	598	99.8	90.5	83.6	5,010
J-T088	598	74.0	62.9	57.1	5,010
J-T089	598	71.3	62.1	57.5	5,010
J-T090	599	78.2	65.8	58.8	5,010
J-T091	599	71.5	62.2	57.8	1,590
J-T092	599	100.0	90.9	84.0	5,010
J-T094	599	80.8	67.9	60.2	2,360
J-T095	599	83.8	71.2	63.1	3,090

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T096	599	78.0	65.5	58.4	5,010
J-T097	600	82.6	69.9	61.9	5,010
J-T098	600	82.5	69.5	61.6	1,780
J-T099	600	99.0	89.6	82.6	5,010
J-T100	600	82.6	69.8	61.8	5,010
J-T101	600	71.9	61.5	56.0	2,230
J-T102	600	76.3	64.0	57.3	2,440
J-T103	600	72.4	61.7	56.2	5,010
J-T104	600	76.3	64.2	57.5	5,010
J-T105	600	71.7	61.4	55.9	2,110
J-T106	600	71.7	61.4	55.9	1,610
J-T107	600	105.1	98.8	94.1	5,010
J-T108	600	73.2	62.0	56.5	1,720
J-T109	600	73.2	62.0	56.4	1,750
J-T110	600	102.2	94.8	89.3	5,010
J-T111	600	79.0	66.2	58.7	1,160
J-T112	600	79.8	67.0	59.4	1,650
J-T113	600	97.4	87.5	80.0	2,060
J-T114	600	81.0	68.3	60.5	5,010
J-T115	600	88.2	70.5	54.9	1,470
J-T116	600	103.7	96.7	91.5	5,010
J-T117	600	73.0	61.9	56.1	5,010
J-T118	600	71.6	61.2	55.8	1,830
J-T119	601	98.1	88.7	81.6	4,350
J-T120	601	124.3	112.2	103.4	2,840
J-T121	601	71.2	61.0	55.6	1,920
J-T122	601	77.1	64.7	57.7	5,010
J-T123	601	77.3	64.9	57.8	5,010
J-T124	601	75.7	63.7	57.0	5,010
J-T125	601	78.6	66.0	58.6	2,380
J-T126	601	77.4	65.0	57.8	5,010
J-T127	601	87.8	70.1	54.5	1,470
J-T128	602	73.9	61.8	55.4	1,270
J-T130	602	119.8	107.2	98.4	2,750
J-T131	602	119.9	107.4	98.5	2,750
J-T132	603	105.3	99.3	94.6	1,710
J-T133	603	105.3	99.2	94.6	3,540
J-T134	603	87.1	69.4	53.8	1,470
J-T135	603	82.7	70.2	62.0	1,030
J-T136	603	105.4	99.7	95.5	2,400
J-T137	603	105.4	99.7	95.5	5,010
J-T139	603	105.1	99.1	94.5	4,980
J-T140	603	82.6	70.1	62.0	1,920
J-T141	603	82.6	70.1	61.9	4,660
J-T142	603	74.8	62.7	55.9	2,040

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T143	603	81.7	69.1	61.0	4,670
J-T144	604	105.1	99.4	95.1	5,010
J-T145	604	76.1	63.7	56.6	5,010
J-T146	604	73.6	61.1	54.5	1,650
J-T147	604	70.2	59.7	54.2	5,010
J-T148	604	75.3	62.9	56.0	5,010
J-T149	604	100.0	92.4	86.8	5,010
J-T150	604	75.8	63.4	56.4	5,010
J-T151	605	126.9	115.7	107.1	3,070
J-T152	605	86.3	68.7	53.0	1,460
J-T153	605	68.9	59.4	54.5	5,010
J-T154	605	69.8	59.3	53.9	1,880
J-T155	605	96.2	86.8	79.8	5,010
J-T156	605	70.3	59.5	53.9	5,010
J-T157	605	98.0	89.9	83.9	5,010
J-T158	605	117.7	105.0	96.0	2,040
J-T159	605	117.9	105.3	96.5	2,710
J-T160	606	69.3	59.0	53.5	2,090
J-T161	606	114.8	101.9	92.7	2,180
J-T162	606	111.8	98.7	89.4	2,050
J-T163	606	69.1	58.8	53.4	1,790
J-T164	606	94.8	84.9	77.5	3,900
J-T165	606	85.7	68.0	52.4	1,480
J-T166	606	85.7	68.0	52.4	1,460
J-T167	606	103.8	97.7	93.1	1,320
J-T168	606	94.8	85.1	77.7	5,010
J-T169	606	85.6	67.9	52.3	1,460
J-T170	607	116.9	104.3	95.5	2,400
J-T171	607	86.0	70.3	56.6	1,540
J-T172	607	69.5	59.2	54.6	4,860
J-T173	607	117.2	104.6	95.8	2,570
J-T174	607	122.0	110.0	101.1	2,000
J-T175	607	95.5	86.1	79.0	5,010
J-T176	607	68.1	58.0	52.2	1,110
J-T177	607	68.6	58.4	52.9	2,020
J-T178	607	66.9	58.3	54.2	5,010
J-T179	607	68.8	58.4	52.9	1,430
J-T180	607	116.6	104.1	95.4	2,660
J-T182	607	68.8	58.3	52.8	2,200
J-T183	607	79.3	66.4	58.6	2,000
J-T184	608	94.4	84.7	77.4	3,290
J-T185	608	79.9	67.3	59.2	3,620
J-T186	608	106.5	98.7	93.4	2,840
J-T187	608	68.7	58.1	52.4	2,090
J-T188	608	85.0	67.3	51.7	1,460

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T189	608	68.4	58.0	52.6	5,010
J-T190	608	82.9	65.4	49.8	1,480
J-T191	608	67.7	57.4	51.7	5,010
J-T192	608	68.5	58.0	52.5	5,010
J-T193	608	66.8	57.9	53.8	1,750
J-T194	608	84.8	67.2	51.6	1,530
J-T195	608	68.2	57.5	51.6	1,500
J-T196	608	67.9	57.2	51.2	1,380
J-T197	608	68.3	57.9	52.4	5,010
J-T198	608	97.1	88.4	82.0	2,420
J-T199	608	96.2	87.2	80.6	3,460
J-T200	608	99.1	91.6	86.0	5,010
J-T201	608	91.2	79.8	71.1	3,890
J-T202	608	74.2	61.8	54.6	5,010
J-T203	608	74.2	61.8	54.7	5,010
J-T204	609	94.2	85.0	78.0	5,010
J-T205	609	96.9	88.3	82.1	5,010
J-T206	609	84.6	67.0	51.3	1,460
J-T207	609	67.8	57.6	52.4	5,010
J-T208	609	77.9	66.3	58.9	1,520
J-T209	609	74.1	61.6	54.5	5,010
J-T210	609	93.7	83.9	76.6	2,840
J-T211	609	84.4	66.7	51.2	1,490
J-T212	609	74.1	61.6	54.5	5,010
J-T213	609	94.3	85.0	78.0	5,010
J-T214	609	94.1	84.9	78.0	5,010
J-T215	609	67.2	56.6	50.5	1,060
J-T216	609	67.3	56.6	50.5	1,270
J-T217	609	102.8	89.9	80.8	1,270
J-T218	609	94.0	84.8	77.9	5,010
J-T219	609	78.7	66.0	58.0	5,010
J-T220	609	84.3	66.6	51.0	1,440
J-T221	609	92.9	82.7	75.2	2,810
J-T222	609	97.0	88.6	82.4	3,320
J-T223	609	68.0	57.4	51.9	3,370
J-T224	610	91.3	80.7	73.0	3,940
J-T225	610	98.3	90.5	84.7	3,200
J-T226	610	95.5	86.6	80.1	5,020
J-T227	610	120.2	108.0	98.8	1,210
J-T228	610	67.9	57.3	51.8	2,650
J-T229	610	73.8	61.4	54.2	5,010
J-T230	610	67.9	57.3	51.8	5,010
J-T231	610	73.8	61.3	54.2	5,010
J-T232	610	74.9	62.3	54.9	5,010
J-T233	610	92.1	81.8	74.2	3,660

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T234	610	66.8	56.9	51.5	2,040
J-T235	610	91.5	80.9	73.4	3,030
J-T236	610	68.0	57.3	51.7	5,010
J-T237	610	67.9	57.3	51.7	5,010
J-T238	610	66.7	56.3	50.3	1,870
J-T239	610	99.1	91.8	86.4	2,640
J-T240	610	67.7	57.1	51.4	2,730
J-T241	610	66.6	56.1	50.1	1,390
J-T242	610	67.1	57.7	52.3	4,610
J-T243	610	66.7	56.8	51.1	5,010
J-T244	610	66.7	56.6	50.8	5,010
J-T245	610	93.9	85.2	78.7	5,010
J-T246	610	90.4	79.5	71.8	4,710
J-T247	610	91.5	81.0	73.3	3,270
J-T248	610	73.5	61.1	53.9	5,010
J-T249	610	83.8	66.1	50.5	1,440
J-T250	611	73.4	60.9	53.8	5,010
J-T251	611	67.8	57.1	51.5	5,010
J-T252	611	89.0	78.0	70.3	5,010
J-T253	611	91.6	80.3	72.5	2,150
J-T254	611	95.0	85.9	79.2	2,860
J-T255	611	83.7	66.1	50.6	1,530
J-T256	611	73.3	60.8	53.7	5,010
J-T257	611	67.7	56.9	51.3	5,010
J-T258	611	67.2	56.5	50.8	5,010
J-T259	611	88.2	77.1	69.3	3,120
J-T260	611	89.9	79.0	71.3	2,980
J-T261	611	66.3	56.0	50.4	1,600
J-T262	611	91.4	81.1	73.8	5,010
J-T263	611	68.2	57.2	51.5	5,010
J-T264	611	71.3	59.3	52.6	5,010
J-T265	611	71.3	59.3	52.6	5,010
J-T266	611	65.8	55.2	49.0	1,660
J-T267	611	65.6	54.8	48.5	1,560
J-T268	611	65.8	55.3	49.2	1,540
J-T269	611	90.9	80.0	72.3	3,320
J-T270	611	87.2	76.0	68.3	5,010
J-T271	611	85.3	73.8	66.0	5,010
J-T272	611	67.4	56.7	51.1	5,010
J-T273	611	85.3	73.7	65.9	5,010
J-T274	611	73.1	60.6	53.5	5,010
J-T275	612	64.3	56.3	52.4	5,010
J-T276	612	90.7	80.2	72.7	3,650
J-T277	612	92.1	82.0	74.5	2,350
J-T278	612	81.9	69.6	61.6	2,810

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MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T279	612	67.0	56.3	50.6	5,010
J-T280	612	65.4	55.0	48.9	1,090
J-T281	612	66.5	55.8	49.9	5,010
J-T282	612	64.6	53.8	47.3	1,400
J-T283	612	65.0	54.7	48.7	5,010
J-T284	612	66.7	55.9	50.0	1,490
J-T285	612	65.6	55.4	49.6	4,210
J-T286	612	91.5	81.2	73.6	1,740
J-T287	612	115.5	103.0	94.1	2,540
J-T288	612	77.2	64.8	57.0	5,010
J-T289	612	75.3	62.5	54.7	1,590
J-T290	612	75.8	63.0	55.2	3,190
J-T291	613	76.8	64.1	56.1	2,670
J-T292	613	109.1	98.3	91.3	2,430
J-T293	613	65.6	55.0	49.0	5,010
J-T294	613	75.7	62.9	55.1	3,460
J-T295	613	66.0	55.2	49.3	5,010
J-T296	613	78.9	66.3	58.2	2,750
J-T297	613	89.2	77.9	69.3	4,630
J-T298	613	80.5	68.1	60.1	3,190
J-T299	613	75.6	62.8	55.0	3,540
J-T300	613	80.8	68.7	60.9	5,010
J-T301	613	77.2	64.6	56.5	5,010
J-T302	613	66.2	55.4	49.5	4,300
J-T303	613	65.9	55.0	49.0	3,760
J-T304	613	65.0	54.5	48.5	5,010
J-T305	613	61.6	50.6	43.7	740
J-T306	613	75.5	62.7	54.8	1,890
J-T307	613	76.8	64.1	56.1	2,570
J-T308	614	76.8	64.1	56.1	5,010
J-T309	614	64.8	55.4	50.6	2,230
J-T310	614	76.9	64.4	56.5	5,010
J-T311	614	90.6	81.7	75.1	5,010
J-T312	614	91.0	82.1	75.6	5,010
J-T313	614	62.2	51.0	44.1	770
J-T314	614	64.5	53.8	47.6	1,930
J-T315	614	64.7	53.8	47.5	2,900
J-T316	614	63.9	53.0	46.5	1,540
J-T317	614	65.1	54.2	48.1	3,480
J-T318	614	64.9	54.0	47.7	3,350
J-T319	614	65.1	54.1	47.9	1,490
J-T320	614	64.3	53.5	47.1	1,680
J-T321	614	65.4	54.5	48.3	1,340
J-T322	614	82.1	68.8	59.4	4,770
J-T323	614	78.9	66.2	57.9	1,620

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T324	614	77.9	65.2	57.0	5,010
J-T325	615	64.1	53.2	46.9	2,380
J-T326	615	64.6	53.7	47.4	1,460
J-T327	615	64.5	53.6	47.3	2,180
J-T328	615	64.5	53.6	47.3	2,660
J-T329	615	81.8	68.4	59.0	3,070
J-T330	615	64.2	53.5	47.3	1,600
J-T331	615	64.5	53.6	47.3	1,370
J-T332	615	81.8	64.2	48.6	1,350
J-T333	615	76.5	64.0	55.9	5,010
J-T334	615	76.6	63.9	55.8	3,400
J-T335	615	110.1	98.3	90.6	2,260
J-T336	616	76.1	63.6	55.7	5,010
J-T337	616	76.3	63.7	55.7	5,010
J-T338	616	64.1	54.2	48.8	1,230
J-T339	616	76.4	63.7	55.7	3,140
J-T340	616	62.8	52.0	45.5	1,410
J-T341	616	63.9	52.9	46.6	1,430
J-T342	616	63.1	52.3	45.8	1,640
J-T343	616	62.6	51.7	45.0	1,250
J-T344	617	75.8	63.4	55.5	5,010
J-T345	617	76.2	63.6	55.5	3,110
J-T346	617	62.1	53.8	49.7	3,190
J-T347	617	62.7	51.9	45.6	1,370
J-T348	617	65.8	55.9	50.9	1,230
J-T349	617	75.6	63.0	55.0	2,530
J-T350	618	75.4	62.9	55.0	2,050
J-T351	618	62.3	51.5	45.2	760
J-T352	618	62.7	51.8	45.4	1,320
J-T353	618	75.3	62.7	54.8	3,230
J-T354	618	61.9	51.2	45.0	1,580
J-T355	618	75.6	63.0	54.9	3,160
J-T356	619	60.3	53.0	49.5	5,010
J-T357	619	74.6	62.2	54.4	4,690
J-T358	620	74.2	62.0	54.3	1,900
J-T359	620	62.3	52.1	46.4	3,880
J-T360	620	61.7	52.2	46.8	900
J-T361	620	61.8	51.0	44.7	1,600
J-T362	620	62.2	52.1	46.4	4,210
J-T363	620	62.3	52.0	46.3	1,790
J-T364	620	62.3	52.0	46.3	4,880
J-T365	620	63.8	53.5	49.3	4,320
J-T366	621	107.2	95.4	88.0	1,340
J-T367	621	75.3	62.9	54.7	2,280
J-T368	621	76.5	64.6	56.6	3,910

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T369	621	75.2	62.8	54.6	2,420
J-T370	621	75.7	63.6	55.7	4,140
J-T371	621	74.2	61.8	53.9	2,450
J-T372	621	73.7	61.5	53.8	4,890
J-T373	621	76.7	64.8	56.8	3,810
J-T374	621	74.4	62.2	54.3	3,670
J-T375	621	60.8	51.9	47.1	1,020
J-T376	621	60.4	52.1	47.9	2,820
J-T377	621	61.8	51.6	46.0	3,940
J-T378	621	61.6	51.8	46.3	1,220
J-T379	621	75.6	63.3	55.2	1,750
J-T380	621	72.8	61.2	53.7	4,500
J-T381	621	77.3	65.7	57.8	4,660
J-T382	622	78.4	67.1	59.1	2,090
J-T383	623	75.4	63.8	56.0	3,910
J-T384	623	77.6	66.3	58.4	2,050
J-T385	624	62.2	51.9	47.5	4,310
J-T386	624	75.9	64.5	56.7	4,250
J-T387	624	77.2	66.2	58.6	4,910
J-T388	624	79.9	70.5	63.8	5,010
J-T389	624	78.7	68.5	61.3	5,010
J-T390	624	79.1	69.9	63.3	5,020
J-T391	624	79.8	70.2	63.4	5,010
J-T392	624	71.0	59.7	52.4	4,150
J-T393	624	79.1	69.1	61.9	1,320
J-T394	625	75.3	63.7	55.9	1,790
J-T395	625	75.7	64.3	56.6	2,390
J-T396	625	63.9	60.1	57.7	3,970
J-T397	625	95.6	89.5	84.9	1,900
J-T398	625	60.3	49.9	44.3	5,010
J-T399	625	76.8	66.0	58.5	2,830
J-T400	626	61.4	51.1	46.7	4,240
J-T401	626	109.2	91.3	67.0	1,750
J-T402	626	109.2	91.3	67.0	1,370
J-T403	626	65.9	56.4	50.7	1,590
J-T404	626	66.0	56.6	50.8	1,600
J-T405	626	59.4	49.1	43.3	3,570
J-T406	626	59.1	48.8	42.9	3,770
J-T407	626	61.3	50.9	46.8	4,170
J-T408	626	61.4	51.0	47.2	4,220
J-T409	626	114.0	109.0	101.9	5,010
J-T410	626	114.0	108.9	101.6	2,820
J-T411	626	113.0	105.7	95.5	4,970
J-T412	626	66.6	54.2	47.1	5,010
J-T413	626	92.6	85.7	80.5	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T414	626	85.2	74.8	67.3	3,310
J-T415	626	66.1	53.8	46.7	5,010
J-T416	626	59.9	49.9	44.2	4,500
J-T417	626	86.1	76.2	68.7	1,180
J-T418	626	110.9	98.5	81.6	3,570
J-T419	626	61.0	50.8	46.1	4,530
J-T420	626	109.0	90.5	65.7	2,780
J-T421	626	113.9	108.6	101.2	5,010
J-T422	626	61.4	51.0	47.4	4,240
J-T423	626	65.8	56.5	50.5	1,250
J-T424	698	77.4	57.6	31.9	1,440
J-T425	626	62.7	52.5	48.3	1,850
J-T426	626	66.9	57.9	51.7	1,720
J-T427	626	109.2	91.3	66.9	1,040
J-T428	626	109.1	91.1	66.7	2,880
J-T429	626	70.0	62.2	55.1	800
J-T430	626	77.1	59.8	44.6	1,400
J-T431	626	61.0	50.8	46.1	3,070
J-T432	626	85.1	74.6	66.6	3,840
J-T433	626	113.4	106.9	97.8	5,010
J-T435	626	55.0	49.9	47.4	5,010
J-T436	626	109.3	92.0	68.1	3,010
J-T437	626	114.0	108.8	101.5	1,170
J-T438	626	53.1	49.8	48.2	5,010
J-T439	626	78.0	67.9	60.9	5,010
J-T440	626	114.0	108.9	101.8	5,010
J-T441	626	108.6	88.8	63.1	2,420
J-T442	626	114.0	108.9	101.7	5,010
J-T443	626	49.6	48.9	48.0	5,010
J-T444	626	59.8	49.9	44.2	2,670
J-T445	626	66.2	53.8	46.8	5,010
J-T446	626	112.7	104.7	93.5	4,690
J-T447	626	77.6	67.2	59.9	1,720
J-T448	626	114.0	108.8	101.5	970
J-T449	626	71.3	58.6	50.6	5,010
J-T450	626	74.6	62.8	54.8	2,900
J-T451	626	74.5	62.6	54.6	3,740
J-T452	626	77.0	66.3	58.9	5,010
J-T453	626	78.5	68.8	61.9	5,010
J-T454	626	77.7	67.5	60.3	5,010
J-T455	626	71.1	58.4	50.4	5,010
J-T456	626	78.5	65.2	55.7	4,400
J-T457	626	86.1	76.3	68.8	5,010
J-T458	626	78.5	65.2	55.6	4,550
J-T459	626	49.3	47.9	46.1	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T460	626	79.1	66.1	56.6	4,020
J-T461	626	76.5	65.2	57.3	1,790
J-T462	626	95.7	86.2	59.3	2,260
J-T463	626	76.5	65.2	57.3	980
J-T464	628	57.0	47.1	41.3	4,110
J-T465	628	57.0	47.0	41.2	2,920
J-T466	629	59.6	49.9	45.2	890
J-T467	629	57.1	46.3	39.7	830
J-T468	630	57.2	47.9	42.6	710
J-T469	630	56.6	45.7	39.0	740
J-T471	634	54.1	44.2	38.5	3,800
J-T472	630	55.1	45.7	40.2	3,600
J-T473	636	65.7	57.9	51.0	1,570
J-T474	638	56.0	45.7	41.3	3,890
J-T475	638	69.9	58.0	50.0	1,250
J-T476	638	70.3	58.6	50.7	1,980
J-T479	642	88.7	79.1	52.2	1,210
J-T480	642	97.3	92.6	86.7	1,530
J-T481	643	88.3	78.7	51.7	1,210
J-T482	644	87.8	78.2	51.3	1,210
J-T483	644	49.2	38.1	31.1	360
J-T484	645	96.2	84.6	77.3	1,790
J-T485	647	86.6	76.9	50.0	1,210
J-T486	648	86.1	76.5	49.6	1,210
J-T488	650	51.3	42.3	37.2	600
J-T489	650	52.2	41.9	36.1	2,790
J-T490	652	84.4	74.8	47.8	1,210
J-T491	652	92.8	81.2	74.0	1,840
J-T492	653	84.4	75.9	49.5	1,270
J-T493	653	84.4	75.9	49.5	3,270
J-T494	654	83.5	73.9	47.0	1,210
J-T495	655	83.1	73.6	46.6	1,210
J-T496	655	83.1	73.5	46.6	1,210
J-T497	656	83.1	74.6	48.2	3,270
J-T498	656	48.3	38.0	33.9	3,360
J-T499	660	81.4	72.9	46.5	2,360
J-T501	660	44.2	33.7	27.8	2,220
J-T502	660	81.2	72.2	45.5	1,240
J-T504	660	81.0	71.4	44.4	1,210
J-T505	660	99.3	99.0	98.3	1,470
J-T506	662	88.9	77.1	69.8	1,140
J-T507	662	80.0	70.4	43.5	1,210
J-T508	664	79.2	69.6	42.6	1,210
J-T509	664	79.2	69.7	42.7	1,210
J-T510	665	78.8	69.3	42.4	1,210

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T511	666	78.3	68.7	41.8	1,210
J-T512	666	54.8	48.3	41.3	1,300
J-T513	668	77.4	67.8	40.9	1,200
J-T514	669	77.0	67.5	40.5	1,210
J-T515	669	77.1	67.6	40.7	1,210
J-T516	670	72.4	62.4	38.2	1,070
J-T517	670	76.6	67.1	40.1	1,210
J-T518	676	74.1	64.6	37.6	1,210
J-T519	678	73.1	63.6	36.6	1,190
J-T520	680	72.4	62.9	36.0	1,220
J-T521	682	80.1	68.4	61.1	1,110
J-T522	684	70.7	61.2	34.3	1,220
J-T523	690	68.1	58.7	31.7	1,220
J-T524	692	67.6	59.2	33.0	1,440
J-T526	693	66.1	60.0	55.3	1,230
J-T527	694	66.2	56.6	29.7	1,190
J-T528	696	65.5	56.2	29.3	1,150
J-T529	698	65.0	56.7	30.4	1,300
J-T530	699	72.6	60.9	53.6	730
J-T531	700	77.6	61.2	38.1	1,920
J-T532	700	63.8	54.5	27.6	1,100
J-T533	700	82.2	82.0	81.8	1,570
J-T535	702	63.1	54.1	27.5	1,190
J-T536	702	62.8	53.2	26.3	1,130
J-T537	703	62.4	52.8	25.7	950
J-T538	704	61.9	52.4	25.5	1,090
J-T539	705	61.6	52.1	25.2	1,070
J-T540	706	61.2	51.9	25.0	960
J-T542	709	59.8	50.3	23.4	1,020
J-T543	710	59.5	50.4	23.6	1,030
J-T544	712	73.0	58.9	39.9	2,140
J-T546	714	57.8	48.5	21.6	960
J-T548	716	56.8	47.4	20.5	910
J-T549	718	56.0	46.7	19.8	890
J-T551	718	106.4	102.8	99.1	4,280
J-T552	719	55.8	46.4	19.6	880
J-T555	721	72.9	67.8	60.5	1,460
J-T556	721	72.9	67.8	60.6	3,360
J-T557	723	72.0	66.9	59.6	1,380
J-T558	724	71.6	66.5	59.3	2,820
J-T560	725	71.1	66.1	58.8	2,630
J-T561	626	52.5	49.8	48.4	5,010
J-T565	751	89.9	84.9	79.5	1,560
J-T566	759	87.4	83.2	79.0	2,990
J-T568	761	86.3	82.2	77.9	2,910

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2019 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T569	766	84.9	80.7	76.4	1,450
J-T570	767	83.7	79.1	74.2	1,660
J-T572	626	109.2	91.3	67.0	2,910
J-T573	650	103.6	98.5	91.2	3,670

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T002	584	74.7	68.5	62.0	2,890
J-T004	585	109.8	105.9	100.4	3,740
J-T005	585	74.7	68.4	61.7	2,620
J-T006	585	74.2	68.0	61.4	2,700
J-T007	585	74.1	68.1	61.8	3,140
J-T008	585	109.8	105.8	100.4	2,100
J-T009	587	71.7	66.7	60.2	2,050
J-T010	587	73.4	67.3	60.8	2,890
J-T011	587	72.0	66.7	59.9	5,010
J-T012	587	73.3	67.0	60.0	2,000
J-T013	587	71.9	66.8	60.9	1,920
J-T014	587	72.0	66.7	59.9	5,010
J-T015	587	71.8	66.7	60.0	5,010
J-T016	587	73.3	67.0	60.0	2,010
J-T017	587	71.8	66.6	59.9	5,010
J-T018	587	72.0	66.7	61.1	5,010
J-T019	588	71.2	66.4	60.3	3,770
J-T020	588	72.4	66.8	60.9	1,840
J-T021	588	71.4	66.3	59.7	2,380
J-T022	588	72.3	66.7	60.9	4,780
J-T023	589	72.5	66.1	59.1	1,960
J-T024	589	75.4	68.5	60.0	5,010
J-T025	589	72.5	66.1	59.1	2,010
J-T026	589	71.3	65.9	59.0	5,010
J-T027	589	70.9	65.8	59.2	5,010
J-T028	589	74.5	67.8	59.5	5,030
J-T029	590	70.7	65.5	58.6	3,150
J-T030	590	71.9	66.0	58.7	5,040
J-T031	590	71.5	65.8	58.7	5,010
J-T032	590	98.0	89.6	79.2	1,250
J-T033	590	72.0	65.7	58.6	1,850
J-T034	590	71.6	65.8	58.5	5,010
J-T035	590	98.5	92.5	84.2	2,280
J-T036	590	71.0	65.5	58.6	5,010
J-T037	590	75.6	68.6	59.9	5,100
J-T038	590	70.7	65.2	58.0	2,660
J-T039	591	71.6	65.2	58.2	1,940
J-T040	592	69.7	64.6	58.1	5,010
J-T041	592	75.5	68.3	59.4	2,210
J-T042	592	90.9	83.0	73.0	1,820
J-T043	592	69.4	64.5	58.7	1,820
J-T044	592	72.5	66.1	58.0	5,010
J-T045	592	80.5	72.7	63.0	1,530
J-T046	593	69.9	64.3	57.0	5,030

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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T047	593	74.3	67.4	58.6	5,010
J-T048	593	70.7	64.4	57.3	1,790
J-T049	593	72.9	66.2	57.7	2,480
J-T050	593	90.2	82.4	72.4	2,100
J-T051	593	69.4	63.9	56.6	2,510
J-T052	593	95.8	89.6	80.8	2,890
J-T053	594	70.1	64.2	56.9	5,030
J-T054	594	68.4	63.6	57.5	4,650
J-T055	594	70.9	64.6	56.9	5,010
J-T056	594	95.9	89.7	81.1	2,170
J-T057	595	97.1	91.2	83.1	3,720
J-T058	595	78.3	70.7	61.1	2,050
J-T059	595	97.6	91.8	83.8	3,770
J-T060	595	102.1	97.6	91.4	5,010
J-T061	595	96.4	90.5	82.2	3,210
J-T062	595	68.3	63.1	56.4	2,700
J-T063	595	68.3	63.1	56.4	5,010
J-T064	595	68.4	63.1	56.0	2,120
J-T065	595	70.8	63.9	55.6	2,810
J-T066	595	78.9	71.2	61.5	1,790
J-T067	595	68.1	63.0	56.2	4,770
J-T068	595	96.5	90.6	82.4	3,610
J-T069	596	98.7	93.3	85.8	4,250
J-T071	596	69.3	63.3	55.8	5,060
J-T072	596	70.0	63.4	55.4	2,990
J-T073	597	103.1	98.9	93.2	5,010
J-T074	597	72.8	65.8	57.0	1,910
J-T075	597	72.0	65.2	56.6	5,010
J-T076	597	67.0	62.3	56.6	2,400
J-T077	597	73.1	66.0	57.1	3,260
J-T078	597	67.4	62.0	54.8	1,870
J-T079	597	84.1	76.5	66.8	2,430
J-T080	598	68.4	62.6	55.1	5,010
J-T081	598	96.0	90.2	82.1	5,010
J-T082	598	108.9	100.2	89.8	1,600
J-T083	598	67.4	61.9	54.6	3,030
J-T084	598	72.2	65.2	56.3	730
J-T086	598	66.9	61.9	55.2	5,010
J-T087	598	95.5	89.7	81.5	5,010
J-T088	598	68.2	62.3	54.8	5,010
J-T089	598	66.4	61.7	55.6	5,010
J-T090	599	72.0	65.0	56.3	5,010
J-T091	599	66.7	61.8	56.0	1,570
J-T092	599	95.8	90.0	82.0	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T094	599	74.5	67.0	57.7	2,320
J-T095	599	77.8	70.2	60.6	3,040
J-T096	599	71.7	64.7	56.0	5,010
J-T097	600	76.4	68.9	59.3	5,010
J-T098	600	76.1	68.5	59.0	1,750
J-T099	600	94.7	88.8	80.6	5,010
J-T100	600	76.4	68.9	59.3	5,010
J-T101	600	66.4	61.0	53.8	2,190
J-T102	600	70.1	63.3	54.8	2,400
J-T103	600	66.8	61.2	53.9	5,010
J-T104	600	70.2	63.5	55.1	5,010
J-T105	600	66.2	60.9	53.7	2,070
J-T106	600	66.2	60.9	53.7	1,590
J-T107	600	102.2	98.2	92.7	5,010
J-T108	600	67.7	61.3	54.3	1,690
J-T109	600	67.7	61.3	54.3	1,730
J-T110	600	98.8	94.1	87.7	5,010
J-T111	600	72.7	65.4	56.2	1,150
J-T112	600	73.5	66.2	56.9	1,630
J-T113	600	92.8	86.6	77.7	2,040
J-T114	600	74.8	67.4	58.0	5,010
J-T115	600	80.1	68.7	49.8	1,420
J-T116	600	100.5	96.1	90.0	5,010
J-T117	600	67.2	61.3	53.9	5,010
J-T118	600	66.2	60.8	53.5	1,800
J-T119	601	93.8	87.8	79.5	4,310
J-T120	601	119.3	110.9	101.4	2,800
J-T121	601	65.8	60.5	53.3	1,890
J-T122	601	70.9	64.0	55.2	5,010
J-T123	601	71.1	64.1	55.3	5,010
J-T124	601	69.6	63.0	54.6	5,010
J-T125	601	72.4	65.2	56.1	2,350
J-T126	601	71.2	64.2	55.4	5,010
J-T127	601	79.8	68.4	49.4	1,410
J-T128	602	67.7	61.1	53.0	1,260
J-T130	602	114.5	105.9	96.5	2,710
J-T131	602	114.7	106.1	96.6	2,720
J-T132	603	102.6	98.7	93.2	1,700
J-T133	603	102.5	98.7	93.3	3,520
J-T134	603	79.1	67.7	48.7	1,410
J-T135	603	76.7	69.2	59.5	1,020
J-T136	603	102.8	99.2	94.2	2,390
J-T137	603	102.8	99.2	94.2	5,010
J-T139	603	102.4	98.5	93.2	4,950

CITY OF TRAVERSE CITY
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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T140	603	76.6	69.1	59.5	1,900
J-T141	603	76.6	69.1	59.4	4,590
J-T142	603	68.7	62.0	53.5	2,010
J-T143	603	75.6	68.1	58.5	4,590
J-T144	604	102.4	98.8	93.8	5,010
J-T145	604	69.9	62.9	54.1	5,010
J-T146	604	67.2	60.4	52.1	1,630
J-T147	604	64.7	59.3	52.0	5,010
J-T148	604	69.1	62.2	53.6	5,010
J-T149	604	96.5	91.8	85.2	5,010
J-T150	604	69.6	62.7	53.9	5,010
J-T151	605	122.5	114.4	105.1	3,030
J-T152	605	78.3	66.9	48.0	1,400
J-T153	605	63.9	59.0	52.5	5,010
J-T154	605	64.3	58.9	51.6	1,850
J-T155	605	91.9	85.9	77.7	5,010
J-T156	605	64.7	59.0	51.7	5,010
J-T157	605	94.3	89.2	82.2	5,010
J-T158	605	112.3	103.7	94.0	2,020
J-T159	605	112.6	104.0	94.6	2,680
J-T160	606	63.9	58.5	51.2	2,060
J-T161	606	109.3	100.6	90.6	2,160
J-T162	606	106.1	97.4	87.1	2,030
J-T163	606	63.7	58.4	51.1	1,760
J-T164	606	90.2	84.0	75.2	3,850
J-T165	606	77.7	66.3	47.4	1,410
J-T166	606	77.7	66.3	47.4	1,400
J-T167	606	101.1	97.2	91.7	1,320
J-T168	606	90.3	84.2	75.5	5,010
J-T169	606	77.6	66.2	47.3	1,400
J-T170	607	111.6	103.1	93.6	2,370
J-T171	607	78.6	68.8	52.1	1,480
J-T172	607	64.3	58.6	53.1	4,720
J-T173	607	111.9	103.3	93.8	2,540
J-T174	607	117.1	108.7	99.1	1,980
J-T175	607	91.1	85.2	77.0	5,010
J-T176	607	63.0	57.5	50.0	1,100
J-T177	607	63.2	57.9	50.7	1,980
J-T178	607	62.4	58.0	52.5	5,010
J-T179	607	63.3	57.9	50.6	1,420
J-T180	607	111.3	102.8	93.6	2,630
J-T182	607	63.3	57.9	50.6	2,170
J-T183	607	73.0	65.5	56.0	1,970
J-T184	608	89.9	83.8	75.2	3,260

CITY OF TRAVERSE CITY
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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T185	608	73.8	66.3	56.7	3,560
J-T186	608	103.0	97.9	92.0	2,820
J-T187	608	63.1	57.6	50.2	2,060
J-T188	608	76.9	65.5	46.7	1,400
J-T189	608	62.9	57.6	50.4	5,010
J-T190	608	74.5	63.8	44.6	1,400
J-T191	608	62.2	56.9	49.4	5,010
J-T192	608	63.0	57.6	50.3	5,010
J-T193	608	62.2	57.6	52.0	1,730
J-T194	608	76.8	65.4	46.5	1,470
J-T195	608	62.6	57.0	49.4	1,480
J-T196	608	62.4	56.6	49.0	1,370
J-T197	608	62.8	57.4	50.2	5,010
J-T198	608	93.1	87.6	80.1	2,400
J-T199	608	92.0	86.4	78.7	3,430
J-T200	608	95.6	90.9	84.3	5,010
J-T201	608	85.9	78.8	68.5	3,800
J-T202	608	68.0	61.0	52.2	5,010
J-T203	608	68.0	61.0	52.2	5,010
J-T204	609	90.0	84.1	75.9	5,010
J-T205	609	92.9	87.5	80.2	5,010
J-T206	609	76.6	65.2	46.3	1,400
J-T207	609	62.4	57.2	50.2	5,010
J-T208	609	72.4	65.4	56.7	1,510
J-T209	609	67.8	60.8	52.0	5,010
J-T210	609	89.2	83.0	74.5	2,820
J-T211	609	76.4	65.0	46.2	1,420
J-T212	609	67.8	60.8	52.0	5,010
J-T213	609	90.0	84.1	76.0	5,010
J-T214	609	89.9	84.1	75.9	5,010
J-T215	609	61.7	56.0	48.2	1,040
J-T216	609	61.8	56.0	48.3	1,250
J-T217	609	97.1	88.7	78.5	1,260
J-T218	609	89.8	84.0	75.9	5,010
J-T219	609	72.5	65.0	55.4	5,010
J-T220	609	76.3	64.9	46.0	1,380
J-T221	609	88.2	81.8	72.9	2,780
J-T222	609	93.2	87.8	80.5	3,290
J-T223	609	62.5	57.0	49.7	3,310
J-T224	610	86.4	79.7	70.7	3,890
J-T225	610	94.7	89.8	83.0	3,180
J-T226	610	91.4	85.8	78.1	5,020
J-T227	610	115.2	106.7	96.7	1,200
J-T228	610	62.4	56.9	49.6	2,610

CITY OF TRAVERSE CITY
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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T229	610	67.6	60.6	51.8	5,010
J-T230	610	62.3	56.8	49.5	5,010
J-T231	610	67.5	60.5	51.7	5,010
J-T232	610	68.7	61.5	52.4	5,010
J-T233	610	87.3	80.8	72.0	3,620
J-T234	610	61.6	56.4	49.3	2,010
J-T235	610	86.6	80.0	71.1	3,000
J-T236	610	62.4	56.8	49.5	5,010
J-T237	610	62.3	56.8	49.5	5,010
J-T238	610	61.4	55.7	48.1	1,840
J-T239	610	95.8	91.2	84.8	2,620
J-T240	610	62.1	56.6	49.2	2,680
J-T241	610	61.3	55.5	47.8	1,370
J-T242	610	62.3	57.2	50.2	4,540
J-T243	610	61.6	56.3	48.9	5,010
J-T244	610	61.4	56.1	48.6	5,010
J-T245	610	89.8	84.4	76.8	5,010
J-T246	610	85.3	78.6	69.5	4,650
J-T247	610	86.6	80.0	71.0	3,230
J-T248	610	67.3	60.3	51.5	5,010
J-T249	610	75.8	64.4	45.5	1,370
J-T250	611	67.2	60.2	51.3	5,010
J-T251	611	62.2	56.6	49.2	5,010
J-T252	611	83.9	77.1	68.0	5,010
J-T253	611	86.3	79.3	70.2	2,130
J-T254	611	90.8	85.1	77.2	2,830
J-T255	611	75.7	64.3	45.6	1,460
J-T256	611	67.1	60.1	51.2	5,010
J-T257	611	62.1	56.4	49.0	5,010
J-T258	611	61.6	56.0	48.6	5,010
J-T259	611	83.0	76.1	66.9	3,080
J-T260	611	84.8	78.1	69.0	2,950
J-T261	611	60.9	55.5	48.1	1,570
J-T262	611	86.6	80.2	71.6	5,010
J-T263	611	62.5	56.7	49.2	5,010
J-T264	611	65.2	58.6	50.2	5,010
J-T265	611	65.2	58.6	50.2	5,010
J-T266	611	60.4	54.6	46.7	1,640
J-T267	611	60.1	54.2	46.2	1,540
J-T268	611	60.4	54.7	47.0	1,520
J-T269	611	85.9	79.1	70.0	3,280
J-T270	611	82.0	75.1	66.0	5,010
J-T271	611	79.8	72.8	63.6	5,010
J-T272	611	61.8	56.2	48.9	5,010

CITY OF TRAVERSE CITY
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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T273	611	79.8	72.8	63.5	5,010
J-T274	611	66.8	59.8	51.0	5,010
J-T275	612	60.1	56.0	50.8	5,010
J-T276	612	85.8	79.2	70.4	3,610
J-T277	612	87.4	81.0	72.2	2,320
J-T278	612	76.0	68.7	59.1	2,770
J-T279	612	61.4	55.8	48.4	5,010
J-T280	612	60.1	54.4	46.6	1,080
J-T281	612	60.9	55.2	47.7	5,010
J-T282	612	59.1	53.2	44.9	1,370
J-T283	612	59.7	54.1	46.5	5,010
J-T284	612	61.1	55.3	47.7	1,470
J-T285	612	60.3	54.9	47.4	4,130
J-T286	612	86.8	80.3	71.4	1,730
J-T287	612	110.2	101.7	92.2	2,510
J-T288	612	71.1	63.9	54.6	5,010
J-T289	612	69.0	61.6	52.2	1,570
J-T290	612	69.5	62.1	52.6	3,140
J-T291	613	70.6	63.1	53.6	2,630
J-T292	613	104.3	97.2	89.9	2,400
J-T293	613	60.1	54.4	46.7	4,910
J-T294	613	69.4	62.0	52.5	3,400
J-T295	613	60.4	54.7	47.0	5,010
J-T296	613	72.9	65.4	55.7	2,710
J-T297	613	84.0	76.9	66.6	4,540
J-T298	613	74.5	67.2	57.6	3,140
J-T299	613	69.3	61.9	52.4	3,480
J-T300	613	75.0	67.8	58.4	5,010
J-T301	613	71.1	63.6	54.0	5,010
J-T302	613	60.6	54.9	47.3	4,210
J-T303	613	60.2	54.5	46.7	3,680
J-T304	613	59.6	53.9	46.3	4,980
J-T305	613	56.0	49.9	41.3	730
J-T306	613	69.2	61.8	52.3	1,860
J-T307	613	70.6	63.2	53.6	2,530
J-T308	614	70.7	63.2	53.6	5,010
J-T309	614	59.8	55.0	48.6	2,200
J-T310	614	70.8	63.5	54.0	5,010
J-T311	614	86.5	80.9	73.2	5,010
J-T312	614	86.9	81.3	73.7	5,010
J-T313	614	56.6	50.4	41.6	750
J-T314	614	59.0	53.2	45.2	1,900
J-T315	614	59.1	53.2	45.2	2,830
J-T316	614	58.3	52.4	44.1	1,510

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Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T317	614	59.5	53.7	45.7	3,400
J-T318	614	59.3	53.4	45.4	3,260
J-T319	614	59.5	53.5	45.5	1,460
J-T320	614	58.8	52.9	44.8	1,650
J-T321	614	59.7	53.9	46.0	1,320
J-T322	614	75.7	67.6	56.6	4,660
J-T323	614	72.8	65.2	55.4	1,600
J-T324	614	71.8	64.2	54.4	5,010
J-T325	615	58.5	52.6	44.5	2,330
J-T326	615	59.0	53.1	45.1	1,440
J-T327	615	58.9	53.0	45.0	2,140
J-T328	615	58.9	53.0	45.0	2,600
J-T329	615	75.4	67.2	56.1	3,010
J-T330	615	58.7	52.9	45.0	1,580
J-T331	615	58.9	53.0	45.0	1,350
J-T332	615	73.8	62.4	43.6	1,290
J-T333	615	70.4	63.0	53.4	5,010
J-T334	615	70.5	62.9	53.3	3,340
J-T335	615	104.9	97.1	89.0	2,240
J-T336	616	70.0	62.6	53.2	5,010
J-T337	616	70.2	62.7	53.1	5,010
J-T338	616	58.9	53.8	46.6	1,210
J-T339	616	70.3	62.8	53.1	3,090
J-T340	616	57.3	51.4	43.1	1,380
J-T341	616	58.2	52.3	44.3	1,410
J-T342	616	57.6	51.6	43.4	1,610
J-T343	616	57.0	51.0	42.6	1,230
J-T344	617	69.8	62.4	53.1	4,960
J-T345	617	70.2	62.7	53.0	3,070
J-T346	617	57.8	53.5	48.0	3,140
J-T347	617	57.2	51.3	43.3	1,350
J-T348	617	60.8	55.4	48.9	1,220
J-T349	617	69.6	62.1	52.5	2,500
J-T350	618	69.4	62.0	52.6	2,030
J-T351	618	56.7	50.9	42.9	760
J-T352	618	57.1	51.2	43.1	1,300
J-T353	618	69.2	61.8	52.3	3,180
J-T354	618	56.4	50.7	42.7	1,550
J-T355	618	69.6	62.1	52.4	3,110
J-T356	619	56.5	52.8	48.0	5,010
J-T357	619	68.6	61.3	52.0	4,600
J-T358	620	68.3	61.1	51.9	1,880
J-T359	620	56.9	51.6	44.1	3,790
J-T360	620	56.6	51.7	44.7	890

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MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T361	620	56.0	50.4	42.3	1,570
J-T362	620	56.8	51.6	44.2	4,110
J-T363	620	56.8	51.5	44.1	1,760
J-T364	620	56.9	51.5	44.1	4,760
J-T365	620	58.7	52.9	48.2	4,180
J-T366	621	102.0	94.3	86.5	1,330
J-T367	621	69.4	61.9	52.2	2,250
J-T368	621	70.8	63.6	54.2	3,840
J-T369	621	69.3	61.8	52.1	2,390
J-T370	621	70.0	62.7	53.3	4,070
J-T371	621	68.2	60.8	51.5	2,420
J-T372	621	67.9	60.6	51.5	4,790
J-T373	621	71.1	63.8	54.4	3,740
J-T374	621	68.6	61.3	52.0	3,610
J-T375	621	56.0	51.5	45.1	1,010
J-T376	621	56.1	51.7	46.2	2,780
J-T377	621	56.4	51.2	43.8	3,850
J-T378	621	56.4	51.3	44.1	1,200
J-T379	621	69.8	62.3	52.7	1,730
J-T380	621	67.2	60.3	51.4	4,420
J-T381	621	71.8	64.7	55.4	4,580
J-T382	622	73.1	66.1	56.8	2,060
J-T383	623	69.9	62.8	53.6	3,850
J-T384	623	72.3	65.4	56.1	2,020
J-T385	624	57.1	51.4	46.1	4,170
J-T386	624	70.5	63.5	54.4	4,180
J-T387	624	72.0	65.3	56.4	4,830
J-T388	624	75.5	69.7	61.8	5,010
J-T389	624	73.9	67.6	59.1	5,010
J-T390	624	74.8	69.1	61.3	5,020
J-T391	624	75.3	69.3	61.4	5,010
J-T392	624	65.6	58.8	50.2	4,080
J-T393	624	74.4	68.2	59.8	1,300
J-T394	625	69.8	62.8	53.6	1,770
J-T395	625	70.3	63.4	54.3	2,360
J-T396	625	62.0	59.9	56.8	3,940
J-T397	625	92.8	89.0	83.5	1,890
J-T398	625	54.8	49.5	42.0	5,010
J-T399	625	71.7	65.1	56.3	2,800
J-T400	626	56.2	50.5	45.3	4,100
J-T401	626	102.1	89.1	57.3	1,700
J-T402	626	102.1	89.1	57.3	1,350
J-T403	626	61.3	55.8	48.5	1,560
J-T404	626	61.5	56.0	48.6	1,580

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T405	626	54.1	48.6	41.1	3,490
J-T406	626	53.8	48.3	40.7	3,680
J-T407	626	56.1	50.3	45.8	4,040
J-T408	626	56.2	50.4	46.6	4,090
J-T409	626	112.1	108.4	99.1	5,010
J-T410	626	112.0	108.2	98.8	2,800
J-T411	626	110.2	104.8	91.5	4,950
J-T412	626	60.4	53.4	44.6	5,010
J-T413	626	89.4	85.0	79.0	5,010
J-T414	626	80.4	73.9	65.0	3,270
J-T415	626	59.9	53.0	44.3	5,010
J-T416	626	54.7	49.4	42.1	4,400
J-T417	626	81.6	75.3	66.5	1,170
J-T418	626	105.9	97.0	75.0	3,550
J-T419	626	55.9	50.2	44.4	4,380
J-T420	626	101.6	88.2	56.0	2,690
J-T421	626	111.9	108.0	98.3	5,010
J-T422	626	56.2	50.5	47.0	4,020
J-T423	626	61.3	55.9	48.1	1,240
J-T424	698	69.6	55.2	22.1	1,350
J-T425	626	57.7	52.0	47.3	1,830
J-T426	626	62.6	57.3	49.2	1,690
J-T427	626	102.1	89.1	57.2	1,020
J-T428	626	102.0	88.9	57.0	2,850
J-T429	626	66.3	61.6	51.6	790
J-T430	626	69.2	58.1	39.7	1,330
J-T431	626	55.9	50.2	44.4	3,020
J-T432	626	80.3	73.7	64.3	3,760
J-T433	626	110.9	106.1	94.3	5,010
J-T435	626	52.3	49.7	46.3	5,010
J-T436	626	102.4	89.9	58.4	2,970
J-T437	626	112.0	108.2	98.6	1,170
J-T438	626	51.3	49.7	47.5	5,010
J-T439	626	73.3	67.1	58.7	5,010
J-T440	626	112.0	108.3	98.9	5,010
J-T441	626	100.7	86.4	53.4	2,340
J-T442	626	112.0	108.3	98.9	5,010
J-T443	626	49.3	48.8	47.7	5,010
J-T444	626	54.7	49.4	42.0	2,610
J-T445	626	60.0	53.1	44.4	5,010
J-T446	626	109.5	103.7	89.1	4,660
J-T447	626	72.8	66.3	57.7	1,700
J-T448	626	112.0	108.2	98.6	960
J-T449	626	65.1	57.6	48.0	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T450	626	69.0	61.8	52.4	2,860
J-T451	626	68.9	61.6	52.2	3,680
J-T452	626	72.0	65.4	56.7	5,010
J-T453	626	74.0	68.0	59.9	5,010
J-T454	626	72.9	66.6	58.1	5,010
J-T455	626	65.0	57.5	47.9	5,010
J-T456	626	72.2	64.1	52.8	4,290
J-T457	626	81.6	75.4	66.6	5,010
J-T458	626	72.2	64.0	52.8	4,430
J-T459	626	48.7	47.7	45.3	5,010
J-T460	626	73.0	64.9	53.8	3,920
J-T461	626	71.2	64.3	55.0	1,760
J-T462	626	95.2	83.6	49.5	2,200
J-T463	626	71.2	64.3	54.9	970
J-T464	628	51.9	46.5	39.1	4,000
J-T465	628	51.9	46.5	39.1	2,860
J-T466	629	54.6	49.4	43.3	880
J-T467	629	51.5	45.6	37.3	820
J-T468	630	52.2	47.4	40.4	710
J-T469	630	51.0	45.0	36.6	720
J-T471	634	49.1	43.7	36.4	3,690
J-T472	630	50.3	45.2	38.1	3,510
J-T473	636	62.0	57.4	47.5	1,530
J-T474	638	50.8	45.1	40.1	3,750
J-T475	638	64.3	57.1	47.5	1,240
J-T476	638	64.8	57.6	48.3	1,950
J-T479	642	88.1	76.5	42.4	1,120
J-T480	642	95.9	92.0	84.9	1,510
J-T481	643	87.7	76.0	42.0	1,120
J-T482	644	87.3	75.6	41.5	1,120
J-T483	644	43.6	37.4	28.6	350
J-T484	645	91.1	83.4	75.9	1,760
J-T485	647	86.0	74.3	40.2	1,120
J-T486	648	85.5	73.9	39.8	1,120
J-T488	650	46.5	41.9	35.1	590
J-T489	650	46.8	41.4	33.9	2,680
J-T490	652	83.9	72.2	38.1	1,120
J-T491	652	87.7	80.1	72.6	1,810
J-T492	653	84.4	73.4	39.7	1,180
J-T493	653	84.4	73.4	39.7	3,120
J-T494	654	82.9	71.3	37.2	1,120
J-T495	655	82.6	70.9	36.8	1,120
J-T496	655	82.5	70.9	36.8	1,120
J-T497	656	83.1	72.1	38.4	3,120

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T498	656	43.1	37.4	33.0	3,230
J-T499	660	81.3	70.4	36.7	2,240
J-T501	660	38.6	33.1	25.5	2,110
J-T502	660	80.9	69.7	35.7	1,150
J-T504	660	80.4	68.7	34.6	1,120
J-T505	660	99.3	98.9	98.1	1,460
J-T506	662	83.7	76.0	68.3	1,120
J-T507	662	79.5	67.8	33.7	1,120
J-T508	664	78.6	66.9	32.9	1,120
J-T509	664	78.7	67.0	32.9	1,120
J-T510	665	78.3	66.7	32.6	1,120
J-T511	666	77.8	66.1	32.0	1,120
J-T512	666	51.7	47.9	37.2	1,270
J-T513	668	76.9	65.2	31.1	1,110
J-T514	669	76.5	64.8	30.7	1,120
J-T515	669	76.6	65.0	30.9	1,120
J-T516	670	71.1	60.0	29.4	1,020
J-T517	670	76.1	64.5	30.4	1,120
J-T518	676	73.6	62.0	27.8	1,120
J-T519	678	72.6	60.9	26.8	1,110
J-T520	680	71.9	60.3	26.2	1,130
J-T521	682	75.0	67.3	59.6	1,100
J-T522	684	70.2	58.6	24.5	1,130
J-T523	690	67.6	56.1	21.9	1,130
J-T524	692	67.6	56.8	23.1	1,350
J-T526	693	63.3	59.4	54.0	1,220
J-T527	694	65.7	54.0	19.9	1,100
J-T528	696	65.1	53.6	19.5	1,070
J-T529	698	65.0	54.2	20.6	1,200
J-T530	699	67.5	59.8	52.1	720
J-T531	700	71.0	59.2	28.5	1,820
J-T532	700	63.4	51.9	17.8	1,030
J-T533	700	82.1	82.0	81.7	1,560
J-T535	702	62.8	51.6	17.7	1,110
J-T536	702	62.3	50.6	16.5	1,040
J-T537	703	61.8	50.1	15.9	880
J-T538	704	61.4	49.8	15.7	1,010
J-T539	705	61.1	49.5	15.4	990
J-T540	706	60.8	49.3	15.2	890
J-T542	709	59.3	47.7	13.6	930
J-T543	710	59.2	47.8	13.8	950
J-T544	712	67.3	57.2	32.4	2,050
J-T546	714	57.3	45.9	11.8	870
J-T548	716	56.3	44.8	10.7	820

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH EXISTING INFRASTRUCTURE

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T549	718	55.6	44.1	10.0	810
J-T551	718	105.3	102.3	98.2	4,220
J-T552	719	55.3	43.8	9.8	800
J-T555	721	70.9	67.1	57.7	1,440
J-T556	721	70.9	67.2	57.8	3,300
J-T557	723	70.0	66.3	56.8	1,360
J-T558	724	69.6	65.8	56.4	2,770
J-T560	725	69.2	65.4	56.0	2,590
J-T561	626	51.1	49.7	47.8	5,010
J-T565	751	88.5	84.1	78.1	1,540
J-T566	759	86.2	82.7	77.9	2,940
J-T568	761	85.1	81.6	76.8	2,860
J-T569	766	83.7	80.2	75.3	1,440
J-T570	767	82.3	78.4	73.0	1,650
J-T572	626	102.1	89.1	57.3	2,880
J-T573	650	101.6	97.9	88.4	3,640

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T002	584	74.7	68.5	62.0	2,890
J-T004	585	109.7	105.8	100.3	3,740
J-T005	585	74.7	68.4	61.7	2,620
J-T006	585	74.3	68.0	61.3	2,700
J-T007	585	74.1	68.1	61.7	3,140
J-T008	585	109.6	105.7	100.3	2,100
J-T009	587	71.7	66.7	60.1	2,050
J-T010	587	73.4	67.3	60.8	2,890
J-T011	587	72.0	66.7	59.8	5,010
J-T012	587	73.4	67.0	59.9	2,000
J-T013	587	71.9	66.8	60.9	1,920
J-T014	587	72.0	66.7	59.8	5,010
J-T015	587	71.8	66.7	59.9	5,010
J-T016	587	73.4	67.0	59.9	2,010
J-T017	587	71.8	66.6	59.8	5,010
J-T018	587	72.0	66.7	61.0	5,010
J-T019	588	71.2	66.4	60.3	3,770
J-T020	588	72.4	66.8	60.9	1,840
J-T021	588	71.4	66.3	59.6	2,380
J-T022	588	72.3	66.7	60.8	4,780
J-T023	589	72.5	66.1	59.0	1,960
J-T024	589	74.6	68.0	59.7	5,010
J-T025	589	72.5	66.1	59.0	2,010
J-T026	589	71.3	65.9	58.9	5,010
J-T027	589	70.9	65.8	59.1	5,010
J-T028	589	73.8	67.3	59.3	5,030
J-T029	590	70.7	65.4	58.6	3,150
J-T030	590	71.7	65.9	58.5	5,040
J-T031	590	71.4	65.7	58.5	5,010
J-T032	590	97.6	89.3	79.0	1,250
J-T033	590	72.1	65.7	58.6	1,850
J-T034	590	71.4	65.7	58.4	5,010
J-T035	590	98.2	92.3	84.1	2,280
J-T036	590	70.9	65.5	58.5	5,010
J-T037	590	74.8	68.1	59.6	5,100
J-T038	590	70.7	65.2	57.9	2,660
J-T039	591	71.6	65.2	58.2	1,940
J-T040	592	69.7	64.6	58.0	5,010
J-T041	592	74.9	67.9	59.2	2,210
J-T042	592	90.5	82.8	72.9	1,820
J-T043	592	69.4	64.5	58.6	1,820
J-T044	592	72.0	65.7	57.8	5,010
J-T045	592	79.9	72.4	62.8	1,520
J-T046	593	69.9	64.2	56.9	5,030
J-T047	593	73.5	66.8	58.3	5,010

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T048	593	70.8	64.4	57.3	1,790
J-T049	593	72.1	65.5	57.3	2,470
J-T050	593	89.8	82.1	72.2	2,090
J-T051	593	69.4	63.9	56.6	2,510
J-T052	593	95.5	89.4	80.6	2,880
J-T053	594	69.9	64.1	56.8	5,030
J-T054	594	68.4	63.6	57.4	4,650
J-T055	594	70.5	64.4	56.7	5,010
J-T056	594	95.6	89.5	81.0	2,160
J-T057	595	96.8	91.0	83.0	3,720
J-T058	595	77.8	70.3	60.9	2,050
J-T059	595	97.3	91.7	83.7	3,770
J-T060	595	101.9	97.4	91.3	5,010
J-T061	595	96.1	90.3	82.1	3,210
J-T062	595	68.3	63.1	56.3	2,700
J-T063	595	68.3	63.1	56.3	5,010
J-T064	595	68.4	63.1	55.9	2,120
J-T065	595	70.3	63.6	55.3	2,800
J-T066	595	78.3	70.8	61.3	1,790
J-T067	595	68.1	63.0	56.1	4,780
J-T068	595	96.2	90.4	82.3	3,610
J-T069	596	98.5	93.1	85.7	4,250
J-T071	596	69.0	63.1	55.7	5,060
J-T072	596	69.5	63.1	55.2	2,990
J-T073	597	102.9	98.8	93.1	5,010
J-T074	597	72.1	65.3	56.7	1,910
J-T075	597	71.1	64.5	56.2	5,010
J-T076	597	67.0	62.3	56.5	2,400
J-T077	597	72.5	65.6	56.9	3,260
J-T078	597	67.5	62.0	54.7	1,870
J-T079	597	83.6	76.2	66.6	2,430
J-T080	598	68.3	62.5	55.0	5,010
J-T081	598	95.8	90.0	82.0	5,010
J-T082	598	108.7	100.0	89.7	1,600
J-T083	598	67.4	61.9	54.6	3,030
J-T084	598	71.4	64.6	56.0	730
J-T086	598	67.0	61.9	55.1	5,010
J-T087	598	95.3	89.5	81.4	5,010
J-T088	598	68.0	62.2	54.7	5,010
J-T089	598	66.5	61.7	55.5	5,010
J-T090	599	71.1	64.4	56.0	5,010
J-T091	599	66.7	61.8	56.0	1,570
J-T092	599	95.5	89.8	81.9	5,010
J-T094	599	73.9	66.7	57.5	2,320
J-T095	599	77.1	69.7	60.2	3,040

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MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T096	599	71.3	64.5	55.9	5,010
J-T097	600	75.5	68.3	58.9	5,010
J-T098	600	75.6	68.2	58.8	1,750
J-T099	600	94.4	88.6	80.5	5,010
J-T100	600	75.5	68.2	58.9	5,010
J-T101	600	66.4	61.0	53.7	2,190
J-T102	600	69.1	62.5	54.4	2,390
J-T103	600	66.9	61.2	53.9	5,010
J-T104	600	68.6	62.4	54.5	5,010
J-T105	600	66.3	60.9	53.7	2,070
J-T106	600	66.3	60.9	53.7	1,590
J-T107	600	102.0	98.1	92.6	5,010
J-T108	600	67.7	61.3	54.3	1,690
J-T109	600	67.7	61.3	54.2	1,730
J-T110	600	98.6	94.0	87.6	5,010
J-T111	600	71.9	64.8	55.9	1,150
J-T112	600	72.4	65.4	56.4	1,660
J-T113	600	92.5	86.4	77.6	2,040
J-T114	600	73.6	66.5	57.4	5,010
J-T115	600	79.7	68.5	49.6	1,410
J-T116	600	100.3	95.9	89.9	5,010
J-T117	600	67.0	61.2	53.7	5,010
J-T118	600	66.3	60.8	53.5	1,810
J-T119	601	93.5	87.6	79.4	4,300
J-T120	601	119.2	110.8	101.3	2,800
J-T121	601	65.9	60.5	53.3	1,890
J-T122	601	70.1	63.4	54.9	5,010
J-T123	601	70.4	63.6	55.0	5,010
J-T124	601	67.4	61.4	53.7	5,010
J-T125	601	70.7	63.9	55.3	5,010
J-T126	601	70.6	63.8	55.2	5,010
J-T127	601	79.3	68.1	49.2	1,400
J-T128	602	67.2	60.8	52.7	1,250
J-T130	602	114.3	105.8	96.4	2,710
J-T131	602	114.5	106.0	96.5	2,720
J-T132	603	102.4	98.6	93.1	1,700
J-T133	603	102.4	98.6	93.2	3,520
J-T134	603	78.7	67.4	48.6	1,400
J-T135	603	76.0	68.6	59.1	1,010
J-T136	603	102.6	99.1	94.2	2,390
J-T137	603	102.6	99.1	94.2	5,010
J-T139	603	102.2	98.4	93.1	4,950
J-T140	603	75.9	68.6	59.1	1,900
J-T141	603	75.9	68.6	59.1	4,600
J-T142	603	67.4	61.0	52.8	2,000

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MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T143	603	74.9	67.5	58.1	4,610
J-T144	604	102.3	98.7	93.7	5,010
J-T145	604	69.4	62.6	54.0	5,010
J-T146	604	66.6	60.0	51.8	1,620
J-T147	604	64.8	59.3	52.0	5,010
J-T148	604	68.0	61.5	53.2	5,010
J-T149	604	96.3	91.6	85.1	5,010
J-T150	604	68.8	62.1	53.6	5,010
J-T151	605	122.3	114.3	105.0	3,030
J-T152	605	77.9	66.7	47.8	1,390
J-T153	605	63.9	59.0	52.4	5,010
J-T154	605	64.3	58.9	51.6	1,850
J-T155	605	91.6	85.7	77.6	5,010
J-T156	605	64.8	59.1	51.6	5,010
J-T157	605	94.0	89.0	82.1	5,010
J-T158	605	112.2	103.6	93.9	2,010
J-T159	605	112.4	103.9	94.6	2,670
J-T160	606	63.9	58.5	51.2	2,060
J-T161	606	109.1	100.5	90.5	2,150
J-T162	606	105.9	97.2	87.0	2,030
J-T163	606	63.7	58.4	51.1	1,760
J-T164	606	90.0	83.8	75.1	3,840
J-T165	606	77.3	66.0	47.2	1,410
J-T166	606	77.3	66.0	47.2	1,390
J-T167	606	100.9	97.0	91.6	1,320
J-T168	606	90.0	84.0	75.4	5,010
J-T169	606	77.2	65.9	47.1	1,390
J-T170	607	111.4	102.9	93.5	2,370
J-T171	607	78.2	68.6	52.0	1,470
J-T172	607	64.3	58.6	53.1	4,720
J-T173	607	111.7	103.2	93.7	2,540
J-T174	607	117.0	108.6	99.1	1,980
J-T175	607	90.9	85.0	76.8	5,010
J-T176	607	62.8	57.2	49.6	1,100
J-T177	607	63.3	57.9	50.6	1,990
J-T178	607	62.4	58.0	52.4	5,010
J-T179	607	63.4	57.9	50.6	1,420
J-T180	607	111.1	102.7	93.5	2,630
J-T182	607	63.4	57.9	50.5	2,170
J-T183	607	72.5	65.2	55.9	1,970
J-T184	608	89.6	83.6	75.1	3,250
J-T185	608	73.1	65.8	56.3	3,560
J-T186	608	102.8	97.8	92.0	2,810
J-T187	608	63.2	57.6	50.1	2,060
J-T188	608	76.5	65.3	46.5	1,390

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T189	608	63.0	57.6	50.4	5,010
J-T190	608	74.2	63.6	44.4	1,390
J-T191	608	62.3	56.8	49.4	5,010
J-T192	608	63.1	57.6	50.3	5,010
J-T193	608	62.2	57.5	51.9	1,730
J-T194	608	76.4	65.2	46.4	1,470
J-T195	608	62.7	56.9	49.3	1,480
J-T196	608	62.4	56.5	48.8	1,370
J-T197	608	62.9	57.4	50.2	5,010
J-T198	608	92.9	87.4	80.0	2,390
J-T199	608	91.7	86.2	78.6	3,420
J-T200	608	95.4	90.7	84.2	5,010
J-T201	608	85.6	78.6	68.3	3,800
J-T202	608	67.4	60.6	52.0	5,010
J-T203	608	67.5	60.7	52.1	5,010
J-T204	609	89.7	83.9	75.8	5,010
J-T205	609	92.7	87.3	80.1	5,010
J-T206	609	76.2	64.9	46.1	1,390
J-T207	609	62.5	57.2	50.2	5,010
J-T208	609	71.8	65.0	56.4	1,510
J-T209	609	67.3	60.5	51.8	5,010
J-T210	609	88.9	82.8	74.3	2,810
J-T211	609	76.0	64.7	46.0	1,410
J-T212	609	67.3	60.5	51.8	5,010
J-T213	609	89.8	83.9	75.8	5,010
J-T214	609	89.6	83.9	75.8	5,010
J-T215	609	61.6	55.8	48.0	1,040
J-T216	609	61.7	55.9	48.1	1,250
J-T217	609	96.8	88.5	78.3	1,260
J-T218	609	89.5	83.8	75.7	5,010
J-T219	609	71.7	64.4	55.0	5,010
J-T220	609	75.9	64.6	45.8	1,370
J-T221	609	87.9	81.6	72.8	2,780
J-T222	609	92.9	87.6	80.4	3,290
J-T223	609	62.6	57.0	49.6	3,320
J-T224	610	86.0	79.5	70.6	3,880
J-T225	610	94.5	89.6	82.9	3,180
J-T226	610	91.1	85.6	78.0	5,020
J-T227	610	115.0	106.6	96.6	1,200
J-T228	610	62.5	56.9	49.5	2,610
J-T229	610	67.0	60.2	51.6	5,010
J-T230	610	62.5	56.9	49.5	5,010
J-T231	610	67.0	60.2	51.5	5,010
J-T232	610	67.0	60.1	51.5	5,010
J-T233	610	87.0	80.6	71.8	3,610

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MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T234	610	61.6	56.5	49.3	2,010
J-T235	610	86.2	79.7	70.9	2,990
J-T236	610	62.5	56.8	49.5	5,010
J-T237	610	62.4	56.8	49.4	5,010
J-T238	610	61.1	55.4	47.7	1,870
J-T239	610	95.5	91.0	84.7	2,620
J-T240	610	62.2	56.6	49.1	2,690
J-T241	610	61.1	55.3	47.5	1,370
J-T242	610	62.2	57.1	50.1	4,540
J-T243	610	61.5	56.1	48.7	5,010
J-T244	610	61.4	55.9	48.5	5,010
J-T245	610	89.6	84.2	76.7	5,010
J-T246	610	84.9	78.3	69.3	4,640
J-T247	610	86.3	79.8	70.8	3,220
J-T248	610	66.7	59.9	51.3	5,010
J-T249	610	75.4	64.1	45.3	1,370
J-T250	611	66.6	59.8	51.2	5,010
J-T251	611	62.4	56.7	49.2	5,010
J-T252	611	83.5	76.8	67.8	5,010
J-T253	611	86.0	79.1	70.0	2,120
J-T254	611	90.5	84.9	77.1	2,830
J-T255	611	75.3	64.1	45.4	1,450
J-T256	611	66.5	59.7	51.1	5,010
J-T257	611	62.3	56.5	49.0	5,010
J-T258	611	61.7	56.0	48.5	5,010
J-T259	611	82.6	75.8	66.7	3,080
J-T260	611	84.5	77.8	68.8	2,940
J-T261	611	60.9	55.5	48.1	1,580
J-T262	611	86.3	79.9	71.4	5,010
J-T263	611	62.3	56.5	49.0	5,010
J-T264	611	62.5	56.7	49.1	5,010
J-T265	611	62.7	56.8	49.2	5,010
J-T266	611	59.8	53.9	45.9	2,520
J-T267	611	59.8	53.9	45.9	2,520
J-T268	611	59.8	53.9	45.9	2,490
J-T269	611	85.5	78.8	69.8	3,270
J-T270	611	81.5	74.8	65.8	5,010
J-T271	611	79.4	72.5	63.4	5,010
J-T272	611	62.0	56.3	48.9	5,010
J-T273	611	79.3	72.4	63.3	5,010
J-T274	611	66.3	59.5	50.8	5,010
J-T275	612	60.1	56.0	50.8	5,010
J-T276	612	85.4	79.0	70.3	3,600
J-T277	612	87.1	80.8	72.1	2,320
J-T278	612	75.5	68.3	58.9	2,760

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T279	612	61.6	55.8	48.3	5,010
J-T280	612	60.1	54.4	46.7	1,140
J-T281	612	61.0	55.2	47.6	5,010
J-T282	612	59.3	53.4	45.4	2,460
J-T283	612	59.6	53.9	46.3	5,010
J-T284	612	61.2	55.3	47.6	1,470
J-T285	612	60.3	54.7	47.2	4,130
J-T286	612	86.5	80.1	71.2	1,730
J-T287	612	110.1	101.5	92.1	2,510
J-T288	612	70.5	63.5	54.3	5,010
J-T289	612	67.9	60.7	51.6	1,560
J-T290	612	68.8	61.6	52.3	3,130
J-T291	613	69.9	62.6	53.2	2,620
J-T292	613	104.1	97.1	89.8	2,400
J-T293	613	60.1	54.3	46.5	4,920
J-T294	613	68.7	61.5	52.2	3,390
J-T295	613	60.4	54.6	46.9	5,010
J-T296	613	72.2	64.9	55.4	2,700
J-T297	613	83.6	76.6	66.5	4,530
J-T298	613	74.0	66.8	57.4	3,130
J-T299	613	68.6	61.4	52.1	3,470
J-T300	613	74.4	67.4	58.2	5,010
J-T301	613	70.3	63.1	53.7	5,010
J-T302	613	60.7	54.9	47.2	4,260
J-T303	613	60.2	54.4	46.6	3,760
J-T304	613	59.5	53.7	46.0	4,990
J-T305	613	58.8	52.9	44.9	2,350
J-T306	613	68.4	61.2	51.9	1,860
J-T307	613	69.9	62.6	53.3	2,520
J-T308	614	69.9	62.6	53.2	5,010
J-T309	614	59.7	55.0	48.5	2,710
J-T310	614	70.2	63.0	53.7	5,010
J-T311	614	86.2	80.7	73.1	5,010
J-T312	614	86.6	81.1	73.5	5,010
J-T313	614	58.4	52.5	44.4	1,080
J-T314	614	58.8	53.0	45.1	1,920
J-T315	614	58.9	53.0	45.0	3,090
J-T316	614	58.6	52.6	44.6	1,720
J-T317	614	59.4	53.5	45.6	3,510
J-T318	614	59.2	53.2	45.3	3,450
J-T319	614	59.4	53.4	45.4	1,470
J-T320	614	58.6	52.7	44.7	1,720
J-T321	614	59.7	53.8	45.9	1,330
J-T322	614	75.2	67.3	56.4	4,650
J-T323	614	72.1	64.8	55.1	1,600

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T324	614	71.1	63.8	54.2	5,010
J-T325	615	58.3	52.3	44.3	2,850
J-T326	615	58.9	52.9	44.9	1,450
J-T327	615	58.7	52.8	44.8	2,170
J-T328	615	58.7	52.8	44.8	2,680
J-T329	615	74.9	66.9	55.9	3,010
J-T330	615	58.6	52.7	44.8	1,580
J-T331	615	58.7	52.8	44.8	1,340
J-T332	615	73.4	62.1	43.4	1,280
J-T333	615	69.7	62.5	53.1	5,010
J-T334	615	69.7	62.4	52.9	3,340
J-T335	615	104.8	97.0	88.9	2,240
J-T336	616	69.4	62.2	52.9	5,010
J-T337	616	69.5	62.2	52.8	5,010
J-T338	616	58.9	53.8	46.7	1,230
J-T339	616	69.6	62.2	52.8	3,090
J-T340	616	57.8	51.8	43.9	2,730
J-T341	616	58.1	52.1	44.1	1,430
J-T342	616	57.8	51.8	43.9	2,800
J-T343	616	57.7	51.7	43.7	1,570
J-T344	617	69.1	61.9	52.8	4,960
J-T345	617	69.5	62.1	52.7	3,060
J-T346	617	57.8	53.5	48.0	3,150
J-T347	617	57.4	51.4	43.4	1,410
J-T348	617	60.8	55.4	48.9	1,220
J-T349	617	68.8	61.5	52.2	2,490
J-T350	618	68.7	61.5	52.4	2,020
J-T351	618	56.9	51.0	43.1	760
J-T352	618	57.0	51.0	43.0	1,320
J-T353	618	68.5	61.3	52.0	3,170
J-T354	618	56.7	50.8	42.9	1,640
J-T355	618	68.9	61.5	52.1	3,110
J-T356	619	56.5	52.8	48.0	5,010
J-T357	619	67.9	60.8	51.7	4,590
J-T358	620	67.7	60.6	51.7	1,880
J-T359	620	57.0	51.6	44.1	3,810
J-T360	620	56.9	51.9	44.9	1,070
J-T361	620	56.1	50.4	42.3	1,570
J-T362	620	56.9	51.6	44.1	4,130
J-T363	620	56.9	51.5	44.0	1,760
J-T364	620	56.9	51.5	44.0	4,780
J-T365	620	58.7	52.9	48.2	4,190
J-T366	621	101.8	94.1	86.4	1,330
J-T367	621	68.7	61.4	51.9	2,240
J-T368	621	70.2	63.2	53.9	3,830

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation	Pressure (psi)			Available Fire
	(ft)	Avg Day	Max Day	Peak Hour	Flow (gpm)
J-T369	621	68.6	61.3	51.8	2,380
J-T370	621	69.4	62.2	53.0	4,060
J-T371	621	67.5	60.3	51.2	2,410
J-T372	621	67.2	60.1	51.3	4,780
J-T373	621	70.5	63.4	54.2	3,740
J-T374	621	67.9	60.8	51.7	3,610
J-T375	621	56.5	51.8	45.3	2,330
J-T376	621	56.1	51.7	46.1	2,780
J-T377	621	56.5	51.1	43.7	3,870
J-T378	621	56.5	51.4	44.2	1,280
J-T379	621	69.2	61.9	52.4	1,720
J-T380	621	66.6	59.9	51.1	4,410
J-T381	621	71.3	64.3	55.2	4,580
J-T382	622	72.6	65.7	56.6	2,060
J-T383	623	69.3	62.4	53.4	3,840
J-T384	623	71.9	65.0	55.8	2,010
J-T385	624	57.1	51.4	46.1	4,180
J-T386	624	70.0	63.2	54.2	4,170
J-T387	624	71.5	64.9	56.2	4,820
J-T388	624	75.2	69.4	61.6	5,010
J-T389	624	73.5	67.3	58.9	5,010
J-T390	624	74.4	68.8	61.1	5,020
J-T391	624	74.9	69.1	61.2	5,010
J-T392	624	65.0	58.4	50.0	4,070
J-T393	624	74.1	67.9	59.6	1,300
J-T394	625	69.3	62.4	53.4	1,760
J-T395	625	69.8	63.0	54.0	2,350
J-T396	625	62.0	59.8	56.8	3,940
J-T397	625	92.7	88.8	83.4	1,890
J-T398	625	54.9	49.4	42.0	5,010
J-T399	625	71.3	64.7	56.1	2,790
J-T400	626	56.2	50.5	45.3	4,100
J-T401	626	102.1	89.1	57.1	1,700
J-T402	626	102.1	89.1	57.1	1,350
J-T403	626	61.3	55.8	48.5	1,560
J-T404	626	61.5	56.0	48.6	1,580
J-T405	626	54.0	48.4	40.9	3,480
J-T406	626	53.7	48.1	40.5	3,680
J-T407	626	56.1	50.3	45.7	4,040
J-T408	626	56.2	50.4	46.5	4,090
J-T409	626	112.1	108.4	99.1	5,010
J-T410	626	112.0	108.2	98.7	2,800
J-T411	626	110.2	104.8	91.5	4,950
J-T412	626	59.8	53.0	44.4	5,010
J-T413	626	89.2	84.9	78.9	5,010

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MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T414	626	80.0	73.6	64.9	3,260
J-T415	626	58.6	52.0	43.7	5,010
J-T416	626	54.6	49.3	41.9	4,410
J-T417	626	81.3	75.1	66.3	1,170
J-T418	626	105.9	97.0	74.9	3,550
J-T419	626	55.9	50.2	44.4	4,380
J-T420	626	101.6	88.2	55.8	2,690
J-T421	626	111.9	108.0	98.2	5,010
J-T422	626	56.3	50.5	46.9	4,020
J-T423	626	61.3	55.9	48.0	1,240
J-T424	698	69.6	55.2	22.0	1,350
J-T425	626	57.7	52.0	47.3	1,830
J-T426	626	62.6	57.3	49.1	1,690
J-T427	626	102.1	89.1	57.1	1,020
J-T428	626	102.0	88.9	56.9	2,850
J-T429	626	66.3	61.6	51.5	790
J-T430	626	68.8	57.8	39.5	1,320
J-T431	626	55.9	50.2	44.4	3,020
J-T432	626	79.9	73.4	64.1	3,750
J-T433	626	110.9	106.1	94.2	5,010
J-T435	626	52.3	49.7	46.3	5,010
J-T436	626	102.4	89.9	58.3	2,970
J-T437	626	112.0	108.2	98.6	1,170
J-T438	626	51.4	49.7	47.5	5,010
J-T439	626	72.9	66.8	58.6	5,010
J-T440	626	112.0	108.3	98.9	5,010
J-T441	626	100.7	86.4	53.2	2,340
J-T442	626	112.0	108.3	98.9	5,010
J-T443	626	49.3	48.8	47.7	5,010
J-T444	626	54.6	49.2	41.8	2,600
J-T445	626	58.6	52.1	43.8	5,010
J-T446	626	109.6	103.7	89.1	4,660
J-T447	626	72.4	66.0	57.5	1,700
J-T448	626	112.0	108.2	98.6	960
J-T449	626	64.3	57.0	47.6	5,010
J-T450	626	68.5	61.4	52.2	2,850
J-T451	626	68.3	61.2	52.0	3,670
J-T452	626	71.6	65.1	56.5	5,010
J-T453	626	73.6	67.7	59.7	5,010
J-T454	626	72.5	66.3	58.0	5,010
J-T455	626	64.1	56.8	47.4	5,010
J-T456	626	71.8	63.7	52.5	4,280
J-T457	626	81.3	75.2	66.4	5,010
J-T458	626	71.7	63.7	52.5	4,420
J-T459	626	48.7	47.7	45.3	5,010

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MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T460	626	72.5	64.6	53.6	3,910
J-T461	626	70.8	63.9	54.7	1,760
J-T462	626	95.2	83.6	49.3	2,200
J-T463	626	70.8	63.9	54.7	970
J-T464	628	51.9	46.4	39.0	4,010
J-T465	628	51.9	46.4	39.0	2,880
J-T466	629	54.7	49.4	43.3	880
J-T467	629	52.2	46.2	38.2	2,320
J-T468	630	52.6	47.7	40.8	920
J-T469	630	51.7	45.7	37.6	890
J-T471	634	49.0	43.6	36.2	3,700
J-T472	630	50.3	45.1	38.0	3,510
J-T473	636	62.0	57.4	47.5	1,530
J-T474	638	50.8	45.1	40.0	3,750
J-T475	638	63.7	56.6	47.3	1,230
J-T476	638	64.2	57.3	48.0	1,940
J-T479	642	88.1	76.5	42.3	1,120
J-T480	642	95.8	92.2	85.6	3,490
J-T481	643	87.7	76.0	41.8	1,120
J-T482	644	87.3	75.6	41.4	1,120
J-T483	644	45.4	39.5	31.4	460
J-T484	645	90.9	83.3	75.9	1,760
J-T485	647	86.0	74.3	40.1	1,120
J-T486	648	85.5	73.9	39.7	1,120
J-T488	650	46.9	42.2	35.7	1,510
J-T489	650	46.8	41.3	33.8	2,680
J-T490	652	83.9	72.2	37.9	1,120
J-T491	652	87.5	80.0	72.5	1,810
J-T492	653	84.4	73.4	39.6	1,180
J-T493	653	84.4	73.4	39.6	3,120
J-T494	654	82.9	71.3	37.1	1,120
J-T495	655	82.6	70.9	36.7	1,120
J-T496	655	82.6	70.9	36.7	1,120
J-T497	656	83.1	72.1	38.3	3,120
J-T498	656	43.2	37.4	33.0	3,230
J-T499	660	81.3	70.4	36.5	2,240
J-T501	660	38.7	33.1	25.4	2,110
J-T502	660	80.9	69.7	35.6	1,150
J-T504	660	80.4	68.7	34.5	1,120
J-T505	660	99.3	98.9	98.1	1,460
J-T506	662	83.5	75.9	68.2	1,120
J-T507	662	79.5	67.8	33.6	1,120
J-T508	664	78.6	66.9	32.7	1,120
J-T509	664	78.7	67.0	32.8	1,120
J-T510	665	78.3	66.7	32.5	1,120

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T511	666	77.8	66.1	31.9	1,120
J-T512	666	51.7	47.9	37.1	1,270
J-T513	668	76.9	65.2	31.0	1,110
J-T514	669	76.5	64.8	30.6	1,120
J-T515	669	76.6	65.0	30.8	1,120
J-T516	670	71.1	60.0	29.3	1,020
J-T517	670	76.1	64.5	30.2	1,120
J-T518	676	73.6	62.0	27.7	1,120
J-T519	678	72.6	60.9	26.7	1,110
J-T520	680	71.9	60.3	26.0	1,130
J-T521	682	74.8	67.2	59.6	1,090
J-T522	684	70.2	58.6	24.4	1,130
J-T523	690	67.6	56.1	21.8	1,130
J-T524	692	67.6	56.8	23.0	1,350
J-T526	693	63.2	59.3	53.9	1,220
J-T527	694	65.7	54.0	19.8	1,100
J-T528	696	65.1	53.6	19.3	1,070
J-T529	698	65.0	54.2	20.5	1,200
J-T530	699	67.3	59.7	52.0	710
J-T531	700	71.1	59.2	28.4	1,820
J-T532	700	63.4	51.9	17.7	1,030
J-T533	700	82.1	82.0	81.7	1,560
J-T535	702	62.8	51.6	17.6	1,110
J-T536	702	62.3	50.6	16.4	1,040
J-T537	703	61.8	50.1	15.8	880
J-T538	704	61.4	49.8	15.5	1,010
J-T539	705	61.1	49.5	15.2	990
J-T540	706	60.8	49.3	15.1	890
J-T542	709	59.3	47.7	13.5	930
J-T543	710	59.2	47.8	13.7	950
J-T544	712	67.3	57.2	32.3	2,050
J-T546	714	57.3	45.9	11.7	870
J-T548	716	56.3	44.8	10.5	820
J-T549	718	55.6	44.1	9.9	810
J-T551	718	105.3	102.3	98.2	4,220
J-T552	719	55.3	43.8	9.6	800
J-T555	721	70.9	67.1	57.7	1,440
J-T556	721	70.9	67.2	57.7	3,300
J-T557	723	70.0	66.3	56.8	1,360
J-T558	724	69.6	65.8	56.4	2,770
J-T560	725	69.2	65.4	55.9	2,590
J-T561	626	51.1	49.7	47.8	5,010
J-T565	751	88.4	84.1	78.1	1,540
J-T566	759	86.1	82.6	77.9	2,940
J-T568	761	85.1	81.5	76.8	2,860

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL OUTPUT - 2034 DEMANDS WITH RECOMMENDED IMPROVEMENTS

Label	Elevation (ft)	Pressure (psi)			Available Fire Flow (gpm)
		Avg Day	Max Day	Peak Hour	
J-T569	766	83.6	80.1	75.3	1,440
J-T570	767	82.3	78.4	73.0	1,640
J-T572	626	102.1	89.1	57.2	2,880
J-T573	650	101.6	97.8	88.4	3,640

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-1	J-T396	J-1	6	897	56
P-2	J-1	J-T480	6	1661	56
P-3	J-G580	J-G205	12	1441	104
P-4	J-T062	J-2	6	138	56
P-5	J-2	J-T027	6	415	56
P-6	J-T029	J-3	6	209	56
P-7	J-3	J-T017	6	266	56
P-8	J-2	J-3	8	519	130
P-9	PMP-1	J-G222	12	56	88
P-10	PMP-1	J-T501	12	56	88
P-11	J-T290	J-4	8	478	130
P-12	J-4	J-T296	6	633	88
P-13	J-T139	J-T397	8	2229	96
P-T001	J-T242	J-T176	6	799	56
P-T002	J-T216	J-T215	6	425	56
P-T003	J-T216	J-T196	6	430	56
P-T004	J-T196	J-T195	6	430	56
P-T005	J-T187	J-T195	6	431	56
P-T006	J-T187	J-T240	8	1042	56
P-T007	J-T240	J-T258	6	590	56
P-T008	J-T195	J-T281	6	1641	56
P-T009	J-T295	J-T196	6	1654	56
P-T010	J-T293	J-T216	6	1671	56
P-T011	J-T241	J-T304	6	1170	56
P-T012	J-T215	J-T241	6	520	56
P-T013	J-T176	J-T238	6	485	56
P-T014	J-T268	J-T238	6	580	56
P-T015	J-T283	J-T268	6	610	56
P-T016	J-T266	J-T243	6	571	56
P-T017	J-T244	J-T285	12	567	60
P-T018	J-T543	J-T546	12	236	96
P-T019	J-T266	J-T267	6	155	56
P-T020	J-T243	J-T244	12	173	60
P-T021	J-T552	J-T548	12	293	96
P-T022	J-T548	J-T542	12	91	96
P-T023	J-T238	J-T241	6	428	56
P-T024	J-T542	J-T538	12	239	96
P-T025	J-T538	J-T536	12	82	96
P-T026	J-T268	J-T266	6	641	56
P-T027	J-T536	J-T537	8	212	80
P-T028	J-T283	J-T304	12	411	60
P-T029	J-T537	J-T541	8	119	80
P-T030	J-T304	J-T293	12	426	60
P-T031	J-T541	J-T547	8	110	80
P-T032	J-T295	J-T293	12	425	60

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T033	J-T547	J-T559	8	87	80
P-T034	J-T281	J-T295	12	429	60
P-T035	J-T559	J-T562	8	124	80
P-T036	J-T281	J-T258	12	430	60
P-T037	J-T562	J-T563	8	121	80
P-T038	J-T258	J-T279	6	1191	56
P-T039	J-T563	J-T564	8	103	80
P-T040	J-T302	J-T281	6	1199	56
P-T041	J-T542	J-T539	12	161	96
P-T042	J-T303	J-T295	6	1199	56
P-T043	J-T317	J-T293	6	1199	56
P-T044	J-T304	J-T330	6	592	56
P-T045	J-T536	J-T527	12	158	96
P-T046	J-T330	J-T318	6	606	56
P-T047	J-T527	J-T519	12	46	96
P-T048	J-T330	J-T314	6	429	56
P-T049	J-T519	J-T513	12	209	96
P-T050	J-T314	J-T283	6	593	56
P-T051	J-T513	J-T508	12	34	96
P-T052	J-T314	J-T315	6	605	56
P-T053	J-T508	J-T494	12	182	96
P-T054	J-T320	J-T314	6	672	56
P-T055	J-T494	J-T486	12	151	96
P-T056	J-T267	J-T320	6	1001	56
P-T057	J-T486	J-T482	12	82	96
P-T058	J-T325	J-T320	6	643	56
P-T059	J-T508	J-T507	12	31	96
P-T060	J-T315	J-T325	10	665	60
P-T061	J-T507	J-T511	8	66	80
P-T062	J-T318	J-T315	10	429	60
P-T063	J-T511	J-T514	8	107	80
P-T064	J-T317	J-T318	10	427	60
P-T065	J-T514	J-T517	8	157	80
P-T066	J-T303	J-T317	10	426	60
P-T067	J-T302	J-T303	10	431	60
P-T068	J-T279	J-T302	10	429	60
P-T069	J-T279	J-T257	10	1398	60
P-T070	J-T284	J-T302	6	1523	56
P-T071	J-T303	J-T321	6	1441	56
P-T072	J-T317	J-T326	6	717	56
P-T073	J-T326	J-T319	6	723	56
P-T074	J-T518	J-T515	8	193	80
P-T075	J-T328	J-T318	10	728	60
P-T076	J-T515	J-T510	8	21	80
P-T077	J-T327	J-T328	10	709	60

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T078	J-T510	J-T509	8	332	80
P-T079	J-T315	J-T341	6	736	56
P-T080	J-T509	J-T504	8	89	80
P-T081	J-T352	J-T325	6	725	56
P-T082	J-T504	J-T490	8	154	80
P-T083	J-T341	J-T352	6	677	56
P-T084	J-T490	J-T485	8	67	80
P-T085	J-T341	J-T328	6	429	56
P-T086	J-T485	J-T481	8	95	80
P-T087	J-T326	J-T328	6	436	56
P-T088	J-T481	J-T479	8	160	80
P-T089	J-T319	J-T327	6	430	56
P-T090	J-T319	J-T321	6	436	56
P-T091	J-T321	J-T284	6	659	56
P-T092	J-T257	J-T284	6	447	56
P-T093	J-T342	J-T325	6	429	56
P-T094	J-T342	J-T340	6	428	56
P-T095	J-T340	J-T467	6	457	56
P-T096	J-T467	J-G764	6	633	56
P-T097	J-T465	J-T467	4	729	52
P-T098	J-T354	J-T340	6	721	56
P-T099	J-T347	J-T342	6	722	56
P-T100	J-T352	J-T347	6	420	56
P-T101	J-T347	J-T354	6	434	56
P-T102	J-T354	J-T465	6	461	56
P-T103	J-T465	J-T471	8	294	60
P-T104	J-T467	J-T469	6	688	56
P-T105	J-T340	J-T343	6	685	56
P-T106	J-T316	J-T342	6	687	56
P-T107	J-T316	J-T320	6	499	56
P-T108	J-T343	J-T316	6	431	56
P-T109	J-T523	J-T522	8	37	80
P-T110	J-T469	J-T343	6	442	56
P-T111	J-T522	J-T520	8	126	80
P-T112	J-T520	J-T518	8	172	80
P-T113	J-T313	J-T483	6	698	85
P-T114	J-T543	J-T532	8	270	80
P-T115	J-T313	J-T343	6	505	56
P-T116	J-T546	J-T549	12	83	96
P-T117	J-T305	J-T313	6	451	56
P-T118	J-T549	J-T552	12	81	96
P-T119	J-T282	J-T316	6	964	56
P-T120	J-T549	J-T540	8	281	80
P-T121	J-T282	J-T267	6	431	56
P-T122	J-T282	J-T305	6	472	56

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T123	PMP-T006	J-T305	6	842	56
P-T124	PMP-T006	J-T480	6	212	56
P-T125	J-T243	J-T280	6	438	56
P-T126	J-T280	J-T282	6	730	56
P-T128	J-T396	J-T242	12	2578	60
P-T129	J-T532	J-T528	8	91	80
P-T130	J-T192	J-T187	6	416	56
P-T131	J-T528	J-T523	8	175	80
P-T132	J-T182	J-T192	6	424	56
P-T133	J-T182	J-T223	6	1001	56
P-T134	J-T192	J-T230	24	1007	130
P-T135	J-T230	J-T240	8	427	56
P-T136	J-T230	J-T223	8	414	56
P-T137	J-T237	J-T230	24	593	130
P-T138	J-T258	J-T237	12	431	60
P-T139	J-T236	J-T237	12	410	60
P-T140	J-T237	J-T272	24	1188	130
P-T141	J-T236	J-T156	6	1213	56
P-T142	J-T236	J-T223	6	593	56
P-T143	J-T103	J-T236	12	436	60
P-T144	J-T223	J-T228	8	433	56
P-T145	J-T228	J-T103	4	588	52
P-T146	J-T103	J-T046	12	448	60
P-T147	J-T083	J-T228	8	436	56
P-T148	J-T179	J-T182	6	428	56
P-T149	J-T160	J-T179	6	454	56
P-T150	J-T154	J-T160	6	415	56
P-T151	J-T154	J-T083	6	600	56
P-T152	J-T078	J-T154	10	430	60
P-T153	J-T160	J-T101	6	431	56
P-T154	J-T101	J-T078	6	404	56
P-T155	J-T482	J-T479	8	58	80
P-T156	J-T507	J-T496	8	220	80
P-T157	J-T051	J-T078	4	607	52
P-T158	J-T496	J-T495	8	193	80
P-T159	J-T083	J-T051	8	429	56
P-T160	J-T051	J-T038	8	457	56
P-T161	J-T038	J-T036	6	194	56
P-T162	J-T064	J-T038	6	999	56
P-T163	J-T046	J-T083	6	601	56
P-T164	J-T031	J-T046	12	816	60
P-T165	J-T036	J-T031	16	1037	100
P-T166	J-T071	J-T053	12	603	60
P-T167	J-T053	J-T080	12	423	60
P-T168	J-T088	J-T080	12	582	130

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T169	J-T156	J-T080	12	903	60
P-T170	J-T020	J-T013	6	322	56
P-T171	J-T348	J-T020	6	831	56
P-T172	J-T466	J-T348	6	671	56
P-T173	J-T091	J-T466	6	569	56
P-T174	J-T043	J-T091	6	422	56
P-T175	J-T043	J-T013	6	436	56
P-T176	J-T013	J-T019	6	665	56
P-T177	J-T054	J-T019	8	417	130
P-T178	J-T054	J-T076	6	475	56
P-T179	J-T076	J-T043	6	458	56
P-T180	J-T193	J-T076	6	427	56
P-T181	J-T091	J-T193	6	460	56
P-T182	J-T193	J-T356	6	558	56
P-T183	J-T356	J-T275	16	235	100
P-T184	J-T275	J-T178	16	200	100
P-T185	J-T178	J-T076	6	551	56
P-T186	J-T178	J-T089	16	441	100
P-T187	J-T089	J-T054	8	539	130
P-T188	J-T040	J-T089	16	431	100
P-T189	J-T009	J-T040	6	587	56
P-T190	J-T019	J-T009	6	583	56
P-T191	J-T021	J-T009	6	446	56
P-T192	J-T021	J-T027	6	299	56
P-T193	J-T027	J-T040	16	330	100
P-T194	J-T027	J-T015	16	370	100
P-T195	J-T529	J-T535	12	682	96
P-T196	J-T021	J-T015	6	460	56
P-T197	J-T017	J-T015	16	184	100
P-T199	J-T067	J-T029	6	471	56
P-T200	J-T040	J-T086	16	690	130
P-T201	J-T153	J-T089	8	736	130
P-T202	J-T309	J-T178	6	775	56
P-T203	J-T275	J-T346	12	1395	64
P-T204	J-T375	J-T356	6	812	56
P-T205	J-T064	J-T029	6	345	56
P-T206	J-T014	J-T029	6	406	56
P-T207	J-T026	J-T014	6	293	56
P-T208	J-T011	J-T014	12	201	60
P-T209	J-T017	J-T011	16	480	100
P-T210	J-T011	J-T026	16	315	100
P-T211	J-T026	J-T036	16	387	100
P-T212	J-T086	J-T153	10	450	60
P-T213	J-T153	J-T309	8	437	56
P-T214	J-T309	J-T375	4	430	52

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T215	J-T375	J-T488	6	378	56
P-T216	J-T488	J-T468	6	531	56
P-T217	J-T468	J-T360	6	380	56
P-T218	J-T360	J-T375	4	564	52
P-T219	J-T378	J-T360	6	497	56
P-T220	J-T378	J-T338	6	442	56
P-T221	J-T338	J-T309	4	1098	52
P-T222	J-T338	J-T234	6	460	56
P-T223	J-T234	J-T153	6	1116	56
P-T224	J-T234	J-T207	6	397	56
P-T225	J-T207	J-T086	16	1175	130
P-T226	J-T177	J-T207	6	401	56
P-T227	J-T163	J-T177	6	424	56
P-T228	J-T121	J-T163	6	308	56
P-T229	J-T067	J-T121	6	465	56
P-T230	J-T101	J-T163	6	526	56
P-T231	J-T177	J-T160	6	476	56
P-T232	J-T177	J-T118	4	855	52
P-T233	J-T189	J-T207	16	855	130
P-T234	J-T234	J-T261	6	869	56
P-T235	J-T362	J-T359	12	659	80
P-T236	J-T378	J-T359	6	865	56
P-T237	J-T359	J-T261	6	901	56
P-T238	J-T261	J-T191	6	430	56
P-T239	J-T191	J-T197	12	414	88
P-T240	J-T197	J-T189	16	413	130
P-T241	J-T118	J-T189	6	386	56
P-T242	J-T147	J-T118	4	426	52
P-T243	J-T147	J-T197	24	393	130
P-T244	J-T192	J-T147	24	523	130
P-T245	J-T182	J-T118	6	517	56
P-T246	J-T030	J-T071	16	580	100
P-T247	J-T055	J-T071	16	727	100
P-T248	J-T055	J-T044	16	723	100
P-T249	J-T028	J-T044	16	611	100
P-T250	J-T049	J-T028	6	412	56
P-T251	J-T044	J-T065	6	410	56
P-T252	J-T072	J-T055	6	427	56
P-T253	J-T071	J-T088	12	421	60
P-T254	J-T088	J-T072	8	749	56
P-T255	J-T065	J-T072	8	710	56
P-T256	J-T065	J-T049	6	613	56
P-T257	J-T049	J-T102	6	427	56
P-T258	J-T146	J-T065	6	429	56
P-T259	J-T072	J-T128	6	358	56

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T260	J-T117	J-T088	12	210	60
P-T261	J-T128	J-T146	6	715	56
P-T262	J-T102	J-T146	6	615	56
P-T263	J-T272	J-T156	12	313	60
P-T264	J-T251	J-T272	24	268	130
P-T265	J-T102	J-T142	6	422	56
P-T266	J-T142	J-T124	6	434	56
P-T267	J-T272	J-T279	12	431	60
P-T268	J-T028	J-T024	16	611	100
P-T269	J-T024	J-T037	16	611	100
P-T270	J-T024	J-T075	10	839	60
P-T271	J-T075	J-T102	6	608	56
P-T272	J-T148	J-T075	6	437	56
P-T273	J-T075	J-T148	10	436	60
P-T274	J-T142	J-T148	6	616	56
P-T275	J-T148	J-T104	6	444	56
P-T276	J-T124	J-T104	24	599	130
P-T277	J-T049	J-T047	6	1208	56
P-T278	J-T037	J-T047	16	365	64
P-T279	J-T122	J-T047	16	428	64
P-T280	J-T122	J-T075	6	598	56
P-T281	J-T150	J-T122	24	431	130
P-T282	J-T148	J-T150	4	601	52
P-T283	J-T090	J-T150	24	428	130
P-T284	J-T037	J-T041	6	1634	56
P-T285	J-T047	J-T074	6	908	56
P-T286	J-T074	J-T123	6	445	56
P-T287	J-T123	J-T122	16	903	64
P-T288	J-T150	J-T145	4	705	52
P-T289	J-T145	J-T096	24	378	130
P-T290	J-T096	J-T090	24	728	130
P-T291	J-T077	J-T074	6	604	56
P-T292	J-T202	J-T123	16	568	64
P-T293	J-T203	J-T145	24	828	130
P-T294	J-T096	J-T125	6	590	56
P-T295	J-T041	J-T077	8	447	56
P-T296	J-T077	J-T202	8	406	60
P-T297	J-T203	J-T202	12	492	60
P-T298	J-T232	J-T203	12	506	60
P-T299	J-T037	J-T126	24	4323	104
P-T300	J-T090	J-T084	6	510	56
P-T301	J-T100	J-T143	10	745	60
P-T302	J-T143	J-T141	10	609	60
P-T303	J-T141	J-T381	10	1379	60
P-T304	J-T382	J-T384	12	661	104

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T305	J-T393	J-T391	6	469	56
P-T306	J-T041	J-T058	6	1317	56
P-T307	J-T094	J-T077	6	1294	56
P-T308	J-T202	J-T209	16	1339	64
P-T309	J-T045	J-T042	6	1338	56
P-T310	J-T058	J-T045	6	150	56
P-T311	J-T058	J-T066	6	468	56
P-T312	J-T094	J-T058	6	420	56
P-T313	J-T098	J-T094	6	494	56
P-T314	J-T066	J-T098	6	424	56
P-T315	J-T079	J-T066	6	852	56
P-T316	J-T098	J-T183	6	851	56
P-T317	J-T183	J-T079	6	429	56
P-T318	J-T050	J-T079	6	448	56
P-T319	J-T042	J-T050	6	189	56
P-T320	J-T248	J-T126	24	587	64
P-T321	J-T229	J-T248	18	462	68
P-T322	J-T212	J-T229	18	442	68
P-T323	J-T209	J-T212	16	440	64
P-T324	J-T209	J-T094	6	394	56
P-T325	J-T248	J-T183	6	365	56
P-T326	J-T248	J-T274	24	423	130
P-T327	J-T274	J-T256	24	449	130
P-T328	J-T256	J-T229	6	439	56
P-T329	J-T256	J-T231	24	440	130
P-T330	J-T231	J-T212	6	437	56
P-T331	J-T231	J-T250	24	432	130
P-T332	J-T250	J-T209	6	431	56
P-T333	J-T250	J-T203	24	1403	130
P-T334	J-T274	J-T288	12	328	60
P-T335	J-T288	J-T336	12	763	60
P-T337	J-T256	J-T290	6	741	56
P-T338	J-T290	J-T294	8	441	130
P-T339	J-T294	J-T231	6	705	56
P-T340	J-T294	J-T299	8	434	130
P-T341	J-T299	J-T250	6	668	56
P-T342	J-T299	J-T306	6	461	56
P-T343	J-T306	J-T289	6	425	56
P-T344	J-T289	J-T232	6	449	56
P-T345	J-T042	J-T032	6	506	56
P-T346	J-T032	J-T082	6	1118	56
P-T347	J-T082	J-T227	6	1628	56
P-T348	J-T082	J-T162	6	516	56
P-T349	J-T162	J-T161	6	151	56
P-T350	J-T217	J-T162	6	623	56

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T351	J-T161	J-T170	6	516	56
P-T352	J-T161	J-T158	6	376	56
P-T353	J-T158	J-T173	6	372	56
P-T354	J-T173	J-T170	8	318	64
P-T355	J-T170	J-T180	6	434	56
P-T356	J-T180	J-T159	8	370	130
P-T357	J-T159	J-T173	6	380	56
P-T358	J-T159	J-T287	6	694	56
P-T359	J-T130	J-T159	8	626	130
P-T360	J-T173	J-T131	8	555	56
P-T361	J-T158	J-T120	6	1044	56
P-T362	J-T120	J-T131	8	461	56
P-T363	J-T131	J-T130	8	334	130
P-T364	J-T287	J-T130	8	306	130
P-T365	J-T174	J-T287	6	876	56
P-T366	J-T174	J-T151	6	466	56
P-T367	J-T120	J-T174	6	607	56
P-T368	J-T151	J-T120	8	387	56
P-T369	J-T227	J-T151	6	682	56
P-T370	J-T253	J-T217	6	868	56
P-T371	J-T219	J-T289	4	1323	88
P-T372	J-T185	J-T219	6	731	88
P-T373	J-T095	J-T185	6	638	88
P-T374	J-T141	J-T095	6	444	88
P-T375	J-T143	J-T185	6	439	88
P-T376	J-T308	J-T219	12	436	130
P-T377	J-T185	J-T334	6	425	88
P-T378	J-T095	J-T355	6	426	88
P-T379	J-T355	J-T334	6	631	88
P-T380	J-T334	J-T308	6	735	88
P-T381	J-T306	J-T308	6	1325	88
P-T382	J-T291	J-T299	6	392	88
P-T383	J-T307	J-T291	6	360	88
P-T384	J-T301	J-T307	6	588	88
P-T385	J-T339	J-T301	6	713	88
P-T386	J-T345	J-T339	6	630	88
P-T387	J-T355	J-T345	6	470	88
P-T388	J-T334	J-T339	6	467	88
P-T389	J-T308	J-T301	12	470	130
P-T390	J-T353	J-T349	6	264	88
P-T391	J-T349	J-T337	6	1058	88
P-T392	J-T345	J-T353	6	662	88
P-T393	J-T339	J-T349	6	1041	88
P-T394	J-T301	J-T337	12	655	130
P-T395	J-T310	J-T307	6	1317	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T396	J-T291	J-T336	6	1319	88
P-T397	J-T337	J-T333	12	664	130
P-T398	J-T353	J-T344	6	663	88
P-T399	J-T344	J-T333	10	1310	84
P-T400	J-T333	J-T310	12	646	96
P-T401	J-T336	J-T310	12	361	96
P-T402	J-T381	J-T373	6	387	88
P-T403	J-T391	J-T399	6	429	88
P-T404	J-T399	J-T387	6	660	88
P-T405	J-T373	J-T379	6	692	88
P-T406	J-T367	J-T355	6	656	88
P-T407	J-T379	J-T367	6	460	88
P-T408	J-T387	J-T386	8	466	88
P-T409	J-T399	J-T395	6	459	88
P-T410	J-T395	J-T394	6	431	88
P-T411	J-T386	J-T383	8	421	88
P-T412	J-T370	J-T368	8	420	88
P-T413	J-T369	J-T367	6	470	88
P-T414	J-T345	J-T369	6	644	88
P-T415	J-T369	J-T370	6	684	88
P-T416	J-T383	J-T370	6	673	88
P-T417	J-T394	J-T383	6	659	88
P-T418	J-T171	J-T190	6	328	88
P-T419	J-T383	J-T380	8	1335	88
P-T420	J-T370	J-T374	8	667	88
P-T421	J-T371	J-T353	6	633	88
P-T422	J-T374	J-T371	6	695	88
P-T423	J-T372	J-T374	8	659	88
P-T424	J-T357	J-T371	6	665	88
P-T425	J-T344	J-T357	10	638	88
P-T426	J-T357	J-T372	10	681	88
P-T427	J-T380	J-T372	10	716	88
P-T428	J-T380	J-T392	12	618	96
P-T429	J-T300	J-T288	12	908	96
P-T430	J-T079	J-T269	6	1339	88
P-T431	J-T253	J-T050	6	1402	88
P-T432	J-T278	J-T298	6	382	88
P-T433	J-T300	J-T273	12	812	96
P-T434	J-T271	J-T278	6	429	88
P-T435	J-T269	J-T253	6	448	88
P-T436	J-T298	J-T296	6	239	88
P-T437	J-T298	J-T300	6	418	88
P-T438	J-T273	J-T271	12	418	96
P-T439	J-T273	J-T270	12	403	96
P-T440	J-T262	J-T270	12	1536	96

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T441	J-T269	J-T262	8	701	88
P-T442	J-T276	J-T262	6	174	88
P-T443	J-T270	J-T252	8	385	88
P-T444	J-T259	J-T271	6	385	88
P-T445	J-T252	J-T259	6	823	88
P-T446	J-T259	J-T260	6	429	88
P-T447	J-T246	J-T252	8	429	88
P-T448	J-T235	J-T276	6	548	88
P-T449	J-T246	J-T235	6	615	88
P-T450	J-T260	J-T246	6	825	88
P-T451	J-T350	J-T344	6	657	88
P-T452	J-T324	J-T333	12	661	96
P-T453	J-T350	J-T324	6	1313	88
P-T454	J-T296	J-T324	6	1320	88
P-T455	J-T323	J-T278	6	1333	88
P-T456	J-T392	J-T208	6	669	88
P-T457	J-T358	J-T372	6	657	88
P-T458	J-T208	J-T358	6	1317	88
P-T459	J-T358	J-T350	6	1320	88
P-T460	J-T292	J-T335	6	525	88
P-T461	J-T366	J-T491	6	528	88
P-T462	J-T484	J-T491	6	385	88
P-T463	J-T292	J-T186	6	456	88
P-T464	J-T224	J-T247	6	831	88
P-T465	J-T233	J-T224	6	250	88
P-T466	J-T226	J-T199	6	267	88
P-T467	J-T226	J-T205	12	235	96
P-T468	J-T225	J-T205	6	356	88
P-T469	J-T239	J-T225	6	898	88
P-T470	J-T116	J-T239	6	349	88
P-T471	J-T205	J-T200	12	623	84
P-T472	J-T200	J-T116	12	286	96
P-T473	J-T199	J-T222	6	858	88
P-T474	J-T198	J-T254	6	653	88
P-T475	J-T175	J-T233	6	1305	88
P-T476	J-T247	J-T221	6	365	88
P-T477	J-T221	J-T184	6	424	88
P-T478	J-T184	J-T155	6	275	88
P-T479	J-T155	J-T119	6	241	88
P-T480	J-T119	J-T175	6	353	88
P-T481	J-T175	J-T099	12	442	96
P-T482	J-T099	J-T087	12	330	96
P-T483	J-T087	J-T081	12	346	96
P-T484	J-T092	J-T081	12	359	96
P-T485	J-T069	J-T092	6	490	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T486	J-T081	J-T059	6	519	88
P-T487	J-T087	J-T057	6	470	88
P-T488	J-T099	J-T068	6	482	88
P-T489	J-T175	J-T061	6	591	88
P-T490	J-T061	J-T035	6	610	88
P-T491	J-T035	J-T119	6	618	88
P-T492	J-T068	J-T061	6	332	88
P-T493	J-T057	J-T068	6	335	88
P-T494	J-T059	J-T057	6	325	88
P-T495	J-T059	J-T069	6	352	88
P-T496	J-T073	J-T069	6	326	88
P-T497	J-T366	J-T506	6	1585	88
P-T498	J-T491	J-T521	6	1421	88
P-T499	J-P181	J-T551	12	2021	96
P-T500	J-T186	J-T484	6	775	88
P-T501	R-T002	J-P181	12	1539	96
P-T502	J-T137	J-T144	24	294	100
P-T503	J-T137	J-T144	24	293	100
P-T504	J-T144	J-T139	8	314	88
P-T505	J-T139	J-T004	8	1753	130
P-T506	J-T008	J-T004	6	614	88
P-T507	J-T133	J-T139	8	364	88
P-T508	J-T133	J-T008	6	1356	88
P-T509	J-T132	J-T133	6	1287	88
P-T510	J-T526	J-T132	6	497	88
P-T511	J-T167	J-T505	6	466	88
P-T512	J-T506	J-T521	6	548	88
P-T513	J-T551	J-T566	12	664	88
P-T514	J-T566	J-T570	6	863	88
P-T515	J-T569	J-T551	6	764	88
P-T516	J-T570	J-T569	6	878	88
P-T517	J-T570	J-T565	6	284	88
P-T518	J-T247	J-T260	6	435	88
P-T519	J-T224	J-T246	8	433	88
P-T520	J-T222	J-T198	6	266	88
P-T521	J-T222	J-T200	6	267	88
P-T522	J-T297	J-T201	8	719	88
P-T523	J-T201	J-T171	6	740	88
P-T524	J-T168	J-T297	8	677	88
P-T525	J-T218	J-T210	6	479	88
P-T526	J-T210	J-T277	6	368	88
P-T527	J-T286	J-T277	6	435	88
P-T528	J-T247	J-T286	6	1354	88
P-T529	J-T277	J-T221	6	1322	88
P-T530	J-T184	J-T210	6	1337	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T531	J-T119	J-T056	6	652	88
P-T532	J-T056	J-T052	6	637	88
P-T533	J-T052	J-T164	8	508	88
P-T534	J-T324	J-T323	6	624	88
P-T535	J-T255	J-T211	12	762	96
P-T536	J-T211	J-T206	12	713	96
P-T537	J-T206	J-T188	12	522	96
P-T538	J-T188	J-T169	12	363	96
P-T539	J-T169	J-T152	12	429	96
P-T540	J-T190	J-T255	6	1060	88
P-T541	J-T115	J-T134	12	208	96
P-T542	J-T093	J-T115	12	208	96
P-T543	J-T127	J-T093	12	902	96
P-T544	J-T134	J-T152	12	979	96
P-T545	J-T220	J-T127	12	1972	96
P-T546	J-T249	J-T220	12	1666	92
P-T547	J-T252	J-T276	6	926	88
P-T548	J-T262	J-T226	12	839	96
P-T549	J-T322	J-T324	12	3195	96
P-T550	J-5	R-T001	30	42	104
P-T551	J-T335	J-T366	6	364	88
P-T552	J-T292	J-T491	6	582	88
P-T553	J-T254	J-T199	6	358	88
P-T554	J-T395	J-T386	6	656	88
P-T555	J-T386	J-T368	6	676	88
P-T556	J-T257	J-T251	24	1204	130
P-T557	J-T471	J-T472	16	1009	64
P-T559	J-T186	J-T144	8	1222	88
P-T560	J-T558	J-T556	12	884	96
P-T561	J-T558	J-T560	12	494	96
P-T562	J-T555	J-T557	6	381	96
P-T563	J-T561	J-T553	12	170	96
P-T564	PMP-T001	J-5	24	63	88
P-T565	PMP-T002	J-5	24	47	88
P-T566	J-5	PMP-T003	24	38	88
P-T567	J-5	PMP-T004	24	50	88
P-T568	J-T178	J-T018	12	1501	84
P-T569	J-T018	J-T022	12	845	84
P-T570	J-T363	J-T359	6	310	88
P-T571	J-T191	J-T363	6	865	88
P-T572	J-T155	J-T175	12	242	84
P-T573	J-T060	J-T073	24	1003	88
P-T574	J-T110	J-T060	24	659	88
P-T575	J-T218	J-T245	12	223	84
P-T576	J-T400	J-T474	12	151	96

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T577	J-T385	J-T400	12	119	92
P-T578	J-T172	J-T385	12	445	96
P-T579	J-T362	J-T191	12	1913	92
P-T580	J-T474	J-T365	12	444	96
P-T581	J-T364	J-T244	12	3115	92
P-T582	J-T125	J-T232	6	171	56
P-T583	J-T112	J-T125	6	787	56
P-T584	J-T180	J-T335	6	371	104
P-T585	J-T004	J-T073	6	1036	104
P-T586	J-T111	J-T112	6	535	56
P-T587	J-T096	J-T111	6	860	56
P-T588	J-T164	J-T113	8	791	96
P-T589	J-T204	J-T168	12	448	100
P-T590	J-T359	J-T361	6	344	56
P-T591	PMP-T003	J-T137	24	167	88
P-T592	J-T137	PMP-T001	24	188	88
P-T593	PMP-T004	J-T137	24	178	88
P-T594	J-5	PMP-T005	24	66	88
P-T595	PMP-T005	J-T137	24	200	20
P-T596	J-T137	PMP-T002	24	170	88
P-T597	J-T031	J-T034	16	287	100
P-T598	J-T034	J-T030	16	526	100
P-T599	J-T053	J-T034	12	683	96
P-T600	J-T505	J-T533	6	682	56
P-T601	J-T484	J-T530	6	992	56
P-T602	J-T530	J-T550	6	662	56
P-T603	J-T249	J-T332	12	1188	96
P-T604	J-T322	J-T329	12	1827	96
P-T605	J-T329	J-T332	6	3022	56
P-T606	J-T144	J-T107	30	1872	100
P-T607	J-T107	J-T073	30	718	100
P-T608	J-T107	J-T225	6	1795	96
P-T609	J-T361	J-T501	8	1067	64
P-T610	J-T191	J-T398	12	10	92
P-T611	J-T398	J-T364	12	1649	92
P-T612	J-T501	J-T398	12	1553	92
P-T614	J-T501	J-T489	10	2057	88
P-T615	J-T489	J-T364	12	927	92
P-T616	J-T167	J-T397	6	366	88
P-T617	J-T397	J-T526	6	295	88
P-T618	J-T397	J-T533	6	1705	56
P-T619	J-T550	PRV-T001	6	116	56
P-T620	PRV-T001	J-T551	6	134	56
P-T621	J-T521	J-T550	6	671	56
P-T622	J-T565	PRV-T002	6	422	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T623	PRV-T002	J-T533	6	494	88
P-T624	J-T505	J-T534	6	532	56
P-T625	J-T534	J-P083	8	374	56
P-T627	J-T179	J-T228	4	1016	52
P-T628	J-T112	J-T097	6	558	56
P-T629	J-T097	J-T100	12	169	104
P-T630	J-T097	J-T140	6	1419	56
P-T631	J-T140	J-T141	6	223	56
P-T632	J-T097	J-T135	12	1646	104
P-T633	J-T135	J-T382	12	1381	104
P-T634	J-T140	J-T135	6	203	56
P-T635	J-T232	J-T114	12	760	54
P-T636	J-T112	J-T114	8	186	104
P-T637	J-T283	J-T464	16	4056	104
P-T638	J-T464	J-T471	16	292	104
P-T639	J-T465	J-T464	6	47	56
P-T640	J-T391	J-T388	20	395	72
P-T641	J-T388	J-T390	20	591	72
P-T642	J-T251	J-T263	12	168	60
P-T643	J-T263	J-T117	12	981	60
P-T644	J-T264	J-T257	10	202	60
P-T645	J-T263	J-T264	12	1420	56
P-T646	J-T354	J-T351	6	603	56
P-T647	J-T137	J-T136	6	96	56
P-T648	J-T124	J-T265	24	338	130
P-T649	J-T265	J-T264	24	171	130
P-T650	J-T351	J-T331	6	2016	56
P-T651	J-T331	J-T327	6	455	56
P-T652	J-T265	J-T331	6	1950	56
P-T653	J-T331	J-T464	6	2850	56
P-T654	J-T497	J-T492	12	118	96
P-T655	J-T022	J-T007	12	1584	96
P-T656	J-T007	J-T010	12	516	96
P-T657	J-T010	J-T002	12	280	96
P-T658	J-T002	J-T006	12	824	96
P-T659	J-T010	J-T005	12	837	96
P-T660	J-T006	J-T025	12	2306	96
P-T661	J-T025	J-T016	12	32	96
P-T662	J-T039	J-T109	12	1225	96
P-T667	J-T016	J-T039	12	161	96
P-T669	J-T012	J-T023	12	100	96
P-T670	J-T023	J-T033	12	682	96
P-T671	J-T033	J-T048	12	247	96
P-T672	J-T033	J-T108	12	502	96
P-T673	J-T016	J-T012	12	35	96

CITY OF TRAVERSE CITY
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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T674	J-T493	J-T499	12	151	96
P-T675	J-T499	J-T502	8	401	80
P-T676	J-T524	J-T499	12	854	96
P-T677	J-T524	J-T529	12	200	96
P-T678	J-T502	J-T510	8	238	56
P-T679	J-T518	J-T517	8	426	130
P-T680	J-T540	J-T518	6	565	56
P-T681	J-T478	J-T487	6	56	56
P-T682	J-T473	J-T512	6	69	56
P-T683	J-T544	J-T531	12	1009	96
P-T684	J-T560	J-T573	12	110	96
P-T685	J-T477	J-T503	12	184	96
P-T686	J-T503	J-T516	6	778	56
P-T687	J-T516	J-T508	6	116	56
P-T688	J-T553	T-T001	12	7	96
P-T689	J-T346	J-T376	12	425	64
P-T690	J-T086	J-T063	10	331	60
P-T692	J-T377	J-T362	12	156	84
P-T693	J-T377	J-T376	6	299	56
P-T694	J-T063	J-T067	10	38	60
P-T695	J-T063	J-T062	6	96	56
P-T696	J-T106	J-T121	6	304	56
P-T697	J-T101	J-T105	6	272	56
P-T698	J-T105	J-T064	6	164	56
P-T699	J-T105	J-T106	6	181	56
P-T700	J-T188	J-T165	12	497	96
P-T701	J-T165	J-T220	12	1278	96
P-T702	J-T165	J-T166	12	228	56
P-T703	J-T211	J-T194	12	633	96
P-T704	J-T194	J-T249	12	977	96
P-T705	J-T166	J-T194	12	1048	56
P-T706	J-T311	J-T388	24	9798	104
P-T707	J-T245	J-T312	24	1030	88
P-T708	J-T311	J-T312	24	191	56
P-T709	J-T213	J-T155	12	817	96
P-T710	J-T204	J-T214	12	70	96
P-T711	J-T214	J-T218	12	2	96
P-T712	J-T213	J-T214	12	577	56
P-T713	J-T149	J-T110	24	322	88
P-T714	J-T245	J-T157	24	1357	88
P-T715	J-T140	J-T475	6	1189	56
P-T716	J-T149	J-T157	24	470	56
P-T717	J-T381	J-T476	6	212	56
P-T718	J-T476	J-T382	6	190	56
P-T719	J-T475	J-T476	6	189	56

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T720	J-T443	J-T553	6	6	56
P-T721	J-T442	J-T556	12	534	96
P-T722	J-T442	J-T555	6	285	56
P-T723	J-T440	J-T442	6	4	56
P-T724	PRV-T003	J-T529	12	13	96
P-T725	J-T459	J-T443	6	8	56
P-T726	J-T545	J-T438	16	85	100
P-T727	J-T438	J-T561	16	153	100
P-T728	J-T573	J-T437	6	356	56
P-T729	J-T437	J-T448	6	181	56
P-T730	J-T568	J-P085	12	1067	89.6
P-T731	J-T420	J-T441	12	674	96
P-T732	J-T422	J-T425	6	121	56
P-T733	J-T426	J-T473	6	104	56
P-T734	J-T428	J-T420	12	254	96
P-T735	J-T572	J-T428	12	72	96
P-T736	J-T022	J-T419	12	67	96
P-T737	J-T419	J-T172	12	415	96
P-T738	J-T285	J-T405	12	469	60
P-T739	J-T431	J-T020	6	582	56
P-T740	J-T419	J-T431	6	19	56
P-T741	J-T243	J-T416	12	38	60
P-T742	J-T416	J-T242	12	303	60
P-T743	J-T406	J-T283	12	580	60
P-T744	J-T405	J-T406	6	21	56
P-T745	J-T238	J-T444	6	606	56
P-T746	J-T416	J-T444	6	25	56
P-T747	J-T415	J-T148	10	431	60
P-T748	J-T104	J-T445	10	35	60
P-T749	J-T445	J-T090	24	572	130
P-T750	J-T415	J-T445	6	8	56
P-T751	J-T114	J-T455	12	551	54
P-T752	J-T455	J-T100	12	19	54
P-T753	J-T387	J-T450	6	649	88
P-T754	J-T449	J-T219	12	441	130
P-T755	J-T449	J-T455	6	5	56
P-T756	J-T368	J-T451	8	465	88
P-T757	J-T451	J-T373	8	43	88
P-T758	J-T451	J-T450	6	29	56
P-T759	J-T452	J-T381	10	659	60
P-T760	J-T452	J-T389	6	13	56
P-T761	J-T453	J-T391	20	649	68
P-T762	J-T389	J-T454	8	28	88
P-T763	J-T454	J-T387	8	396	88
P-T764	J-T454	J-T453	6	12	56

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T765	J-T391	J-T439	6	643	56
P-T766	J-T439	J-T389	6	12	56
P-T767	J-T447	J-T393	6	663	56
P-T768	J-T389	J-T447	6	430	56
P-T769	J-T439	J-T453	6	28	56
P-T770	J-T382	J-T461	6	48	56
P-T771	J-T461	J-T463	6	189	56
P-T772	J-T461	J-T447	6	689	56
P-T773	J-T452	J-T384	6	388	56
P-T774	J-T312	J-T456	6	215	56
P-T775	J-T297	J-T460	8	842	88
P-T776	J-T456	J-T458	8	28	88
P-T777	J-T458	J-T322	8	131	88
P-T778	J-T460	J-T458	6	14	56
P-T779	J-T168	J-T457	8	43	96
P-T780	J-T430	J-T255	12	1468	104
P-T781	J-T456	J-T430	6	256	56
P-T782	J-T457	J-T164	8	305	96
P-T783	J-T201	J-T432	8	551	88
P-T784	J-T113	J-T417	6	378	96
P-T785	J-T457	J-T432	6	37	56
P-T786	J-T233	J-T414	6	54	88
P-T787	J-T414	J-T235	6	505	88
P-T788	J-T254	J-T414	6	398	56
P-T789	J-T073	J-T413	16	481	96
P-T790	J-T413	J-T116	16	48	96
P-T791	J-T413	J-T092	6	329	56
P-T792	J-T126	J-T412	30	2406	104
P-T793	J-T144	J-T412	6	4194	56
P-T794	J-T433	J-T411	12	200	96
P-T795	J-T411	J-T446	12	179	96
P-T796	T-T001	J-T459	6	9	56
P-T797	J-T557	J-T410	6	1007	96
P-T798	J-T410	J-T573	6	175	96
P-T799	J-T493	J-T492	12	93	96
P-T800	J-T409	J-T440	12	9	96
P-T801	J-T459	J-T409	6	16	56
P-T802	J-T446	J-T418	12	1063	96
P-T803	J-T418	J-T544	12	407	96
P-T804	J-T422	J-T408	12	356	96
P-T805	J-T408	J-T498	12	506	96
P-T806	J-T407	J-T498	12	277	96
P-T807	J-T459	PMP-T007	6	5	56
P-T808	PMP-T007	J-T409	6	9	56
P-T809	J-T459	PMP-T008	6	5	56

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T810	PMP-T008	J-T409	6	8	56
P-T811	J-T531	PRV-T004	12	34	96
P-T812	J-T404	J-T426	6	79	56
P-T813	J-T425	J-T403	6	291	56
P-T814	J-T459	PMP-T009	6	5	56
P-T815	J-T403	J-T404	6	14	56
P-T816	PMP-T009	J-T409	6	9	56
P-T817	J-T572	J-T402	6	138	56
P-T818	J-T572	J-T401	6	69	56
P-T819	J-T401	J-T427	6	210	56
P-T820	PRV-T004	J-T422	12	867	96
P-1	J-T396	J-1	6	897	56
P-2	J-1	J-T480	6	1661	56
P-3	J-G580	J-G205	12	1441	104
P-4	J-T062	J-2	6	138	56
P-5	J-2	J-T027	6	415	56
P-6	J-T029	J-3	6	209	56
P-7	J-3	J-T017	6	266	56
P-8	J-2	J-3	8	519	130
P-9	PMP-1	J-G222	12	56	88
P-10	PMP-1	J-T501	12	56	88
P-11	J-T290	J-4	8	478	130
P-12	J-4	J-T296	6	633	88
P-13	J-T139	J-T397	8	2229	96
P-T001	J-T242	J-T176	6	799	56
P-T002	J-T216	J-T215	6	425	56
P-T003	J-T216	J-T196	6	430	56
P-T004	J-T196	J-T195	6	430	56
P-T005	J-T187	J-T195	6	431	56
P-T006	J-T187	J-T240	8	1042	56
P-T007	J-T240	J-T258	6	590	56
P-T008	J-T195	J-T281	6	1641	56
P-T009	J-T295	J-T196	6	1654	56
P-T010	J-T293	J-T216	6	1671	56
P-T011	J-T241	J-T304	6	1170	56
P-T012	J-T215	J-T241	6	520	56
P-T013	J-T176	J-T238	6	485	56
P-T014	J-T268	J-T238	6	580	56
P-T015	J-T283	J-T268	6	610	56
P-T016	J-T266	J-T243	6	571	56
P-T017	J-T244	J-T285	12	567	60
P-T018	J-T543	J-T546	12	236	96
P-T019	J-T266	J-T267	6	155	56
P-T020	J-T243	J-T244	12	173	60
P-T021	J-T552	J-T548	12	293	96

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T022	J-T548	J-T542	12	91	96
P-T023	J-T238	J-T241	6	428	56
P-T024	J-T542	J-T538	12	239	96
P-T025	J-T538	J-T536	12	82	96
P-T026	J-T268	J-T266	6	641	56
P-T027	J-T536	J-T537	8	212	80
P-T028	J-T283	J-T304	12	411	60
P-T029	J-T537	J-T541	8	119	80
P-T030	J-T304	J-T293	12	426	60
P-T031	J-T541	J-T547	8	110	80
P-T032	J-T295	J-T293	12	425	60
P-T033	J-T547	J-T559	8	87	80
P-T034	J-T281	J-T295	12	429	60
P-T035	J-T559	J-T562	8	124	80
P-T036	J-T281	J-T258	12	430	60
P-T037	J-T562	J-T563	8	121	80
P-T038	J-T258	J-T279	6	1191	56
P-T039	J-T563	J-T564	8	103	80
P-T040	J-T302	J-T281	6	1199	56
P-T041	J-T542	J-T539	12	161	96
P-T042	J-T303	J-T295	6	1199	56
P-T043	J-T317	J-T293	6	1199	56
P-T044	J-T304	J-T330	6	592	56
P-T045	J-T536	J-T527	12	158	96
P-T046	J-T330	J-T318	6	606	56
P-T047	J-T527	J-T519	12	46	96
P-T048	J-T330	J-T314	6	429	56
P-T049	J-T519	J-T513	12	209	96
P-T050	J-T314	J-T283	6	593	56
P-T051	J-T513	J-T508	12	34	96
P-T052	J-T314	J-T315	6	605	56
P-T053	J-T508	J-T494	12	182	96
P-T054	J-T320	J-T314	6	672	56
P-T055	J-T494	J-T486	12	151	96
P-T056	J-T267	J-T320	6	1001	56
P-T057	J-T486	J-T482	12	82	96
P-T058	J-T325	J-T320	6	643	56
P-T059	J-T508	J-T507	12	31	96
P-T060	J-T315	J-T325	10	665	60
P-T061	J-T507	J-T511	8	66	80
P-T062	J-T318	J-T315	10	429	60
P-T063	J-T511	J-T514	8	107	80
P-T064	J-T317	J-T318	10	427	60
P-T065	J-T514	J-T517	8	157	80
P-T066	J-T303	J-T317	10	426	60

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T067	J-T302	J-T303	10	431	60
P-T068	J-T279	J-T302	10	429	60
P-T069	J-T279	J-T257	10	1398	60
P-T070	J-T284	J-T302	6	1523	56
P-T071	J-T303	J-T321	6	1441	56
P-T072	J-T317	J-T326	6	717	56
P-T073	J-T326	J-T319	6	723	56
P-T074	J-T518	J-T515	8	193	80
P-T075	J-T328	J-T318	10	728	60
P-T076	J-T515	J-T510	8	21	80
P-T077	J-T327	J-T328	10	709	60
P-T078	J-T510	J-T509	8	332	80
P-T079	J-T315	J-T341	6	736	56
P-T080	J-T509	J-T504	8	89	80
P-T081	J-T352	J-T325	6	725	56
P-T082	J-T504	J-T490	8	154	80
P-T083	J-T341	J-T352	6	677	56
P-T084	J-T490	J-T485	8	67	80
P-T085	J-T341	J-T328	6	429	56
P-T086	J-T485	J-T481	8	95	80
P-T087	J-T326	J-T328	6	436	56
P-T088	J-T481	J-T479	8	160	80
P-T089	J-T319	J-T327	6	430	56
P-T090	J-T319	J-T321	6	436	56
P-T091	J-T321	J-T284	6	659	56
P-T092	J-T257	J-T284	6	447	56
P-T093	J-T342	J-T325	6	429	56
P-T094	J-T342	J-T340	6	428	56
P-T095	J-T340	J-T467	6	457	56
P-T096	J-T467	J-G764	6	633	56
P-T097	J-T465	J-T467	4	729	52
P-T098	J-T354	J-T340	6	721	56
P-T099	J-T347	J-T342	6	722	56
P-T100	J-T352	J-T347	6	420	56
P-T101	J-T347	J-T354	6	434	56
P-T102	J-T354	J-T465	6	461	56
P-T103	J-T465	J-T471	8	294	60
P-T104	J-T467	J-T469	6	688	56
P-T105	J-T340	J-T343	6	685	56
P-T106	J-T316	J-T342	6	687	56
P-T107	J-T316	J-T320	6	499	56
P-T108	J-T343	J-T316	6	431	56
P-T109	J-T523	J-T522	8	37	80
P-T110	J-T469	J-T343	6	442	56
P-T111	J-T522	J-T520	8	126	80

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T112	J-T520	J-T518	8	172	80
P-T113	J-T313	J-T483	6	698	85
P-T114	J-T543	J-T532	8	270	80
P-T115	J-T313	J-T343	6	505	56
P-T116	J-T546	J-T549	12	83	96
P-T117	J-T305	J-T313	6	451	56
P-T118	J-T549	J-T552	12	81	96
P-T119	J-T282	J-T316	6	964	56
P-T120	J-T549	J-T540	8	281	80
P-T121	J-T282	J-T267	6	431	56
P-T122	J-T282	J-T305	6	472	56
P-T123	PMP-T006	J-T305	6	842	56
P-T124	PMP-T006	J-T480	6	212	56
P-T125	J-T243	J-T280	6	438	56
P-T126	J-T280	J-T282	6	730	56
P-T128	J-T396	J-T242	12	2578	60
P-T129	J-T532	J-T528	8	91	80
P-T130	J-T192	J-T187	6	416	56
P-T131	J-T528	J-T523	8	175	80
P-T132	J-T182	J-T192	6	424	56
P-T133	J-T182	J-T223	6	1001	56
P-T134	J-T192	J-T230	24	1007	130
P-T135	J-T230	J-T240	8	427	56
P-T136	J-T230	J-T223	8	414	56
P-T137	J-T237	J-T230	24	593	130
P-T138	J-T258	J-T237	12	431	60
P-T139	J-T236	J-T237	12	410	60
P-T140	J-T237	J-T272	24	1188	130
P-T141	J-T236	J-T156	6	1213	56
P-T142	J-T236	J-T223	6	593	56
P-T143	J-T103	J-T236	12	436	60
P-T144	J-T223	J-T228	8	433	56
P-T145	J-T228	J-T103	4	588	52
P-T146	J-T103	J-T046	12	448	60
P-T147	J-T083	J-T228	8	436	56
P-T148	J-T179	J-T182	6	428	56
P-T149	J-T160	J-T179	6	454	56
P-T150	J-T154	J-T160	6	415	56
P-T151	J-T154	J-T083	6	600	56
P-T152	J-T078	J-T154	10	430	60
P-T153	J-T160	J-T101	6	431	56
P-T154	J-T101	J-T078	6	404	56
P-T155	J-T482	J-T479	8	58	80
P-T156	J-T507	J-T496	8	220	80
P-T157	J-T051	J-T078	4	607	52

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T158	J-T496	J-T495	8	193	80
P-T159	J-T083	J-T051	8	429	56
P-T160	J-T051	J-T038	8	457	56
P-T161	J-T038	J-T036	6	194	56
P-T162	J-T064	J-T038	6	999	56
P-T163	J-T046	J-T083	6	601	56
P-T164	J-T031	J-T046	12	816	60
P-T165	J-T036	J-T031	16	1037	100
P-T166	J-T071	J-T053	12	603	60
P-T167	J-T053	J-T080	12	423	60
P-T168	J-T088	J-T080	12	582	130
P-T169	J-T156	J-T080	12	903	60
P-T170	J-T020	J-T013	6	322	56
P-T171	J-T348	J-T020	6	831	56
P-T172	J-T466	J-T348	6	671	56
P-T173	J-T091	J-T466	6	569	56
P-T174	J-T043	J-T091	6	422	56
P-T175	J-T043	J-T013	6	436	56
P-T176	J-T013	J-T019	6	665	56
P-T177	J-T054	J-T019	8	417	130
P-T178	J-T054	J-T076	6	475	56
P-T179	J-T076	J-T043	6	458	56
P-T180	J-T193	J-T076	6	427	56
P-T181	J-T091	J-T193	6	460	56
P-T182	J-T193	J-T356	6	558	56
P-T183	J-T356	J-T275	16	235	100
P-T184	J-T275	J-T178	16	200	100
P-T185	J-T178	J-T076	6	551	56
P-T186	J-T178	J-T089	16	441	100
P-T187	J-T089	J-T054	8	539	130
P-T188	J-T040	J-T089	16	431	100
P-T189	J-T009	J-T040	6	587	56
P-T190	J-T019	J-T009	6	583	56
P-T191	J-T021	J-T009	6	446	56
P-T192	J-T021	J-T027	6	299	56
P-T193	J-T027	J-T040	16	330	100
P-T194	J-T027	J-T015	16	370	100
P-T195	J-T529	J-T535	12	682	96
P-T196	J-T021	J-T015	6	460	56
P-T197	J-T017	J-T015	16	184	100
P-T199	J-T067	J-T029	6	471	56
P-T200	J-T040	J-T086	16	690	130
P-T201	J-T153	J-T089	8	736	130
P-T202	J-T309	J-T178	6	775	56
P-T203	J-T275	J-T346	12	1395	64

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T204	J-T375	J-T356	6	812	56
P-T205	J-T064	J-T029	6	345	56
P-T206	J-T014	J-T029	6	406	56
P-T207	J-T026	J-T014	6	293	56
P-T208	J-T011	J-T014	12	201	60
P-T209	J-T017	J-T011	16	480	100
P-T210	J-T011	J-T026	16	315	100
P-T211	J-T026	J-T036	16	387	100
P-T212	J-T086	J-T153	10	450	60
P-T213	J-T153	J-T309	8	437	56
P-T214	J-T309	J-T375	4	430	52
P-T215	J-T375	J-T488	6	378	56
P-T216	J-T488	J-T468	6	531	56
P-T217	J-T468	J-T360	6	380	56
P-T218	J-T360	J-T375	4	564	52
P-T219	J-T378	J-T360	6	497	56
P-T220	J-T378	J-T338	6	442	56
P-T221	J-T338	J-T309	4	1098	52
P-T222	J-T338	J-T234	6	460	56
P-T223	J-T234	J-T153	6	1116	56
P-T224	J-T234	J-T207	6	397	56
P-T225	J-T207	J-T086	16	1175	130
P-T226	J-T177	J-T207	6	401	56
P-T227	J-T163	J-T177	6	424	56
P-T228	J-T121	J-T163	6	308	56
P-T229	J-T067	J-T121	6	465	56
P-T230	J-T101	J-T163	6	526	56
P-T231	J-T177	J-T160	6	476	56
P-T232	J-T177	J-T118	4	855	52
P-T233	J-T189	J-T207	16	855	130
P-T234	J-T234	J-T261	6	869	56
P-T235	J-T362	J-T359	12	659	80
P-T236	J-T378	J-T359	6	865	56
P-T237	J-T359	J-T261	6	901	56
P-T238	J-T261	J-T191	6	430	56
P-T239	J-T191	J-T197	12	414	88
P-T240	J-T197	J-T189	16	413	130
P-T241	J-T118	J-T189	6	386	56
P-T242	J-T147	J-T118	4	426	52
P-T243	J-T147	J-T197	24	393	130
P-T244	J-T192	J-T147	24	523	130
P-T245	J-T182	J-T118	6	517	56
P-T246	J-T030	J-T071	16	580	100
P-T247	J-T055	J-T071	16	727	100
P-T248	J-T055	J-T044	16	723	100

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T249	J-T028	J-T044	16	611	100
P-T250	J-T049	J-T028	6	412	56
P-T251	J-T044	J-T065	6	410	56
P-T252	J-T072	J-T055	6	427	56
P-T253	J-T071	J-T088	12	421	60
P-T254	J-T088	J-T072	8	749	56
P-T255	J-T065	J-T072	8	710	56
P-T256	J-T065	J-T049	6	613	56
P-T257	J-T049	J-T102	6	427	56
P-T258	J-T146	J-T065	6	429	56
P-T259	J-T072	J-T128	6	358	56
P-T260	J-T117	J-T088	12	210	60
P-T261	J-T128	J-T146	6	715	56
P-T262	J-T102	J-T146	6	615	56
P-T263	J-T272	J-T156	12	313	60
P-T264	J-T251	J-T272	24	268	130
P-T265	J-T102	J-T142	6	422	56
P-T266	J-T142	J-T124	6	434	56
P-T267	J-T272	J-T279	12	431	60
P-T268	J-T028	J-T024	16	611	100
P-T269	J-T024	J-T037	16	611	100
P-T270	J-T024	J-T075	10	839	60
P-T271	J-T075	J-T102	6	608	56
P-T272	J-T148	J-T075	6	437	56
P-T273	J-T075	J-T148	10	436	60
P-T274	J-T142	J-T148	6	616	56
P-T275	J-T148	J-T104	6	444	56
P-T276	J-T124	J-T104	24	599	130
P-T277	J-T049	J-T047	6	1208	56
P-T278	J-T037	J-T047	16	365	64
P-T279	J-T122	J-T047	16	428	64
P-T280	J-T122	J-T075	6	598	56
P-T281	J-T150	J-T122	24	431	130
P-T282	J-T148	J-T150	4	601	52
P-T283	J-T090	J-T150	24	428	130
P-T284	J-T037	J-T041	6	1634	56
P-T285	J-T047	J-T074	6	908	56
P-T286	J-T074	J-T123	6	445	56
P-T287	J-T123	J-T122	16	903	64
P-T288	J-T150	J-T145	4	705	52
P-T289	J-T145	J-T096	24	378	130
P-T290	J-T096	J-T090	24	728	130
P-T291	J-T077	J-T074	6	604	56
P-T292	J-T202	J-T123	16	568	64
P-T293	J-T203	J-T145	24	828	130

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T294	J-T096	J-T125	6	590	56
P-T295	J-T041	J-T077	8	447	56
P-T296	J-T077	J-T202	8	406	60
P-T297	J-T203	J-T202	12	492	60
P-T298	J-T232	J-T203	12	506	60
P-T299	J-T037	J-T126	24	4323	104
P-T300	J-T090	J-T084	6	510	56
P-T301	J-T100	J-T143	10	745	60
P-T302	J-T143	J-T141	10	609	60
P-T303	J-T141	J-T381	10	1379	60
P-T304	J-T382	J-T384	12	661	104
P-T305	J-T393	J-T391	6	469	56
P-T306	J-T041	J-T058	6	1317	56
P-T307	J-T094	J-T077	6	1294	56
P-T308	J-T202	J-T209	16	1339	64
P-T309	J-T045	J-T042	6	1338	56
P-T310	J-T058	J-T045	6	150	56
P-T311	J-T058	J-T066	6	468	56
P-T312	J-T094	J-T058	6	420	56
P-T313	J-T098	J-T094	6	494	56
P-T314	J-T066	J-T098	6	424	56
P-T315	J-T079	J-T066	6	852	56
P-T316	J-T098	J-T183	6	851	56
P-T317	J-T183	J-T079	6	429	56
P-T318	J-T050	J-T079	6	448	56
P-T319	J-T042	J-T050	6	189	56
P-T320	J-T248	J-T126	24	587	64
P-T321	J-T229	J-T248	18	462	68
P-T322	J-T212	J-T229	18	442	68
P-T323	J-T209	J-T212	16	440	64
P-T324	J-T209	J-T094	6	394	56
P-T325	J-T248	J-T183	6	365	56
P-T326	J-T248	J-T274	24	423	130
P-T327	J-T274	J-T256	24	449	130
P-T328	J-T256	J-T229	6	439	56
P-T329	J-T256	J-T231	24	440	130
P-T330	J-T231	J-T212	6	437	56
P-T331	J-T231	J-T250	24	432	130
P-T332	J-T250	J-T209	6	431	56
P-T333	J-T250	J-T203	24	1403	130
P-T334	J-T274	J-T288	12	328	60
P-T335	J-T288	J-T336	12	763	60
P-T337	J-T256	J-T290	6	741	56
P-T338	J-T290	J-T294	8	441	130
P-T339	J-T294	J-T231	6	705	56

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T340	J-T294	J-T299	8	434	130
P-T341	J-T299	J-T250	6	668	56
P-T342	J-T299	J-T306	6	461	56
P-T343	J-T306	J-T289	6	425	56
P-T344	J-T289	J-T232	6	449	56
P-T345	J-T042	J-T032	6	506	56
P-T346	J-T032	J-T082	6	1118	56
P-T347	J-T082	J-T227	6	1628	56
P-T348	J-T082	J-T162	6	516	56
P-T349	J-T162	J-T161	6	151	56
P-T350	J-T217	J-T162	6	623	56
P-T351	J-T161	J-T170	6	516	56
P-T352	J-T161	J-T158	6	376	56
P-T353	J-T158	J-T173	6	372	56
P-T354	J-T173	J-T170	8	318	64
P-T355	J-T170	J-T180	6	434	56
P-T356	J-T180	J-T159	8	370	130
P-T357	J-T159	J-T173	6	380	56
P-T358	J-T159	J-T287	6	694	56
P-T359	J-T130	J-T159	8	626	130
P-T360	J-T173	J-T131	8	555	56
P-T361	J-T158	J-T120	6	1044	56
P-T362	J-T120	J-T131	8	461	56
P-T363	J-T131	J-T130	8	334	130
P-T364	J-T287	J-T130	8	306	130
P-T365	J-T174	J-T287	6	876	56
P-T366	J-T174	J-T151	6	466	56
P-T367	J-T120	J-T174	6	607	56
P-T368	J-T151	J-T120	8	387	56
P-T369	J-T227	J-T151	6	682	56
P-T370	J-T253	J-T217	6	868	56
P-T371	J-T219	J-T289	4	1323	88
P-T372	J-T185	J-T219	6	731	88
P-T373	J-T095	J-T185	6	638	88
P-T374	J-T141	J-T095	6	444	88
P-T375	J-T143	J-T185	6	439	88
P-T376	J-T308	J-T219	12	436	130
P-T377	J-T185	J-T334	6	425	88
P-T378	J-T095	J-T355	6	426	88
P-T379	J-T355	J-T334	6	631	88
P-T380	J-T334	J-T308	6	735	88
P-T381	J-T306	J-T308	6	1325	88
P-T382	J-T291	J-T299	6	392	88
P-T383	J-T307	J-T291	6	360	88
P-T384	J-T301	J-T307	6	588	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T385	J-T339	J-T301	6	713	88
P-T386	J-T345	J-T339	6	630	88
P-T387	J-T355	J-T345	6	470	88
P-T388	J-T334	J-T339	6	467	88
P-T389	J-T308	J-T301	12	470	130
P-T390	J-T353	J-T349	6	264	88
P-T391	J-T349	J-T337	6	1058	88
P-T392	J-T345	J-T353	6	662	88
P-T393	J-T339	J-T349	6	1041	88
P-T394	J-T301	J-T337	12	655	130
P-T395	J-T310	J-T307	6	1317	88
P-T396	J-T291	J-T336	6	1319	88
P-T397	J-T337	J-T333	12	664	130
P-T398	J-T353	J-T344	6	663	88
P-T399	J-T344	J-T333	10	1310	84
P-T400	J-T333	J-T310	12	646	96
P-T401	J-T336	J-T310	12	361	96
P-T402	J-T381	J-T373	6	387	88
P-T403	J-T391	J-T399	6	429	88
P-T404	J-T399	J-T387	6	660	88
P-T405	J-T373	J-T379	6	692	88
P-T406	J-T367	J-T355	6	656	88
P-T407	J-T379	J-T367	6	460	88
P-T408	J-T387	J-T386	8	466	88
P-T409	J-T399	J-T395	6	459	88
P-T410	J-T395	J-T394	6	431	88
P-T411	J-T386	J-T383	8	421	88
P-T412	J-T370	J-T368	8	420	88
P-T413	J-T369	J-T367	6	470	88
P-T414	J-T345	J-T369	6	644	88
P-T415	J-T369	J-T370	6	684	88
P-T416	J-T383	J-T370	6	673	88
P-T417	J-T394	J-T383	6	659	88
P-T418	J-T171	J-T190	6	328	88
P-T419	J-T383	J-T380	8	1335	88
P-T420	J-T370	J-T374	8	667	88
P-T421	J-T371	J-T353	6	633	88
P-T422	J-T374	J-T371	6	695	88
P-T423	J-T372	J-T374	8	659	88
P-T424	J-T357	J-T371	6	665	88
P-T425	J-T344	J-T357	10	638	88
P-T426	J-T357	J-T372	10	681	88
P-T427	J-T380	J-T372	10	716	88
P-T428	J-T380	J-T392	12	618	96
P-T429	J-T300	J-T288	12	908	96

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T430	J-T079	J-T269	6	1339	88
P-T431	J-T253	J-T050	6	1402	88
P-T432	J-T278	J-T298	6	382	88
P-T433	J-T300	J-T273	12	812	96
P-T434	J-T271	J-T278	6	429	88
P-T435	J-T269	J-T253	6	448	88
P-T436	J-T298	J-T296	6	239	88
P-T437	J-T298	J-T300	6	418	88
P-T438	J-T273	J-T271	12	418	96
P-T439	J-T273	J-T270	12	403	96
P-T440	J-T262	J-T270	12	1536	96
P-T441	J-T269	J-T262	8	701	88
P-T442	J-T276	J-T262	6	174	88
P-T443	J-T270	J-T252	8	385	88
P-T444	J-T259	J-T271	6	385	88
P-T445	J-T252	J-T259	6	823	88
P-T446	J-T259	J-T260	6	429	88
P-T447	J-T246	J-T252	8	429	88
P-T448	J-T235	J-T276	6	548	88
P-T449	J-T246	J-T235	6	615	88
P-T450	J-T260	J-T246	6	825	88
P-T451	J-T350	J-T344	6	657	88
P-T452	J-T324	J-T333	12	661	96
P-T453	J-T350	J-T324	6	1313	88
P-T454	J-T296	J-T324	6	1320	88
P-T455	J-T323	J-T278	6	1333	88
P-T456	J-T392	J-T208	6	669	88
P-T457	J-T358	J-T372	6	657	88
P-T458	J-T208	J-T358	6	1317	88
P-T459	J-T358	J-T350	6	1320	88
P-T460	J-T292	J-T335	6	525	88
P-T461	J-T366	J-T491	6	528	88
P-T462	J-T484	J-T491	6	385	88
P-T463	J-T292	J-T186	6	456	88
P-T464	J-T224	J-T247	6	831	88
P-T465	J-T233	J-T224	6	250	88
P-T466	J-T226	J-T199	6	267	88
P-T467	J-T226	J-T205	12	235	96
P-T468	J-T225	J-T205	6	356	88
P-T469	J-T239	J-T225	6	898	88
P-T470	J-T116	J-T239	6	349	88
P-T471	J-T205	J-T200	12	623	84
P-T472	J-T200	J-T116	12	286	96
P-T473	J-T199	J-T222	6	858	88
P-T474	J-T198	J-T254	6	653	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T475	J-T175	J-T233	6	1305	88
P-T476	J-T247	J-T221	6	365	88
P-T477	J-T221	J-T184	6	424	88
P-T478	J-T184	J-T155	6	275	88
P-T479	J-T155	J-T119	6	241	88
P-T480	J-T119	J-T175	6	353	88
P-T481	J-T175	J-T099	12	442	96
P-T482	J-T099	J-T087	12	330	96
P-T483	J-T087	J-T081	12	346	96
P-T484	J-T092	J-T081	12	359	96
P-T485	J-T069	J-T092	6	490	88
P-T486	J-T081	J-T059	6	519	88
P-T487	J-T087	J-T057	6	470	88
P-T488	J-T099	J-T068	6	482	88
P-T489	J-T175	J-T061	6	591	88
P-T490	J-T061	J-T035	6	610	88
P-T491	J-T035	J-T119	6	618	88
P-T492	J-T068	J-T061	6	332	88
P-T493	J-T057	J-T068	6	335	88
P-T494	J-T059	J-T057	6	325	88
P-T495	J-T059	J-T069	6	352	88
P-T496	J-T073	J-T069	6	326	88
P-T497	J-T366	J-T506	6	1585	88
P-T498	J-T491	J-T521	6	1421	88
P-T499	J-P181	J-T551	12	2021	96
P-T500	J-T186	J-T484	6	775	88
P-T501	R-T002	J-P181	12	1539	96
P-T502	J-T137	J-T144	24	294	100
P-T503	J-T137	J-T144	24	293	100
P-T504	J-T144	J-T139	8	314	88
P-T505	J-T139	J-T004	8	1753	130
P-T506	J-T008	J-T004	6	614	88
P-T507	J-T133	J-T139	8	364	88
P-T508	J-T133	J-T008	6	1356	88
P-T509	J-T132	J-T133	6	1287	88
P-T510	J-T526	J-T132	6	497	88
P-T511	J-T167	J-T505	6	466	88
P-T512	J-T506	J-T521	6	548	88
P-T513	J-T551	J-T566	12	664	88
P-T514	J-T566	J-T570	6	863	88
P-T515	J-T569	J-T551	6	764	88
P-T516	J-T570	J-T569	6	878	88
P-T517	J-T570	J-T565	6	284	88
P-T518	J-T247	J-T260	6	435	88
P-T519	J-T224	J-T246	8	433	88

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T520	J-T222	J-T198	6	266	88
P-T521	J-T222	J-T200	6	267	88
P-T522	J-T297	J-T201	8	719	88
P-T523	J-T201	J-T171	6	740	88
P-T524	J-T168	J-T297	8	677	88
P-T525	J-T218	J-T210	6	479	88
P-T526	J-T210	J-T277	6	368	88
P-T527	J-T286	J-T277	6	435	88
P-T528	J-T247	J-T286	6	1354	88
P-T529	J-T277	J-T221	6	1322	88
P-T530	J-T184	J-T210	6	1337	88
P-T531	J-T119	J-T056	6	652	88
P-T532	J-T056	J-T052	6	637	88
P-T533	J-T052	J-T164	8	508	88
P-T534	J-T324	J-T323	6	624	88
P-T535	J-T255	J-T211	12	762	96
P-T536	J-T211	J-T206	12	713	96
P-T537	J-T206	J-T188	12	522	96
P-T538	J-T188	J-T169	12	363	96
P-T539	J-T169	J-T152	12	429	96
P-T540	J-T190	J-T255	6	1060	88
P-T541	J-T115	J-T134	12	208	96
P-T542	J-T093	J-T115	12	208	96
P-T543	J-T127	J-T093	12	902	96
P-T544	J-T134	J-T152	12	979	96
P-T545	J-T220	J-T127	12	1972	96
P-T546	J-T249	J-T220	12	1666	92
P-T547	J-T252	J-T276	6	926	88
P-T548	J-T262	J-T226	12	839	96
P-T549	J-T322	J-T324	12	3195	96
P-T550	J-5	R-T001	30	42	104
P-T551	J-T335	J-T366	6	364	88
P-T552	J-T292	J-T491	6	582	88
P-T553	J-T254	J-T199	6	358	88
P-T554	J-T395	J-T386	6	656	88
P-T555	J-T386	J-T368	6	676	88
P-T556	J-T257	J-T251	24	1204	130
P-T557	J-T471	J-T472	16	1009	64
P-T559	J-T186	J-T144	8	1222	88
P-T560	J-T558	J-T556	12	884	96
P-T561	J-T558	J-T560	12	494	96
P-T562	J-T555	J-T557	6	381	96
P-T563	J-T561	J-T553	12	170	96
P-T564	PMP-T001	J-5	24	63	88
P-T565	PMP-T002	J-5	24	47	88

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T566	J-5	PMP-T003	24	38	88
P-T567	J-5	PMP-T004	24	50	88
P-T568	J-T178	J-T018	12	1501	84
P-T569	J-T018	J-T022	12	845	84
P-T570	J-T363	J-T359	6	310	88
P-T571	J-T191	J-T363	6	865	88
P-T572	J-T155	J-T175	12	242	84
P-T573	J-T060	J-T073	24	1003	88
P-T574	J-T110	J-T060	24	659	88
P-T575	J-T218	J-T245	12	223	84
P-T576	J-T400	J-T474	12	151	96
P-T577	J-T385	J-T400	12	119	92
P-T578	J-T172	J-T385	12	445	96
P-T579	J-T362	J-T191	12	1913	92
P-T580	J-T474	J-T365	12	444	96
P-T581	J-T364	J-T244	12	3115	92
P-T582	J-T125	J-T232	6	171	56
P-T583	J-T112	J-T125	6	787	56
P-T584	J-T180	J-T335	6	371	104
P-T585	J-T004	J-T073	6	1036	104
P-T586	J-T111	J-T112	6	535	56
P-T587	J-T096	J-T111	6	860	56
P-T588	J-T164	J-T113	8	791	96
P-T589	J-T204	J-T168	12	448	100
P-T590	J-T359	J-T361	6	344	56
P-T591	PMP-T003	J-T137	24	167	88
P-T592	J-T137	PMP-T001	24	188	88
P-T593	PMP-T004	J-T137	24	178	88
P-T594	J-5	PMP-T005	24	66	88
P-T595	PMP-T005	J-T137	24	200	20
P-T596	J-T137	PMP-T002	24	170	88
P-T597	J-T031	J-T034	16	287	100
P-T598	J-T034	J-T030	16	526	100
P-T599	J-T053	J-T034	12	683	96
P-T600	J-T505	J-T533	6	682	56
P-T601	J-T484	J-T530	6	992	56
P-T602	J-T530	J-T550	6	662	56
P-T603	J-T249	J-T332	12	1188	96
P-T604	J-T322	J-T329	12	1827	96
P-T605	J-T329	J-T332	6	3022	56
P-T606	J-T144	J-T107	30	1872	100
P-T607	J-T107	J-T073	30	718	100
P-T608	J-T107	J-T225	6	1795	96
P-T609	J-T361	J-T501	8	1067	64
P-T610	J-T191	J-T398	12	10	92

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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T611	J-T398	J-T364	12	1649	92
P-T612	J-T501	J-T398	12	1553	92
P-T614	J-T501	J-T489	10	2057	88
P-T615	J-T489	J-T364	12	927	92
P-T616	J-T167	J-T397	6	366	88
P-T617	J-T397	J-T526	6	295	88
P-T618	J-T397	J-T533	6	1705	56
P-T619	J-T550	PRV-T001	6	116	56
P-T620	PRV-T001	J-T551	6	134	56
P-T621	J-T521	J-T550	6	671	56
P-T622	J-T565	PRV-T002	6	422	88
P-T623	PRV-T002	J-T533	6	494	88
P-T624	J-T505	J-T534	6	532	56
P-T625	J-T534	J-P083	8	374	56
P-T627	J-T179	J-T228	4	1016	52
P-T628	J-T112	J-T097	6	558	56
P-T629	J-T097	J-T100	12	169	104
P-T630	J-T097	J-T140	6	1419	56
P-T631	J-T140	J-T141	6	223	56
P-T632	J-T097	J-T135	12	1646	104
P-T633	J-T135	J-T382	12	1381	104
P-T634	J-T140	J-T135	6	203	56
P-T635	J-T232	J-T114	12	760	54
P-T636	J-T112	J-T114	8	186	104
P-T637	J-T283	J-T464	16	4056	104
P-T638	J-T464	J-T471	16	292	104
P-T639	J-T465	J-T464	6	47	56
P-T640	J-T391	J-T388	20	395	72
P-T641	J-T388	J-T390	20	591	72
P-T642	J-T251	J-T263	12	168	60
P-T643	J-T263	J-T117	12	981	60
P-T644	J-T264	J-T257	10	202	60
P-T645	J-T263	J-T264	12	1420	56
P-T646	J-T354	J-T351	6	603	56
P-T647	J-T137	J-T136	6	96	56
P-T648	J-T124	J-T265	24	338	130
P-T649	J-T265	J-T264	24	171	130
P-T650	J-T351	J-T331	6	2016	56
P-T651	J-T331	J-T327	6	455	56
P-T652	J-T265	J-T331	6	1950	56
P-T653	J-T331	J-T464	6	2850	56
P-T654	J-T497	J-T492	12	118	96
P-T655	J-T022	J-T007	12	1584	96
P-T656	J-T007	J-T010	12	516	96
P-T657	J-T010	J-T002	12	280	96

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2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T658	J-T002	J-T006	12	824	96
P-T659	J-T010	J-T005	12	837	96
P-T660	J-T006	J-T025	12	2306	96
P-T661	J-T025	J-T016	12	32	96
P-T662	J-T039	J-T109	12	1225	96
P-T667	J-T016	J-T039	12	161	96
P-T669	J-T012	J-T023	12	100	96
P-T670	J-T023	J-T033	12	682	96
P-T671	J-T033	J-T048	12	247	96
P-T672	J-T033	J-T108	12	502	96
P-T673	J-T016	J-T012	12	35	96
P-T674	J-T493	J-T499	12	151	96
P-T675	J-T499	J-T502	8	401	80
P-T676	J-T524	J-T499	12	854	96
P-T677	J-T524	J-T529	12	200	96
P-T678	J-T502	J-T510	8	238	56
P-T679	J-T518	J-T517	8	426	130
P-T680	J-T540	J-T518	6	565	56
P-T681	J-T478	J-T487	6	56	56
P-T682	J-T473	J-T512	6	69	56
P-T683	J-T544	J-T531	12	1009	96
P-T684	J-T560	J-T573	12	110	96
P-T685	J-T477	J-T503	12	184	96
P-T686	J-T503	J-T516	6	778	56
P-T687	J-T516	J-T508	6	116	56
P-T688	J-T553	T-T001	12	7	96
P-T689	J-T346	J-T376	12	425	64
P-T690	J-T086	J-T063	10	331	60
P-T692	J-T377	J-T362	12	156	84
P-T693	J-T377	J-T376	6	299	56
P-T694	J-T063	J-T067	10	38	60
P-T695	J-T063	J-T062	6	96	56
P-T696	J-T106	J-T121	6	304	56
P-T697	J-T101	J-T105	6	272	56
P-T698	J-T105	J-T064	6	164	56
P-T699	J-T105	J-T106	6	181	56
P-T700	J-T188	J-T165	12	497	96
P-T701	J-T165	J-T220	12	1278	96
P-T702	J-T165	J-T166	12	228	56
P-T703	J-T211	J-T194	12	633	96
P-T704	J-T194	J-T249	12	977	96
P-T705	J-T166	J-T194	12	1048	56
P-T706	J-T311	J-T388	24	9798	104
P-T707	J-T245	J-T312	24	1030	88
P-T708	J-T311	J-T312	24	191	56

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T709	J-T213	J-T155	12	817	96
P-T710	J-T204	J-T214	12	70	96
P-T711	J-T214	J-T218	12	2	96
P-T712	J-T213	J-T214	12	577	56
P-T713	J-T149	J-T110	24	322	88
P-T714	J-T245	J-T157	24	1357	88
P-T715	J-T140	J-T475	6	1189	56
P-T716	J-T149	J-T157	24	470	56
P-T717	J-T381	J-T476	6	212	56
P-T718	J-T476	J-T382	6	190	56
P-T719	J-T475	J-T476	6	189	56
P-T720	J-T443	J-T553	6	6	56
P-T721	J-T442	J-T556	12	534	96
P-T722	J-T442	J-T555	6	285	56
P-T723	J-T440	J-T442	6	4	56
P-T724	PRV-T003	J-T529	12	13	96
P-T725	J-T459	J-T443	6	8	56
P-T726	J-T545	J-T438	16	85	100
P-T727	J-T438	J-T561	16	153	100
P-T728	J-T573	J-T437	6	356	56
P-T729	J-T437	J-T448	6	181	56
P-T730	J-T568	J-P085	12	1067	89.6
P-T731	J-T420	J-T441	12	674	96
P-T732	J-T422	J-T425	6	121	56
P-T733	J-T426	J-T473	6	104	56
P-T734	J-T428	J-T420	12	254	96
P-T735	J-T572	J-T428	12	72	96
P-T736	J-T022	J-T419	12	67	96
P-T737	J-T419	J-T172	12	415	96
P-T738	J-T285	J-T405	12	469	60
P-T739	J-T431	J-T020	6	582	56
P-T740	J-T419	J-T431	6	19	56
P-T741	J-T243	J-T416	12	38	60
P-T742	J-T416	J-T242	12	303	60
P-T743	J-T406	J-T283	12	580	60
P-T744	J-T405	J-T406	6	21	56
P-T745	J-T238	J-T444	6	606	56
P-T746	J-T416	J-T444	6	25	56
P-T747	J-T415	J-T148	10	431	60
P-T748	J-T104	J-T445	10	35	60
P-T749	J-T445	J-T090	24	572	130
P-T750	J-T415	J-T445	6	8	56
P-T751	J-T114	J-T455	12	551	54
P-T752	J-T455	J-T100	12	19	54
P-T753	J-T387	J-T450	6	649	88

CITY OF TRAVERSE CITY
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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T754	J-T449	J-T219	12	441	130
P-T755	J-T449	J-T455	6	5	56
P-T756	J-T368	J-T451	8	465	88
P-T757	J-T451	J-T373	8	43	88
P-T758	J-T451	J-T450	6	29	56
P-T759	J-T452	J-T381	10	659	60
P-T760	J-T452	J-T389	6	13	56
P-T761	J-T453	J-T391	20	649	68
P-T762	J-T389	J-T454	8	28	88
P-T763	J-T454	J-T387	8	396	88
P-T764	J-T454	J-T453	6	12	56
P-T765	J-T391	J-T439	6	643	56
P-T766	J-T439	J-T389	6	12	56
P-T767	J-T447	J-T393	6	663	56
P-T768	J-T389	J-T447	6	430	56
P-T769	J-T439	J-T453	6	28	56
P-T770	J-T382	J-T461	6	48	56
P-T771	J-T461	J-T463	6	189	56
P-T772	J-T461	J-T447	6	689	56
P-T773	J-T452	J-T384	6	388	56
P-T774	J-T312	J-T456	6	215	56
P-T775	J-T297	J-T460	8	842	88
P-T776	J-T456	J-T458	8	28	88
P-T777	J-T458	J-T322	8	131	88
P-T778	J-T460	J-T458	6	14	56
P-T779	J-T168	J-T457	8	43	96
P-T780	J-T430	J-T255	12	1468	104
P-T781	J-T456	J-T430	6	256	56
P-T782	J-T457	J-T164	8	305	96
P-T783	J-T201	J-T432	8	551	88
P-T784	J-T113	J-T417	6	378	96
P-T785	J-T457	J-T432	6	37	56
P-T786	J-T233	J-T414	6	54	88
P-T787	J-T414	J-T235	6	505	88
P-T788	J-T254	J-T414	6	398	56
P-T789	J-T073	J-T413	16	481	96
P-T790	J-T413	J-T116	16	48	96
P-T791	J-T413	J-T092	6	329	56
P-T792	J-T126	J-T412	30	2406	104
P-T793	J-T144	J-T412	6	4194	56
P-T794	J-T433	J-T411	12	200	96
P-T795	J-T411	J-T446	12	179	96
P-T796	T-T001	J-T459	6	9	56
P-T797	J-T557	J-T410	6	1007	96
P-T798	J-T410	J-T573	6	175	96

CITY OF TRAVERSE CITY
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MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T799	J-T493	J-T492	12	93	96
P-T800	J-T409	J-T440	12	9	96
P-T801	J-T459	J-T409	6	16	56
P-T802	J-T446	J-T418	12	1063	96
P-T803	J-T418	J-T544	12	407	96
P-T804	J-T422	J-T408	12	356	96
P-T805	J-T408	J-T498	12	506	96
P-T806	J-T407	J-T498	12	277	96
P-T807	J-T459	PMP-T007	6	5	56
P-T808	PMP-T007	J-T409	6	9	56
P-T809	J-T459	PMP-T008	6	5	56
P-T810	PMP-T008	J-T409	6	8	56
P-T811	J-T531	PRV-T004	12	34	96
P-T812	J-T404	J-T426	6	79	56
P-T813	J-T425	J-T403	6	291	56
P-T814	J-T459	PMP-T009	6	5	56
P-T815	J-T403	J-T404	6	14	56
P-T816	PMP-T009	J-T409	6	9	56
P-T817	J-T572	J-T402	6	138	56
P-T818	J-T572	J-T401	6	69	56
P-T819	J-T401	J-T427	6	210	56
P-T820	PRV-T004	J-T422	12	867	96
P-T821	PRV-T005	J-T512	6	302	56
P-T822	J-T544	PRV-T005	6	54	56
P-T823	J-T429	J-T478	6	68	56
P-T824	J-T473	J-T429	6	264	56
P-T825	J-T005	PRV-T006	12	1160	96
P-T826	PRV-T006	J-T477	12	691	96
P-T827	J-T531	J-T436	12	445	96
P-T828	J-T436	J-T572	12	245	96
P-T829	J-T421	J-T433	12	287	96
P-T830	J-T356	J-T435	16	628	100
P-T831	J-T435	J-T545	16	453	100
P-T832	J-T543	J-T535	12	253	96
P-T834	J-T441	J-T424	12	21	96
P-T835	J-T424	PRV-T003	12	12	96
P-T837	J-T498	PRV-T007	12	28	96
P-T838	PRV-T007	J-T497	12	20	96
P-T839	J-T365	J-T407	12	117	96
P-T840	J-T423	J-T348	6	703	56
P-T841	J-T426	J-T423	6	197	56
P-T842	J-T495	J-T462	8	301	80
P-T843	J-T462	J-T510	8	77	80
P-T844	J-T462	J-T515	6	74	56
P-T845	J-T568	J-T566	12	44	56

CITY OF TRAVERSE CITY
2014 WATER SYSTEM RELIABILITY STUDY

MODEL INPUT - EXISTING INFRASTRUCTURE

Label	Start Node	Stop Node	Diameter (in)	Approx Length (ft)	Hazen-Williams C
P-T846	J-T421	J-T440	12	47	96
P-T847	J-G630	J-T396	12	672	60

Appendix E

Drinking Water Quality Report for the Year 2012

2012 Traverse City Water Quality Report

This report covers the drinking water quality for Traverse City Water System for the calendar year 2012 as well as an update on recent Water Treatment Plant capital improvements. This information is a snapshot of the quality of the water that we provided to you in 2012. Included are details about where your water comes from, what it contains, and how it compares to Environmental Protection Agency (EPA) and state standards.

Your water is surface water and comes from the East arm of Grand Traverse Bay. The State performed an assessment of our source water in 2004. A determination of sensitivity and susceptibility to contamination was made by reviewing our source water geology, intake location, water chemistry, and potential contaminant sources within the source water area. The State has determined that our source water has a moderate geologic sensitivity with a moderate susceptibility to contamination. A copy of this State report may be obtained by logging onto the City of Traverse City website (www.ci.traverse-city.mi.us) or by contacting the Traverse City Utility Accounting Office at the Governmental Center located at 400 Boardman Avenue, Traverse City, MI 49684.

- **Contaminants and their presence in water:** Drinking Water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the **EPA's Safe Drinking Water Hotline (800-426-4791)**.

- **Vulnerability of sub-populations:** Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

- **Sources of drinking water:** The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. Our water comes from Lake Michigan. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.
  - Contaminants that may be present in source water include:
    - **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.
    - **Inorganic contaminants**, such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.
    - **Pesticides and herbicides**, which may come from a variety of sources such as agriculture and residential uses.
    - **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.
    - **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban stormwater runoff, and septic systems.

In order to ensure that tap water is safe to drink, EPA prescribes regulations that limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration regulations establish limits for contaminants in bottled water which provide the same protection for public health.

LT2 Rule

The EPA has created the Long Term 2 Enhanced Surface Water Treatment Rule for the sole purpose of reducing illness linked with the contaminant Cryptosporidium and other disease-causing microorganisms in drinking water. The rule has bolstered existing regulations and provides a higher protection level of your drinking water supply.

Sampling of our water source has shown the following:

It is important to note that these results are from our raw water source only and not our treated drinking water supply.

Cryptosporidium: (1) Cryptosporidium cyst in one 10 liter volume raw water sample out of 24 samples tested, dated January 12, 2010.

Cryptosporidium is a microbial pathogen found in surface water throughout the U.S. Although filtration removes Cryptosporidium, the most commonly-used filtration methods cannot guarantee 100% removal. Our monitoring indicates the presence of these organisms in our source water and/or finished water. Current test methods do not allow us to determine if the organisms are dead or if they are capable of causing disease. Ingestion of Cryptosporidium may cause cryptosporidiosis, an abdominal infection. Symptoms of infection include nausea, diarrhea and abdominal cramps. Most healthy individuals can overcome the disease within a few weeks. However, immuno-compromised people, infants and small children, and the elderly are at greater risk of developing life-threatening illness. We encourage immuno-compromised individuals to consult their doctor regarding appropriate precautions to take to avoid infection. Cryptosporidium must be ingested to cause the disease, and it may be spread through means other than drinking water.

Water Quality Data

The table below lists all the drinking water contaminants that were detected during the 2012 calendar year. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. Unless otherwise noted, the data presented in this table is from testing performed January 1, 2012 to December 31, 2012. The State allows monitoring for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. All of the data is representative of the water quality, but some are more than one year old.

Terms and abbreviations used below:

- Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
- Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
- Maximum Residual Disinfectant Level (MRDL): means the highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Maximum Residual Disinfectant Level Goal (MRDLG): means the level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- N/A: Not applicable ND: not detectable at testing limit ppb: parts per billion or micrograms per liter ppm: parts per million or milligrams per liter
- Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

Regulated Contaminant	MCL	MCLG	Level Detected	Range	Year Sampled	Violation Yes / No	Typical Source of Contaminant
Fluoride (ppm)	4	4	0.74	N/A	2012	No	Erosion of natural deposits. Water additive that promotes strong teeth.
TTHM - Total Trihalomethanes (ppb)	80	N/A	26.6	21.0 – 36.2	2012	No	Byproduct of drinking water disinfection
HAA5 Haloacetic Acids (ppb)	60	N/A	7.8	7.0 – 9.0	2012	No	Byproduct of drinking water disinfection
Chlorine (ppm)	**MRDL**	**MRDLG**	0.46	0.33 – 0.57	2012 Weekly	No	Water additive used to control microbes
	4	4					

Special Monitoring and Unregulated Contaminant *	Level Detected	Range	Year Sampled	Typical Source of Contaminant
Sodium (ppm)	8.6	N/A	2012	Erosion of natural deposits
Sulfate (ppm)	26	N/A	2012	Erosion of natural deposits

Contaminant Subject to AL	Action Level	MCLG	90% of Samples ≤ This Level	Year Sampled	Number of Samples Above AL	Typical Source of Contaminant
Lead (ppb)	15	0	0	Summer 2011	2	Corrosion of household plumbing systems; Erosion of natural deposits
Copper (ppm)	1.3	1.3	0.176	Summer 2011	0	Corrosion of household plumbing systems; Erosion of natural deposits; Leaching from wood preservatives

* Unregulated contaminants are those for which EPA has not established drinking water standards. Monitoring helps EPA to determine where certain contaminants occur and whether it needs to regulate those contaminants.

Information about lead: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The Traverse City Water Plant is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Terms and abbreviations used below:

- Nephelometric Turbidity Units (NTU): The measurement of the clarity, or turbidity, of water. Turbidity in excess of 5 NTU is just noticeable to the average person.
- Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

Samples collected at the Water Plant

Regulated Substance	MCL/ MCLG	Limit	Range Detected	Sample Date	Violation Yes / No	Typical Source of Contaminant
Turbidity (NTU)	TT	≤ 0.1**	0.04 - 0.08	Daily	No	Soil Runoff
Turbidity lowest monthly percentage of samples meeting limit	TT	N/A	100%	Daily	No	Soil Runoff

** 95% of samples less than or equal to this level

Monitoring and Reporting Requirements: The State and EPA require us to test our water on a regular basis to ensure health safety. We met all the monitoring and reporting requirements for 2012.

We will update this report annually and will keep you informed of any problems occurring throughout the year, as required. Copies are available at the Traverse City Water Plant at 2010 Eastern Avenue, the Governmental Center at 400 Boardman Avenue, & the Department of Public Services Building at 625 Woodmere Avenue in Traverse City.

We invite public participation in decisions that affect drinking water quality. City Commission meetings are conducted on the first and third Mondays of each month in the Commission Chambers of the Governmental Center at 400 Boardman Avenue, public comment is welcome. For more information about your water, or the contents of this report, contact Arthur J. Krueger / Water Plant Supt. at 231-922-4920 or email at akrueger@traversecitymi.gov. For more information about safe drinking water, visit the U.S. Environmental Protection Agency at www.epa.gov/safewater/.

Water Treatment Plant Capital Improvements: In 2012, the City completed a $250,000 capital improvement project at the Water Treatment Plant to further protect public health, safety and welfare and enhance treatment reliability. The project included upgrading the chlorine bulk storage and chemical feed rooms with new transfer piping and valves, replacing the chemical feed pumps, the chlorine day tank and scale. The project also included upgrading the Huron Hills Booster Pump Station by replacing one smaller booster pump with a larger pump and installing Variable Frequency Drive controls on all three booster pumps to improve operations and energy efficiency. A large pneumatic air tank was replaced with two captive air bladder tanks. A new magnetic meter and electronic controls were installed to operate more efficiently. Other plant improvements included replacement of three turbidimeters, upgrade of the compressed air system along with miscellaneous electrical upgrades. The roof was also repaired on the Huron Hills Booster Pump Station at the Water Plant.

City of Traverse City Water System – Primary Assets

INSERT CURRENT VERSION PROVIDED BY CITY

- Lab -

2013 WTP Equipment Inventory

BH 8/12/13

Room Name: LAB

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Incubator	GENERAL ELECTRIC	TA 12 SABW				PRECISION SCIENTIFIC
Incubator	PRECISION SCIENTIFIC	805			50/60 cycle	
TURBIDIMETER 2100N	HACH	110506027452	2011			2100N Turbidimeter
Chlorine Reader	HACH	030800002324	2011			DR/2400 Portable Spectrometer
Prominent Chlorine Reader	Prominent fluid controls	7744258	2004			D1C Control package
Prominent Chlorine Reader	Prominent fluid controls	7744258	2004			D1C Control package
Mini Refrigerator	General Elec.	TAX6SNXARWW				
Ultraviolet light	Spectronics Corps.	EA-160				Spectroline
pH reader	Symphony	D07298	2011			VWR
Cimarec Stir/Hotplate	Barnstead Thermolyne	Sp131325/S130815				Cimarec
OHAUS Scale	OHAUS	GT 400				OHAUS Precision Advanced
Fluoride Reader	VWR Scientific	8015				VWR Scientific
Fluoride Probe	Thermo Scientific	9409SC				ORION
Fluroide probe	Thermo Scientific	900100				ORION
Vacuum pump	General Elec.	5KH32EG558AS				A-C Motor
microscope	American optical/Spencer	620941				Spencer
OHAUS Scale	OHAUS	PA114	2010			Pioneer
AutoClave	Market Forge					

High Service Room

2013 WTP Equipment Inventory

Room Name:

Item Name / Make	Model Num	Year Installed	Year rebuilt	Size	Type
3 MGD Worthington Pump - 125HP #1	1358416	1964	-	125HP	Vertical Pump #1
5 MGD Worthington Pump - #3	1361290	1964	-	200HP	Vertical Pump #3
8 MGD Worthington Pump #5	5K3449DP6071P	1993		300HP	Vertical Pump #5
8 MGD Worthington Pump #4	1358172	1964 (*)	-	300HP	Vertical Pump #4
5 MGD Worthington Pump #2	1361291	1964	-	200HP	Vertical Pump #2
Switchgear for Pumps		1964			
Caterpillar Generator	23204724	1994			
Switchgear for High Flow Service		1994			
East wetwell level sensor	Allen Bradley cat# 2711-M3A18L1	for (2012) A		2.5	AB
West " " "					AB

(*) shaft rebuilt in 2009
Not motor

2/18

2013 WTP Equipment Inventory

Room Name: High Service Basement

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
E. 36" Sluice Gate			1965			
W. 36" " "			↓			
E-W 24" Sluice Gate						
E. 18" H.S. meter - Fischer Porter						Mag meter
W. 18" " " - " "			↓			Mag Meter
10EA 24" Butterfly Valves - Header Piping	Pratt		1968			
Pump #1 Discharge 12" B-Fly Valve			1965			
Pump #2 " 14" B-Fly Valve			↓			
Pump #3 " 14" " "						
Pump #4 " 14" " "			↓			
~~Pump #5 " " B-Fly Valve~~						
Pump #5 "14" B-Fly Valve			2006	N/A	14"	
Pump #5 "14" DeZurik plug Valve			2012	N/A	14"	
Pump #1 "12" Willamette Cone Valve			1965		12"	
Pump #2 "14" " " "			1965		14"	
Pump #3 "14" " " "			↓		↓	
Pump #4 "14" " " "						
8" Ross Pressure Relief valve			~~1970's~~ 1973		8"	

3/18

Chemical Room - upstairs

2013 WTP Equipment Inventory

Room Name: Chemical Room

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Al2 pump #1	Leeson Elec. corp.	A4K17DR7D	1993?		60 Hertz 1/4 H.P.	Watt Saver - D.C. motor
Al2 pump #2 x2	General Elec.	5KC32GN13G			60 Hertz 1/4 H.P	G.E. Motors A-C motor
Al2 pump #1	Wallace + Tiernan	AX 20679		2004	Max Dis. 100	Metering Pump
Al2 pump #2	Wallace + Tiernan	AX 20578		2004	Max Dis. 100	Metering Pump
Al2 pump #3	Wallace + Tiernan	AX 20580		2004	Max Dis. 100	Metering pump
Al2 Day Tank injector	Liquid Metronics	D131-25 T			Max output 192 GPD	
~~Flocculator #1~~	~~Sew-Eurodrive inc.~~	~~85001722A 3~~	1993		~~Hrf. 20 max~~	~~VUF5/8 DV16 DL4~~
Flocculator #2	Sew-Eurodrive inc.	85001722A 3	1993		Hrf. 20 max	~~VUF5/8 DV15 DL4~~

4/18

Filter Gallery

2013 WTP Equipment Inventory

Room Name: Filter Gallery

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
flocculator #1 mixer motor	Sew-Eurodrive inc.	8500172243	1993		h.p. 20 max	VUf51BDV160L4
flocculator #2 mixer motor	Sew-Eurodrive inc.	8500172243	1993		h.p. 20 max	VUf51BDV150L4
Cone level sensor #1	Fisher-Porter	805/unreadable	↓			
Cone level sensor #2	Fisher-porter	605+02BUC3				
filters 4+5 control panel			1994			Commerce Control inc.
filters 1+2 control panel	fisher-porter		1972			
filter 3 control panel	fisher-porter		1972			

5/18

2013 WTP Equipment Inventory

Room Name: Basement (EAST)

	Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
	Backwash pump	U.S. motors	1363098	1965	~~1965~~	bocycle 100 h.p.	
	Butterfly Valve	Henry Pratt	1-8832-8 R	1965		3 RH	
	Backwash Valve	Limitorque	L856146	2009		30	Flowserve
East	Green Compressor Frame	Alco Division	QW10-123390	65			S.N. 65291
East	Green Lincoln Motor	Lincoln Motor	265-U	65			S.N. 223975
East	Green Compressor	Binks MFG Co.	33-597	65			S.N. 390-15 47715HLS
West	Blue Compressor Frame	Saylor Beall MFG	B-PL-45100	2012			S.N. 45Y-1-G12
West	Blue Baldor Motor	Baldor Elec. Co.	EM3313T	2012			S.N. 37F614T853
West	Blue Compressor	Saylor Beall MFG	PL-4500	2012			S.N. 45Y-1-D13
	Air Bladder Tank	Silvan Ind.		~~2000~~ 2012			S.N. 733 983
	High Temp Refridgerator	Great Lakes	EDR-B2-116	2012			S.N. 41583
	Air Dryer	Air		1			
	Sump Motor #1	Gen. Elec.	5K215AN305	65			
	Sump Motor #2	Gen. Elec.	9K215TTDR7076HFW	65			
	Sump Check Valve #1	Arco		65			disk check valve
	Sump Check Valve #2	Arco		65			disk check valve
	Sump 4" Gate Valve	TCIW	404 175W	65		4"	valve to drain #1
	Sump 4" Gate Valve	TCIW	404 175W	65		4"	valve to drain #2
	Elevator	Harris ~~Pratte~~ Preble	682 845	65			fire door
	Raw Meter	Fisher-Porter	10D1416A	65			Mag Meter

2013 WTP Equipment Inventory

Room Name: Basement (East) (Continued)

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Boiler (SE)	Weil McLain	PFG 5 PIDN	2011			Series No. 7
Boiler (NE)	Weil McLain	PFG 5 PI	1987			Series No. 4
Diaphram Expansion Tank	ELBI of America (Ellon)	XT-90	2008			Batch No. A-000005 (East)
Boiler (NW)	Weil McLain	PFG-5 PIDN	1994			Series No. 6
Boiler (SW)	Weil McLain	PFG 5 PIDN	1994			Series No. 6
Diaphram Expansion Tank	Amtrol (Extrol)	60	2010			(West)
Hot Water Heater	Lochinvar	LTN0 5040300	2012			S.N. 1205A0204160
Dewatering Pump Motor	Gen Elec.	5K4324A31	1964			SN. ZY105829
Dewatering Check Valve	TCIW		1964		6"	125 lb FL
Dewatering Gate Valve	TCIW	F406F	1964		6"	Goes up to drain
Dewatering Gate Valve	TCIW	408E	1964		8"	HS-W
Dewatering Gate Valve	TCIW	408E	1964		8"	HS-E
Dewatering Gate Valve	TCIW	408E	1964		8"	Plant Res.
Dewatering Gate Valve	TCIW	408E	1964		8"	1-2 CW

2013 WTP Equipment Inventory

3/3

Room Name: BASEMENT (EAST)

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
BACKWASH PRESSURE RELIEF CIRCUIT						
1. CHECK VALVE	APCO	SLANTING DISC	← 1964		8"	
2. GATE (ISOLATION)	TEXW		← 1964		8"	
3. PRV	ROSS VALVE	SDRWR SET @ 25	PSI ← 1964		8"	SN 647778
BACKWASH Pump Supply ISO.		PRATT VALVE	No. 1-8832-8		24"	(NOTE LONG LAYING LENGTH
BACKWASH PUMP AIR RELEASE		CHICAGO NO. 75 VALVE & PRIMER COPY	AIR RELEASE			
ART - FEEL FREE TO REFORMAT AS YOU			WISH		w/	MOTORIZED
			GATE V			MANUAL HW

8/18

2013 WTP Equipment Inventory

Room Name: Basement (west)

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Turbidmeter #1	Hach	050005010575	~~2012~~ 2008			1720 E
Turbidmeter #2	HACH	06090009244	2012			1720 E
Turbidmeter #3	Hach	12110821461l				1720 E
Turbidmeter #4	HACH	12050820266l				1720 E
Turbidmeter #5	Hach	120508208668				1720 E
Dehumidifier #1	High-E-Dry Thermastor	Hi E Dry 195	2000±			S.N. E0671086
Dehumidifier #2	High-E-Dry Thermastor	Hi E Dry 195				S.N. C0586190
Dehumidifier #3	High-E-Dry Thermastor	Hi E Dry 195				S.N. E0671085
Dehumidifier #4	High-E-Dry Thermastor	Hi E Dry 195				S.N. C0586191
DP Cell #1 Head	Fischer Porter	50DPF1103BH5A	72			S.N. 90W00459
DP Cell # Flow	Fischer Porter	50DPF1103BH5AE	72			S.N. 90W00449
DP Cell #2 Head	F.P.	50DPF1103BH5AE	72			S.N. 90W004058
DP Cell #2 Flow	F.P.	50DPF1103BH5A	72			S.N. 90W004060
DP Cell #3 Head	F.P	50DPF1103BH5A	72			S.N. 90W004056
DP Cell #3 Flow	F.P	50DPF1103BH5A	72			S.N. 90W004057
Surface Wash Motor	U.S. Elec Motors		65			S.N. 3735442
Gate Valve Surf. Wash.	TCIW		65		4"	
Gate Valve Surf. Wash.	TCIW		65		6"	

4" Checkvalve on Surf. wash Pump Discharge
SW Pump 2½ LR13

A 104936

9/18

2013 WTP Equipment Inventory

Room Name: Basement - below 4+5 filters

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Rapid mixer #1	Walker	M30400-2	92			
Rapid mixer #2	walker	unreadable	92			
RAW water Butterfly valve - Pratt		S30572-2	92			
RAW water B-valve	Pratt	S05572-2	92			
filter 5 control valve	limitorque	486031	94			
filter 4 control valve	limitorque	255021	94			
filter 4 flow meter	fisher-porter	97W002664	94			
filter 5 flow meter	fisher porter	93W008663	94			
filter 4 DP Cell	ABB Kent-taylor	505TB01210A0100-1000 63990	94			
filter 5 DP Cell	ABB Kent-taylor	505TB01210A0100-1000 63981	94			

10/18

2013 WTP Equipment Inventory

Room Name: Chlorine Storage / Feed System

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Peristaltic Metering Pump (Cl_2)		M-3	2012			piping is new @ 2012
			2012			
			2012			
Eyewash Shower	Haws		2012			
Century Chem Scale		12D60	2012			
Cl_2 Day Tank		P.O. # 12-0005 11 M-2	2012			447gal New Bulk feed pipes
Phosphate Chem Pump		A1 71 1507	98			50gal
Dayton Mixer	Dayton	5K001A	98			
Trane Unit Heater	Trane		92			
East Cl Transfer Pump	WEG	75336ES3EED5UC	2009			
West Cl Transfer Pump	WEG	20013336ES3E080910	2012			
Unit Heater	Trane		92			
Eye Wash Shower			1992			
South Storage Tank			1995			8,200 gal
North Storage Tank			1995			8,200 gal
HydroRanger 1 (North)			92			
HydroRanger 1 (South)			92			
Pneumatic Sump Pump			92			

11/18

2013 WTP Equipment Inventory

Room Name: Huron Booster Station

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
pump 1	Christensen pumps	MF 600787	2012		7-6.69	
pump 2	U.S. Elec. motors	9163754-191 R2147804 g0960298	82		~~3phase to 60Hz~~	H.P. 60 - 3phase 60 Hz
pump 3	U.S. Elec. motors	6234A-A10 A223835m	82			H.P. 60 - 3 phase 60 Hz
pump 1 VFD	Allen Bradley	22C-D088A103	2012			Power Flex 400
pump 2 VFD	Allen Bradley	"	↓			"
pump 3 VFD	Allen Bradley	"	↓			"
meter	Process Master	fep315200m10 4A181A 100p183C1AYJ1M5	2012			
Air tank 1	well/trol	243961	2012		WX453C	
Air tank 2	well/trol	243960	2012		WX453C	

12/18

Plant

2013 WTP Equipment Inventory

Room Name: Reservoir & Clearwell Effluent Vaults

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Conc. Reservoir		1.5 MG	1965			Conc.
Baffles			1993			Cone.
30" Butterfly Valve Res. ~~Influent~~			1965			
30" " " Res. Bypass			↓			
36" " "W.H.S. ~~West~~ Influent						
36" Sluice Gate on Res. outlet						
Clearwell Effluent Vaults			1965 1992			

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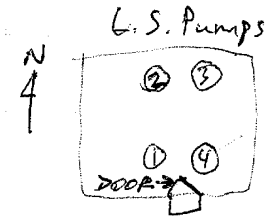

2013 WTP Equipment Inventory

Room Name: Low Service

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
36" Intake Pipe				1964		
Crib Structure				1964		
N. 36" Butterfly Valve				1965		
S. 36" " "						
N. Sluice Gate valve for Sump Drain					12"	
S. " " " " " "					12"	
N. Rex Traveling Screen						
S. " " "				↓		
Screen wash pump				1965		
Intake Valve Pit 4" Floor drain valve @ Sump				1965	4"	
4" Sump Pump				1965	4"	
Pump #1	US motors			1965	75 HP	
Pump #2	US motors			1965	75 HP	
Pump #3	GE			1993	125 HP	
Pump #4	US Motors			1973	~~125 HP~~ 100 HP	
Pump #1 discharge check valve				1965	14"	
Pump #2 " " "				1965	14"	
Pump #3 " " "				1994		
Pump #4 " " "				1973		

Air Compressor - supply for REX units 1965

Clear Well Level Sensor Radar/Ultrasonic - N. side only

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Wayne Hill Booster

2013 WTP Equipment Inventory

Room Name:

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
valve victaulic	~~STATE~~	V08076150 300MS	06		8"	
Butterfly Actuator ↑		HQ0015-6	06		40 w	AC 115V
valve victaulic		300MS	06		8"	
Butterfly Actuator ↑		HQ0015-6	06		40 watt	AC 115V
PSI gauge	ABB		06			
Butterfly valve	NIBCO	~~H00~~ T			8"	
"	"	"	N200235LH			
"	"	"				
"	"	"				
"	"	"				
"	"	"				
G.A. Silent check valve		290	06			400 PSI
"	"	"				
"	"	"				
Butterfly valve			06		8"	
"	"	"				
Butterfly valve	victaulic	300MS	06		8"	
"	"	"	L	06		8"
"	"	"	"	06		8"
"	"	"	"	06		8"

2013 WTP Equipment Inventory

Room Name: Wayne Hill Booster (cont)

Item Name Pump / Make	Model Num	Year Installed	Year rebuilt	Size	Type
TYP CR90-4-2-A-B-A-E-KUHE		2006			Tanks
mot. A964237444-92060803Y	Flow PSI meter				ADAMSON Global/ Technology
60 HP / 435/194					150 PSI
motor IEEE Std. 841-1994	Hart				ser. 7387
WEG W21 Frame 364/5TS 04/99	Mod 260DT ser:4				Built 2005
8 HP(KW) 60(45) RPM 3560	ser. 6206000251				
model 060365P3Q ie364TS	Prog. Code 2L4HSPSTA1EGLI	B13 IN2			
2nd — Mod.# — 058		2006			
motor Same as ↑					
#3					
Mod# — 035		2006			
motor - Same ↑					
Flow meter ABB		2006			
mod 10Dx3111EDE17P1B3DK21321					
ser 03w012828 Teflon liner					

meter cap 26426 PM
130 mm
HZ conv 50 xm

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2013 WTP Equipment Inventory

Room Name: (cont) Wayne Hill Booster & Barlow Tank

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
VFD Panels - Controls			2006			Wayne Hill Booster (cont)
Guardoit By Raco			↓			↓
www.Racoman.com						
Allen Bradley VFD - (3)						
Barlow						Barlow Tank
1972 Gate valve 8"			1972			↓
Butterfly valve			1972			
Pratt Controller						
Part 1754823						
115 volt						
mod. 512CD						
2 Panels - Electric			?			
Fisher Porter			↓			
1 - communication						
1 - valve						

Barlow Tank 1972 - old - Brown - Minneapolis

2013 WTP Equipment Inventory

Room Name: Wayne Hill Reservoir

Item Name	Make	Model Num	Year Installed	Year rebuilt	Size	Type
Butterfly	Victaulic valve	—	06	—	6"	—
"	" "	—	06	—	6"	—
CIA Valve	6"	90-48BY	06		6"	
CIA valve	4"	50-01B	06		4"	
CIA Valve	6"	90-48BY	06		6"	
Butterfly valve	victaulic		06		6"	
Actuator	↑	HQ6015-6	06		40 watt 115V	
PSI Tank	Adamson Global Tech coop		06		195PSI	
Butterfly	victaulic 4"	—	06?	—	4"	
Generator	Cummins	DGFC-5757982	2006			
Gate valve			1948		16"	
"	"		1948		16"	
check valve	Jenkins		1948		16"	
Gate valve			↓		12"	
Gate valve			↓		12"	
Automatic valve	Limit Torque	128069	TYPE H		12"	
Gate valve mod valve			1948		4"	
Gate valve			1944		8"	

Appendix G

Water Shortage Response Plan – Table of Contents and Introduction

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EMERGENCY RESPONSE (CONTINGENCY) PLAN PURPOSE

Contingency planning is planning ahead for a possible occurring emergency. Conditions and events are not static during emergencies and the person in charge at the time is going to have to react to the existing conditions. The enclosed plans should help in responding to emergencies.

The person in charge at the time of the emergency is going to have to think in terms of sequential events or action. The following is a list of sequential actions to be taken in an emergency:

1. Define the problem.
2. How does it affect the water supply?
3. What must be done to correct the problem?
4. What affect the problem and correction has on the customers?
5. Who must be notified?
6. The expected duration.
7. Analyze cause or source.
8. Record the events.
9. Review plans and re-plan in case it happens again.

A good contingency plan is one that is drawn up from actual experience and one that is periodically updated. **BY LAW THE PLAN MUST BE UPDATED EVERY 10 YEARS.**

REVISION/UPDATE HISTORY

Creation	1978
Updated	1990
Updated	1995
Updated	2000
Updated	2001
Updated	2004
Updated	2005
Updated	2011
Updated	2012
Updated	2013

Also under Act 399, the State Department of Environmental Quality Water Bureau must be notified immediately in case of an emergency and within 90 days after such event they must receive a full written report on the incident.

AWWA MANUAL LOCATION

AWWA Manual No. 19, Emergency Planning for Water Utility Management, is located at the Water Treatment Plant in the Superintendent's office file cabinet under Emergency Planning.