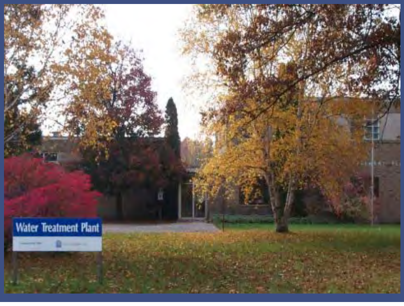

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

Submitted to the
City of Traverse City

Submitted on
September 8, 2008

Revised May 3, 2010 to include
Addendum I dated 12/22/2009 and
Appendix L dated 2/5/2010

Submitted by
Wilcox Professional Services, LLC
with Black & Veatch Corporation

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APPENDICES

I. EXECUTIVE SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. Introduction

In an effort to plan for the future, Traverse City and Grand Traverse County have commissioned a master planning study for area potable water supply systems. The consulting team is Wilcox Professional Services and Black & Veatch. The project has been conducted throughout the 2007 calendar year and into 2008. Based on the significant growth that has taken place in the area over the past 15 years, the multiple jurisdictions believe that reliable service to meet future needs is paramount. In addition to growth, local communities face increasing challenges brought about by geopolitical realities on state, regional, national and international levels. For these reasons, preparations should begin for changes that will occur in the next 10-20 years.

This study encompasses more than technical issues, and includes additional master planning efforts to address regional cooperation, resource protection, sustainability and environmental protection challenges. The study includes the evaluation of opportunities for water and energy conservation and addresses factors that can lead to increased intergovernmental cooperation for the reliable delivery of water. The recommendations made in this study are conceptual in nature. Additional planning should include the establishment of priorities/phasing with opinions of cost being developed for each phase. Detailed engineering studies should also be completed prior to implementation of any improvements.

The project team developed a set of goals by which the scope was developed and the project was driven. These goals are as follows:

- Provide for Public Participation and Input
- Undertake Engineering Master Planning and Reliability Assessment
- Evaluate Opportunities for Water and Energy Conservation
- Consider Potential Future Challenges
- Identify Opportunities for Intergovernmental Cooperation

Citizen participation and input were planned to be a critical element of the project. This was accomplished through a public meeting and web pages containing project information.

The technical portion of the project focused on system component capacity and reliability as necessary to fulfill the requirements of Part 12 of the Administrative Rules of the Michigan Safe Drinking Water Act, PA 399 of 1976 as Amended for selected public water supplies.

Additional engineering work included the cursory evaluation of the City's Water Treatment Plant (WTP) in light of previous studies and a walk-through tour of the plant. This was undertaken to ensure that important opportunities are not overlooked in the best use of this critical resource.

The City and County considered it important for this study to encompass larger master-planning issues than just the standard Reliability Study work. For that reason, consideration has been given to water and energy conservation, evaluation of potential future challenges facing water supplies in the area, identification of opportunities for expanded collaboration between governmental entities and the development of recommended standards that will facilitate future planning.

The study encompasses the City of Traverse City, nine surrounding Townships and the East Bay Water Utilities owned by the Grand Traverse Band of Ottawa and Chippewa Indians. The study has been tailored to the needs of each entity participating in the study.

B. Resource Protection

Increasing instabilities in our world today give rise to the need to build resiliency into the area's water systems. This will help the Grand Traverse Area not only in resisting terrorist threats but also in terms of facing the many other real challenges of the future.

World-wide epidemics (pandemics) have occurred at a frequency of about once every three decades. Therefore, a water utility needs to have an emergency response plan for a pandemic that can be a variation of a previously-developed emergency response plan, with specifics focused on the unique situation that would be presented by a pandemic. For systems that have completed vulnerability assessments (VA) and emergency response plans (ERPs), it is important to:

- Continue toward implementation of the security improvements recommended for implementation in the VA.

- Periodically review the VA, and update recommendations for improvements and implementation thereof.
- Periodically exercise the ERP (table top exercise), and revise as necessary.

For those systems that were not required to complete a VA and/or ERP under the Bioterrorism Act, it is recommended that a VA be performed in order to identify the potential for any relatively easy and inexpensive measures that can be implemented to improve security of the water supply and safety of the utility staff.

Acts 179 through 190 of the Public Acts of 2008, made effective on July 9, 2008, require that the MDEQ, as part of the permitting process for certain large quantity water withdrawals, evaluate the potential for adverse impacts from such proposed withdrawals. Any withdrawals deemed to create an adverse resource impact will not be allowed, unless there is proven to be no feasible or prudent alternative. All proposed withdrawals of greater than 2 million gallons per day (mgd) capacity, and those smaller withdrawals deemed Zone C withdrawals, will also need to comply in some manner with water management/conservation measures. Many resource management strategies including water conservation are addressed in Section V.C of this report.

A source water assessment for the Traverse City water supply was completed by the Michigan Department of Environmental Quality (MDEQ) in 2002, and identified the vulnerability of the City's source as being of moderately high susceptibility, but notes that the treatment plant and intake have a historic record of maintaining safety of the water supply. Following the completion of the source water assessments, the MDEQ encourages water systems to develop a Surface Water Intake Protection Program (SWIPP).

The MDEQ maintains a wellhead protection program (WHPP) to assist communities utilizing groundwater for their municipal drinking water supply systems in protecting their water source. Although not a regulatory requirement, it is recommended that the area's groundwater systems complete a WHPP as a means of ensuring the safety and protection of the water supply.

A focus on minimizing pumping operations and increasing efficiency of required pumping operations will be to the benefit of a Public Water Supply (PWS) and its rate payers. Primary means of minimizing energy costs in pumping operations include:

- Ensuring distribution systems are properly configured to avoid unnecessary pumping operations; in the Grand Traverse area. Specific recommendations for the water systems are made in Sections VI.B.1 and VI.B.5.6 of this report.
- Evaluating required pumping operations to ensure operation of pumps in most efficient areas of their curves'; This may be predicated on the availability of system storage to allow "fill-drain" cycles to limit pump operation at rated/most efficient capacity vs. meeting varying system demands, or installing adjustable speed drives on pumping units to maximize efficiency.

As follow-up to this study, it is recommended that important water systems planning and management work be continued. This may include components such as a water systems planning task force, centralized planning and public education.

C. Technical Recommendations

The Near-term Recommended Improvements are improvements that are recommended to be made over the next ten years that will be designed based on projected Year 2037 demands. These recommendations are referred to in this study as the *Near-term Plan*. The Near-term Plan has been developed with the purpose of meeting goals that are briefly re-iterated here:

- Improve systems' reliability and resiliency
- Improve water quality
- Reduce all costs
- Prepare for emergencies
- Position the water systems to accommodate growth as necessary and to meet regulatory capacity requirements

Specific recommendations for meeting these goals are provided in Section VI.B.5. Implementation of the plan will position the water systems to meet future challenges while providing high quality water reliably and efficiently.

The owners of each water system should work diligently to procure the necessary land as required for improvements to accomplish the Near-term Plan. As land is procured, space should be provided for future expansions in addition to the Near-term improvements. In addition, as booster stations, storage tanks, etc. are built, room for additional capacity should be considered. The Ultimate Build-out demands and capacity requirements in Section VI.B.6 can be used as a guide to make provision for additional capacity to be added later.

It is highly recommended that the suggested standardized system of only six pressure zones be adopted throughout the entire study area. Once these are implemented, interconnections can be made between water systems and water districts anywhere within a pressure zone. This will result in the following benefits:

- Plans for new developments will fit an overall master plan,
- Connections between adjacent areas at similar elevations will be feasible because of matching hydraulic grade lines. This will facilitate redundancy (reliability), looping and fire flows. It will also reduce the number of areas dependent upon a single booster or PRV station.
- The water systems will be simplified and minimize unnecessary duplication of water facilities (booster stations, storage, etc.),
- The proposed standardization will minimize areas of unusually high or low pressures,
- Energy costs will be reduced because of more efficient movement of water,
- Costs for capital improvements, operation and maintenance will be lower in the long run without an ever increasing number of pressure zones.
- Sharing water between various areas in an emergency will be much easier to accomplish.

As further consideration is made of system modifications and improvements that may lead to commingling of the various source waters (surface and ground water sources), it is recommended that additional specific water characteristic data be collected and evaluated (Section V.F.5).

Although the County Department of Public Works (DPW) has a system of shared trailer-mounted generators that meet the State's reliability provisions it is recommended that on-site generators be provided for the Holiday Hills well building, the iron removal plant (and Well #8) and either the well building at Carlisle Road or Three Mile Road (Cherry Ridge). In this way, the best assurance is given for uninterrupted water supply during a general regional power outage. It is also recommended that a confirmation be made of adequate, functioning back-up power for all sites with essential controls (water storage facilities, etc.).

The Water Treatment Plant (WTP) appears to be well-positioned to continue to meet projected MDD through the year 2017. However, based on the year 2037 planning demands, expansion of capacity will be required sometime beyond the year 2017. In addition, depending on the extent of T&O issues in the future, it is likely that some treatment modifications may be required in the future. Any capacity expansion should be made ensuring ability to address T&O and vice versa.

The 2003 TetraTech-MPS report recommended conversion to membrane filtration to meet future demands. However, this recommendation was based on a projection that the WTP capacity would be exceeded by the year 2019, and therefore was based primarily on capacity factors, and did not necessarily focus on treatment challenges such as T&O. It is now suggested, based on the demand projections of this study, that treatment capacity alternatives be focused primarily on treatment challenges, with the ability to gain additional capacity considered in conjunction. As previously noted, the ability to increase treatment capacity exists via uprating of filters. However, in order to be prepared to deal with T&O issues, a change to the treatment process, involving either Granular Activated Carbon (GAC) filtration or alternative treatment technology would be required, based on the initial alternative analysis. Therefore, based on projected demands, and a desire to be well-positioned to address T&O issues, the most viable treatment alternatives are:

- GAC filtration within existing filtration facilities – the viability of this option will depend on the effectiveness of the GAC contact available given the required filtration rate (pilot testing recommended to confirm).
- Addition of Ultra Violet (UV), possibly with additional oxidant, in conjunction with improvements to increase filtration rates.

Confirmation of these alternatives, along with detailed water quality study and development of specific capital and operational costs is out side the scope of this master planning study, and should be done in a specific treatment plant improvements study.

Although well-positioned in general for meeting future projected demands, the WTP is in need of reliability improvements, mainly focused on addressing replacement of older equipment, upgrades to newer technologies, and addressing individual unit capacity issues (primarily low service pumping) in support of the current overall rated WTP capacity.

The City should proceed with initial studies in support of longer term improvements as indicated in “Recommended Improvements”, and proceed with implementation of a project encompassing the “0 to 5 Years” improvements items.

The entities within the Level III Category for the purpose of this study (Acme Township, East Bay Water Utilities, Green Lake Township, Long Lake Township and Whitewater Township) are all likely to have public water supplies (PWS) in the near-term time frame of this study (years 2017-2037). The “Suggested Criteria for Systems Expansion" (Section V.E.) would also apply to the development of new PWS and should provide guidance as to the areas that might be served by the new PWS. Any new PWS should be developed based on the guiding principles found in this report (i.e. standardized pressure zones, emergency connections with nearby systems, etc.).

Specific engineering standards are recommended for the sole purpose of facilitating future coordination between systems and master planning efforts. Many of these practices are already being used to some extent making implementation more practical. These are found in Appendix K.

There are some specific monitoring and data collection improvements that could be made to improve management of the systems and facilitate future planning studies. These include:

- Telemetric Monitoring of flows at Pressure Reducing Valve (PRV) Stations
- Improved Data Collection and Management
  - Daily automated, telemetric readings of master meters and meters in well buildings, booster stations and PRV stations at a fixed time each day
  - Automated storage of these meter readings in organized, electronic format to facilitate future analysis. Available summaries would include daily, monthly, annual, peak day, peak month, average day.
  - Monthly Reading of Customer Water Meters (end of month). Automated available summaries would include totals by month (by water district and by system), and information on the largest users.
- Monitoring screen showing flow throughout and between the water systems

It is recommended that a hydrogeological investigation be conducted to document water quality and quantity parameters for the purpose of identifying local or regional groundwater resources that could supplement or provide redundancy to the City's existing surface water supply.

A standard set of equipment should be used where connections between systems are made. These would be standards that are in place for emergency connections or for everyday water service. Many of these practices are already being used to some extent making implementation more practical. Specific recommendations are found in Appendix M.

II. STUDY BACKGROUND

A. Background/Statement of Problem

In an effort to plan for the future, Traverse City and Grand Traverse County have commissioned a master planning study for area potable water supply systems. A Qualifications Based Selection process was used to select the consulting team of Wilcox Professional Services and Black & Veatch. The project has been conducted throughout the 2007 calendar year and into 2008. Based on the significant growth that has taken place in the area over the past 15 years, the multiple jurisdictions believe that reliable service to meet future needs is paramount. In addition to growth, local communities face increasing challenges brought about by geopolitical realities on state, regional, national and international levels. For these reasons, preparations should begin for changes that will occur in the next 10-20 years.

This study encompasses more than technical issues, and includes additional master planning efforts to address regional cooperation, resource protection, sustainability and environmental protection challenges. The study includes the evaluation of opportunities for water and energy conservation and addresses factors that can lead to increased intergovernmental cooperation for the reliable delivery of water. The recommendations made in this study are conceptual in nature. Additional planning should include the establishment of priorities/phasing with opinions of cost being developed for each phase. Detailed engineering studies should also be completed prior to implementation of any improvements.

B. Project Goals

The project team developed a set of goals by which the scope was developed and the project was driven. These goals are as follows:

- Provide for Public Participation and Input
- Undertake Engineering Master Planning and Reliability Assessment
- Evaluate Opportunities for Water and Energy Conservation
- Consider Potential Future Challenges
- Identify Opportunities for Intergovernmental Cooperation

These goals were confirmed in meetings with the Grand Traverse Board of Public Works Sewer and Water Committee, in meetings with the County Department of Public Works (DPW) Director, City Engineer and in meetings with each of the participating entities.

C. Project Organization

Scope items were developed to organize the project to accomplish the goals listed above. The detailed list of scope items is found in Appendix B. For efficient use of resources, the study effort began with a review of the individual planning efforts of the multiple water supplies through studies that have been completed over the last 10 years. The first phase of the work was the collection of these documents and many other forms of pertinent information. The information and raw data were then compiled into a form that lent itself to analyses. The efforts of Grand Traverse County, the City of Traverse City, the Townships and their consultants and many others in providing important information are greatly appreciated.

The Wilcox/Black & Veatch team used many helpful tools in the analysis. This included synthesis of information into a regional planning map that showed in a schematic way all of the public and private type I water systems in the study area, development of graphs and statistical analysis of data, figures and tables and finally, computer modeling of water systems.

Citizen participation and input were planned to be a critical element of the project. This was accomplished through a public meeting and web pages containing project information.

The technical portion of the project focused on system component capacity and reliability as necessary to fulfill the requirements of Part 12 of the Administrative Rules of the Michigan Safe Drinking Water Act, PA 399 of 1976 as Amended. This information will be presented to the Michigan Department of Environmental Quality on behalf of the City of Traverse City, East Bay Township, Elmwood Township, Garfield Township, and Peninsula Township.

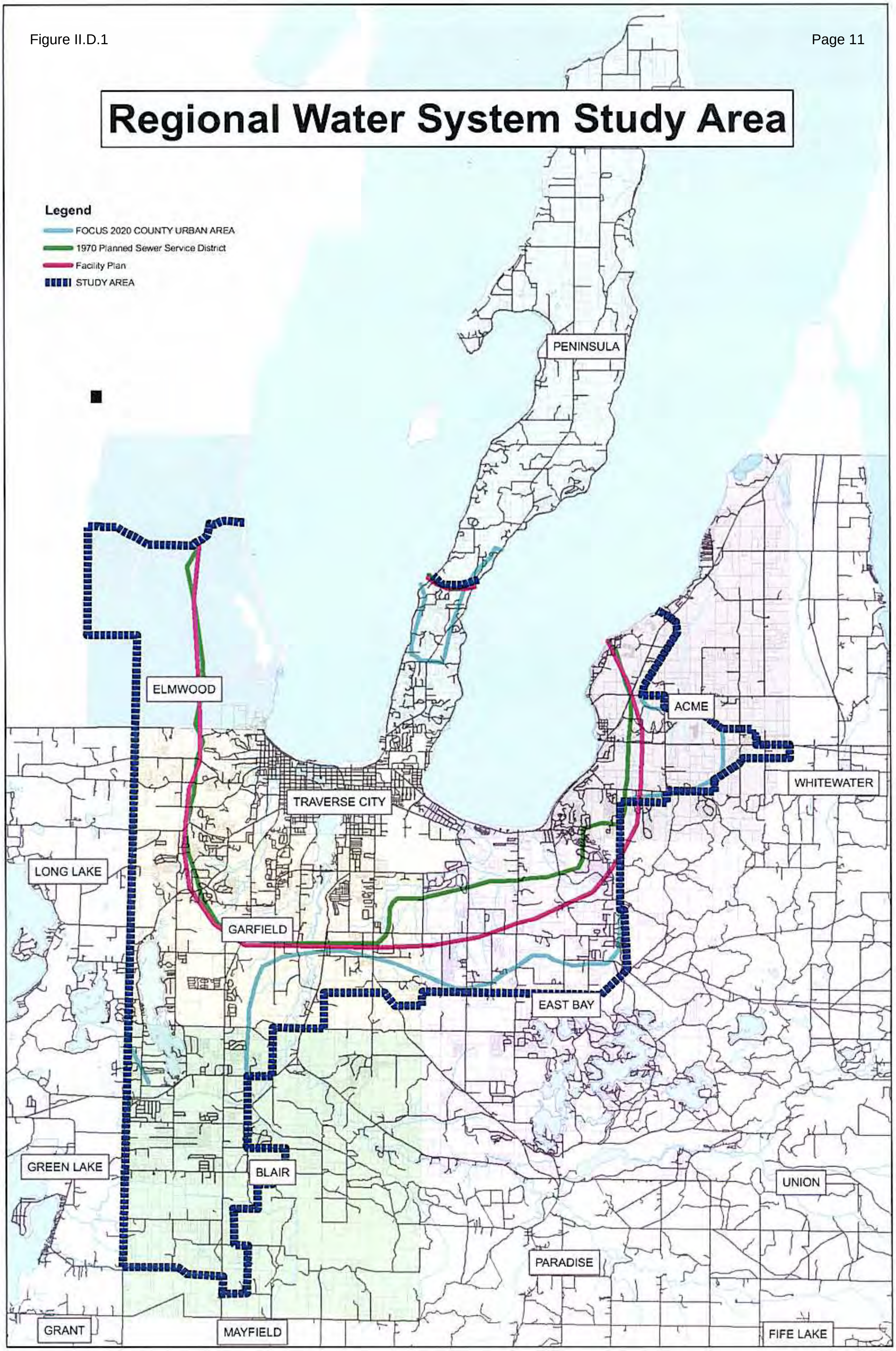
Additional engineering work included the cursory evaluation of the City's Water Treatment Plant (WTP) in light of previous studies and a walk-through tour of the plant. This was undertaken to ensure that important opportunities are not overlooked in the best use of this critical resource.

The City and County considered it important for this study to encompass larger master-planning issues than just the standard Reliability Study work. For that reason, consideration has been given to water and energy conservation, evaluation of potential future challenges facing water supplies in the area, identification of opportunities for expanded collaboration between governmental entities and the development of recommended standards that will facilitate future planning.

The project culminated in the compilation and presentation of study findings in this final project reporting document.

D. Study Area/Participation Level

The study encompasses the City of Traverse City, nine surrounding Townships and the East Bay Water Utilities owned by the Grand Traverse Band of Ottawa and Chippewa Indians. The study area pertaining to public or quasi-public water supplies is shown in Figure II.D.1. Several townships outside of that study area also participated in the study relative to identifying challenges, exploring opportunities and managing valuable regional water resources. The study has been tailored to the needs of each entity participating in the study. Those needs and the scope of work are summarized in the following table. A detailed outline of the scope by task is provided in Sections I through III in Appendix B. Although the scope is listed in three sections for ease of communicating various aspects of the scope, the three sections are complementary and build upon each other. Therefore, presentation of the study findings has been woven into one report document.


Regional Water System Study Area
Legend
FOCUS 2020 COUNTY URBAN AREA
1970 Planned Sewer Service District
Facility Plan
STUDY AREA
PENINSULA
ELMWOOD
ACME
WHITEWATER
TRAVERSE CITY
LONG LAKE
GARFIELD
EAST BAY
GREEN LAKE
BLAIR
UNION
PARADISE
GRANT
MAYFIELD
FIFE LAKE

LEVEL	DESCRIPTION (See Appendix B for further detail)	ENTITIES
Level 1	1) Full reliability study meeting MDEQ requirements 2) Full scope of technical master planning and regional resource management master planning indicated in outline below.	• City of Traverse City • Elmwood Twp. • Peninsula Twp. • East Bay Twp. • Garfield Township
Level 2	1) Evaluate overall supply, treatment and storage capacities vs. projected 10-year demands. 2) Identify Opportunities for Valuable Intergovernmental Cooperation.	• Blair Twp.
Level 3	1) Indicate location of Type I systems on overall planning map. 2) Identify Opportunities for Valuable Intergovernmental Cooperation.	• Long Lake Twp. • Green Lake Twp. • Whitewater Twp. • Acme Twp. • East Bay Water Utilities (G.T. Band of Ottawa and Chippewa Indians)

III. PUBLIC INPUT

A citizen input component was part of the project for the purpose of understanding what is important to the public, to obtain early feedback on the project scope and to gain insights on the public perception of development and water conservation. A project web page was also developed that can has a link on the City's home web page. The project scope document can be accessed through the project web page. The web page is provided in Appendix C.

A public input meeting was held at 7 p.m. on Tuesday, July 24, 2007 at the Traverse Area District Library, 610 Woodmere Avenue. The meeting consisted of introductions, a PowerPoint presentation summarizing the scope of the project, a question and answer period, a breakout session for group discussions and reporting on the breakout sessions. The meeting was filmed for showing on the public access cable channel TCTV-2. The meeting agenda is provided in Appendix D.

A list of questions was provided to the discussion groups to stimulate thoughts and conversations relative to public water supplies. Redundancy, reliability and fire-fighting capability were cited as some of the benefits of having public water supplies. The ideas reported back from the two discussion groups are summarized in Appendix D. The participants seemed to have a positive attitude about water supplies in the area whether the source be private wells or a public water supply. Water conservation seemed to be a topic of importance for some present at the meeting along with concern for current levels on the Great Lakes.

IV. DESCRIPTION OF EXISTING SYSTEMS

A. Introduction and Existing Water Systems General Information

The study encompasses the City of Traverse City, nine surrounding Townships and the East Bay Water Utilities (EBWU) owned by the Grand Traverse Band of Ottawa and Chippewa Indians. The systems include public and private Type I water supplies under the jurisdiction of the MDEQ. The EBWU operates under the jurisdiction of the U.S. Environmental Protection Agency (EPA).

There are seven public water systems in the study area. The City and three other water systems (Elmwood-Greilickville, Garfield and Peninsula) are served by the City's Water Treatment Plant (WTP). The East Bay, Elmwood-Timberlee and Blair systems are served by their own wells. With the exception of Traverse City, the water systems' customer base has continued to expand steadily over time. A schematic map showing the basic layout of public water systems and location of private systems is provided as Figure IV.A.1 in Appendix E. Table IV.A.1 provides a summary of information about each of the systems.

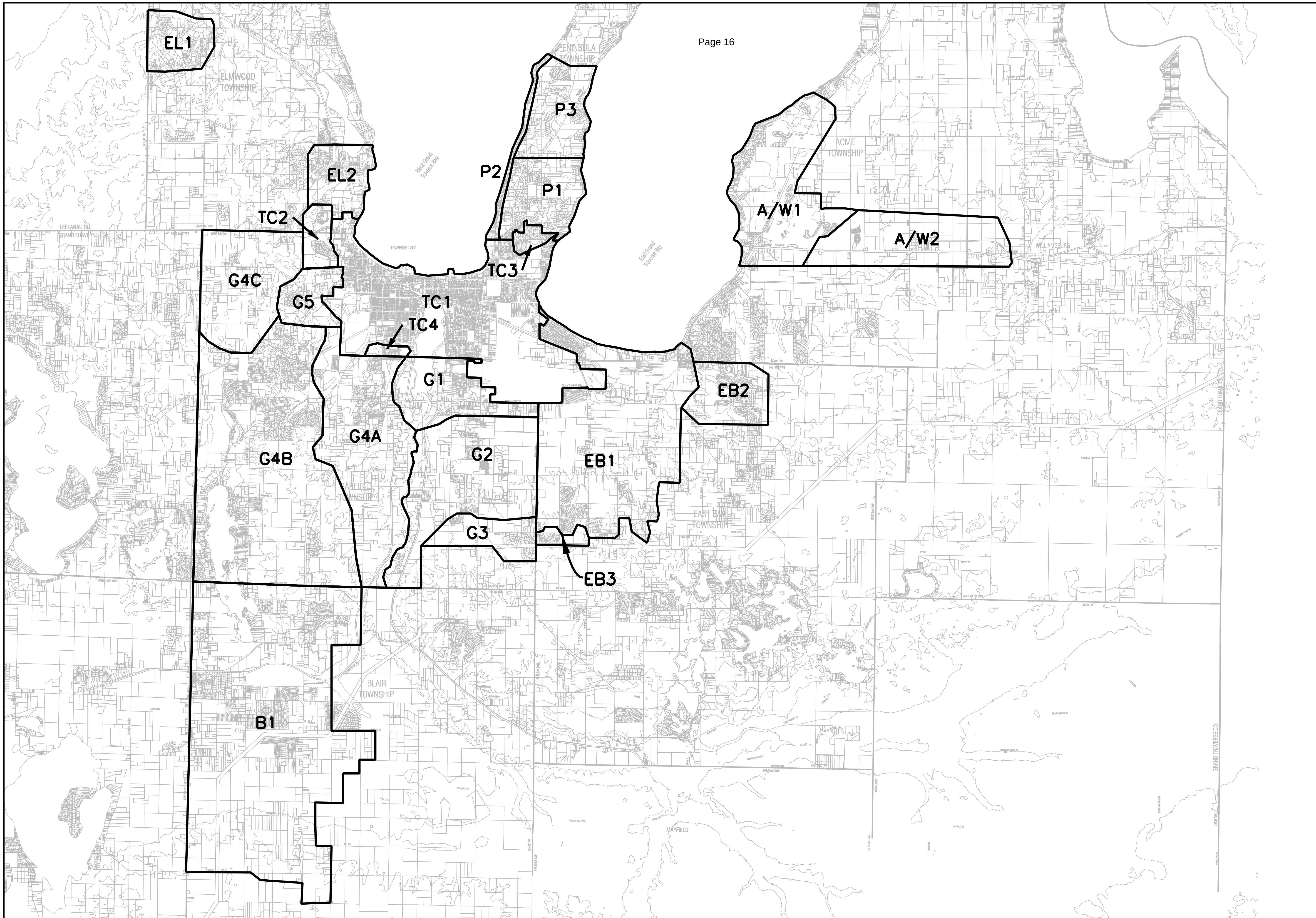
Table IV.A.1. Water Systems Inventory and Overview

Name	Type	Approx. Immediate Area Served (sq. mi.)	Operator/ Manager	Supply
East Bay Township				
East Bay Township	Public Type I	5	G.T. County DPW	Wells
Elmwood Township				
Greilickville	Public Type I	0.2	G.T. County DPW	T.C. WTP
Timberlee	Public Type I	1	G.T. County DPW	Wells
Garfield Township				
Garfield Township	Public Type I	12	G.T. County DPW	T.C. WTP
Silver Lake View MHP	Private Type I		Private	Wells
Meadow Lane MHP	Private Type I		Private	Wells
Traverse Manor AFC	Private Type I		Private	Wells
King's Court MHP	Private Type I		Private	Wells
Cherryland MHP	Private Type I		Private	Wells
Peninsula Township				
Peninsula Township	Public Type I	2	G.T. County DPW	T.C. WTP
Peninsula Knolls Assoc.	Private Type I		Private	Wells
Cherrywood Commons Condo Assoc.	Private Type I		Private	Wells

Traverse City				
Traverse City	Public Type I	6.7	Traverse City	T.C. WTP
Blair Township				
Blair Township	Public Type I	4	Blair/Wade-Trim	Wells
Acme Township				
EBWU (Also in Whitewater Twp.)	U.S. EPA	2	G.T. Band-Ottawa & Chippewa Indians	Wells
Hope Village	Private Type I		G.T. County DPW	Wells
Juniper Hills Condo Assoc.	Private Type I		Private	Wells
Deepwater Pointe Condos	Private Type I		Private	Wells
Lochen Heath	Private Type I		G.T. County DPW	EBWU Wells
Green Lake Township				
Interlochen Center for the Arts	Private Type I		Private	Wells
Long Lake Township				
Black Bear Farms	Private Type I		Private	Wells
Country Eden	Private Type I		Private	Wells
Rolling Meadows	Private Type I		Private	Wells
Suburban Estates MHP	Private Type I		Private	Wells
Whitewater Township				
EBWU (Also in Acme Twp.)	U.S. EPA		G.T. Band-Ottawa & Chippewa Indians	Wells
TOTAL		*33*		

For the purposes of this study the existing water systems have been divided into water districts. A water district is defined as an area of water distribution that is served by a particular source such as the WTP, a group of wells or a particular booster station. Larger water districts also have their own storage. The existing water districts are shown in Figure IV.A.2. Proposed water districts will be covered later in this report. This analysis is useful for evaluating capacities of water system treatment, pumping and storage installations.

Looking at the water systems in a different way, there are more than 35 different water pressure zones throughout the study area not counting Private Type I systems (see Figure IV.A.3). A pressure zone is an area that under static water conditions would have a common hydraulic grade line. The hydraulic grade line is the elevation to which the water would rise in an open-top tube or vessel. In general, this report will define a pressure zone by the elevation of the static hydraulic grade line or the normal high water level in a water storage tank. Two different pressure zones have differing pressures at a common elevation preventing a normal connection between the two.



PROJECT LOG

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: N/A
SHEET: OF

FIGURE IV.A.2

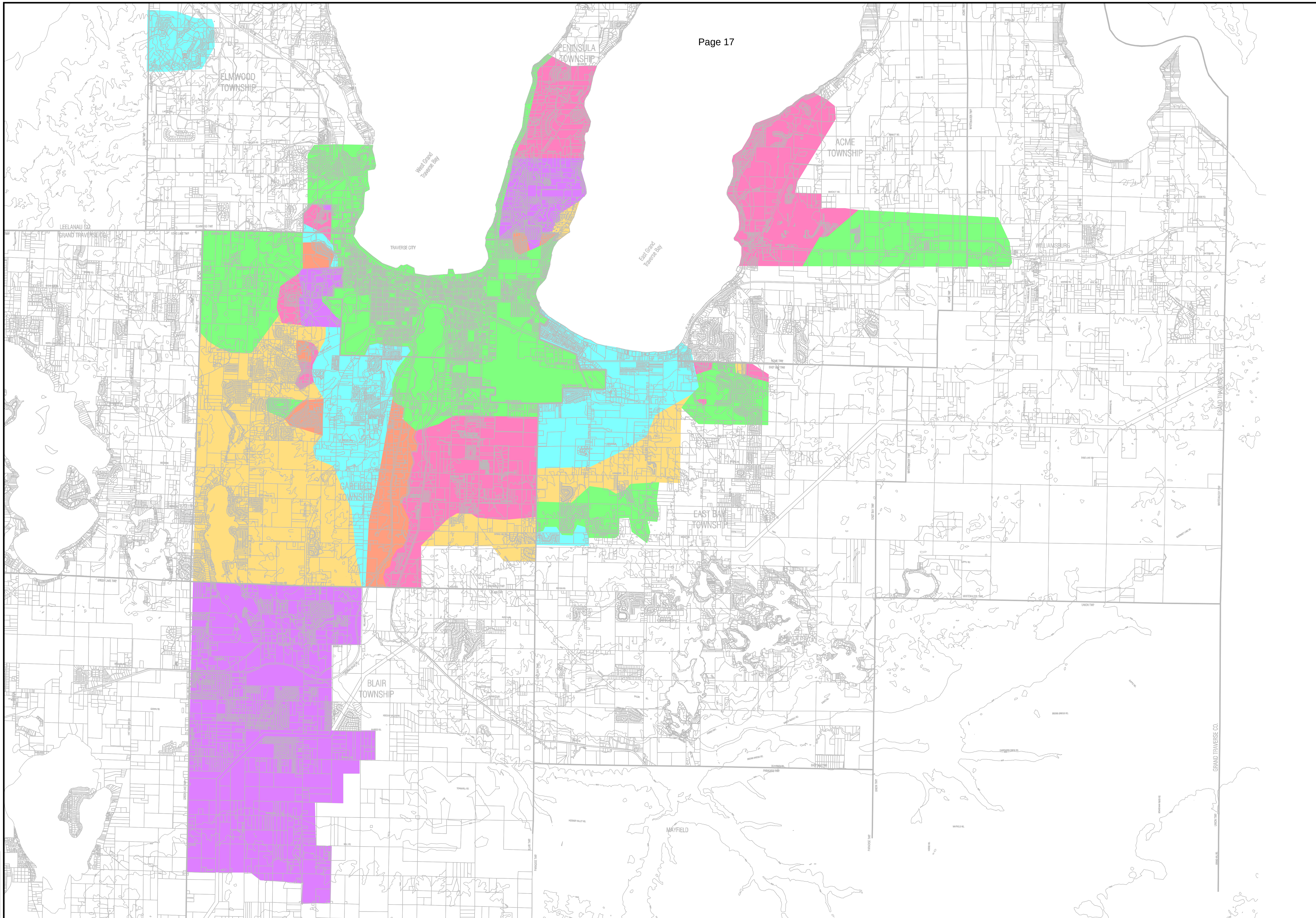
GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

EXISTING SERVICE DISTRICTS

Wilcox Professional Services
1 Madison Avenue
Cadillac, MI 49601
www.wilcox.us

1

11115.00002



PROJECT LOG

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: N/A
SHEET: OF

FIGURE IV.A.3

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

EXISTING PRESSURE DISTRICTS

Wilcox Professional Services
1 Madison Avenue
Cadillac, MI 49601
www.wilcox.us

2

11115.00002

B. Public Water Supply Facilities Descriptions

1.0 East Bay Township

The East Bay Township water system served 1,276 residential customers and 157 Industrial/Commercial/Industrial (ICI) Customers at the end of 2006. The system consists of two water districts. The largest district, EB1, is located in the western half of the Township and runs from the Bay at the north end down to about the center of the Township. This district is served by Wells 4-8 and a 200,000 gallon elevated water storage tank in the Cherry Ridge Subdivision. The second district, EB2, is located in roughly the northeast quarter of the Township and serves principally the subdivisions in that portion of the Township. This district is served by Wells 1 and 2 and a 300,000 gallon tank. Water can flow between the two districts at the Five Mile Road Booster Station location via the booster pumps in one direction or a PRV in the other.

Supply

East Bay Township has its own system of wells for water supply. Summary information about the wells is provided in Table IV.B.1.

Table IV.B.1. East Bay Township Well Information

Well Name	Diameter (in.)	Capacity (gpm)	Screen Depth (ft)
Western District, EB1			
Cherry Ridge-4	10	425	187-217
Cherry Ridge-5	10	425	180-210
Carlisle Road-6	12	970	173-215
Carlisle Road-7	12	970	141-181
Iron Removal Plant-8	12	800	180-205
Total/Firm Capacity-West		3,590/2,620	
Northeastern District, EB2			
Holiday East-1	6	160	121-141
Holiday East-2	8	150	116-136
Total/Firm Capacity-N.E.		310/150	
Overall Total/Firm Capacity		3,900/2,930	

Current well capacities were taken from the MDEQ Water System Review document. The overall total well capacity is 5.62 MGD and the overall total firm well capacity is 4.22 MGD. The County DPW has trailer-mounted generators that are rotated as necessary between the wells to fill the elevated water storage tanks. These generators are shared with other facilities.

Treatment

The water from wells in the Western District is high in iron and is treated in the iron removal plant south of the Township Hall that was built in 2003/2004. Chlorine is injected at the well buildings and the precipitated iron is then filtered at the plant with four Hungerford and Terry filtration units using anthracite ferro sand and gravel pack filter media. The total capacity of the iron removal plant is 3.89 MGD with a firm capacity of 2.92 MGD. There is no on-site generator for the iron removal plant. The County DPW has trailer-mounted generators that are shared with other facilities.

Chlorine injection is also provided at the Holiday East well building for the two wells serving the Northeastern District.

Distribution

The East Bay Township water distribution system consists of almost 40 miles of 6 to 16 inch ductile iron pipe covering a service area of approximately 5 square miles. About 80 percent of the pipe in the system is 8 and 12 inch diameter. The system has nine PRVs.

There are two booster stations in the system. The Five Mile Road Booster Station was built in 2002 and is used to move water from District EB1 to EB2. It has two 500 gpm pumps and a firm capacity of 500 gpm. The Five Mile Road Booster Station is also outfitted with a PRV for reverse flow if that becomes necessary. The Windmill Farms Booster Station obtains water from District EB1 and serves that portion of the Windmill Farms subdivision located in East Bay Township. It was built in 2005. The below-grade station has one 100 gpm pump, two 500 gpm pumps and one 1,500 gpm pump providing a total capacity of 2,600 gpm and a firm capacity of 1,100 gpm. The pumps are VFD driven with no storage capacity. Both of East Bay Township's booster stations have on-site stand-by generators.

Storage

District EB1 is served by a 200,000 gallon elevated single pedestal spheroid tank built in 1991. District EB2 is served by a 300,000 gallon elevated single pedestal spheroid tank built in 1993.

2.0 Elmwood Township- Greilickville

The Elmwood Township (Greilickville) water system serves the urban southeastern portion of the Township, District EL2.

Supply/Bulk Purchase Agreement

The urban southeastern portion of Elmwood Township (Greilickville) is served by a water system with supply from the City of Traverse City through a bulk purchase agreement. The agreement is a 25 year agreement effective July 1, 2004 for providing the Township with 0.750 MGD of water on a maximum day.

Distribution

The Greilickville system serves mostly the commercial district along M-22 and limited branches along Carter, Grandview and Cherry Bend Roads. The system has approximately 2 miles of mostly ductile iron water main with 0.5 mile of 8 inch pipe and 1.6 miles of 12 inch pipe and a limited quantity of 6 inch pipe. There are no booster stations or PRVs in the Greilickville System.

Storage

The Greilickville system relies on storage within the City of Traverse City.

3.0 Elmwood Township- Timberlee

Elmwood Township's Timberlee water system is located in the western central portion of the Township and serves the Timberlee subdivision and resort area. Together, the Greilickville and Timberlee systems served 141 residential customers and 8 ICI Customers at the end of 2006.

Supply

Supply is provided by three wells with an overall total well capacity of 1.39 MGD and the overall total firm well capacity is 0.806 MGD. Further information is provided in Table IV.B.2.

Table IV.B.2. Timberlee Well Information

Well Name	Diameter (in.)	Capacity (gpm)	Screen Depth (ft)
Timberlee-1	8	250	110-135
Timberlee-2	12	403	117-152
Timberlee-3	8	310	129-157
Overall Total/Firm Capacity		963/560	

Current well capacities were taken from the MDEQ Water System Review document. The Timberlee wells have a stand-by generator on site.

Treatment

There is currently no treatment of the Timberlee well water.

Distribution

The Timberlee system has approximately 3.5 miles of 6 inch Transite pipe and a limited amount of 8 inch pipe. The system has one booster station to serve a branch line that extends to a high elevation and it has one PRV for a lower branch line. The booster station could be operated using one of the County DPW's trailer-mounted generators. However, if there is a general power outage it is not likely that a generator would be available because of the priority to serve other facilities that share the generators. This is because of the small number of users served by the booster station and the ability to provide minimum pressures even without the booster station. There are no fire hydrants on the Timberlee distribution system.

Storage

The main well building has a 15,000 gallon hydropneumatic tank. The booster station has a 1,000 gallon hydropneumatic tank.

4.0 Garfield Township

The Garfield Township system is a large system serving 1,803 residential and 920 ICI customers at the end of 2006. Bulk water is purchased from the City of Traverse City as metered through several master meters along the City/Township limits. A large portion of the Township is served by the water system and growth in water demand over the past several years has been roughly proportional to population growth within the Township.

Water Storage for the system is provided to some extent by City water storage tanks but also by an elevated storage tank east of the river, a large ground storage tank and a stand pipe west of the river. Seven booster stations pump water to outlying districts at higher elevations and water is fed back down towards Traverse City to some extent through pressure reducing valves (PRVs) to intermediate pressure zones.

Supply/Bulk Purchase Agreement

The Garfield Township system relies on supply from the City of Traverse City through a bulk purchase agreement. The agreement is a 25 year agreement effective July 1, 2003 for providing the Township with 5 MGD of water on a maximum day.

Distribution

The Garfield Township water distribution system consists of approximately 76 miles of 6 to 20 inch ductile iron pipe covering an immediate service area of approximately 12 square miles. About 83 percent of the pipe in the system is 8 and 12 inch diameter.

A small portion of the water system shares a pressure zone with the main part of Traverse City (City District). This area relies solely on City storage. Three main booster stations send water from the City District up to outlying Township water districts. Three additional booster stations in series with the primary three send water to higher elevations even further out in the system. Another booster station on Herkner Road is the third in a series and serves the area north of Long Lake Road near the western limits of the Township. Water is fed back down to intermediate pressure zones via ten PRV stations throughout the system. High ground in the southwest corner of the City is also served by the Garfield system. A summary of booster station information is provided in Table IV.B.3. All of the Garfield Township booster stations are served by on-site generators.

Table IV.B.3. Garfield Booster Station Information

Booster Station Name	Source	Area Served	Capacity (gpm/MGD)	Firm Capacity * (gpm/MGD)
Garfield 1 (G1) (Cass Rd.)	City	Most of the system W. of River and S. of the City	7,200/10.4	4,800/6.9
Garfield 2 (LaFranier)	City	All of the high ground S. of the City and E. of the River	2,160/3.1	1,440/2.1
Garfield 3 (Silver Pines)	G1	West central portion of the Township	3,450/5.0	2,300/3.3
Garfield 4 (Brook Dr.)	City	High ground west of Munson Hospital	1,200/1.7	800/1.2
Garfield 5 (Herkner)	G1 then G3	Western portion of Township just N. of Long Lake Road	2,046/2.9	800/1.2
Garfield 6 (Greyhawk)	G4	Greyhawk Subdivision	800/1.2	300/0.4
Garfield 7 (Traditions)	G2	Traditions Subdivision	2,850/4.1	1,350/1.9

* MDEQ, Water System Review document except G7

Storage

As mentioned above, there is a small portion of the Garfield Township system that is served directly by the City district and is served by City storage. Although the entire Township system relies on City storage to some extent as part of the system supply, the Township system also has three storage facilities.

The Garfield #2 booster station on LaFranier Road pumps into District G2 that is served by the 300,000 gallon Birmley elevated storage tank that was built in 1989. The Traditions booster station takes water from this water district using VFD driven pumps to serve District G3. There is no storage in District G3.

The Garfield #1 booster station pumps water to the McRae Hill Road ground storage tank, built in 2002 serving Districts G4A and TC4. This tank has a capacity of 2.25 MG with room for expansion to 4.5 MG. Dimensions of this tank were not made available. Actual tank capacity may be diminished based on the inability to access storage within the lower portion of the tank.

The Garfield #3 booster station takes water from the McRae Hill tank and pumps to District G4B along the western limits of the Township to a 300,000 gallon 30 foot diameter standpipe within the Heritage Estates subdivision that was built in 1987.

5.0 Peninsula Township

The Peninsula Township water system served 356 residential customers and 4 ICI Customers by early 2007. Bulk water is purchased from the City of Traverse City as metered through several master meters along the City/Township limits. Township planning efforts have limited growth of the water system to the area defined by Wilson Road to the North and the City Limits to the south. One City and one Township booster station serve higher areas within the water system. Areas along the Bays are served directly from the City's main pressure zone.

Supply/Bulk Purchase Agreement

The City of Traverse City supplies water to Peninsula Township through a bulk purchase agreement. The agreement is a 25 year agreement effective July 1, 2004 for providing the Township with 1 MGD of water on a maximum day.

Distribution

The Peninsula water distribution system consists of almost 12 miles of 6 to 12 inch ductile iron pipe covering an immediate service area of approximately two square miles. About 86 percent of the pipe in the system is 8 and 12 inch diameter. The system has nine PRVs. Additional water main will be added in a pending water project and some private systems will be incorporated into the public water supply.

The Huron Hills Booster Station at the City's WTP serves high ground within the City at the base of the Peninsula and most of the southern area of the Township's water system. The water is fed back down to intermediate districts in the City/Township border area through two PRVs in the City and two PRVs in the Township (see City of Traverse City Distribution Section for further information about the Huron Hills Booster Station).

The McKinley Road Booster Station serves most of the high ground in the northern portion of the water system and was built in 2004. The below-grade station has one 150 gpm pump, two 400 gpm pumps and one 1,500 gpm pump providing a total capacity of 2,450 gpm and a firm capacity of 950 gpm. The pumps are VFD driven with no storage capacity. There is no on-site generator for the booster station. The County DPW has trailer-mounted generators that are shared with other facilities. There is a pending water project where it is proposed to move this booster station to the top of Carpenter Hill in the Cherrywood Commons Development. Storage will be provided adjacent to the relocated booster station that will act as equalization storage to serve the booster station. This equalization storage will be fed by the Huron Hills booster station. The relocated booster station will pump back into the district currently served by the Huron Hills booster station but will also pump into a new district of higher elevations as well.

Storage

The Township system has no storage facilities. As mentioned above there is a hydropneumatic tank at the City's Huron Hills Booster Station. As mentioned above, a pending project will provide equalization storage to supply the relocated booster station.

6.0 Traverse City

Supply/Bulk Purchase Agreements

The City's water supply is provided by a nominal 20 MGD direct filtration water treatment plant that is evaluated elsewhere in this report. The City also sells bulk water based on agreements established with Elmwood Township (0.75 MGD), Garfield Township (5 MGD) and Peninsula Township (1 MGD).

Treatment

The City's Water Treatment Plant draws high quality water from East Bay, provides direct filtration treatment and chlorination then pumps water to the City's distribution system via high service pumps. The WTP is evaluated elsewhere in this report.

Distribution

The City's distribution system serves the entire City. The distribution system consists of approximately 100 miles of 4 to 30 inch pipe covering a service area of almost 7 square miles. Some of the pipe in the system is old cast iron pipe. Table IV.B.4 provides further information about the distribution piping.

Table IV.B.4. Traverse City Distribution Piping

Pipe Diameter (in)	Total Length of Pipe (mi)	Percentage of Total
4	2.0	2.0
6	53.0	53.4
8	6.4	6.4
10	4.5	4.5
12	10.7	20.9
16	5.4	5.4
18	0.2	0.2
20	2.2	2.2
24	4.0	4.1
30	0.9	1.0
Total	99.2	

By far the most common pipe sizes within the system are 6 inch and 12 inch. The MDEQ in the most recent Water System Review has recommended that the City go to 8 inch pipe as the minimum size of water main.

The City has two booster pump stations. The Huron Hills Booster Station located at the City's WTP serves high ground within the City at the base of the Peninsula and most of the southern area of Peninsula Township's water system. The water is fed back down to intermediate districts in the City/Township border area through two PRVs in the City and two PRVs in the Township. The Huron Hills Booster Station was built in 1983 and has a total capacity of 1,200 gpm with a firm capacity of 700 gpm. A large hydropneumatic tank is also located adjacent to the booster pumps. Backup power is provided for this booster station by the on-site WTP generator.

The Wayne Hill Booster Station is located adjacent to the Wayne Hill Storage Tank. The station, built in 2006, has three 500 GPM pumps with a firm capacity of 1,000 GPM. Pressure Reducing Valves allow for service to a total of three pressure zones. Those pressure zones consist of 1) the Wayne Hill summit area, 2) the Incochee Woods/Morgan Farms areas and 3) higher elevations of Wayne Street east of the Wayne Hill storage tank. In addition to Variable Frequency Drives for the pumps there are three 726 gallon hydro-pneumatic tanks for the purpose of pressure stabilization to prevent pump cycling. Backup power is provided for this booster station by an on-site generator.

Storage

The City has three ground storage tanks. The storage tank at the WTP has a capacity of 1.5 MG. This clearwell stores treated water and feeds the WTP's high service pumps. The City's two other storage tanks are on high ground in the outer limits of the distribution system.

The Barlow storage tank is located near LaFranier Road south of South Airport Road. It is a 132 foot diameter steel tank with a capacity of four million gallons. It has a pump off setting elevation of 743 and an overflow elevation of 751. Built in 1972, a 2007 inspection report by Dixon Engineering recommended interior and exterior blast cleaning and re-painting and other less costly improvements. The City has planned this work for the spring of 2008.

The Wayne Hill storage tank is a reinforced concrete tank located at the northwest corner of Wayne Street and Incochee Road. The tank has plan dimensions of 135 feet by 90 feet with a height of 15 feet. Nominal capacity is 1.3 million gallons. The tank was built in 1948. The 2006 inspection report indicated that the tank is in "exceptionally good condition for its age and method of construction". The tank has a pump off setting of 739 and an overflow of 741.

7.0 Blair Township

The Blair Township water system is a fairly new system that was constructed in 1999. The system consists of wells, an iron removal plant, distribution system and one elevated storage tank. Several pre-existing Type I Private water systems serving specific developments were absorbed into the new system.

Supply

The Blair Township system is served by three wells with a total capacity of 1,650 GPM (2.38MGD) and a combined firm capacity of 1,100 GPM (1.58 MGD). The wells and iron removal plant are located on a parcel of land just south of the Township Hall on County Road 633.

Treatment

The system provides iron removal through the process of aeration, chlorination and potassium permanganate addition then filtration using pressure filters. The plant has a rated firm capacity of 1.58 MGD. There are four high service pumps with a total capacity of 2.63 MGD and a firm capacity of 1.94 MGD.

Distribution

The Blair Township water distribution system consists of approximately 34.5 miles of 6 to 12 inch pipe covering an immediate service area of approximately 3.7 square miles. Approximately 74 percent of the pipe is PVC and 26 percent is Asbestos Cement pipe with a very minimal amount of HDPE pipe (about 0.5 percent). About 54 percent of the pipe in the system is 8 inch diameter with 17 percent being 6 inch and 29 percent being 12 inch. There are no booster stations in the Blair Township system. There are no PRVs in the distribution system but some homes in the lower elevations of the system along Blair Valley Road have individual PRVs.

Storage

The Blair Township System is served by a single pedestal elevated spheroid tank with a capacity of 0.5 MG. The tank has a pump off elevation of 1043.3.

8.0 East Bay Water Utilities

Although the East Bay Water Utilities (EBWU) system is not a public water supply a description is in order here because of the size of the operation and existing/ potential bulk water sales to other private systems. This system serves principally the Turtle Creek Casino and the Grand Traverse Resort. The Utility also provides water through contract to several condominium associations, a restaurant and a couple of housing developments.

Supply

At the time this study was initiated, the EBWU system had two wells at the Casino and two wells at the Resort. The total capacity of all of the wells was 1,340 GPM with a firm capacity of 930 GPM. Since that time, further improvements have been made at the Casino by increasing the pumping capacity of the wells and adding a third well.

Treatment

The water is treated by the addition of chlorine.

Distribution

The distribution system consists principally of two main areas. These are the Casino area and the Resort area. The two areas are connected by a single 12 inch pipeline along M-72 with a PRV near Lautner Road. Water can flow from the Casino area to the Resort area but there is no booster station at this time for reverse flow.

Storage

There are two single pedestal elevated storage tanks in the system. The Casino tank is a 500,000 gallon tank with a water elevation of approximately 936. The Resort tank is a 200,000 gallon tank with a water elevation of approximately 821.

C. Historical Demands and Existing Demands/Capacity Evaluation

1.0 Introduction, general information about demands

A water utility must be able to supply water at rates that fluctuate over a wide range. Yearly, monthly, daily and hourly variations in water use occur, with higher use during dry years and in hot months. Also, water use typically follows a diurnal pattern, being lower at night and peaking in the early morning and late afternoon. Demands most important to the hydraulic design and operation of supply and distribution system components are average day demand (ADD), maximum day demand (MDD) maximum hour demand (MHD) and peak instantaneous demand (PID).

Average day demand is the total annual water demand divided by the 365 days of the year. The average day demand is used primarily as a basis for estimating maximum day and maximum hour demands. The average day demand is also used for estimating future revenues and operating costs.

Maximum day demand is the maximum quantity of water used on any one day of the year. The maximum day demand is used to size water supply hydraulics, treatment facilities and pumping stations. The raw water facilities must be adequate to supply water at the maximum day demand rate plus whatever water is used in the treatment process and treatment facilities must be capable of processing this quantity of water. The average day demand for the maximum month (ADDMM) multiplied by a peaking factor is sometimes used for estimating MDD when daily meter readings are not available because ADDMM has been demonstrated to have a better correlation with MDD than does ADD.

Maximum hour demand is the peak rate at which water is required during any one hour of the year. Since minimum distribution system pressures are usually experienced during maximum hour, the sizes and locations of distribution facilities are generally determined on the basis of this condition, or fire flows, whichever is greater. Maximum hour water requirements are partially met through the use of strategically located system storage. The use of system storage minimizes the required capacity of supply, treatment, and pumping facilities and transmission mains and permits a more uniform and economical construction and operation of those system components.

Peak Instantaneous Demand is the peak rate of demand (flow rate) that could be seen in a water district at any given instant under normal circumstances. This demand set is used to evaluate pumping systems serving a small number of customers without any storage downstream of the pumps.

Because water use characteristics vary between water systems, historical water production and sales records are used as the primary basis for predicting future requirements.

2.0 Historical Demands (trends)

Table IV.C.1 presents the average day and maximum day demands in 2006. This provides an indication of the relative size of the various water systems. Average day demands came from analysis of water system supply meter and other master meter records. Maximum day demands were determined in the following manner. Existing supply meter and other master meter records were analyzed to determine the relationship between ADD and MDD. Where meter data was not recorded on a daily basis (most cases) the average daily demand for the maximum month (ADDMM) was computed. The average daily demand for the maximum month was then multiplied by a factor between 1.3 and 1.5 (depending on the system or district size and based on guidance from the MDEQ) to arrive at the MDD values provided in Table IV.C.1.

Table IV.C.1- 2006 Average Day and Maximum Day Demands

	2006 ADD (MGD)	2006 MDD (MGD)
Blair	0.307	1.147
East Bay	0.721	1.881
Elmwood-Greilickville	0.016	0.045
Elmwood-Timberlee	0.053	0.168
Garfield	1.775	4.555
Peninsula	0.118	0.412
City	3.602	9.829

Figures IV.C.1 & IV.C.2 provide an indication of historical demand trends for the largest and longest established water systems in the study area.

Figure IV.C.1- Average Day Demand Trends for East Bay, Garfield and Blair Townships

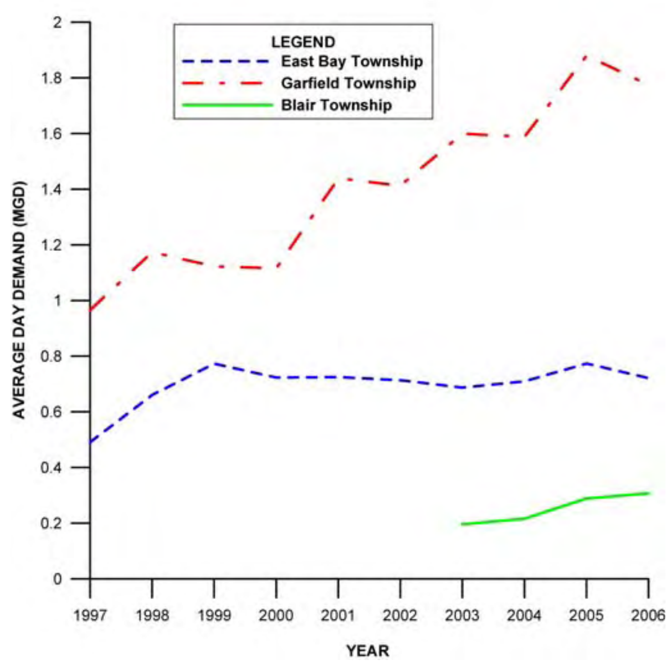
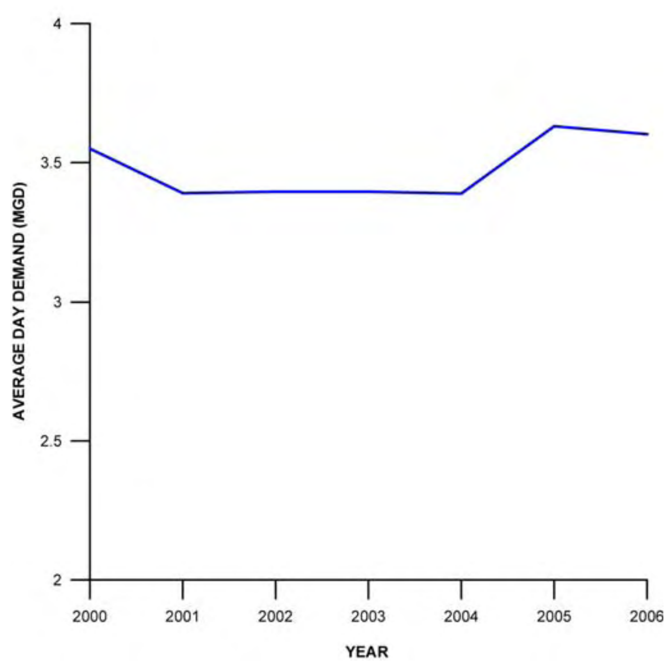


Figure IV.C.2- Average Day Demand Trends for Traverse City



3.0 Existing System Demands and Capacity Assessment by Water District

3.1.1 Existing Demands

Existing demands have been determined for each existing water district for the purpose of evaluating supply, pumping and storage capacities for each water district. These demands and supply/pumping capacity evaluations are provided in Table IV.C.2. The ADD demand information comes for the most part from master meter records and Monthly Operating Reports (MORs). The MORs document meter data from the WTP, well buildings and booster stations. The methodology for determining MDD, MHD and PID is described here.

Maximum Day Demand (MDD)

Maximum day demand was determined directly for the WTP based on daily meter readings. For most of the remaining water systems and districts the average day demand for the maximum month (ADDMM) has been multiplied by a peaking factor to estimate MDD because daily meter readings are not available and ADDMM correlates well with MDD. In these cases, a peaking factor of 1.3 to 1.6 has been used based on a particular water district or water system size using MDEQ Water System Review documents for guidance. In a few instances, MDD comes from estimates provided in the MDEQ Water System Review documents (Garfield Booster numbers 3, 4, 6 and 7).

Maximum Hour Demand (MHD)

The maximum hour demands have been determined by multiplying the MDD by peaking factors. The peaking factors are derived from linear regression of peaking factors for similar-sized water districts in Madison, Wisconsin as determined by diurnal data. The equation developed from linear regression is as follows: MHD = -0.06865 x MDD + 2.205

Peak Instantaneous Demand (PID)

For water districts served by booster stations without downstream storage the PID was determined for the purpose of evaluating booster station capacity. The following guidance for determining PID based on the number of residential unit served was provided by the MDEQ:

2.5 gpm/unit, first 40 units = 100 gpm

1.75 gpm/unit, units 41-80 = 70 gpm

1.5 gpm/unit, units 81-150 = 105 gpm

Because some of the service areas have ICI customers, it was necessary to determine an equivalent number of residential units to use the above method. Therefore, 250 gallons per day per REU was assumed. The number of REUs for each of the water districts was then derived by dividing the gross ADD for the water district (including residential use) by 250 GPD/REU. This was done to compensate for the large variation in residential demand depending on the type and location of the residential developments.

Because in some cases these computations yielded more than 150 REUs (even though there are less than 150 connections) a demand of 1.25 gpm/REU was used for everything over 150 REUs.

3.1.2 Supply/Pumping Capacity Evaluation

The basis for the evaluations is provided here:

Supply Wells, Water Treatment Plant and Booster Stations Serving Areas with Storage

> Firm Capacity should be greater than MDD for water district(s) served by supply wells, the WTP or booster stations (compare the MDD and Actual Firm Capacity columns in Table IV.C.2).

Booster Stations Serving Areas Without Storage

> Firm Capacity should be greater than PID for water districts serving areas with no storage (compare the PID and Actual Firm Capacity columns in Table IV.C.2). In the case of the Huron Hills booster station the MHD was used to evaluation booster station firm capacity because of the large customer base.

Based on the information provided in Table IV.C.2 there are no concerns about WTP, well supply or booster station capacity for existing demand conditions. In addition, contractual arrangements for purchasing water from the City appear to be adequate based on maximum day demands although it should be noted that Garfield Township is nearing their contractual limit of 5 MGD.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY

Table IV.C.2- Existing Demands and Supply/Pumping Capacity Evaluation by Water District (2006)

Wilcox/Black & Veatch

Revised: November 23, 2009

Exist. Water District	Description	ADD (MGD)	ADD of Max. Month (ADDMM) (MGD)	Peaking Factor MDD/ADDMM (Note 1)	MDD (MGD)	MDD/ADD 2006	Peaking Factor MHD/MDD (Note 2)	MHD (MGD)	MHD (GPM)	PID (Peak Instantaneous Demand) (GPM)	Actual Firm Capacity (MGD)
	EAST BAY TOWNSHIP- TOTAL ALL WELLS	0.721	1.393	1.35	1.881	2.61	2.1	3.905	2,712		4.147
EB1 & EB3	**Cherry Ridge District (Note 3)**	0.553	1.040	1.35	1.405	2.54	2.1	2.963	2,057		3.701 Wells, 2.918 Iron
EB1	**Cherry Ridge District Minus B#2**	0.532			1.342	2.52	2.1	2.836	1,969		
EB2	**Holiday Hills District (Note 4)**	0.168	0.363	1.35	0.489	2.91	2.2	1.062	737		0.216
	E. Bay Booster #1 (Five Mile Rd)	0.097	0.278	1.35	0.375	3.85	2.2	0.817	568		0.72 (0.864 MDEQ)
EB3	**E. Bay Booster #2 (Windmill Farms) (Note 5)**	0.021			0.063	3.00	2.2	0.139	96		1.584 (1.39 MDEQ)
	Total of Individual Districts (math check)	0.721			1.894		2.1	3.930	2,729		
	ELMWOOD TOWNSHIP										
EL1	**Timberlee District**	0.053	0.112	1.50	0.168	3.16	2.2	0.369	256	354	560 GPM
EL2	**Greilickville District-Master Meter**	0.017	0.0302	1.50	0.045	2.75	2.2	0.100	69		0.75 (Agreement)
	GARFIELD TOWNSHIP- TOTAL MASTER METERS	1.775	3.500	1.30	4.550	2.55	1.9	8.612	5,981		5.0 (Agreement)
G1	**Master Meters - B#2 - B#1 + TC4 -B#4**	0.220			0.360	1.64	2.2	0.785	545		
G2 & G3	**Booster #2 (Lafranier)**	0.410	0.823	1.40	1.153	2.81	2.1	2.451	1,702		2.074
G2	**Booster #2 minus B#7**	0.402			1.124	2.80	2.1	2.392	1,661		
G3	**Booster #7 (Traditions) (B#7 Served by B#2)**	0.008			0.029	3.60	2.2	0.064	44	83	1350 GPM
TC4 (10)	**Traverse City Area Served from G4A**	0.110			0.469	4.26	2.2	1.019	708		
G4 & TC4	**Booster #1 (Cass Rd)**	1.197	2.535	1.30	3.296	2.75	2.0	6.522	4,529		6.912
G4A	**Booster #1 minus B#3 minus TC4**	0.700			1.400	2.00	2.1	2.953	2,050		
G4B & G4C	**Booster #3 (Silver Pines Rd) (B#3 Served by B#1)**	0.387	1.123	1.57	1.427	3.69	2.1	3.007	2,088		3.312
G4B	**Booster #3 minus Booster #5**	0.371			1.370	3.69	2.1	2.892	2,008		
G4C	**Booster #5 (Herkner Rd) (B#5 Served by B#1 and B#3)**	0.016	0.038	1.50	0.057	3.56	2.2	0.125	87	123	800 GPM
G5	**Booster #4 (Brook Dr)**	0.058	0.135	1.50	0.210	3.62	2.2	0.460	319	375	800 GPM
G5A	**Booster #4 minus B#6**	0.047			0.145	3.10	2.2	0.318	221		
G5B	**Booster #6 (Greyhawk) (B#6 Served by B#4)**	0.011	0.044	1.45	0.065	5.75	2.2	0.143	99	109	300 GPM
	Total of Individual Districts (math check)	1.775	3.500	1.30	4.550		1.9	8.612	5,981		
P1, P2 & P3	**PENINSULA TOWNSHIP- TOTAL ALL MASTER METERS**	0.118			0.412	3.50	2.2	0.897	623		1.0 (Agreement)
P1	**Total of Master Meters 2-4**	0.041	0.0843	1.50	0.126	3.06	2.2	0.278	193		
P2 & P3	**Master Meter #1 at Peninsula Drive**	0.077	0.1951	1.50	0.293	3.83	2.2	0.640	445		
P2	**Master Meter #1 minus Peninsula B#1 (P3)**	0.020			0.011	0.56	2.2	0.024	17		
P3	**Peninsula Booster #1 (McKinley Rd) (Note 12)**	0.057	0.1880	1.50	0.282	4.95	2.2	0.616	428	428	950 GPM
	Total of Individual Districts (math check)	0.118			0.419		2.2	0.913	634		
	TRAVERSE CITY										
TC	**Traverse City (By Difference; Note 6)**	3.602	7.560	1.30	9.828	2.73	1.5	15.042	10,446		11.75 (Capacity minus Agreements)
	Huron Hills Booster Station (Note 14)	0.117	0.245	1.50	0.367	3.14	2.2	0.800	556		1.010
TC1 & TC2	**Traverse City (TC) minus TC3 & TC4 (Note 11)**	3.416			9.118	2.67	1.6	14.400	10,000		
TC3	**Huron Hills Booster minus Peninsula P1**	0.076			0.241	3.18	2.2	0.527	366		
TC4	**Traverse City Area Served from Garfield G4A**	0.110	0.313	1.50	0.469	4.26	2.2	1.019	708		
	Total of Individual Districts (math check)	3.602			9.828	2.73	1.5	15.042	10,446		
	Water Treatment Plant Discharge (Note 13)	5.511	11.224	1.30	14.591	2.65	1.2	17.561	12,195		18.5

Notes:
1) Peaking Factor MDD/ADD of Max. Month is based on actual data where daily meter readings were available. Otherwise a range of 1.3 to 1.57 was used based on Water System or Water District size using MDEQ Water System Review Documents for guidance.
2) Peaking Factors were used for MHD/MDD based on linear regression of peaking factors for similar-sized water districts in Madison, Wisconsin as determined by diurnal data.
3) Cherry Ridge Wells Minus Booster Station #1 Demands
4) Holiday Hills Wells Plus Booster Station #1 Demands. Well Capacity less than District demand is not a problem because of the ability to supplement water from Cherry Ridge Wells using B#1.
5) ADD and MDD from MDEQ Water System Review Document. Only about 2 homes and very little usage in 2006.
6) Traverse City WTP-Garfield-Peninsula-Greilickville= T.C.
7) B#1 means Booster Station Number 1, etc.
11) Includes area downstream of Wayne Hill Booster Station. Inadequate data for evaluation of Wayne Hill Booster Station
12) MHD exceeds PID possibly because of very large irrigation demand in the summer. Therefore MHD used for PID.
13) Traverse City WTP capacity based on MDEQ Water System Review Document
14) MHD used to evaluate capacity of Huron Hills Booster Station instead of PID because of such a large ADD.
(yellow box) - Demand used for checking adequacy of firm capacity

3.2 Existing Demands and Storage Capacity Evaluation

The existing demands that have been determined for each existing water district are also used to evaluate storage capacities. The maximum day demands and storage capacity evaluations are provided in Table IV.C.3. The basis for the evaluations is provided here:

Storage Facilities

> Adequate storage capacity must be provided for Equalization, Fire Flows and Emergencies. An explanation of this analysis is provided in Appendix F and provides a basis for the numbers used in Table IV.C.3.

In Table IV.C.3, each storage tank is evaluated on the basis of demands for the water district or districts that rely directly on the tank being evaluated. Tanks that do not prove to be adequate for existing demand conditions are highlighted in pink.

As can be seen from this analysis the Birmley, Heritage Estates and Cherry Ridge water storage tanks have inadequate capacities. This may be mitigated to some extent by the fact that supply or booster station capacities supplying the particular districts have capacities much greater than maximum day demands. Although this may suffice in the near-term some drawbacks to this approach come from over-providing capacity, insufficient storage in case of supply interruption or over-reliance on storage capacities upstream of the pumping facility. Recommendations will be made relative to storage improvements later in this report.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
Table IV.C.3- 2006 Storage Requirements
Wilcox/Black & Veatch
Revised: December 20, 2009

Water District	Max. Day	Water Treatment Plant	Wayne Hill	Barlow	Birmley	McRae Hill	Heritage Estates (Note 1)	Cherry Ridge	English Woods (Note 2)
WATER STORAGE TANK CAPACITY (MG)		1.500	1.300	4.000	0.300	2.250	0.150	0.200	0.300
EAST BAY TOWNSHIP									
CHERRY RIDGE STORAGE TANK									
EB1	1.342								
EB3	0.063								
Total	1.405								
Equalization 27% Max. Day	0.379								
Fire-Corporate Commerce Center	0.630								
Emergency- 33% Max. Day	0.464								
Total Required Storage	1.473								
Total Provided	0.200							X	
ENGLISH WOODS (HOLIDAY) STORAGE TANK									
EB2	0.489								
Total	0.489								
Equalization 29% Max. Day	0.142								
Fire-Medium Density Residential	0.180								
Emergency- 33% Max. Day	0.161								
Total Required Storage	0.483								
Total Provided (Note 2)	0.300								X
BOTH EAST BAY STORAGE TANKS									
EB1	1.342								
EB2	0.489								
EB3	0.063								
Total	1.894								
Equalization 27% Max. Day	0.511								
Fire-Corporate Commerce Center	0.630								
Emergency- 33% Max. Day	0.625								
Total Required Storage	1.766								
Total Provided	0.500							X	X
GARFIELD TOWNSHIP									
BIRMLEY STORAGE TANK									
G2	1.124								
G3	0.029								
Total	1.153								
Equalization 27.5% Max. Day	0.317								
Fire-Light Industry	0.300								
Emergency- 33% Max. Day	0.380								
Total Required Storage	0.998								
Total Provided	0.300				X				
McRAE HILL STORAGE TANK									
G4A	1.400								
TC4	0.469								
Total	1.869								
Equalization 27% Max. Day	0.505								
Fire-Corporate Commerce Center	0.630								
Emergency- 33% Max. Day	0.617								
Total Required Storage	1.751								
Total Provided	2.250					X			
HERITAGE ESTATES STORAGE TANK									
G4B & G4C	1.427								
Total	1.427								
Equalization 27% Max. Day	0.385								
Fire-Medium Density Residential	0.180								
Emergency- 33% Max. Day	0.471								
Total Required Storage	1.036								
Total Provided	0.150						X		
TRAVERSE CITY									
TRAVERSE CITY WTP CLEAR WELL									
P1	0.126								
TC3	0.241								
Total	0.367								
Equalization 30% Max. Day	0.110								
Fire-Low Density Residential	0.120								
Emergency- 33% Max. Day	0.121								
Total Required Storage	0.351								
Total Provided	1.500	X							
COMBINED TRAVERSE CITY STORAGE TANKS									
P1	0.126								
TC3	0.241								
P2	0.011								
P3	0.282								
TC1 & TC2	9.118								
EL2	0.0453								
G1	0.360								
G5	0.210								
Total	10.3933								
Equalization 20% Max. Day	2.079								
Fire-Corporate Commerce Center	0.630								
Emergency- 33% Max. Day	3.430								
Total Required Storage	6.138								
Total Provided	6.800	X	X	X					

NOTES:

1) Actual Capacity of the Heritage Estates Tank is 0.300 MG. MDEQ Considers the capacity to be 0.150 becase it is a stand pipe.

2) English Woods Tank should be adequate for existing conditions with assistance from 5 Mile Booster Stn.

V. REGIONAL RESOURCE MANAGEMENT

A. Challenges Facing the Area's Water Systems

We are all aware of the increasing instabilities in our world today. These include terrorism, economic instabilities and rising energy costs and others. In a speech on December 13, 2007 to the Army and Navy Club in Washington, D.C., Stephen E. Flynn, the author of the book *The Edge of Disaster: Rebuilding a Resilient Nation* proposed a strategy for confronting terrorism and rebuilding and maintaining the nation's crumbling infrastructure. Flynn said that the future battleground [in terms of terrorism] will be the "economic civil space". "The way in which [our adversaries] can most challenge U.S. power is in our economic civil space because that is where we are the most exposed and that is where you get the most disruption". His recommendations on building resiliency into the nation's infrastructure will help the Grand Traverse Area not only in resisting terrorist threats but also in terms of facing the many other real challenges of the future. He said that resiliency consists of the five Rs:

- Robustness- built in ability of a system to mitigate or withstand threats
- Redundancy- built in alternate methods of service
- Resourcefulness- leadership that includes assessment, planning, mobilizing resources, coordinating efforts, assigning priorities and making decisions
- Restoration- ability to bounce back quickly
- Review- ability to adapt and learn from our own and others' experience

-Adapted from an article in the January 2008 issue of ASCE News

Some of the existing challenges facing the area's water systems are listed briefly in outline form below:

1. **High Rate of Growth in the area-** High rates of growth means increased system demands and pressures for system expansion. Increased demands create the burden of upgrading or replacing system components that have inadequate capacity. The high rate of growth requires better planning and management diligence.

2. **Technical Challenges-** There are many technical challenges facing the area's water systems. These are addressed in a significant way in this report.
   a) Low Pressures, particularly in parts of the City
   b) WTP needing upgrades (see separate Section VI.C on the WTP)
   c) THM Precursor problems in Garfield Township
   d) Low suction side pressures for some booster stations

e) Old and/or undersized watermain
f) Large variation between winter and summer demands

3. Significant Topographical Relief/Proliferation of Pressure Zones- The significant topographical relief in the area and the development of water systems over time have lead to more than 35 different water pressure zones throughout the study area not counting Private Type I systems. This gives rise to several significant concerns that will be addressed in a later section.

4. Private Systems Concerns- Private systems often struggle to meet managerial, technical and financial challenges while keeping up with regulatory requirements. Some specific issues include:
   a) Water Quality in Some Locations- For example, the Private Type I system at Black Bear Farms has well water that has to be treated for high Nitrate levels
   b) Many Private Type I systems face management, financial and technical challenges. These include lack of clear responsible parties (ownership), marginal well capacity, distribution system deficiencies (valves/hydrants), marginal cross connection programs, operation/maintenance concerns, lack of fire protection and others.

5. Private Well Concerns- Groundwater supplies are generally not adequate to provide fire flows to high density residential or commercial developments. Individual storage tanks and pumps to supply fire flows are not generally cost effective. Another concern is that in some areas, groundwater has taste or odor issues.

6. Multiple Jurisdictions/System Owners in the Area- Multiple jurisdictions and system owners in the area creates challenges in the following respects:
   a) Limitations to economy of scale
   b) Limitations to inter-connections, system looping and moving water during emergencies
   c) Challenges for regional planning, coordination and standardization

In spite of these existing challenges, some of them serious, it may well be that even more significant threats and challenges are on the horizon. Some of these are addressed in the following section.

B. Potential Future Challenges

1.0 Introduction – Potential Future Challenges

Regional resource use and planning needs to keep an eye toward issues that may affect the public water suppliers' (PWS) ability to continue to provide the service expected of their systems. Increasingly, such issues are related to more global events and/or issues beyond what was once considered the realm of PWS interest. This section describes several such challenges that require careful planning by the Grand Traverse region's PWS, on an individual and/or regional scale.

2.0 Pandemics

World-wide epidemics (pandemics) have occurred at a frequency of about once every three decades, as discussed in an article on preparation for a pandemic in *Journal AWWA*, June, 2006. An influenza pandemic is not expected to originate in the Grand Traverse region, but with air travel providing for rapid movement of people and disease from continent to continent, starting to plan for dealing with a pandemic after it had begun elsewhere would leave too little time for preparing to cope successfully. Therefore the time to start getting ready for a pandemic is now.

As a general principle, a water utility needs to have an emergency response plan. The response plan for a pandemic can be a variation of a previously-developed emergency response plan, with specifics focused on the unique situation that would be presented by a pandemic in which perhaps as much as 40 percent of staff might be absent due to illness or because of need to care for family members.

A number of actions need to be started, as some require continuing effort over time. Categories for planning include water utility personnel, interactions with others, materials and supplies that would be needed during a pandemic, and public relations actions. In addition, the planning for such an event should be facilitated on a regional basis – the impact of a pandemic would be area-wide, and the potential to assist neighbor utilities with any impacts will ensure that the water systems remain operational. Planning considerations are discussed in the following sections:

<u>Water Utility Personnel</u>

- Consider minimum numbers of staff needed for treatment plant operations, distribution system operations, supply purchasing, and other essential functions that must continue in spite of a pandemic and anticipated staff shortages. Evaluate on a regional scale considering that smaller utilities may be harder hit than larger utilities simply due to lesser number of staff.

- Inventory essential job functions and capabilities of each employee, and develop a matrix identifying any function that each employ can fulfill capably in an emergency situation.
- Plan and implement cross training so employees can successfully perform multiple functions at the treatment plant and in the distribution system. Do the same for office staff with regard to essential business functions. Implement cross-utility/system training to affect a mutual aid type of arrangement in case of emergency. Benefits of cross training were well documented in *Journal AWWA* by Doug Wise of the Eugene Water & Electric Board in October, 1998.
- Develop a management team list and consider who would replace each person on the list if that person was unable to work. Basically this calls for developing a staff succession plan for the individual utility, but also identifies ability to support neighboring systems in time of crisis.
- Consider holding periodic staff meetings to plan how to manage the utility with half to two-thirds of total employees available to work. Consider holding periodic area-wide planning meetings to discuss mutual aid response in event of pandemic.

<u>Interaction with Others</u>

- Work with health officials and others as necessary to ensure that when a pandemic begins, essential water utility employees will have access to vaccine so the possibility of their becoming ill is minimized. A supply of safe drinking water is essential for public health protection, so delivery of an adequate supply of potable water is essential to maintaining the health of persons in the region who do not become ill because of the pandemic.
- For emergency staffing, consider the possibility of developing a list of retired water utility workers in the Grand Traverse region who might be able to assist if needed.
- Work with and discuss plans with MDEQ, hospital staff members in the region, law enforcement personnel, and emergency planners to gain their input and to make sure that they understand the importance of maintaining a supply of safe drinking water during a health emergency.

<u>Materials and Supplies</u>

- Maintain an adequate inventory of fuel and treatment chemicals, taking into consideration the possibility of difficulties with production and transportation of necessary chemicals and fuel that may arise during a pandemic.
- Develop a plan to ensure that necessary chemicals and other essential supplies can be purchased and transported to the treatment plant or other locations where they are needed. This might involve law enforcement officials, emergency response officials, or others.

- Inventory all emergency supplies and equipment, and if more are needed, arrange to acquire them.
- Be sure that emergency power generation facilities function properly and are in good repair, with key spare parts and supplies on hand.
- Consider maintaining an inventory of spare parts for key water treatment and distribution equipment having parts that wear and need repair or replacement, if redundant equipment has not been installed.

Public Relations

- Develop a public relations plan to let the public know that water systems in the Grand Traverse area are prepared for a pandemic. Explain which essential services will be continued even if staff shortages develop.
- Also explain that water conservation measures may be necessary to extend supplies of chemicals or to properly operate the treatment plant during staff shortages. Be prepared to impose a ban on outdoor water uses, especially lawn irrigation in summer. By banning non-essential water use, the supply of chemicals may last twice as long as it would during a hot summer with heavy outdoor water use.

Finally, continue to review and update the pandemic response plan over the years so when an episode does take place, the plan will be current and relevant.

References

- "chat room: Utilities Prepare for Potential Pandemic," Journal AWWA,98:6:48-60, June, 2006.
- Wise, Doug, "Cross-Training Benefits Oregon Plant," *Journal AWWA*, 90:10: 60-66, October, 1998.

3.0 Security and Safety Issues

The terrorist attacks of September 11, 2001 and thereafter continue to have impacts to all aspects of society, PWS included. The immediate impact was the Bioterrorism Act of 2002 which required vulnerability assessments (VA's) and emergency response plans (ERP's) to be developed by all water utilities serving over 3,300 in population. In the Grand Traverse area, this included the City of Traverse City, East Bay Township, and Garfield Township. For these systems that have completed VA's and ERP's, it is important to:

- Continue toward implementation of the security improvements recommended for implementation in the VA. The MDEQ, as well as EPA, have provided continued emphasis on ensuring progress toward this goal.
- Periodically review the VA, and update recommendations for improvements and implementation thereof as appropriate for current threats and conditions.
- Periodically exercise the ERP (table top exercise), and revise as necessary.

For those systems that were not required to complete a VA and/or ERP under the Bioterrorism Act, it is recommended that a VA be performed in order to identify the potential for any relatively easy and inexpensive measures that can be implemented to improve security of the water supply and safety of the utility staff.

Addressing security issues at a utility indirectly affects safety as well (primarily personnel safety from outside threats); however, safety in general must also be a prime concern of water utilities. Water utilities fall under the purview of OSHA and MiOSHA safety regulations, and therefore, must stay vigilant in complying with applicable safety regulations. Although no specific future safety regulatory changes are on the horizon at this point in time, it will be important for the Grand Traverse area water systems to stay abreast of any changes to not only ensure compliance, but also to protect the safety and healthy of their employees.

4.0 Increasing Energy Costs

Energy costs have escalated in recent years, and this escalation has had a direct impact on the budgets of PWS. Power costs provide for one of the largest, if not the largest, components of a PWS budget. Therefore, attention to decreasing energy needs. Typically the largest component of PWS energy requirements is for pumping to and within the distribution system. Therefore, a focus on minimizing pumping operations and increasing efficiency of required pumping operations will be to the benefit of a PWS and its rate payers. Strategies for minimizing energy costs in pumping operations are addressed in Section V.D.

5.0 Water Withdrawal Legislation

Acts 179 through 190 of the Public Acts of 2008, made effective on July 9, 2008, require that the MDEQ, as part of the permitting process for certain large quantity water withdrawals, evaluate the potential for adverse impacts from such proposed withdrawals (PA 187 amends PA 399 public water supply permitting requirements). This set of bills adopts the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact), an agreement among the Great Lakes States that will be passed into law through an interstate compact. The Compact is designed to enact a consistent set of water management guidelines throughout the Great Lakes region, and in doing so, maintain control of the water resources within the Great Lakes basin in order to eliminate the risk of large-scale out of basins water diversions. The process of adoption of the Compact and its standards for water management guidelines is a several year process. However, Michigan's new laws have included regulations that go beyond that required by the Compact, and on accelerated schedules. Under these new laws, any proposed withdrawal of 100,000 gpd average over a 30 day period is to be evaluated for adverse impacts, with any such withdrawals that approach the criteria of an adverse impact (defined as "Zone C" withdrawals), and all withdrawals over 2 mgd requiring compliance with sector-specific water management practices or environmentally sound and economically feasible water conservation measures. Any withdrawals deemed to create an adverse resource impact will not be allowed, unless there is proven to be no feasible or prudent alternative.

Those systems most likely to be affected by the evaluation of adverse resource impacts are groundwater systems in glacial drift that are located near cold or cool streams or rivers (the determination of adverse resource impacts is related to characteristic and thriving fish populations in surface waters as they are affected by reductions in base flows or water levels caused by water withdrawals). Therefore, the siting of any new wells for the groundwater systems in the Grand Traverse Area will fall under these new requirements.

As previously noted, all proposed withdrawals of greater than 2 mgd capacity, and those smaller withdrawals deemed Zone C withdrawals, will also need to comply in some manner with water management/conservation measures.

The Michigan Section of the American Water Works Association (MI-AWWA) has developed water management guidelines for the public water supply sector, as allowed by the new laws, and it is anticipated that the MDEQ will accept these guidelines for compliance with the provisions of the act. The following is a summary of the guidelines; additional details and the full text of the guidelines can be found at the MI-AWWA website (www.mi-water.org):

STRATEGIES UNDER CONTROL OF THE UTILITY

1) Metering – ensuring all applicable users are metered/avoiding un-metered uses.
2) Meter Calibration and Replacement Programs – ensuring accuracy of metering/accuracy of billing.

3) System Audits – knowing where water is used and how much water is unaccounted for.
4) Leak Detection and Repair Programs – minimizing water losses when economically feasible.
5) Full Cost Pricing – ensuring users are cognizant of the value of water and that the water utility is sustainable.
6) Water Use Restrictions – primarily used for emergency conditions.
7) Conservation Pricing – reflecting seasonal demand conditions.

EDUCATION STRATEGIES

8) Public Information Initiatives – to instill conservation/efficient use mindset to the individual user.
9) Public Education Initiatives – similar to above; geared toward groups.

STRATEGIES PROMOTED OR INFLUENCED BY THE UTILITY

10) Irrigation System Efficiency Programs – avoiding over-watering.
11) Water Efficient Landscaping – avoiding the need for irrigation water uses.
12) Water Efficient Fixtures and Appliances – reducing sanitary water demands.
13) Efficiency Based Boiler and Steam Systems, Cooling Equipment and Towers, and High Water Using Processes – reducing seasonal peak demands (cooling) and overall base demands (process).

STRATEGIES FOR PROMOTING NEW TECHNOLOGY, MITIGATION, ALTERNATIVE ENERGY, ETC.

14) Water Reuse and Recycling – reducing demand for potable water by use of alternative sources.
15) Land Use Planning – coordination with other agencies.
16) Additional Opportunities – specific to the locality.

6.0 Source Water Protection Programs

The Michigan Department of Environmental Quality (MDEQ) executed a Source Water Assessment Program as required by the 1996 reauthorization of the federal Safe Drinking Water Act (SDWA). The 1996 amendments to the SDWA required states to:

- Identify the areas that supply public drinking water.
- Inventory contaminants and assess water susceptibility to contamination.
- Inform the public of the results.

A source water assessment for the Traverse City water supply was completed by MDEQ in 2002, and identified the vulnerability of the City's source as being of moderately high susceptibility, but notes that the treatment plant and intake have a historic record of maintaining safety of the water supply. The assessment recommends the implementation of a source water protection program to assure the continued safety of the water supply.

Following the completion of the source water assessments, the MDEQ encourages water systems to develop a Surface Water Intake Protection Program (SWIPP).

Per MDEQ, a SWIPP should have the following basic seven elements:

- Defining roles and duties of government units and water supply agencies.
- Designating a source water protection area for each water supply source based on the state's defined source water area.
- Identifying potential contaminant sources within each source water protection area.
- Utilizing management approaches for protection of source water, including but not limited to education and regulatory approaches.
- Creating contingency plans for public water supply sources including the location of alternate drinking water sources.
- Assuring proper siting on new water sources to minimize potential contamination.
- Encouraging public participation.

A guidance document is available on the MDEQ website to assist communities with surface water systems in developing a SWIPP: http://www.deq.state.mi.us/documents/deq-wb-swpu-swipp-guidance.pdf (link current as of date of report).

7.0 Groundwater Protection Plans

The MDEQ maintains a wellhead protection program (WHPP) to assist communities utilizing groundwater for their municipal drinking water supply systems in protecting their water source. A WHPP minimizes the potential for contamination by identifying and protecting the area that contributes water to municipal water supply wells and avoids costly groundwater clean-ups. The following is a status of implementation of such programs in the Grand Traverse area (as of June 2007):

- Acme Township (Lochenheath) – delineation completed.
- Blair Township – program in place.
- East Bay Township – delineation completed.

Although not a regulatory requirement, it is recommended that the area's groundwater systems complete a WHPP as a means of ensuring the safety and protection of the water supply. Additional information and guidance can be found at the MDEQ website: http://www.michigan.gov/deq/0,1607,7-135-3313_3675_3695---,00.html (link current as of date of report).

8.0 Water Quality Regulations

An overview of pertinent contemporary issues relating to current and pending regulations governing the study area's public water supplies are presented in Appendix G.

C. Water Resource Management

1.0 Introduction – Water Resource Management

Effective water resource management can include both water conservation – initiatives and programs to encourage the minimizing of water use; and water efficiency – initiatives and programs to ensure that the maximum proportion of water withdrawn from a source is accounted for and utilized. Water conservation typically reflects demand side management, while water efficiency entails both supply and demand side management. The historical nature of public water supply systems in the upper Midwest is such that customer demands are highest in the summer when public supply sources are utilized for lawn irrigation and cooling applications. Thus, public water supply systems are designed in order to meet the peak demands, although the vast majority of the time, a significantly lesser amount of water is required to meet actual demands. This situation presents an opportunity to manage water supply such that a system can continue to grow without significant source/treatment capital improvements if the seasonal fluctuations of system demands can be moderated – allowing growth in overall use of water on an annual basis, but affecting the peak summer demands to "shave" such peaks. In this manner, the implementation and use of water conservation and efficiency programs can delay or even avoid the need for major capital investment in the supply and treatment infrastructure.

2.0 Existing System Programs and Performance Benchmarks

This section reviews existing programs and initiatives in the Grand Traverse region aimed at water conservation and/or water efficiency, and then compares key performance indicators against national/regional benchmarks to assess the potential for water conservation and efficiency programs to impact water management by the area's public water supply systems. (Note: Section V.C.5.0 provides detailed information on various water management initiatives referenced through this section)

2.1 Existing Programs

This section also reviews existing policies that may be detrimental to water conservation and efficiency.

Water conservation programs typically consist of educational initiatives aimed at the water users, or incentive-based programs designed to encourage lesser use of water. No formal water conservation programs have been identified as being in use by the area's public water supply systems and/or governmental agencies. However, several informal initiatives are evident in the area, consisting primarily of public education efforts, either by governmental or quasi-governmental entities or local special interest groups. For example:

- The Consumer Confidence Reports prepared by Grand Traverse County include “Use Water Wisely” tips for consumers.
- The *Traverse City Eagle-Record* recently reported that the Grand Traverse Baykeeper, John Nelson (an advocate for clean water and protection of the bay), has worked with the city and county to develop and distribute a water conservation brochure.
- The Watershed Center of Grand Traverse Bay provides water conservation information on their website.

The effectiveness of these programs depends on the extent of audience to which the educational efforts are distributed, and in turn upon the willingness of the audience to implement the recommended practices.

Water rate structures can be set to encourage conservation, or conversely, discourage large volume use. A review of water rate structures in the Grand Traverse Area shows the following:

Table V.C.1

Existing Water Rate Structures

Community/System	Rate Structure	Comments
Traverse City	Declining Block (usage)	First 600 cf cost based on service line size; minimal decline for typical residence
Blair Township	Uniform Rate (usage)	Ready-to-serve charge based on meter size
Acme Township	Flat Rate	Water benefit basis
East Bay, Elmwood, Garfield, Peninsula Townships	Uniform Rate (beyond minimum usage)	Initial minimum on water benefit basis (flat charge)

All of the above- indicated water rate structures are considered to be types that do not encourage water conservation or efficiency.

Water use restrictions are typically utilized to address short-term emergency water shortage situations, such as main breaks and atypical high demand periods (e.g., drought conditions) for source systems that are reaching capacity, and are geared toward limiting water use for non-essential uses such as lawn irrigation, car washing, etc.. However, such restrictions are sometimes also utilized in an attempt to limit the peak demands typically associated with summer peak periods. A review of the systems in the Grand Traverse area showed that Traverse City and Blair Township do not have any such policies in place. Garfield

Township previously had a policy to restrict lawn irrigation to odd or even days depending on the area; this policy was utilized in the summer for about seven years when system storage was limited. When additional storage was installed in the system, the policy was taken out of effect. East Bay Township maintains an emergency water use restriction policy to be implemented during water shortage situations. At the time of writing of this report, it was not evident if Elmwood and Peninsula Townships had any such policies.

The historical availability of water in the Great Lakes region has meant the development of water supply systems designed to deliver water without regard to end use – that is potable quality water for all uses. However, recognition of the opportunity for eliminating non-potable uses from the public water supply system can be an effective means of water management within the public water supply system. This can be implemented through provision of non-potable water supply though alternative means such as reclaimed water systems or dedicated non-potable water systems; these systems can be individual user-based or more widely organized by public or private entities for distribution. Note that the availability of separate non-potable water systems does not necessarily reduce overall water use, but may simply result in a change in the source of water withdrawal and reduce use for the primary potable system by shifting this use to the secondary non-potable system(s). In the Grand Traverse area water systems, there are two policies worth noting, along with their potential effects on water conservation:

- Private well policies: The widespread use of private wells for lawn irrigation can limit the peak demands on municipal water supplies. Traverse City's water use ordinance prohibits the use of private wells when municipal water is within 200 feet of the property. Grand Traverse County (administering many of the township systems) has a program that allows existing private wells to remain for irrigation use once a residence is connected to the municipal system. Blair Twp allows the use of private wells for non-potable uses.
- Non-domestic use water service policies. Since sewer service charges are typically based on water usage, some communities allow the installation of separate metering for non-domestic uses (water that is not returned to the sewer system). This is typically attractive for users that have high non-domestic uses such as irrigation and cooling, and allows such users to only pay water use charges (non-domestic use is not a part of sewer use charges). These policies do not encourage water conservation or efficiency on their own; although an appropriate non-domestic rate structure can be implemented to do so. The Traverse City water use ordinance allows separately metered non-domestic services.

2.2 Existing System Benchmarks

Three key system characteristics can be investigated to provide an indication of the potential for increased water conservation and efficiency to positively impact the system (positive impact being one that maximizes the utilization of water and/or that minimizes the need for excess system capacity that is typically only required a short time throughout the year):

- Unaccounted for water (UFW): measure of water loss, billing inaccuracies, and/or unmetered water use.
- Summer/winter demand variation (average day basis): measure of magnitude of non-potable water use.
- Maximum day/average day variation: similar to above; identifying the severity of system excess capacity (capacity required to meet peak demands vs. average demands).

The following table compares these characteristics of the Grand Traverse Area water systems:

Table V.C.2

Water System Conservation/Efficiency Opportunity Benchmarks

Water System	Unaccounted for Water	Summer/Winter Ratio	MD/AD Ratio (2006)
Traverse City	15% (DEQ SS)	2.90 (ave 1998-2007) 3.41 (max: 2006) 2.57 (min:: 1999)	2.7
Garfield Township	12.8% (2006 customer meter data)	3.01 (wholesale purchase)	2.6
Peninsula Township	No recent data	5.41 (wholesale purchase)	3.5
Elmwood Township	No recent data	2.52 (wholesale purch.-Greilickville) 2.62 (Timberlee)	2.8 (wholesale purchase-Greilickville) 3.2 (Timberlee)
East Bay Township	12.8% (2006 customer meter data)	2.67	2.6
Blair Township	5% (DEQ SS – 2001)	Not available	3.7

A recent American Water Works Association benchmarking study produced the following data on unaccounted for water among water utilities:

- Median: 9 percent
- Top quartile: less than 4 percent (low unaccounted for water)

- Bottom quartile: greater than 14 percent (high unaccounted for water)

Compared to this benchmark data, the indicated UFW for the Traverse City system (as reported in the MDEQ Sanitary Survey) and for Garfield and East Bay Townships appears to leave room for improvement. The indicated UFW for Blair Township (also as reported in the MDEQ Sanitary Survey, but only reported for year 2001), appears to indicate good performance; however, since not available for recent years, this value should be confirmed. To assess the viability of reducing UFW, a detailed analysis is required to confirm the reported value of UFW, and then to assess the source of the UFW. Unaccounted for water can fall into three general categories:

- Real losses (physical loses), including leakage, water main breaks, overflows from storage tanks, etc.
- Apparent losses, including losses in billing, metering errors, illegal use of water, etc.
- Unbilled authorized consumption, including water used for flushing and fire-fighting, etc.

Note that since no data is available for current UFW in the other area systems, no comparison can be made as to the performance of the other systems in comparison to the Traverse City system. Typically, larger systems will have will have higher UFW performance than smaller systems, solely due to the larger potential for water main breaks, billing issues, etc. Note that the feasibility of reducing UFW depends on the source of the UFW and the economics of such reductions. Therefore, it is not recommended that the Grand Traverse Area water systems set arbitrary targets for UFW performance in the various systems, but that instead efforts be initiated to first ensure adequate data exists to allow a true evaluation of UFW (it is not clear upon what data or information the MDEQ Sanitary Survey assessment of Travers City's UFW is based), and second, that each utility, or possibly one coordinating agency, perform an initial water audit to produce information for comparison. The results of a water audit can provide an initial indication if water loss reduction strategies and initiatives may be of economic benefit. In some cases, the completion of an audit in itself will lead to a reduction in perceived or assumed UFW due to the discovery of easily corrected billing/metering/reporting issues.

A free water audit spreadsheet-based tool is available from AWWA; available through the AWWA website (link current as of date of this report):

http://www.awwa.org/Resources/Content.cfm?ItemNumber=590

A discussion of the relevance of summer/winter and maximum day/average day demand characteristics follows in Section V.C.4.0. of this report entitled "Peak Demand Management".

3.0 Large Water Users and Opportunities

Large industrial/institutional/commercial uses can offer opportunities for reduced water use in targeting water management programs. To illustrate, the top 25 largest users of the Traverse City system are listed below (by customer account, based on 2006 usage):

Table V.C.3

Traverse City Large Water Users (x 100 cf)

Customer	Annual Usage (2006)	Peak Month Usage
TC Hotels (631 E. Front St)	19,820	2,993 (August – 1.8 x ave)
Munson Medical (1201 Sixth St)	19,743	2,085 (August – 1.3 x ave)
GT Pavilions (1000 Pavilions Cr)	17,032	2,212 (September – 1.6 x ave)
Munson Medical (1105 Sixth St)	16,953	2,005 (September – 1.4 x ave)
Century Sun Metal Treatment (2411 Aero Park Ct)	15,801	1,965 (September – 1.5 x ave)
Regency of TC (300 E State St – first of two accounts)	10,728 (August thru December only)	3,759 (September – 1.8 x ave)
Regency of TC (300 E State St – second of two accounts)	10,169 (May thru December only)	3,089 (September – 2.4 x ave)
Hillview Terrace Apts (601 Fitzhugh Dr)	8,865 (11 month period)	1,600 (August – 2.0 x ave)
Bayshore Resort (833 E Front St)	8,159	1,711 (August – 2.5 x ave)
Munson Medical (1221 Sixth St)	8,035	2,734 (September – 4.1 x ave)
City of Traverse City (111 E Grandview Pkwy)	7,802	N/A (constant usage basis)
City of Traverse City/National Cherry Festival	7,050 (6 month period)	5,486 (November – 4.7 x)
Munson Community Health (550 Munson Ave)	6,412 (11 month period)	1,676 (August – 2.9 x ave)
Riverview Terrace (150 Pine St)	6,344	634 (December – 1.2 x ave)
St. Francis School (123 E Eleventh St)	6,310	723 (September – 1.4 x ave)
Munson Medical Center (1105 Sixth St	5,750	615 (September – 1.3 x ave)
Grand Traverse County Jail	5,375	593 (December - 1.3 x ave)
North Peak Brewery (101 Hall St)	5,169	986 (September – 2.3 x ave)

Table V.C.3

Traverse City Large Water Users (x 100 cf)

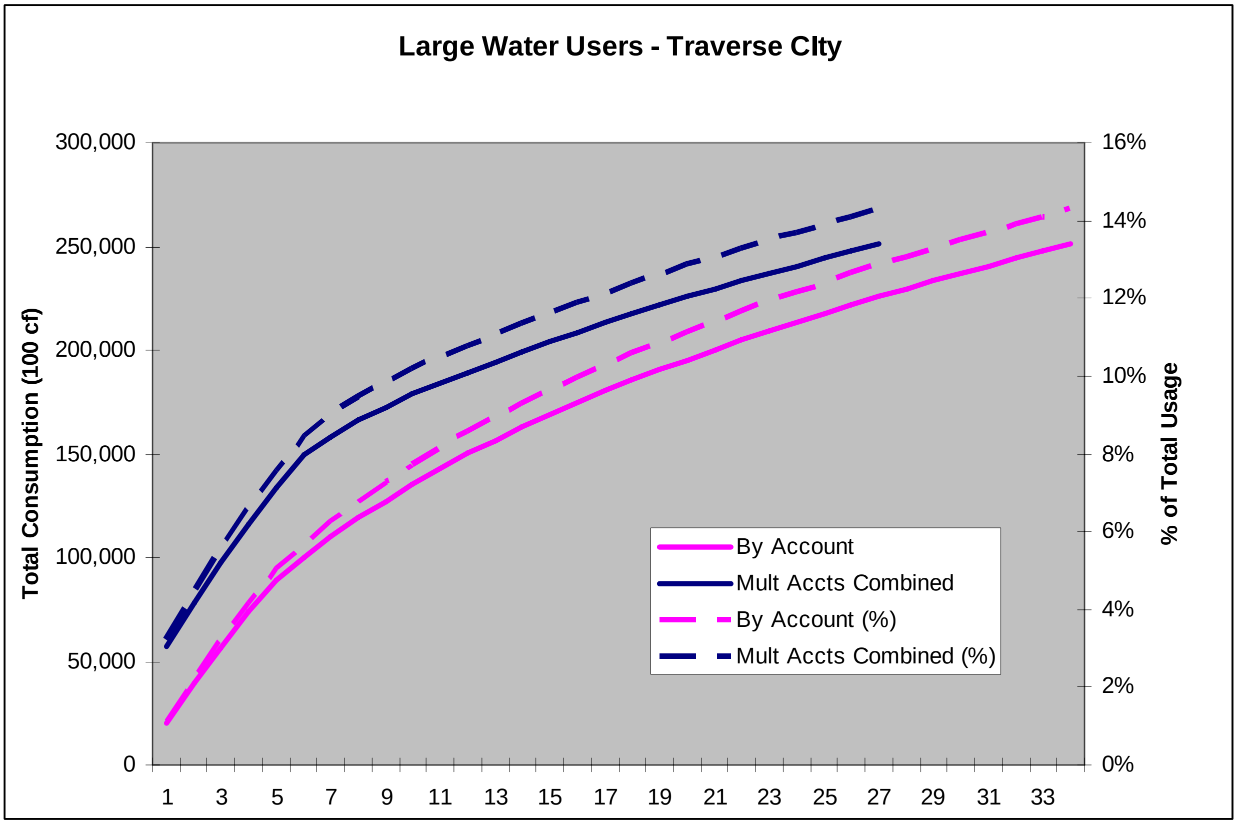
Customer	Annual Usage (2006)	Peak Month Usage
TBA Intermediate School District (880 Parsons Rd)	4,857 (11 month period)	769 (June – 1.7 x ave)
NMC/Maritime (715 E Front St)	4,851 (6 month period)	1,397 (August – 1.7 x ave)
Town & Country Mobile Park (849 Manor Ln)	4,693	598 (July – 1.5 x ave)
OMI (606 Franklin St)	4,826	686 (December – 1.6 x ave)
TC Schools/Central HS (1150 Milliken Dr)	4,450 (11 month period)	980 (May – 2.4 x ave)
Super Wash (709 Parsons Rd)	4,438	606 (April – 1.6 x ave)
Hall 20 Condo Assoc (810 Cottageview Dr)	4,122 (11 month period)	2,255 (May – 6.0 x ave)

The usage characteristics of the above demands indicate that there are two general categories of water management that can be considered for conservation/efficiency opportunities:

- Base demands – those that are fairly consistent throughout the year, as indicated by a lower ratio of peak month to average month usage.
- Peak demands – those that have larger variation in the month to month usage, as indicated by a higher ratio of peak month to average month usage.

Typically, most users will have some opportunity for management in both categories.

The graph below shows cumulative annual consumption by the number of top users, as well as percentage of overall in-City water use by those top users; data is presented considering a user as an individual account, and by combining multiple accounts by the same owner:



A targeted program of water conservation for large users needs to reflect "return on investment". The potential for significant savings is largest with the largest users; therefore, such programs are typically geared toward the number of users. Typically, a "break point", where the cumulative usage graph tends to flatten, is a reasonable target upon which to base the large users for targeted water management programs. From the above graph, it can be seen the largest benefit for "top user" management initiatives can likely initially be gained from targeting the top five to seven users. Based on the effectiveness of an initial targeted program, successful initiatives can be rolled out to additional top users.

When combining multiple accounts, the top six users, in order, are Munson Medical, Regency of Traverse City, Traverse City Hotels, City of Traverse City, Grand Traverse Pavilions and Century Sun Metal Treatment. Water usage for each of these users can be reviewed to identify the feasibility of implementing the following conservation/efficiency initiatives:

- Implementation of water efficient fixtures and appliances – applicable to facilities with large quantities of such units.
- Implementation of water efficient industrial processes (clean in place, etc.) – applicable to industry.

- Irrigation system efficiency measures (off-peak irrigation, moisture sensors, etc.), and use of water efficient landscaping – applicable to those users with high peak demands due to irrigation.
- Promotion of reclaimed water sources where applicable, including on-site collection and reuse, design of water system for both potable and non-potable uses (if separate sources projected to be available in the future; also see Section V.C.5 of this report).

On a more global scale, water rate structures can also provide incentive to reduce water consumption for large water users, as further described in Section V.C.5 of this report.

4.0 Peak Demand Management

As indicated in Table V.C.2, the ratio of summer average day demands to winter average day demands in the Grand Traverse Area water systems ranges from approximately 2.5 to over 5.0. For comparison, listed below are factors for other Michigan communities:

- 1.80 – Medium-size inland community, low tourist and summer transient population.
- 2.83 – Medium-size lakeshore community, moderate tourist and summer transient population.

The relatively higher level of tourist and summer transient population in the Grand Traverse region is the primary factor in the higher summer/winter usage factor of the area's water systems. A 1996 report by the Northwest Michigan Council of Governments estimated Grand Traverse County seasonal population to peak at 22 percent of total population in July (based on 1995 data)

Also as indicated in Table V.C.2, the ratio of maximum day demands to average day demands in the Grand Traverse Area water systems ranges from approximately 2.6 to 3.7. For comparison, listed below are factors for other Michigan communities:

- 1.66 – Rural, low population, township.
- 1.83 – Medium size community, mix of older and newer residential development.
- 2.02 – Small community, high tourist and summer transient population, approximately 11 percent of water consumption by top 10 users.
- 2.34 – Medium size community, moderate tourist and summer transient population.
- 3.16 – Developing suburban community.
- 3.35 – Developing "exurban" community.

The relatively higher demand ratios described above require that the Grand Traverse area water systems be built to accommodate such relatively higher seasonal and peak water usages. Therefore, the excess capacity required by the area's water systems can be minimized by management of peak water demands.

Peak water management can be implemented via the following conservation/efficiency initiatives:

- Full-cost pricing and billing – ensuring that the user pays full value for the water they use (cost-of-service accounting and rate setting); also includes assuring all appropriate uses are billed and are accurate in their billing.
- Development of reclaimed water sources where applicable, including on-site collection and reuse, and implementing a non-potable supply (also see Section V.C.5 of this report).
- Water use restriction policies – minimizing time periods when irrigation is allowed (diurnal and/or by days of the week).

5.0 Regional Strategies for Water Resource Management

As referenced in Section V.B.5.0 of this report, recent Michigan water withdrawal legislation is geared toward encouraging the efficient use and conservation of water as part of any proposal for an increase to or addition of water withdrawal capacity, including those for public water supply systems. As written, a public water supply system must have "considered" implementation of certain water management guidelines as part of the permitting process, apparently geared toward encouraging systems to minimize the amount of water withdrawal required for their systems. In addition, proposed additional legislation has been in development, both on a State and regional level that could lead toward a more strict review of a public water supply's efforts toward water conservation and efficiency. (Refer to the "Future Challenges" Section V.B of this report for additional information.) Therefore, it is in the best interest of the area's water supply systems to evaluate the potential for implementation of such programs and initiatives to be in a position to meet any such requirements when applying for water supply system permits involving increased withdrawals. In addition and as previously mentioned, the implementation of such programs and initiatives may allow for the delay of system capacity improvements, thereby minimizing the economic impact to the system and its rate payers. For the most part, the key to success of water conservation and efficiency programs lies in the ability to implement a consistent set of programs and initiatives area-wise, regardless of the individual system to which any one user is connected. Note, however, that there are several programs/initiatives which can be implemented on a system-by-system basis without relying upon area-wide implementation for effectiveness. The following initiatives are suggested as appropriate for implementation in the Grand Traverse area:

Table V.C.4

Water Management Initiatives

Initiative	Regional Implementation	Individual System Implementation
Public Information/Education • Consistent program/information throughout region • Bill stuffers • Community event displays, etc.	X	
System Audit • Determine/characterize UFW		X
Consistent Rate Structures • Consistent throughout region • Rate explanation on bills • Ensure full-cost pricing • Consider conservation pricing models	X	
Metering • Meter all uses • Meter calibration and replacement		X
Leak Detection and Repair • If deemed economically feasible based on system audit		X
Water Use Restriction Policies • Focused on “smart” irrigation	X	
Private Well Policies • Review and standardize throughout the region. • Allow where low risk	X	
Non-domestic water use policies • Review and standardize throughout the region. • Encourage for non-potable use	X	
Reclaimed Wastewater Reuse • Develop highly treated WWTP effluent distribution system for non-potable and irrigation uses	X	X
Reclaimed Cooling Water Reuse • Develop hot water distribution system from potential biomass project of TC L&P	X	X

D. Energy Efficiencies

Typically the largest component of PWS energy requirements is for pumping to and within the distribution system. Therefore, a focus on minimizing pumping operations and increasing efficiency of required pumping operations will be to the benefit of a PWS and its rate payers. Primary means of minimizing energy costs in pumping operations include:

- Ensuring distribution systems are properly configured to avoid unnecessary pumping operations; in the Grand Traverse area, this means assessing water system configuration by pressure zone requirements and not necessarily by political subdivisions. See Sections VI.B.1 and VI.B.5.6 of this report for additional information.
- Evaluating required pumping operations to ensure operation of pumps in most efficient areas of their curves'; This may be predicated on the availability of system storage to allow "fill-drain" cycles to limit pump operation at rated/most efficient capacity vs. meeting varying system demands, or installing adjustable speed drives on pumping units to maximize efficiency.

E. Suggested Criteria for System Expansion

The evaluation and decision-making process relative to water system expansion is often complex. However, with a list of criteria that can be used in the evaluation process an informed decision can be made. Population growth and associated construction have been constant in the Grand Traverse area over the past few decades. System expansion has to be balanced between providing necessary service, maintaining a healthy economy and the financial and management burden of unnecessary infrastructure. Some criteria to consider are the following:

Groundwater Quality- It is clear that areas that have poor groundwater quality should take priority in terms of development of municipal water infrastructure. Groundwater quality issues that may be of concern could include high nitrate levels or contamination. Aesthetic issues such as odor and taste should be considered but have less significance than contaminants.

Inadequate Local Groundwater Supply- If development in a particular area is adequately concentrated it may be that groundwater supply is inadequate to serve the area. This is a potential problem that is not known to exist at this time because of the plentiful supply of groundwater in the area. However, groundwater supplies are generally not adequate to provide fire flows to high density residential or commercial developments. Individual storage tanks and pumps to supply fire flows are not generally cost effective. A cluster of existing developments or the expectation of future developments, along with zoning, should be seriously considered in the analysis of system expansions.

Zoning Considerations- A governmental entity may wish to promote high-density residential or commercial development within particular zoning areas or to limit it in others. This may weigh heavily on where an extension is made or not made.

Existing Isolated Private Systems- Private systems often struggle to maintain adequate capacity and quality while meeting all of the regulatory requirements. The possibility of incorporating private systems into the municipal system should be a consideration in evaluating system expansions.

Economic Viability- Because financial resources are not unlimited the long-term economic viability of system expansions should be considered. This analysis would include an estimate of the number of potential users over time and the potential return on investment.

F. Opportunities for Valuable Intergovernmental Cooperation

1.0 Introduction

These issues and challenges mentioned in previous sections of this report can best be addressed best by regional cooperation. That does not necessarily mean that the various systems owned by the Townships, the City and private entities should become one regional system. It does mean additional interdependence and functional reliability as a result of good regional planning, coordination, sharing of resources, and preparing for emergencies. Coordination includes periodic updates/improvements to agreements, sharing of management strategies, standardization, and oversight of design for any new projects or improvements.

It is important to understand that good planning and regional cooperation will ultimately result in lower capital, operation and maintenance costs. This results from economies of scale, more efficient designs and simplified operational schemes. Other very important results will be better reliability (on small and large scales), better water quality and the possibility of mutual aid during emergencies.

Regional cooperation can only work effectively in an atmosphere of trust and good will. Systems owners must understand that there is give and take in any cooperative relationship and that positions should be diligently sought that are good for all parties. This is sometimes a challenge in light of political realities but will result in great satisfaction as threats and challenges are overcome.

2.0 Current Mechanisms for Regional Cooperation and Coordination.

There are a few current mechanisms for regional cooperation and coordination. The principle mechanism is the organization of the County's Board of Public Works and the Water and Sewer Committee of that Board. This Committee is made up in part with representatives from the City, East Bay, Elmwood, Garfield, Peninsula, Blair and Acme Townships. The County provides management and operational services for water systems in each of the mentioned Townships except for Blair Township.

A second mechanism for regional cooperation and coordination is the bulk water sale agreements between the City and Elmwood, Garfield and Peninsula Townships. These agreements stipulate points of connection between the systems and metering requirements at those locations, water use ordinances, construction standards, operation and maintenance, service areas within the Townships, the term of contract, methods for resolving disputes, City review of certain improvements, water supply capacity allocations, and the basis for reimbursing the City and other terms and conditions.

The MDEQ is also a mechanism for regional cooperation and coordination in a limited sense. The MDEQ encourages improvements that are in the best interest of the individual users and that positively impact reliability and water quality.

3.0 Historical Regional Planning

Regional planning has historically been very limited. The County Department of Public Works maintains construction standards for distribution systems and works to streamline operation and maintenance of the systems that it is responsible for. However, planning has traditionally been the responsibility of each water system owner. We are not aware of any previous regional master planning studies that have been completed.

4.0 Overview of Various Models for Regional Cooperation

(adapted from "Regional Solutions to Water Supply Provision", AWWARF/EPA, 2006)

Regional cooperation among public water supply systems can be accomplished in many ways. Such regional approaches can include physical integration or interconnection (such as that which exists for some wholesale customers of the City of Traverse City) and/or nonphysical arrangements where water agencies remain distinctly separate (for example, the management of several township systems by Grand Traverse County). This section provides a review of alternative models for regional cooperation among water supply systems.

In general, the following incentives and advantages can be offered by a regional cooperative arrangement:

- Economies of scale
- Increased financial opportunities (affording increased access to capital)
- Elimination of duplicative services
- Increased reliability
- Increased flexibility
- Enhanced protection of public health (through benefits of economies of scale and increased financial opportunities)
- Skills improvement (including more opportunities for advancement for staff)
- Service efficiency

However, there are also several barriers and disadvantages of regional cooperative arrangements:

- Loss of power and community independence
- Differing management goals
- Conflicting regulations (among political jurisdictions)
- Cost and benefit inequities
- Workforce reduction
- Issues regarding shared resources (those shared among water system and other municipal functions)
- Public confusion
- Debt (restructuring associated with consolidation)
- Resistance to change

There exist six general types of regional cooperative approaches applicable to water supply systems, each providing a differing level of sharing and collaboration vs. consolidation of ownership and operations. A summary of each follows:

Mutual Aid Agreements – arrangements for mutual assistance during emergency events.

Benefits:

- Enhanced reliability, especially during emergencies.
- Reduced cost as compared to providing emergency/standby capabilities covered by the agreement.
- Promote good relations at the utility and political levels for additional forms of mutual collaboration.

Potential Issues:

- Concern over liability of "Good Samaritan" activities undertaken in another jurisdiction.
- Limited in benefit for day to day services.

Sharing Arrangements – cooperative purchasing arrangements for consumables, utilities, specialized resources, etc.; shared management/administrative functions.

Benefits:

- Economies of scale in purchasing.
- Afford a higher level of expertise in shared functions.
- Promote good relations at the utility and political levels for additional forms of mutual collaboration.

Potential Issues:

- Added complexity to utility purchasing agreements.
- Concerns over "local control" of shared management/administrative functions.
- Attention required to any affected collective bargaining agreements, insurance coverage, and limitations of liability.

Water Purchase Arrangements – including broad regional collaboration to offer equivalent terms to multiple jurisdictions.

Benefits:

- Economy of scale in source supply improvement projects.
- May offer more economical solution as compared to extension of one's own system.
- Provides redundancy when multiple sources are involved.

Potential Issues:

- Potential regularity issues of larger water distribution systems (disinfection byproduct formation in long water age systems).
- Ensuring cost agreements accurately reflect level of investment by involved party for required improvements.
- Perception of loss of control in long term agreements.

<u>Collaborative Water Resource Development</u> – focused on management of the supply resource while maintaining local control of distribution.

Benefits:

- Economy of scale in source supply improvements projects.
- Opportunity to optimize overall development and use of varied sources.
- Coordination of source protection programs.

Potential Issues:

- Perceived loss of control, especially by smaller systems.
- Need for organizational change.
- Coordination of growth perspectives.
- Funding of the water resource agency.

<u>Contract Service Arrangements</u> – outsourcing operation and maintenance services on a regional basis.

Benefits:

- Addresses current difficulties in attracting/retaining qualified staff.
- Can provide predictability of costs.
- Properly structured, provide a very high level of assurance against even minor violations of SDWA and/or OSHA rules/standards.

Potential Issues:

- Existing workforce concerns of outsourcing.
- Performance incentives and savings can erode over time.

<u>Consolidation</u> – merging of ownership and operations of systems.

Benefits:

- Economy of scale.
- Opportunity to optimize overall development and use of varied sources and distribution of water.
- Enhanced access to capital for system improvements and maintenance.
- Elimination of duplicated management/administrative functions vs. individual systems.

Potential Issues:

- Perceived loss of control.
- Agreement to method/basis of asset transfers to regional entity.
- Need for organizational change.
- Coordination of growth perspectives.

In the development of any of the above regional approaches, it is essential that commitments of participating parties are fully documented in written agreements, even where any informal sharing agreements already exist. A written agreement should provide:

- Confirmation of mutual commitments and clarity and confidence in the relationship(s).
- Documentation of mutual benefits desired by the parties.
- Framework within which to explicitly identify and address issues and concerns to all parties.
- Vehicle for possible expansion of collaborative activities.
- Process (negotiation) that is likely to predict success of the agreement (if issues and concerns can not be resolved through the negotiations, the collaborative approach under consideration may not be the best alternative).

The American Water Works Association Research Foundation (AWWARF) has funded the development of a decision framework tool for assessing opportunities for regional collaboration based on a self-assessment of one's utility. The output of the tool is a focused set of regional approaches that best match the responding utility's needs and priorities.

The following is an example of the tool output, based on responses to the tool survey by City of Traverse City staff:

Regional Solutions Matrix - City of Traverse City

Water System Functional Areas	Regional Solution Categories					
Priority: High / Medium / Low	Mutual Aid Agreements	Sharing Arrangements	Water Purchase Agreements	Collaborative Regional Water Resource Development	Contract Services Agreements	Consolidation of Multiple Systems
Planning, Development and Operation of Supply & Treatment Facilities	Emergency Interconnections & Collaborations in Emergency Response	Joint Purchasing and Sharing of Specialized Resources	Contract Purchase of Treated Water to Augment or Supplant Own Supplies	Joint Planning, Development and Operation of Supply and Treatment Facilities	Contractor Provision of Water Supply & Treatment O&M Services	Merged Ownership and Operation of Supply and Treatment Facilities
Distribution System Operations and Maintenance	Collaboration in Emergency Response	Joint Purchasing and Sharing of Specialized Resources			Contractor Provision of Distribution System O&M Services	Merged Ownership and Operation of Distribution Systems
Water System Management and Administration		Shared Management and Administration Functions			Contractor Provision of Management and Administration Functions	Merged Management and Administration Functions

- These results indicate a reasonable level of opportunity for certain regional approaches (highlighted in yellow above) to provide benefit to the City of Traverse City. Note that responses to the tool survey from staff of other area water systems provided similar results in some cases, but in others, showed limited benefit. It is suggested that if regional approaches are to be pursued, that a collaborative use of the framework tool be facilitated amongst all potential participants in order to gain a better understanding of appropriate opportunities for regional collaboration and cooperation.

5.0 Surface Water/ Ground Water Compatibility Review

The presence of the multiple water systems in the Grand Traverse area allows for the ability to interconnect these systems for reliability and emergency purposes, and also for consideration of integrated operation – that is, true open connectivity between the systems such that certain service areas may be served from multiple source waters. Since the systems in the area are both surface water (Traverse City) and Groundwater (other systems), it is important to understand the potential impacts of commingling of these possibly differing source and treated waters to ensure there are not any issues in the distribution system or at customer sites.

In summary:

- A surface water source is provided by the City of Traverse City.
- The major groundwater sources in the area are Blair Township, and East Bay Township (note that other groundwater systems exist, but are not currently located for ease of interconnection with the others; however, in general, considerations indicated herein would apply to other groundwater sources as well).
- All three are separate systems now, but for the purpose of this study, an evaluation is to be made of the ability to serve some areas currently served by surface water with groundwater, or vice versa, and the ability to mix surface water with either of the groundwater sources in certain areas of the system.
- The potential for distribution system impacts related to a change from surface water to groundwater or vice-versa, as well as any potential impacts from mixing of the surface water with groundwater are to be evaluated.

The following information served as the basis for this evaluation:

- Miscellaneous detailed water quality data for the GW systems, provided by East Bay Township and Blair Township.
- Monthly reports from Traverse City WTP.
- Traverse City WTP treatment process information.
- General information on treatment systems at the groundwater systems from MDEQ Sanitary Surveys and past Reliability Studies.
- Consumer confidence reports.

Although much information is available as indicated above, the available information does not include several of the water quality parameters needed to do a detailed review of potential stability problems associated with blending of the various sources. This is not due to a lack of appropriate data for each source and its regulatory requirements, but simply due to certain critical parameters not being regularly monitored for a given system. For example, no calcium hardness data is available for any of the sources, with this being a critical parameter in assessing compatibility with respect to scaling potential in the distribution system. Other desired information would include treated pH, temperature, and alkalinity for the groundwater systems, and total dissolved solids information for all of the sources. Therefore, without this additional data, the evaluation provides general conclusions based on the available water quality data, along with recommendations for further analysis should commingling of the sources be considered.

In looking at both the groundwater and treated surface water, making some assumptions regarding concentrations for water quality parameters which are not available and performing stability calculations, it appears that none of the evaluated sources likely has any appreciable tendency to deposit protective calcium carbonate scale within the distribution system. Running some blending scenarios using the same assumed quality parameters also did not suggest that blending of the groundwater and surface water at various blend ratios would result in conditions where excessive deposition of calcium carbonate might be expected. Actually, as both sources likely exhibit negative calcium carbonate precipitation potentials (or stated another way, they actually exhibit a tendency to dissolve existing calcium carbonate deposits, rather than to lay down new deposits), blending would not be expected to shift the relative stability of sources such that they would tend to deposit calcium carbonate.

Therefore, on a general basis, there probably does not appear to be a significant potential for issues when commingling source waters; however, this general conclusion is made without the benefit of additional data that could offer a more definitive conclusion.

As further consideration is made of system modifications and improvements that may lead to commingling of the various source waters, it is recommended that data be collected and evaluated to confirm the above conclusion. Recommended data for further evaluation includes:

- Calcium hardness (for both surface water and groundwater systems)
- Total Dissolved Solids (for both surface water and groundwater systems)
- Treated pH, temperature, and alkalinity (for groundwater systems)

6.0 Conclusions and Recommendations

A three-part strategy is recommended for the purpose of improving cooperation and coordination.

- Develop a Water Systems Planning Task Force of the BPW Water and Sewer Committee Made up of Engineering, Operation and Management Representatives from Each System
    - Review Master Plan and make recommendations that can be referred to each water system owner for adoption
        - Pressure Zone Standardization
        - Emergency Connections
        - Regional Projects
        - Security and Safety
        - Models for Regional Cooperation
        - Agreements
        - Water Use Conservation and Efficiency
    - Further Master-Planning Efforts
- Establish centralized planning. Specific services can be contracted out as necessary. The functions of the planning body could include the following:
    - Design Review- to assure compliance with adopted recommendations
    - Improve and maintain water system computer models
    - Maintain systems data
        - Pump Curves

        - Information about Storage Tanks including pertinent elevations
        - Master-planning documents and previous studies
        - Maintain water-meter database (customer and system meters)
        - Information on PRVs (elevations, downstream pressure settings, etc.)
        - MDEQ Water System Review Documents
        - Design Plans and Record Drawings
        - Shop Drawings
        - System Maps
    - provide technical support to owners' consultants
    - Facilitate project financing
- Public Education
    - Develop a plan for providing information to the public about master planning efforts and regional plans that will be implemented

VI. TECHNICAL MASTER PLANNING

A. Introduction

Continued steady growth in the area along with existing and future pending challenges gives rise to the need for a new regional paradigm for the area's public water systems. The seemingly most urgent priority in this regard is for the adoption of a simplified, uniform, standard set of pressure zones that cross all municipal, water system and water district boundaries. A rigorous process was undertaken to identify a system of pressure zones that met this goal to optimize efficiency and preserve the most important potentially affected existing system components (mostly storage tanks and booster stations). Once this was accomplished, water districts were established with logical boundaries based for the most part on the existing systems organization. This made it possible to evaluate capacity requirements of various system components such as supply wells, storage and booster stations on a water district by water district basis at several points in the future.

A capacity evaluation based on demands ten years into the future (year 2017) was the next step in the process. This was done to meet MDEQ Reliability Study requirements. The purpose of MDEQ required Reliability Studies is to evaluate the system water supply capacity in light of ten-year future demands. In addition, it is required that "…a means shall be provided to continuously supply finished water to the entire distribution system during periods when the normal power service is interrupted".

With proposed pressure and water districts defined, a future ultimate build-out conceptual planning map of the water systems was developed to meet the following goals:

- Improve systems' reliability and resiliency
    - Improve system looping
    - Increase system component redundancy
- Improve water quality
    - Improve system looping and reduce the number of dead-ends
- Reduce all costs
    - Provide a master plan that can guide efficient water system development
    - Reduce energy costs for pumping
    - Reduce operation and maintenance costs
    - Minimize storage costs by using ground storage where possible
    - Provide for the efficient movement of water throughout the systems
- Prepare for emergencies

  - Provide for emergency sharing of water
- Position the water systems to accommodate growth as necessary and to meet regulatory capacity requirements

Ultimate build-out demands were developed on a water district by water district basis to give an idea of what the ultimate capacity requirements will be. This ultimate build-out conceptual plan is intended to steer near-term plans in the direction that best positions each water system to meet future demands. This process is meant to ensure that money spent today serves us well tomorrow.

Once the ultimate build-out conceptual plan was completed, a "Near Term" recommended water systems improvement plan was developed. Planning improvements now to meet the ten year demands, as required by the Reliability Study requirements, does not give the systems' owners time to implement or to plan improvements that will serve far enough into the future. This Near Term Plan consists of improvements that are recommended to be made over the next ten years and are based on meeting capacity requirements twenty years beyond that (to the year 2037). The Near Term plan includes those improvements necessary to convert to the new pressure zone plan and to meet the year 2037 capacity requirements while meeting the goals listed above.

The technical master planning portion of the study included for the most part only those entities having public water supplies. The information is presented in the order that the systems will progress in the future as follows:

Section VI.B.4	Reliability Study	Basis: Year 2017 Demands
Section VI.B.5	Near-term Plan	Basis: Year 2037 Demands
Section VI.B.6	Ultimate Build-out	Basis: Ultimate Build-out Demands

Sections VI.B.1 through VI.B.3 lay the ground work for these later sections.

B. Systems Reliability Study and Master Planning

1.0 Regional Pressure Zone Plan

As mentioned earlier, there are more than 35 different water pressure zones throughout the study area not counting Private Type I systems (see Figure IV.A.3). A pressure zone is an area that under static water conditions would have a common hydraulic grade line. A few of these pressure zones have HGLs similar to other pressure zones but they are geographically distant from each other with no current connections.

Some of this fragmentation has been necessary because of the limited extent water systems in some areas. However, without a regional pressure zone master plan to guide future projects some concerns are noted here:

- Plans for new developments often create new pressure zones instead of being adjusted to fit a master plan,
- Connections between adjacent areas at similar elevations are often not feasible because of differing hydraulic grade lines. This can limit redundancy (reliability), looping and fire flows. A particular area is often dependent upon a single booster or PRV station.
- The water systems become unnecessarily complicated and can lead to unnecessary duplication of water facilities (booster stations, storage, etc.),
- There are areas of unusually high or low pressures,
- Energy costs are higher because of inefficient movement of water,
- Costs for capital improvements, operation and maintenance will be higher in the long run with an ever increasing number of pressure zones.
- Sharing water between various areas in an emergency can be much more difficult.

An initial step in the technical master planning process was to work to develop a simplified, uniform, standard set of pressure zones that cross all municipal, water system and water district boundaries. This is a fundamental step towards accomplishing the goals laid out in VI.A above. Proposed pressure zone boundaries follow specific elevation contours with each pressure zone having a lower limit contour and an upper limit contour. The objective that the Wilcox/Black & Veatch team set out to accomplish was to provide pressure zones based on a consistent interval of contours if possible.

One big consideration in the process was the preservation of the most important potentially impacted existing system components such as storage tanks and booster stations. The first step was to develop a list of water district hydraulic grade lines (HGLs) upon which pressure zone boundaries would be based. A list of existing water storage tanks was developed along with normal high water elevation (HGL) for each. A computational scheme was developed to incrementally test potential starting HGL elevations and interval between the selected HGLs. Each particular potential starting HGL elevation and HGL interval combination formed a specific set of potential HGLs. Each potential HGL set was tested for fit with existing water storage tanks. The testing was done by taking the difference between the normal high water elevation for a particular water storage tank and the nearest HGL of the potential HGL set. The absolute values of the differences for all of the tanks were added together. The goal was to find potential HGL sets with a minimal sum of differences. Table VI.B.1 provides the selected HGL set and gives insight into how this process developed.

This approach was taken by sorting the storage tanks according to the following areas and completing the same process for each area:

West of the Boardman River

East of the Boardman River

Acme Township

All areas together

Thousands of potential HGL sets were tested for fit with the existing water storage tanks as a means of preserving the most tanks. Matching the existing storage tanks also provided a surrogate match of existing booster stations and wells. Ultimately tanks that were already under-capacity were eliminated from the analysis. On the basis of this work the following pressure zone solution presented in Table VI.B.1 was deemed to be the best. In the table, minimum differences for tanks that do not fit the proposed pressure zones well at all are highlighted with a tan color. Minimum differences for tanks that fit the proposed pressure zones well are highlighted in yellow. It should be noted that all of the tanks highlighted in tan are already under their required capacity with the possible exception of the Grand Traverse Resort elevated tank for which no capacity analysis was undertaken.

The proposed solution yields only six pressure zones throughout the entire study area. These have boundaries starting at the bay with HGLs at elevations 770, 855, 940, 1040, 1140 and 1240 and pressure zone boundaries at elevations 660, 745, 835, 935,1035 and 1135 as presented in Table VI.B.1. Once these are implemented, interconnections can be made between water systems and water districts anywhere within a pressure zone.

Table VI.B.1- Proposed Standard Pressure Zones

Tank	Tank Normal High Water Elev.	DIFFERENCE BETWEEN TANK NORMAL HIGH WATER ELEVATION AND HGL					
		HGL 770	HGL 855	HGL 940	HGL 1040	HGL 1140	HGL 1240
G.T. Resort	821.0	51.0	-34.0	-119.0	-219.0	-319.0	-419.0
Birmley Estates	879.0	109.0	24.0	-61.0	-161.0	-261.0	-361.0
Turtle Creek	936.0	166.0	81.0	-4.0	-104.0	-204.0	-304.0
McRae Hill	940.0	170.0	85.0	0.0	-100.0	-200.0	-300.0
Cherry Ridge	958.0	188.0	103.0	18.0	-82.0	-182.0	-282.0
English Woods	1038.4	268.4	183.4	98.4	-1.6	-101.6	-201.6
Blair	1043.3	273.3	188.3	103.3	3.3	-96.7	-196.7
Heritage Estates	1089.5	319.5	234.5	149.5	49.5	-50.5	-150.5

Pressure Zone		**Z1**	**Z2**	**Z3**	**Z4**	**Z5**	**Z6**
Upper Elev. Contour of Pressure Zone		660	745	835	935	1035	1135
Pressure at Upper Limit (psi)		47.6	47.6	45.5	45.5	45.5	45.5
Lower Elev. Contour of Pressure Zone		590	660	745	835	935	1035
Pressure at Lower Limit (psi)		77.9	84.4	84.4	88.7	88.7	88.7
Pressure Zone Elevation Range		70	85	90	100	100	100

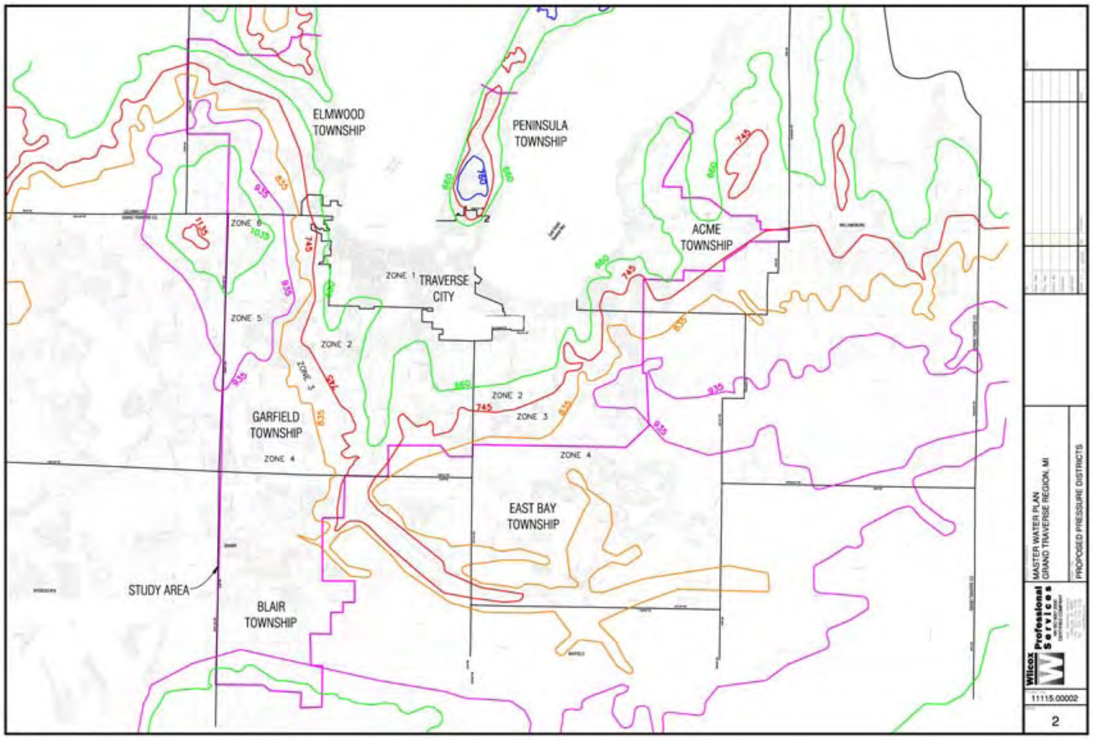
It should be noted that Peninsula Township can be on a different pressure zone solution because of no possible future lateral connections with other systems. For Peninsula Township and that portion of the City served by the Huron Hills Booster Station, the following is proposed:

Table VI.B.2- Peninsula Township Proposed Standard Pressure Zones

Pressure Zone		**Z1**	**Z2P**	**Z3P**
HGL		**770**	**865**	**965**
Upper Elev. Contour of Pressure Zone		660	760	860
Pressure at Upper Limit (psi)		47.6	45.5	45.5
Lower Elev. Contour of Pressure Zone		590	660	760
Pressure at Lower Limit (psi)		77.9	88.7	88.7
Pressure Zone Elevation Range		100	100	100

The proposed pressure zones are shown in Figure VI.B.1. These are shown in greater detail in Figure VI.B.4 in Appendix E.

Figure VI.B.1- Proposed Standard Pressure Zones



2.0 Water District Plan

2.1 Water Districts

For the purposes of this study the existing water systems have been divided into proposed water districts that were established with logical boundaries based on the existing water district organization with adjustments to match the study objectives and recommended improvements. A water district is defined as an area of water distribution that is served by a particular source such as the WTP, a group of connected wells or a particular booster station. The water districts are shown in Figure VI.B.2. It is not critical to understand the water district numbering system but the numbering system was developed as follows. The leading number is arbitrary but denotes a specific source of water (supply or booster station) that can cross political boundaries. The letter(s) denotes the owner of the water system. The number following the letter(s) is an arbitrary but unique number that represents a particular supply or upstream booster station within a particular system. A final letter(s) makes the entire designation unique for the specific water district. Although the proposed water districts are similar to those presented as existing water districts in Figure

IV.A.2, most of them are different because they have been made up based on the proposed configuration of the water systems.

The water district delineation makes it possible to evaluate capacity requirements of various system components such as supply wells, storage and booster stations on a water district by water district basis. Many of the water district boundaries follow pressure zone boundaries. The water districts sometimes cover more than one pressure zone within their boundaries. In that case, water is fed to the separate zones via separate pumps within a booster station or is fed from upper to lower pressure zones via PRVs.

2.2 Population by Water District Using Census Data

Once the proposed water districts were established, Year 2000 census data was used to determine the 2000 population within each water district. This was done using information on a Census Block level with the population for each Block being assigned to a particular water district, or for the occasional Block crossing water district boundaries, distributed among multiple water districts. The 2006 population by Water district was established by increasing the population in each district in proportion to the estimated overall increase in Township population. The 2006 population estimates serve as a base line population for purposes of this study. The 2006 overall Township population estimates are discussed in Section VI.B.3.0 below.

2.3 Customer Meter Data by Water District

Individual monthly customer meter data was obtained from the County for East Bay, Elmwood, Garfield and Peninsula Townships. That data included Account Number, Name, Service Address, Billing Class, Water Benefit Factor, Meter Number, Route Number, and Monthly or Quarterly Consumption for the years 2005 through 2007. The County uses Billing Class designations of Residential, Commercial, Industrial or Other. The data also included GPS coordinates in Binary Angle Measurement (BAM) format for each of the meters. The BAM format data was converted to State Plane Coordinates. The meter location data was placed in the Water district map with the GPS coordinates as X and Y values and the Customer Account Number being the Z value. The meter location data was then exported from the map by Water district such that a Water district label could be assigned to each record of the customer meter data. The 2006 customer meter data was used because it is the baseline year of the study. Accounts with zero consumption were removed from the analysis. Because of some mid-year meter change-outs and clerical issues with the data, the data was reviewed for highly unusual consumption values which were replaced with estimated values. In addition, a minor correction factor was then applied to the consumption data for each meter such that the total of the annual consumption data for that particular water system or water district matched the total water produced.


PROPOSED WATER DISTRICT MAP
ELMWOOD TOWNSHIP
PENINSULA TOWNSHIP
ACME TOWNSHIP
GARFIELD TOWNSHIP
EAST BAY TOWNSHIP
BLAIR TOWNSHIP
STUDY AREA
30EL2
150EL4
110EL5
30EL2
110EL5
60EL3
120EL1
30TC6
60TC5
120G6
110G4C
30G8
60TC2
30G7
60G5
30TC1
70TC4
30TC1
110G4C
100G4B
30G3
30G1
30TC1
70G2A-W
30G1
20EB1-N
10EB2
100G4B
90G4A
30G1
70G2A-E
20EB1-S
30G1
80G2B
85G2C
10EB2
30P2
40P3
50P4
40P3
30P1
40TC3
30TC1
130B1
130B1
130B1
130B1
130B1
140B2
West Grand Traverse Bay
East Grand Traverse Bay
LEELANAU CO.
GRAND TRAVERSE CO.
WILLIAMSBURG
INTERLOCHEN
GRAWN
MAYFIELD
GRAND TRAVERSE CO.
Project Information
MASTER WATER PLAN
GRAND TRAVERSE REGION, MI
Sheet Title
PROPOSED WATER DISTRICTS
Wilcox Professional Services
AN ISO 9001:2000 CERTIFIED COMPANY
ONE MADISON AVENUE
CADILLAC, MI 49601
PH: 231-775-2755
FX: 231-775-3135
www.Wilcox.us
Scale: 1" = 4000'
Project No.
11115.00002
Sheet
3

2.4 Analysis of 2006 Customer Meter Data by Water District

The 2006 customer meter data was analyzed and the ADD was determined for each Water district and each Billing Class within each Water district. The 2006 ADD information by water district, along with additional analysis explained below, are summarized in a spread sheet provided in Appendix H.

The 2006 customer meter data was also analyzed to determine number of residential units, estimated served population, ADD per capita and Residential ADD/Total ADD ratio for each Water district. For many apartment and condominium buildings there is a common water meter for several units. In these cases the number of residential units was determined from the Water Benefit Factor for the common meter. The total number of residential units for each Water district was then determined by adding the sum of the Water Benefit Factors for the common apartment/condominium meters to the number of other residential meters. Estimated Served Population was determined by multiplying the number of residential units by the Average Household Size for that particular Township.

An analysis of per capita ADD was undertaken to determine how it differs between urban and suburban areas as shown in Table VI.B.3.

Table VI.B.3- Per Capita Average Day Demand

Water District	2006 ADD	Estimated Served Population (1)	Per Capita ADD
URBAN AREAS			
20EB1-N	188,150	2,115	89
30EL2	4,573	100	46
30G1	69,915	1,368	51
30G3	2,208	43	51
	264,846	**3,626**	**73**
SUBURBAN AREAS			
10EB2	156,316	1,410	111
20EB1-S	81,346	632	129
40P3	81,720	583	140
80G2B	13,573	71	192
90G4A	5,964	84	71
100G4B	296,539	2,253	132
110EL5	42,106	457	92
110G4C	113,287	604	187
	790,851	**6,094**	**130**
MIXED URBAN/SUBURBAN			
30P1	26,265	238	111
30P2	2,977	37	81
70G2A-E	157,340	2,100	75
70G2A-W	128,329	1,838	70
	314,911	**4,212**	**75**

NOTES:

1) Number of Residential Meters X Average Household Size for that Township

For this report, per capita ADD will be taken as 75 GPD per person for urban areas and 130 GPD per person for suburban areas.

3.0 Population Projections

Population projections are used for determining future demands. Available census data was compiled from 1960 to 2000 for the City and the Townships. This data was plotted for each Township and was modeled using a best fit straight line to develop an equation for population by year. The best fit modeling gave a very high coefficient of determination (close to 1) in each case demonstrating that a straight line fits the data well thus matching the historical growth trend very well. These equations were used to project population growth into the future. This is shown in Figure VI.B.3. The equations for each Township are provided below. The population trend for the City was not modeled because there has clearly been a slight decline in population over the past decades and this methodology for population projections will not be used in estimating future demands.

East Bay Township Population = 197.21 * YEAR - 384410.2

Garfield Township Population = 280.89 * YEAR - 548039.2

Peninsula Township Population = 82.02 * YEAR - 158781

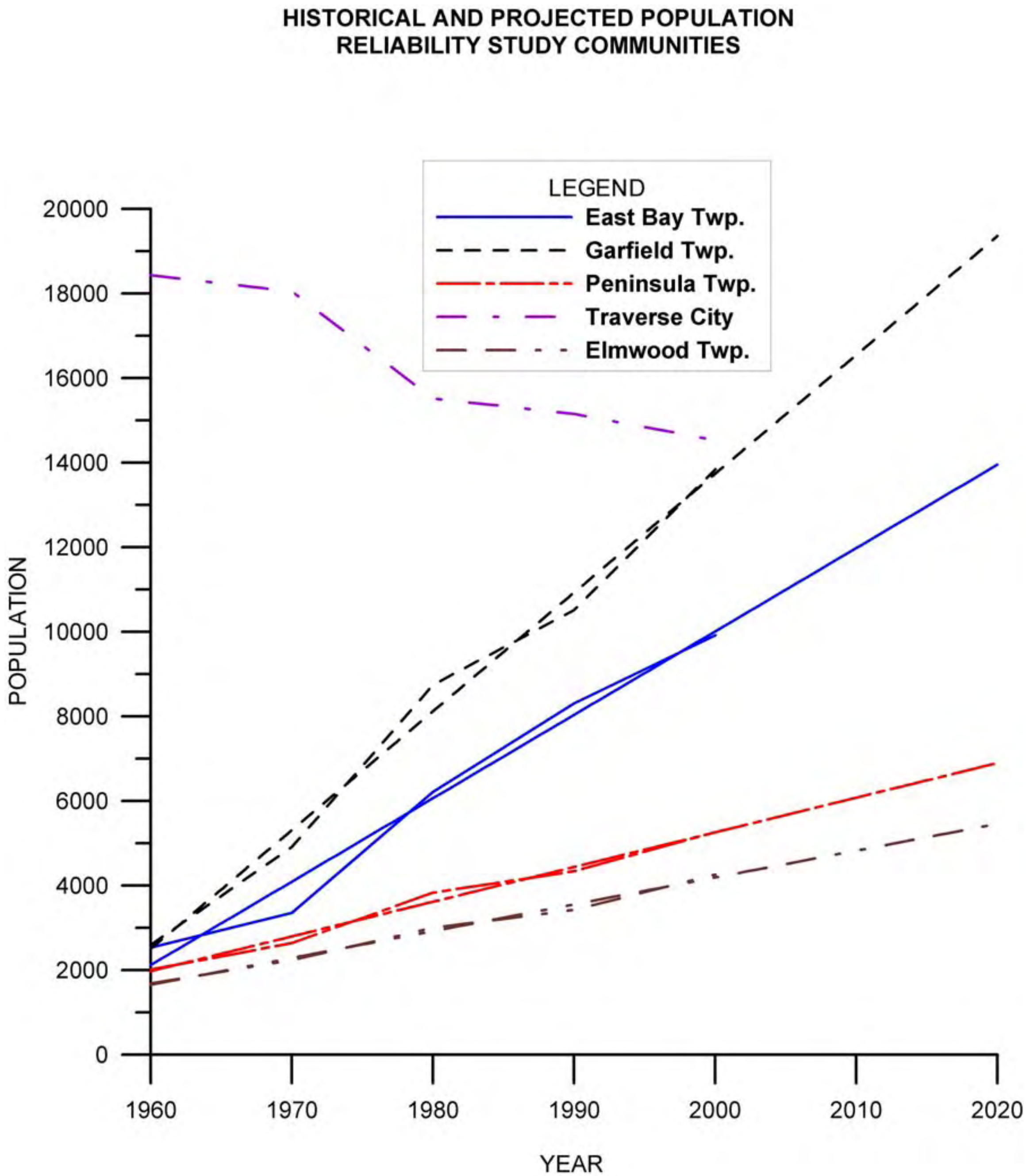
Elmwood Township Population = 63.41 * YEAR - 122627.4

The projections for specific years of interest to this study are presented in Table VI.B.4.

Table VI.B.4- Population Projections

	2000	2006	2017	2037	
Garfield	13,840	15,426	18,516	24,134	
Elmwood	4,264	4,573	5,271	6,539	
East Bay	9,919	11,193	13,362	17,307	
Peninsula	5,265	5,751	6,653	8,294	
Traverse City	14,532	14,667	15,837	16,148	T.C. est.

Figure VI.B.3- Historical Population and Best Fit Straight Line Projected Population



4.0 Reliability Study Capacity Evaluations

The purpose of MDEQ required Reliability Studies is to evaluate the capacity of existing system components in light of ten-year future demands, in this case for the year 2017. This report as previously issued on September 8, 2008 based the Reliability Study Capacity Evaluations on the assumption that all recommendations made in the Near-term Plan would be in place by the year 2017. Therefore, system components that would be obsolete as a result of the Near-term Plan were not evaluated. In addition, no recommendations were made based on the 2017 demands but instead were made on the basis of 2037 demands in the Near-term Plan. With this revision, all system components currently in place are evaluated on the basis of 2017 demands at the request of the MDEQ, and where deficiencies are expected by the year 2017, recommendations for improvements are made with reference to the Near-term Plan for details.

4.1 General Information

Reliability Study work to fulfill the requirements of Part 12 of the Administrative Rules of the Michigan Safe Drinking Water Act (SDWA), PA 399 of 1976 as Amended has been completed for selected systems within the study area. The purpose of the Reliability Study is to analyze the reliability of the Type I water system in order to assure a continuous supply of water for drinking and household (domestic) purposes. It includes analysis of existing and projected capacities of the supply, booster stations and storage. This analysis has been presented to the Michigan Department of Environmental Quality on behalf of this Study's Level One entities (East Bay, Elmwood, Garfield and Peninsula Townships and the City of Traverse City). Some of the provisions of Part 12 are presented here.

It is stated in Part 12 of the Administrative Rules that "The owner of a Type I public water supply shall conduct a study to determine the quantity of water supply needed for the waterworks system and shall propose a method of compliance…" It also states that "The study… shall be based upon 10-year projections of water use by the public water supply. The study shall be updated every 5 years…."

The study requires as a minimum the following information for both present and ten-year projected demand conditions:

- Average daily demand,
- Maximum daily demand,
- Maximum hourly demand,
- Peak instantaneous demand (for systems using hydropneumatic storage),
- Fire flow demand

The basis of the demand projections must be presented in the report.

Rule 1204 of Part 12 states that "A supplier of water of a type I public water supply shall provide sufficient capacity in the waterworks system to meet the approved finished water supply requirements. That capacity may be one or any of the following:

a) Rated capacity from an approved surface water supply or complete treatment system.
b) Firm capacity from an approved groundwater supply where firm capacity equals the flow with the largest producing well out of service.
c) The available capacity obtained under contract and capable of delivery from another approved water supply.
d) Finished water storage capacity in excess of the established normal waterworks system requirements."

Another provision of Part 12 for public Type I water systems is that "a means shall be provided to continuously supply finished water to the entire distribution system during periods when the normal power service is interrupted".

Additional guidance considered in this report relative to storage includes:

- Guidance from the "Recommended Standard for Water Works," 2007 Edition (Ten State Standards) states that "Storage facilities should have sufficient capacity, as determined from engineering studies, to meet domestic demands, and where fire protection is provided, fire flow demands."
- Part 11 of the SDWA is guidance for distribution and storage tanks. Rule 1105 states that "distribution systems shall have sufficient capacity to meet peak demands, including fire flow demands where fire protection is provided, while continuously maintaining positive pressure adequate for service."
- The American Water Works Association AWWA Manual M32, Distribution Network Analysis for Water Utilities, states "enough storage capacity must be available to provide clear-well storage for service-pump operation and system storage for equalization, fire reserve, and emergency needs." Where equalization storage is the amount of water required to meet water system demands in excess of delivery capability.

4.2 Year 2017 Population by Water District

The first step in the determination and evaluation of capacities for the Year 2017 was to estimate the 2017 population by proposed water district. The Year 2006 and Ultimate Build-out population figures were used for this purpose (the Ultimate Build-out population determination methodology is described in Section VI.B.6.0 below). The 2017 population for a particular district was calculated to be X proportion of the distance between the 2006 population and the Ultimate Build-out population, with the factor X being equal to the equivalent proportion for the entire total township population. Since the Ultimate Build-out population was not estimated for the township outside the project Study Area the composite Ultimate/2006 population ratio for all Water districts within the Study Area combined was used to estimate the Ultimate population outside the Study Area for each township. This determination of 2017 population by Water district is shown in Table VI.B.5.

Table VI.B.5- 2017 Population Projections By Water District

Proposed Water District	Water Sub-District	2006 Population	2017 Population	Ultimate Population	Ultimate/ 2006
East Bay Township					
10	EB2	3,569	4,054	17,934	5.0
20	EB1-N	2,207	2,639	15,001	6.8
20	EB1-S	589	906	9,999	17.0
	EB Outside	4,828	5,763	32,561	6.7
	Totals	**11,193**	**13,362**	**75,495**	6.7
Elmwood Township					
30	EL2	1,729	1,964	9,221	5.3
60	EL3	40	78	1,260	31.8
110	EL5	1,343	1,526	7,183	5.3
120	EL1	48	54	226	4.7
150	EL4	224	278	1,935	8.6
	EL Outside	1,189	1,371	6,969	5.9
	Totals	**4,573**	**5,271**	**26,794**	5.9
Garfield Township					
30	G1	1,567	1,741	3,455	2.2
30	G3	89	91	106	1.2
30	G8	18	35	205	11.5
60	G5	218	430	2,510	11.5
70	G2A-E	3,521	3,859	7,189	2.0
70	G2A-W	1,837	2,269	6,524	3.6
80	G2B	202	424	2,607	12.9
85	G2C	26	35	130	5.1
90	G4A	115	205	1,091	9.5
100	G4B	5,227	6,103	14,720	2.8
110	G4C	2,251	2,851	8,753	3.9
120	G6	256	353	1,308	5.1
	G Outside	98	118	311	3.2
	Totals	**15,426**	**18,516**	**48,909**	3.2
Peninsula Township					
30	P1	516	645	2,753	5.3
30	P2	421	538	2,458	5.8
40	P3	888	988	2,620	3.0
50	P4	660	702	1,399	2.1
	P Outside	3,267	3,780	12,141	3.7
	Totals	**5,751**	**6,653**	**21,371**	3.7
Traverse City (Note 1)					
30	TC1	12,880	12,922		
40	TC3	578	580		
60	TC2	92	129		
60	TC5	90	1,175		
70	TC4	1,027	1,031		
	Totals	**14,667**	**15,837**		

NOTES:

1) Traverse City 2006-2017 population estimates using information from County Planner and uniform changes in all water districts except 60TC2 and 60TC5 where estimates are derived from 2005 Basis of Design for Wayne Hill Booster Station.

4.3 Year 2017 Demands by Water District

Once the projected 2017 population was estimated for each Water district it was possible to develop estimated demands for that year. This includes estimates for Average Day Demand (ADD), Maximum Day Demand (MDD), Maximum Hour Demand (MHD) and Peak Instantaneous Demand (PID). The methodology for determination of these demands for the year 2017 is presented here.

Average Day Demand (ADD)

The analysis described here is presented in Table VI.B.7. The first question to answer was how much of the existing population that is not now served by the PWS will be served in 2017? The estimated 2006 un-served population for each water district came from the difference between the total population and the estimated served population which was determined as explained in Section VI.B.2.4 above. The 2006 un-served population in a particular water district that will be served by 2017 was taken across the board as being 25% of the 2006 un-served population for that district.

The next step was to estimate what percentage of the new 2017 population that will come to the water district after 2006 will be served by the PWS. Judgment was used based on the degree of the current PWS development within the Water district to estimate the percentage. One-hundred percent was used for urban areas such as Traverse City. A percentage as low as 25% was used for rural Water districts.

The total newly served population in 2017 was estimated by adding the 2006 un-served population that will be served by 2017 and the new population estimated to be served in 2017. The increase in residential ADD for each Water district from 2006 to 2017 was computed by multiplying the estimated newly served population in 2017 by the appropriate urban or suburban per capita ADD as determined in Section VI.B.2.4 above.

The next step in the analysis was to add in the increased non-residential ADD to come up with the total increase in ADD for each Water district. A *Residential ADD/Total ADD* factor was estimated as 1/3 of the way between the *2006 Residential ADD/Total ADD* ratio and the *Ultimate Build-out Residential ADD/Total ADD* ratio. The increase in residential ADD was divided by this factor to arrive at the total increase in ADD for each water district from 2006 to 2017 as shown in Table VI.B.7.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.7 DETERMINATION OF INCREASE IN AVERAGE DAY DEMAND FROM 2006 TO 2017
Wilcox/Black & Veatch
Revised: December 20, 2009

Water District	Water Sub-District	2006 Est. Served Population	2006 Population	2006 Unserved Population	2006 Unserved Population Est. to be served in 2017 25%	2017 Population	Population Increase 2006-2017	Percent of Pop. Increase Served in 2017	Served Population Increase	Total New Served Population (F + J)	Per Capita ADD	2006 Residential ADD/ Total ADD	Ultimate Residential ADD/ Total ADD	1/3 of Way Between P & Q	Increase in ADD 2006-2107 K*N/R	
A	B	C	D	E	F	G	H	I	J	K	N	P	Q	R	T	
East Bay Township																
10	EB2	1,410	3,569	2,159	540	4,054	485	50%	242	782	130	0.930	1.00	0.95	106,653	
20	EB1-N	2,115	2,207	92	23	2,639	432	100%	432	455	75	0.452	0.69	Note 3	75,446	
20	EB1-S	632	589	0	0	906	317	75%	238	238	130	0.593	0.85	0.68	45,606	
	Totals	4,157	6,366			7,599				1,475					227,705	
Elmwood Township																
30	EL2	100	1,729	1,629	407	1,964	235	75%	176	584	75	0.277	0.82	0.46	95,566	
60	EL3	0	40	40	10	78	38	75%	29	39	75	1.000	1.00	1.00	2,899	
110	EL5	457	1,343	886	221	1,526	183	50%	92	313	130	0.794	0.69	0.76	53,603	
120	EL1	0	48	48	12	54	6	25%	1	13	130	1.000	1.00	1.00	1,750	
150	EL4	0	224	224	56	278	54	25%	13	69	130	1.000	1.00	1.00	9,030	
	Totals	557	3,384			3,900				1,018					162,847	
Garfield Township																
30	G1	1,368	1,567	199	50	1,741	174	100%	174	224	75	0.228	0.33	0.26	64,120	
30	G3	43	89	46	12	91	2	100%	2	13	75	0.031	0.06	0.04	24,151	
30	G7														530	Note 1
30	G8	0	18	18	4	35	17	100%	17	22	75	1.000	1.00	1.00	1,630	
60	G5	0	218	218	55	430	211	75%	159	213	75	0.003	0.57	0.19	83,285	
70	G2A-E	2,100	3,521	1,421	355	3,859	338	75%	254	609	75	0.448	0.39	0.43	106,570	
70	G2A-W	1,838	1,837	-1	0	2,269	433	75%	324	324	75	0.312	0.53	Note 3	77,910	
80	G2B	71	202	131	33	424	222	75%	166	199	130	1.000	1.00	1.00	25,890	
85	G2C	0	26	26	6	35	10	50%	5	11	130	1.000	1.00	1.00	1,459	
90	G4A	84	115	31	8	205	90	50%	45	53	130	0.106	0.25	0.15	44,522	
100	G4B	2,253	5,227	2,974	744	6,103	876	50%	438	1,182	130	0.840	0.76	0.81	188,861	
110	G4C	604	2,251	1,647	412	2,851	600	75%	450	862	130	0.687	0.79	0.72	155,321	
120	G6	7	256	249	62	353	97	50%	49	111	130	1.000	1.00	1.00	14,412	
	Totals	8,368	15,328			18,398				3,823					788,661	
Peninsula Township																
30	P1	238	516	278	69	645	129	75%	97	166	75	1.000	1.00	1.00	12,474	
30	P2	37	421	384	96	538	118	75%	88	184	75	0.697	1.00	0.80	17,307	
40	P3	583	888	305	76	988	100	75%	75	151	130	0.950	1.00	0.97	20,346	
50	P4	5	660	655	164	702	43	75%	32	196	130	1.000	1.00	1.00	25,443	
	Totals	863	2,484			2,874				697					75,571	
Traverse City (Note 2)																
30	TC1	12,880	12,880			12,922	42	100%	42	42	75					
40	TC3	578	578			580	2	100%	2	2	75	1.000	(assumed)	Col. P Used	142	
60	TC2	92	92			129	37	100%	37	37	180	1.000	(assumed)	Col. P Used	6,688	
60	TC5	90	90			1,175	1,085	100%	1,085	1,085	180	1.000	(assumed)	Col. P Used	195,331	
70	TC4	1,027	1,027			1,031	3	100%	3	3	75	1.000	(assumed)	Col. P Used	252	
	Totals	14,667	14,667			15,837				1,170				Note 2:		

NOTES:
1) No existing demand or population information. 2017 ADD assumed to be 1/3 of Ultimate Build-out ADD.
2) Traverse City 2017 ADD is assumed to be 2006 ADD (3.602MGD) times expected population increase (1.003) except for Water Districts 60TC2 and 60TC5 where population estimates are derived from the 2005 Basis of Design for the Wayne Hill Booster Station.
3) Ratio in Column P is used. Otherwise 2017 ADD is lower than 2006 ADD

As a means of taking advantage of the population determinations and the water meter records that were analyzed based on proposed water district these computations for the increase in ADD by water district were carried out on the basis of the proposed water district boundaries. Therefore, the increase in ADD from 2006 to 2017 for the proposed water districts was allocated to the existing water districts and then added to their 2006 ADD to arrive at the 2017 ADD. There was a good correlation between existing and proposed water districts in most cases. In a couple of cases, an estimated allocation based on evaluation of relative growth between districts had to be made. The resulting 2017 ADD by existing water district is presented in Table VI.B.8.

Maximum Day Demand (MDD)

Maximum day demands for each water district as presented in Table VI.B.8 were determined in the following manner:

> Existing 2006 supply and other master meter records were analyzed to determine the relationship between ADD and MDD. Where meter data was not recorded on a daily basis (most cases) the average daily demand for the maximum month was computed. The average daily demand for the maximum month was then multiplied by a factor between 1.3 and 1.5 (depending on the system or district size and based on guidance from the MDEQ) to arrive at the MDD. The MDD/ADD peaking factor was plotted against ADD for several systems and water district areas served by master meters, wells, booster stations and the City WTP to determine a relationship between the peaking factor and ADD that could be used in projecting future MDD values based on projected ADD. The data in the graph was modeled using two best fit lines, one below 0.1188 MGD and one above 0.1188 MGD resulting in the following equations:
>
> *MDD Peaking Factor = -17.2449312 * ADD + 4.775149102 (for ADD below 0.1188 MGD)*
> *MDD Peaking Factor = -0.02062783184 * ADD + 2.728019583 (for ADD above 0.1188 MGD*

These equations were used to establish a MDD/ADD peaking factor for each Water district and the resulting MDD. In some cases where we have good previous data for several years as provided in the MDEQ Water System Review Documents an average MDD/ADD from those years was used instead of the above formula. However, if there was an increase of 1.5 times or more in ADD from 2006 to 2017 then the historical data was disregarded and the formulas above were used which generally produced a smaller peaking factor because of the larger ADD. An exception to this is the area served by the Herkner Road Booster Station where the formula would have created a much larger peaking factor than existing. For this area, because of the influence of the school, which apparently diminishes the peaking factor because of consistent demand and reduced usage in the summer months, a peaking factor mid-way between the peaking factor by formula and the average of peaking factors from historical data was used.

In a few instances, the MDD for a particular water sub-district was determined indirectly from the difference in MDD for the entire district and the MDDs for the other sub-districts. In those cases, the MDD/ADD factor was calculated directly from the ADD and MDD. There was one more special case in the determination of MDDs. The 2017 MDD requirement for East Bay Township Booster Station Number One on 5 Mile Road is developed by computing the 2017 Holiday Hills MDD minus the Holiday Hills firm well capacity.

Maximum Hour Demand (MHD)

The maximum hour demands as presented in Table VI.B.8 have been determined by multiplying the MDD by peaking factors. The peaking factors are derived from linear regression of peaking factors for similar-sized water districts in Madison, Wisconsin as determined by diurnal data. The equation developed from linear regression is as follows: MHD = -0.06865 x MDD + 2.205

Peak Instantaneous Demand (PID)

For water districts served by booster stations without downstream storage the PID was determined for the purpose of evaluating booster station capacity. The resulting PIDs are shown in Table VI.B.8. The following guidance for determining PID based on the number of residential unit served was provided by the MDEQ:

2.5 gpm/unit, first 40 units = 100 gpm

1.75 gpm/unit, 41-80 units = 70 gpm

1.5 gpm/unit, units 81-150 = 105 gpm

Because some of the service areas have ICI customers, it was necessary to determine an equivalent number of residential units to use the above method. Therefore, 250 gallons per day per REU was assumed. The number of REUs for each of the water districts was then derived by dividing the gross ADD for the water district (including residential use) by 250 GPD/REU. This was done to compensate for the large variation in residential demand depending on the type and location of the residential developments. Because in some cases these computations yielded more than 150 REUs (even though in 2017 there may be less than 150 connections) a demand of 1.25 gpm/REU was used for everything over 150 REUs.

4.4 Year 2017 Supply/Pumping Systems Capacity Evaluation

After demands have been estimated for each Water district an evaluation of system component capacities can be undertaken. These demands and supply/pumping capacity evaluations are provided in Table VI.B.8. Storage capacity evaluations are provided in Section 4.5 below. The basis for the supply/pumping capacity evaluations is provided here:

Supply Wells, Water Treatment Plant and Booster Stations Serving Areas with Storage

> Firm Capacity should be greater than MDD for water district(s) served by supply wells, the WTP or booster stations (compare the MDD and Actual Firm Capacity columns in Table VI.B.8).

Booster Stations Serving Areas Without Storage

> Firm Capacity should be greater than PID for water districts serving areas with no storage (compare the PID and Actual Firm Capacity columns in Table IV.C.2).

As described below, the analysis provided in Table VI.B.8 reveals concerns for meeting some 2017 demands with current pumping facilities. Recommendations for system improvements intended to address these concerns are presented in the Near-term Plan described in VI.B.5.

East Bay Township

Although the wells serving Water District 10EB2 (Holiday Hills) are incapable of meeting the demand in the district, this does not appear to be a problem because the Five Mile Road Booster Station can make up the lack supplied from wells in District 20EB1-S. This is possible because the combined Holiday Hills wells and Iron Removal Plant have firm capacity that exceeds the total township MDD for the year 2017.

Elmwood Township

In 2006 there were approximately 120 service connections in the Timberlee Water District (EL1). Based on a review of historical growth in demand and the potential increase in population projected in the area by the year 2017 it is likely that the water system will reach 150 connections prior to the year 2017. It is recommended that plans be laid for providing storage for this district such that storage can be brought on line if necessary in an appropriate time frame. It is not likely that demand will outstrip firm well capacity with 150 connections or less. The provision of storage prior to reaching 150 connections will change the well firm capacity requirement from meeting the peak instantaneous demand to meeting the maximum day demand and will therefore forestall the need for additional well capacity well into the future. The recommended storage capacity is presented in the Near-term Plan, Section VI.B.5.

Garfield Township

Year 2017 estimated MDD for Garfield Township is expected to be approximately 6.9 MGD. This is well in excess of the contractual limit of 5 MGD to be supplied by the City of Traverse City. This issue should be resolved very soon with continued demand growth beyond 2017 in mind.

In 2006 there were only approximately 52 service connections in the Brook Drive Booster Station Water District (G5). Although the number of service connections was about 1/3 of the limit where storage is required the ADD was approximately 58,000 GPD because of the large number of commercial users. Based on a review of historical growth in demand and the potential increase in population and commercial growth projected for the area by the year 2017 it is highly likely that the water system will reach more than an equivalent of 150 residential connections prior to the year 2017. It is recommended that plans be laid for providing storage for this district such that storage can be brought on line in a reasonable time frame. The provision of storage will change the Brook Drive Booster Station firm capacity requirement from meeting the peak instantaneous demand to meeting the maximum day demand and will therefore forestall the need for additional pump capacity well into the future. Otherwise, it will be necessary to keep a close watch on peak demands such that they do not exceed the station's firm capacity of 800 gpm.

The area served by the Traditions Booster Station has the potential based on continued development to reach more than 150 service connections prior to the year 2017. Although there appears to be more than adequate firm pumping capacity, it is recommended that plans be laid for providing storage for this district such that storage can be brought on line in a reasonable time frame before this area crosses the 150 service connection threshold.

Traverse City

According to the 2005 basis of design provided with the permit application for the Wayne Hill Booster Station it is likely that the water district will reach 150 connections prior to the year 2017. It is recommended that plans be laid for providing storage for this district such that storage can be brought on line if necessary in an appropriate time frame. It is not likely that demand will outstrip booster station capacity with 150 connections or less. The provision of storage prior to reaching 150 connections will change the booster station firm capacity requirement from meeting the peak instantaneous demand to meeting the maximum day demand and will therefore eliminate the need for additional pump capacity at any time in the foreseeable future.

The Traverse City WTP year 2017 demands indicated in Table VI.B.8 show a total ADD of 6.6 mgd and MDD of 16.7 mgd. Therefore, with an existing rated capacity of 20 mgd (nominal), or a slightly reduced rated capacity based on low service pumping capacity (see Section VI.C) of 17 to 19 mgd, the WTP appears to have adequate capacity to meet the year 2017 demands. Note that the ability to maintain existing rated capacity, and to ensure ability to meet the reported nominal rating of 20 mgd, some reliability improvements will be required as described in Section VI.C of this report.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.8 2017 SYSTEM DEMANDS AND COMPONENT EVALUATION
Wilcox/Black & Veatch
Revised: December 17, 2009

Exist. Water District	Description	2017 ADD (MGD)	Peaking Factor MDD/ADD	2017 MDD (MGD)	Peaking Factor MHD/MDD (Note 1)	2017 MHD (MGD)	2107 PID (Peak Instantaneous Demand) (GPM)	Actual Firm Capacity (MGD)	
	EAST BAY TOWNSHIP	0.949	2.71	2.570	2.03	5.21		4.147	
EB1 & EB3	**Cherry Ridge District (Note 2)**	0.700	2.45	1.714	2.09	3.58		3.701 Wells, 2.918 Iron	
EB1	**Cherry Ridge District Minus B#2**	0.674	2.38	1.603	2.10	3.36			
EB2	**Holiday Hills District (Note 3)**	0.249	2.93	0.730	2.15	1.57		0.216	
	E. Bay Booster #1 (Five Mile Rd)	0.146	3.52	0.514	2.17	1.12		0.72 (0.864 MDEQ)	
EB3	**E. Bay Booster #2 (Windmill Farms)**	0.026	4.33	0.111	2.20	0.24	206	1,100 GPM (965 GPM MDEQ)	
	ELMWOOD TOWNSHIP	0.219	2.72	0.596	2.16	1.29			
EL1	**Timberlee District**	0.107	2.93	0.313	2.18	0.68	623	560 GPM	Note 6
EL2	**Greilickville District-Master Meter**	0.112	2.84	0.319	2.18	0.70		0.75 (Agreement)	
	GARFIELD TOWNSHIP	2.563	2.68	6.857	1.73	11.89		5.0 (Agreement)	
G1	**City Pressure (Master Meters - B#2 - B#1 + TC4 -B#4)**	0.256	2.72	0.696	2.16	1.50			
G2 & G3	**Booster #2 (Lafranier)**	0.561	2.54	1.426	2.11	3.00		2.074	
G2	**Booster #2 minus B#7**	0.526	2.43	1.280	2.12	2.71			
G3	**Booster #7 (Traditions) (B#7 Served by B#2)**	0.035	4.17	0.146	2.20	0.32	260	1350 GPM	
TC4 (10)	**Traverse City Area Served from G4A**	0.110	2.87	0.317	2.18	0.69			
G4 & TC4	**Booster #1 (Cass Rd)**	1.683	2.61	4.392	1.90	8.36		6.912	
G4A	**Booster #1 minus B#3 minus TC4**	0.831	2.48	2.064	2.06	4.26			
G4B & G4C	**Booster #3 (Silver Pines Rd) (B#3 Served by B#1)**	0.742	2.71	2.012	2.07	4.16		3.312	
G4B	**Booster #3 minus Booster #5**	0.702	2.66	1.866	2.08	3.88			
G4C	**Booster #5 (Herkner Rd) (B#5 Served by B#1 and B#3)**	0.040	3.63	0.145	2.20	0.32	288	800 GPM	
G5	**Booster #4 (Brook Dr)**	0.174	2.72	0.473	2.17	1.03	958	800 GPM	Note 6
G5A	**Booster #4 minus B#6**	0.146	2.42	0.354	2.18	0.77			
G5B	**Booster #6 (Greyhawk) (B#6 Served by B#4)**	0.028	4.30	0.119	2.20	0.26	218	300 GPM	
P1, P2 & P3	**PENINSULA TOWNSHIP (Note 4)**	0.193	2.72	0.527	2.17	1.14		1.0 (Agreement)	
P1 & P3	**Total of Master Meters 2-4**	0.161	2.72	0.440	2.17	0.96			
P1	**Intermediate pressure zone (T.C. Huron Hills Booster)**	0.134	2.41	0.324	2.18	0.71			
P3	**B#1 Relocated- High Pressure Zone (Served by Huron Hills)**	0.027	4.31	0.116	2.20	0.26	212	950 GPM	
P2	**West Bay Side- Master Meter #1 at Peninsula Drive**	0.032	4.22	0.135	2.20	0.30			
	TRAVERSE CITY	3.799	2.65	10.066	1.51	15.24			
TC3+P1+P3	**Huron Hills Booster Station**	0.237	2.96	0.703	2.16	1.52		1.010	
TC1	**Unboosted Traverse City Area**	3.378	2.66	8.980	1.59	14.27			
TC2	**Wayne Hill Booster (Note 8)**	0.235	2.72	0.640	2.16	1.38	1,263	1,000 GPM	Note 6
TC3	**Huron Hills Booster minus Peninsula P1 & P3**	0.076	3.47	0.263	2.19	0.58			
TC4	**Traverse City Area Served from Garfield G4A**	0.110	2.87	0.317	2.18	0.69			
	Water Treatment Plant Discharge (Note 7)	6.668	2.52	16.803				18.5	

Notes:
1) Peaking Factors were used for MHD/MDD based on linear regression of peaking factors for similar-sized water districts in Madison, Wisconsin as determined by diurnal data.
2) Cherry Ridge Wells Minus Booster Station #1 Demands
3) Holiday Hills Wells Plus Booster Station #1 Demands. Well Capacity less than District demand is not a problem because of the ability to supplement water from Cherry Ridge Wells using B#1.
4) Existing Water Service Districts adjusted by 2008/2009 Water Project. Here P1 is taken as pressure district served directly by Huron Hills Booster Station, P3 is high pressure district boosted by relocated booster station and serves highest areas of southern Peninsula Twp., P2 remains district along West Grand Traverse Bay.
5) B#1 means Booster Station Number 1, etc.
6) It is recommended that storage be provided for this water district in the near future (see report narrative for specific recommendations).
7) Traverse City WTP capacity based on MDEQ Water System Review Document
8) Includes a small area of Garfield Township served by the Wayne Hill Booster Station

- Demand used for checking adequacy of firm capacity
- Potential Deficiencies

4.5 Year 2017 Storage Capacity Evaluation

The 2017 demands that have been estimated are also used to evaluate the storage capacity for each Water district. The maximum day demands and storage capacity evaluations are provided in Table VI.B.9. The basis for the evaluations is provided here:

Storage Facilities

> Adequate storage capacity must be provided for Equalization, Fire Flows and Emergencies. The methodology behind this analysis is described in detail in Appendix F and provides a basis for the numbers used in Table VI.B.9.

In Table VI.B.9, each storage tank is evaluated on the basis of demands for the water district or districts that rely directly on the tank being evaluated. Tanks that do not prove to be adequate for 2017 demand conditions are highlighted with rose shading.

Tanks that were considered to be under-capacity in the 2006 analysis include the Cherry Ridge Tank in East Bay Township and the Birmley and Heritage Estates tanks in Garfield Township. Of course, these appear even less able to provide adequate capacity in the 2017 analysis. This may be mitigated to some extent by the fact that supply or booster station capacities supplying these particular districts have capacities much greater than maximum day demands. Although this may suffice in the near-term some drawbacks to this approach come from over-providing capacity, insufficient storage in case of supply interruption or over-reliance on storage capacities upstream of the pumping facility. Recommendations are made relative to storage improvements in the Near-term plan presented in Section VI.B.5.

The English Woods tank is also considered to be under capacity in this analysis. Although not ideal, this is mitigated to some extent that the Five Mile Road Booster Station serves as a backup to the water district's wells and storage. Finally, the new Peninsula Township ground storage tank is considered to be under capacity based on service to all of the water districts downstream of the City's Huron Hills Booster Station.

4.6 Backup Power

Existing backup generator power arrangements are described throughout Section IV.B in the discussion of the existing systems. Some recommendations are made here:

Although the County DPW has a system of shared trailer-mounted generators that meet the State's reliability provisions it is recommended that on-site generators be provided for the Holiday Hills well building, the iron removal plant (and Well #8) and either the well building at Carlisle Road or Three Mile Road (Cherry

Ridge). In this way, the best assurance is given for uninterrupted water supply during a general regional power outage. It is also recommended that a confirmation be made of adequate, functioning back-up power for all sites with essential SCADA controls (water storage facilities, etc.).

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.9 2017 Storage Evaluation
Wilcox/Black & Veatch
Revised: December 15, 2009

Water District	ADD	MDD	Water Treatment Plant	Wayne Hill	Barlow	Birmley	McRae Hill	Heritage Estates (Note 2)	Cherry Ridge	English Woods (Note 3)	Peninsula Township New Ground Storage Tank
WATER STORAGE TANK CAPACITY (MG)			1.500	1.300	4.000	0.300	2.250	0.150	0.200	0.300	0.287
EAST BAY TOWNSHIP											
CHERRY RIDGE STORAGE TANK											
EB1	0.67										
EB3	0.03										
Total	0.70	1.71									
Equalization 27% Max. Day		0.46									
Fire-Corporate Commerce Center		0.63									
Emergency- 33% Max. Day		0.57									
Total Required Storage		1.66									
Total Provided		0.20							X		
ENGLISH WOODS (HOLIDAY) STORAGE TANK											
EB2	0.25										
Total	0.25	0.73									
Equalization 28.5% Max. Day		0.21									
Fire-Medium Density Residential		0.18									
Emergency- 33% Max. Day		0.24									
Total Required Storage		0.63									
Total Provided (Note 3)		0.30								X	
BOTH EAST BAY STORAGE TANKS											
EB1	0.67										
EB2	0.25										
EB3	0.03										
Total	0.95	2.57									
Equalization 25.5% Max. Day		0.66									
Fire-Corporate Commerce Center		0.63									
Emergency- 33% Max. Day		0.85									
Total Required Storage		2.13									
Total Provided		0.50							X	X	
GARFIELD TOWNSHIP											
BIRMLEY STORAGE TANK											
G2	0.53										
G3	0.04										
Total	0.56	1.43									
Equalization 27% Max. Day		0.39									
Fire-Light Industry		0.30									
Emergency- 33% Max. Day		0.47									
Total Required Storage		1.16									
Total Provided		0.30				X					
McRAE HILL STORAGE TANK											
G4A	0.83										
TC4	0.11										
Total	0.94	2.55									
Equalization 25.5% Max. Day		0.65									
Fire-Corporate Commerce Center		0.63									
Emergency- 33% Max. Day		0.84									
Total Required Storage		2.12									
Total Provided		2.25					X				
HERITAGE ESTATES STORAGE TANK											
G4B	0.70										
G4C	0.04										
Total	0.74	2.01									
Equalization 26.5% Max. Day		0.53									
Fire-Medium Density Residential		0.18									
Emergency- 33% Max. Day		0.66									
Total Required Storage		1.38									
Total Provided		0.15						X			
PENINSULA TOWNSHIP											
NEW GROUND STORAGE TANK											
P1	0.13										
P3	0.03										
TC3	0.08										
Total	0.24	0.70									
Equalization 28.5% Max. Day		0.20									
Fire-Medium Density Residential		0.18									
Emergency- 33% Max. Day		0.23									
Total Required Storage		0.61									
Total Provided		0.29									X
TRAVERSE CITY											
TRAVERSE CITY WTP CLEAR WELL-N/A											
COMBINED TRAVERSE CITY STORAGE TANKS											
P2	0.03										
TC1	3.34										
TC2	0.24										
EL2	0.11										
G1	0.26										
G5	0.17										
Total	4.15	10.96									
Equalization 19.5% Max. Day		2.14									
Fire-Corporate Commerce Center		0.63									
Emergency- 33% Max. Day		3.62									
Total Required Storage		6.38									
Total Provided		6.80	X	X	X						

NOTES:

1) The rose colored shading indicates capacity concerns

2) Actual Capacity is 0.300 MG. MDEQ considers the capacity to be 0.150 because it is a stand pipe

3) Water can be transferred via Booster Station on Five Mile Road as a backup to existing English Woods Storage.

5.0 Near-term Recommended Improvements

5.1 Introduction

The Near-term Recommended Improvements are improvements that are recommended to be made over the next ten years that will be designed based on projected Year 2037 demands. These recommendations are referred to in this study as the *Near-term Plan*. The Near-term Plan has been developed with the purpose of meeting goals that are briefly re-iterated here:

- Improve systems' reliability and resiliency
- Improve water quality
- Reduce all costs
- Prepare for emergencies
- Position the water systems to accommodate growth as necessary and to meet regulatory capacity requirements

Implementation of the plan will position the water systems to meet future challenges while providing high quality water reliably and efficiently. This plan has been developed only for this Study's Level One entities (East Bay, Elmwood, Garfield and Peninsula Township and the City of Traverse City). For Blair Township, conceptual Ultimate Build-out system configuration is suggested in Section VI.B.6.0 below but without reference to required capacities or a schedule for implementation.

The owners of each water system should work diligently to procure the necessary land as required for improvements to accomplish the Near-term Plan. As land is procured, space should be provided for future expansions in addition to the Near-term improvements. In addition, as booster stations, storage tanks, etc. are built, room for additional capacity should be considered. The Ultimate Build-out demands and capacity requirements in Section VI.B.6.0 can be used as a guide to make provision for additional capacity to be added later.

It should be noted that the Near-term Plan is a conceptual plan. Implementation of the plan in each specific area should be supported by appropriate field work and investigations, a detailed basis of design including detailed modeling of the proposed improvements, and a rigorous design process that considers all pertinent details.

5.2 Year 2037 Population by Water District

The first step in the determination and evaluation of capacities for the Year 2037 was to estimate the 2037 population by water district. This was done using the same methodology as presented in Section VI.B.4.2. The 2037 population by Water district is shown in Table VI.B.10.

Table VI.B.10- 2037 Population Projections By Water District

Water District	Water Sub-District	2006 Population	2037 Population	Ultimate Population	Ultimate/ 2006
East Bay Township					
10	EB2	3,569	4,935	17,934	5.0
20	EB1-N	2,207	3,424	15,001	6.8
20	EB1-S	589	1,484	9,999	17.0
	EB Outside	4,828	7,464	32,561	6.7
	Totals	**11,193**	**17,307**	**75,495**	**6.7**
Elmwood Township					
30	EL2	1,729	2,392	9,221	5.3
60	EL3	40	148	1,260	31.8
110	EL5	1,343	1,859	7,183	5.3
120	EL1	48	64	226	4.7
150	EL4	224	376	1,935	8.6
	EL Outside	1,189	1,701	6,969	5.9
	Totals	**4,573**	**6,539**	**26,794**	**5.9**
Garfield Township					
30	G1	1,567	2,058	3,455	2.2
30	G3	89	94	106	1.2
30	G8	18	67	205	11.5
60	G5	218	814	2,510	11.5
70	G2A-E	3,521	4,475	7,189	2.0
70	G2A-W	1,837	3,056	6,524	3.6
80	G2B	202	827	2,607	12.9
85	G2C	26	53	130	5.1
90	G4A	115	369	1,091	9.5
100	G4B	5,227	7,696	14,720	2.8
110	G4C	2,251	3,942	8,753	3.9
120	G6	256	530	1,308	5.1
	G Outside	98	154	311	3.2
	Totals	**15,426**	**24,134**	**48,909**	**3.2**
Peninsula Township					
30	P1	516	880	2,753	5.3
30	P2	421	752	2,458	5.8
40	P3	888	1,170	2,620	3.0
50	P4	660	780	1,399	2.1
	P Outside	3,267	4,712	12,141	3.7
	Totals	**5,751**	**8,294**	**21,371**	**3.7**
Traverse City (Note 1)					
30	TC1	12,880	13,172		
40	TC3	578	591		
60	TC2	92	132		
60	TC5	90	1,202		
70	TC4	1,027	1,051		
	Totals	**14,667**	**16,148**		

NOTES:

1) Traverse City 2006-2037 population estimates using information from County Planner and uniform changes in all water districts except 60TC2 and 60TC5 where estimates are derived from 2005 Basis of Design for Wayne Hill Booster Station.

5.3 Year 2037 Demands by Water District

Once the projected 2037 population was estimated for each Water district it was possible to develop estimated demands for that year. This includes estimates for Average Day Demand (ADD) and Maximum Day Demand (MDD). The only water district proposed to not have storage in 2037 is the district 120G6. Therefore, estimates for Maximum Hour Demand (MHD) and Peak Instantaneous Demand (PID) have been determined for Water District 120G6 only. The methodology for determination of these demands for the year 2037 is presented here. A summary is provided in Table VI.B.11.

Average Day Demand (ADD)

The first question to answer was how much of the existing population that is not now served by the PWS will be served in 2037? The estimated 2006 un-served population for each water district came from the difference between the total population and the estimated served population which was determined as explained in Section VI.B.2.4 above. The 2006 un-served population that will be served by 2037 was taken across the board as being 50% of the 2006 un-served population.

The next step was to estimate what percentage of the new 2037 population that came to the water district since 2006 would be served by the PWS. Judgment was used based on the degree of the current PWS development within the Water district to estimate the percentage. One-hundred percent was used for urban areas such as Traverse City. A percentage of 75% was used for rural Water districts not now served by a PWS.

The total 2037 served population was estimated by adding the 2006 un-served population that will be served by 2037 and the new population estimated to be served in 2037 to the population that is currently served. The total 2037 residential ADD for each Water district was computed by multiplying the estimated 2037 served population by the appropriate urban or suburban per capita ADD as determined in Section VI.B.2.4 above.

The next step in the analysis was to add in the non-residential ADD to come up with the total ADD for each Water district. A *Residential ADD/Total ADD* factor was estimated as 1/2 of the way between the *2006 Residential ADD/Total ADD* ratio and the *Ultimate Build-out Residential ADD/Total ADD* ratio. The 2037 residential ADD was divided by this factor to arrive at the total ADD for each Water district.

Maximum Day Demand (MDD)

Maximum day demands for each water district as presented in Table VI.B.11 were determined on the basis of the following equations, with their derivation described in Section VI.B.4:

*MDD Peaking Factor = -17.2449312 * ADD + 4.775149102 (for ADD below 0.1188 MGD)*

*MDD Peaking Factor = -0.02062783184 * ADD + 2.728019583 (for ADD above 0.1188 MGD*

These equations were used to establish a MDD/ADD peaking factor for each Water district and the resulting MDD.

Maximum Hour Demand (MHD) and Peak Instantaneous Demand (PID)

Maximum Hour Demand (MHD) and Peak Instantaneous Demand (PID) for Water District 120G6 have been determined as described in Section VI.B.4.3 above.

5.4 Year 2037 Supply/Pumping Systems Capacity Requirements

After demands have been estimated for each Water district, capacity requirements for any new system supply/pumping systems can be undertaken. It can also be determined if any supply/pumping systems that remain in place have adequate capacity or need to be upgraded/replaced. The demands and supply/pumping capacity requirements are provided in Table VI.B.12. System Improvements are discussed in Section VI.B.5.6.

5.5 Year 2037 Storage Capacity Requirements

The 2037 demands that have been estimated are also used to evaluate the storage capacity for each Water district. The maximum day demands and storage capacity requirements are provided in Table VI.B.13. System Improvements are discussed in Section VI.B.5.6.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.11- DETERMINATION OF 2037 DEMANDS
Wilcox/Black & Veatch
Revised: December 20, 2009

Water District	Water Sub-District	2006 Est. Served Population	2006 Population	2006 Unserved Population	2006 Unserved Population Est. to be served in 2037 50%	2037 Population	Population Increase 2006-2037	Percent of Pop. Increase Served in 2037	Served Population Increase	Total New Served Population (F + J)	2037 Total Served Population (C + K)	Per Capita ADD	Total 2037 Residential ADD	2006 Residential ADD/ Total ADD	Ultimate Residential ADD/ Total ADD	1/2 of Way Between P & Q	Total 2037 ADD (O/R)	2037 Factor MDD/ADD	2037 MDD	
A	B	C	D	E	F	G	H	I	J	K	L	N	O	P	Q	R	S	V	W	
East Bay Township																				
10	EB2	1,410	3,569	2,159	1,080	4,935	1,366	75%	1,024	2,104	3,514	130	456,819	0.930	1.00	0.97	473,388	2.72	1,286,789	
20	EB1-N	2,115	2,207	92	46	3,424	1,217	100%	1,217	1,263	3,378	75	253,321	0.452	0.69	Note 3	560,445	2.72	1,522,427	
20	EB1-S	632	589	0	0	1,484	895	90%	805	805	1,437	130	186,839	0.593	0.85	0.72	258,960	2.72	705,064	
	Totals	4,157	6,366			9,843					8,329						1,292,793	2.70	3,492,289	
Elmwood Township																				
30	EL2	100	1,729	1,629	814	2,392	663	75%	497	1,312	1,412	75	105,866	0.277	0.82	0.55	193,010	2.72	525,767	
60	EL3	0	40	40	20	148	108	90%	97	117	117	75	8,776	1.000	1.00	1.00	8,776	4.62	40,577	
110	EL5	457	1,343	886	443	1,859	517	75%	388	830	1,287	130	167,361	0.794	0.69	0.74	225,554	2.72	614,266	
120	EL1	0	48	48	24	64	16	50%	8	32	32	130	4,159	1.000	1.00	1.00	4,159	4.70	19,562	
150	EL4	0	224	224	112	376	151	50%	76	188	188	130	24,408	1.000	1.00	1.00	24,408	4.35	106,279	
	Totals	557	3,384			4,838					3,036						455,907	2.72	1,239,436	
Garfield Township																				
30	G1	1,368	1,567	199	100	2,058	491	100%	491	591	1,959	75	146,890	0.228	0.33	0.28	526,487	2.72	1,430,551	
30	G3	43	89	46	23	94	4	100%	4	27	70	75	5,285	0.031	0.06	0.05	116,145	2.77	321,982	
30	G7																795	4.76	3,785	Note 1
30	G8	0	18	18	9	67	49	100%	49	58	58	75	4,319	1.000	1.00	1.00	4,319	4.70	20,304	
60	G5	0	218	218	109	814	596	90%	536	646	646	75	48,419	0.003	0.57	0.29	169,002	2.72	460,451	
70	G2A-E	2,100	3,521	1,421	711	4,475	954	90%	859	1,569	3,669	75	275,177	0.448	0.39	0.42	656,748	2.71	1,782,724	
70	G2A-W	1,838	1,837	-1	-1	3,056	1,219	90%	1,097	1,096	2,934	75	220,087	0.312	0.53	Note 3	705,408	2.71	1,914,102	
80	G2B	71	202	131	65	827	626	90%	563	628	699	130	90,915	1.000	1.00	1.00	90,915	3.21	291,594	
85	G2C	0	26	26	13	53	27	75%	20	33	33	130	4,313	1.000	1.00	1.00	4,313	4.70	20,273	
90	G4A	84	115	31	15	369	254	75%	190	206	290	130	37,675	0.106	0.25	0.18	211,658	2.72	576,482	
100	G4B	2,253	5,227	2,974	1,487	7,696	2,469	75%	1,852	3,339	5,592	130	726,926	0.840	0.76	0.80	908,658	2.71	2,461,806	
110	G4C	604	2,251	1,647	824	3,942	1,691	90%	1,522	2,345	2,949	130	383,433	0.687	0.79	0.74	519,205	2.72	1,410,840	
120	G6	7	256	249	125	530	273	75%	205	330	337	130	43,784	1.000	1.00	1.00	43,784	4.02	176,016	
	Totals	8,368	15,328			23,980					19,236						3,957,436	2.65	10,472,907	
Peninsula Township																				
30	P1	238	516	278	139	880	364	90%	328	467	705	75	52,846	1.000	1.00	1.00	52,846	3.86	204,188	
30	P2	37	421	384	192	752	332	90%	299	490	527	75	39,547	0.697	1.00	0.85	46,609	3.97	185,101	
40	P3	583	888	305	153	1,170	282	90%	254	406	989	130	128,608	0.950	1.00	0.98	131,905	2.73	359,482	
50	P4	5	660	655	327	780	120	90%	108	436	441	130	57,290	1.000	1.00	1.00	57,290	3.79	216,968	
	Totals	863	2,484			3,582					2,662						288,650	2.72	785,725	
Traverse City (Note 1)																				
30	TC1	12,880	12,880			13,172	292	100%	292	292	13,172	75	987,897				3,546,677	2.65	9,415,930	
40	TC3	578	578			591	13	100%	13	13	591	75	44,359	1.000	(assumed)	Col. P Used	44,359	4.01	177,888	
60	TC2	92	92			132	40	100%	40	40	132	180	23,760	1.000	(assumed)	Col. P Used	23,760	4.37	103,722	
60	TC5	90	90			1,202	1,112	100%	1,112	1,112	1,202	180	216,360	1.000	(assumed)	Col. P Used	216,360	2.72	589,269	
70	TC4	1,027	1,027			1,051	23	100%	23	23	1,051	75	78,809	1.000	(assumed)	Col. P Used	78,809	3.42	269,219	
	Totals	14,667	14,667			16,148					16,148					Note 2:	3,909,965	2.65	10,351,108	

NOTES:
1) No existing demand or population information. 2037 ADD assumed to be 1/2 of Ultimate Build-out ADD.
2) 2037 ADD for all T.C. water districts is assumed to be 2006 ADD times expected population increase (1.023) except for 60TC2 and 60TC5.
3) Ratio in Column P is used. Otherwise 2037 ADD is not much larger than 2006 ADD

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.12- 2037 SUPPLY/PUMPING SYSTEMS CAPACITY REQUIREMENTS
Wilcox/Black & Veatch
Revised: December 21, 2009

Description	Water District	Sub-District	2037 ADD (MGD)	Peaking Factor MDD/ADD	2037 MDD (MGD)	Peaking Factor MHD/MDD	2037 MHD (MGD/GPM)	2037 PID (GPM)
EAST BAY TOWNSHIP								
Cherry Ridge Wells	**20**	**EB1-N**	0.56					
	20	**EB1-S**	0.26					
		TOTAL	**0.82**	2.71	**2.2**			
Holiday Hills District Wells	**10**	**EB2**	**0.47**	2.72	**1.3**			
All East Bay Wells Together	**20**	**EB1-N**	0.56					
	20	**EB1-S**	0.26					
	10	**EB2**	0.47					
		TOTAL	**1.29**	2.70	**3.5**			
ELMWOOD TOWNSHIP								
Timberlee District (with new storage)	**110**	**EL5**	0.11	2.83	**0.32**			
GARFIELD TOWNSHIP								
Booster #1 (Cass Rd),(Converted to Dual)	**70**	**TC4**	0.08					
	70	**G2A-W**	0.71					
	90	**G4A**	0.21					
	100	**G4B**	0.91					
		TOTAL	**1.90**	2.69	**5.1**			
Booster #2 (Lafranier)	**70**	**G2A-E**	0.66					
	80	**G2B**	0.09					
	85	**G2C**	0.00					
		TOTAL	**0.75**	2.71	**2.0**			
Booster #3 (Silver Pines Rd)	**100**	**G4B**	**0.91**	2.71	**2.5**			
Booster #4 (Brook Dr)	**60**	**EL3**	0.01					
	60	**TC5**	0.22					
	60	**G5**	0.17					
	60	**TC2**	0.02					
	110	**G4C**	0.52					
	120	**G6**	0.04					
	110	**EL5**	0.11	(Assume Half)				
	120	**EL1**	0.00					
		TOTAL	**1.10**	2.71	**3.0**			
New Dual Booster Station (Cedar Run Rd)	**110**	**G4C**	0.52					
	120	**G6**	0.04					
	110	**EL5**	0.11	(Assume Half)				
	120	**EL1**	0.00					
		TOTAL	**0.68**	2.71	**1.8**			
Booster #5 (Herkner Rd)	**120**	**G6**	**0.04**	4.02	**0.18**	2.19	.39/271	306
Booster #6 (Greyhawk) (Eliminated)								
Booster #7 (Traditions-Moved, Dual)	**80**	**G2B**	0.09					
(new storage provided)	**85**	**G2C**	0.00					
			0.10	3.13	**0.30**			
TRAVERSE CITY								
Traverse City Water Treatment Plant	**30**	**EL2**	0.19					
	30	**G1**	0.53					
	30	**G3**	0.12					
	30	**G7**	0.00					
	30	**G8**	0.00					
	30	**P1**	0.05					
	30	**P2**	0.05					
	30	**TC1**	3.55					
	40	**P3**	0.13					
	40	**TC3**	0.04					
	50	**P4**	0.06					
	60	**EL3**	0.01					
	60	**G5**	0.17					
	60	**TC2**	0.02					
	60	**TC5**	0.22					
	70	**G2A-E**	0.66					
	70	**G2A-W**	0.71					
	70	**TC4**	0.08					
	80	**G2B**	0.09					
	85	**G2C**	0.00					
	90	**G4A**	0.21					
	100	**G4B**	0.91					
	110	**EL5**	0.11	(Assume Half)				
	110	**G4C**	0.52					
	120	**EL1**	0.00					
	120	**G6**	0.04					
	150	**EL4**	0.02					
		TOTAL	**8.50**	2.55	**21.7**			
Huron Hills Booster	**40**	**P3**	0.13					
	40	**TC3**	0.04					
	50	**P4**	0.06					
		TOTAL	**0.23**	2.72	**0.64**			

Notes:
1) B#1 means Booster Station Number 1, etc.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.13- 2037 Storage Requirements
Wilcox/Black & Veatch
Revised: December 20, 2009

Water District	Water Sub-District	ADD	MDD
EXISTING WATER STORAGE TANK CAPACITY (MG)			
EAST BAY TOWNSHIP			
NEW NORTH DISTRICT STORAGE (T1)			
20	EB1-N	0.560	
Total		0.560	1.52
Equalization 27% Max. Day			0.411
Fire-Corporate Commerce Center			0.630
Emergency- 33% Max. Day			0.502
Total Required Storage			1.543
CHERRY RIDGE DISTRICT STORAGE (T2)			
20	EB1-S	0.259	
Total		**0.259**	0.71
Equalization 28.5% Max. Day			0.201
Fire-General Commercial			0.300
Emergency- 33% Max. Day			0.233
Total Required Storage			0.734
Existing Total Provided			0.200
ENGLISH WOODS (HOLIDAY) DISTRICT STORAGE (T3)			
10	EB2	0.473	
Total		**0.473**	1.29
Equalization 27.5% Max. Day			0.354
Fire-Medium Density Residential			0.180
Emergency- 33% Max. Day			0.425
Total Required Storage			0.959
Existing Total Provided			0.300
ALL EAST BAY DISTRICTS STORAGE			
20	EB1-N	0.560	
20	EB1-S	0.259	
10	EB2	0.473	
Total		**1.293**	3.49
Equalization 24.5% Max. Day			0.856
Fire-Corporate Commerce Center			0.630
Emergency- 33% Max. Day			1.152
Total Required Storage			2.638
Existing Total Provided			0.500
ELMWOOD TOWNSHIP			
NEW TIMBERLEE GROUND STORAGE (T4)			
110	EL5	0.113	
Total		**0.113**	0.31
Equalization 29.5% Max. Day			0.091
Fire-Low Density Residential			0.120
Emergency- 33% Max. Day			0.101
Total Required Storage			0.312
GARFIELD TOWNSHIP			
BIRMLEY DISTRICT STORAGE (T5)			
70	G2A-E	0.657	
Total		**0.657**	1.78
Equalization 27% Max. Day			0.481
Fire-Light Industry			0.300
Emergency- 33% Max. Day			0.588
Total Required Storage			1.370
Existing Total Provided			0.300
NEW GARFIELD DISTRICTS STORAGE (T6)			
80	G2B	0.091	
85	G2C	0.004	
Total		**0.095**	0.30
Equalization 29% Max. Day			0.087
Fire-Low Density Residential			0.120
Emergency- 33% Max. Day			0.098
Total Required Storage			0.305

McRAE HILL STORAGE (T7)			
70	**G2A-W**	0.705	
70	**TC4**	0.079	
90	**G4A**	0.212	
Total		**0.996**	2.70
Equalization 29% Max. Day	**(90G4A Only)**		0.17
Fire-Corporate Commerce Center			0.630
Emergency- 33% Max. Day			0.890
Total Required Storage			1.687
Existing Total Provided			2.250
NEW COMMERCIAL CENTER STORAGE (T8)			
70	**G2A-W**	0.705	
70	**TC4**	0.079	
Total		**0.784**	2.13
Equalization 26% Max. Day			0.553
Fire (Provided by McRae Hill)			0.000
Emergency (Provided by McRae Hill)			0.000
Total Required Storage			0.553
NEW Z4 STORAGE @ HERITAGE ESTATES (T9)			
100	**G4B**	0.909	
Total		**0.909**	2.46
Equalization 25.5% Max. Day			0.628
Fire-Medium Density Residential			0.180
Emergency- 33% Max. Day			0.812
Total Required Storage			1.620
NEW REGIONAL STORAGE NEAR STONEFIELD DRIVE (T10)			
110	**G4C**	0.519	
110	**EL5**	0.113	(Assume Half)
120	**G6**	0.044	
120	**EL1**	0.004	
Total		**0.680**	1.85
Equalization 26.5% Max. Day			0.489
Fire-Medium Density Residential			0.180
Emergency- 33% Max. Day			0.609
Total Required Storage			1.278
PENINSULA TOWNSHIP			
NEW PENINSULA/TC GROUND STORAGE (NEW T11)			
40	**P3**	0.132	
40	**TC3**	0.044	
50	**P4**	0.057	
Total		**0.234**	0.64
Equalization 28.5% Max. Day			0.181
Fire-Medium Density Residential			0.180
Emergency- 33% Max. Day			0.210
Total Required Storage			0.571
TRAVERSE CITY			
COMBINED TRAVERSE CITY STORAGE (T12, T13)			
30	**EL2**	0.193	
30	**G1**	0.526	
30	**G3**	0.116	
30	**G7**	0.001	
30	**G8**	0.004	
30	**P1**	0.053	
30	**P2**	0.047	
30	**TC1**	3.547	
Total		**4.487**	11.83
Equalization 19.5% Max. Day			2.306
Fire-Corporate Commerce Center			0.630
Emergency- 33% Max. Day			3.902
Total Required Storage			6.838
Existing Total Provided			6.800
NEW CEDAR RUN RD REGIONAL STORAGE (T14)			
60	**EL3**	0.009	
60	**TC5**	0.216	
60	**G5**	0.169	
60	**TC2**	0.024	
Total		**0.418**	1.14
Equalization 27.7% Max. Day			0.315
Fire-Medium/High Density Resid.			0.240
Emergency- 33% Max. Day			0.375
Total Required Storage			0.930

5.6 Near-term Plan Description

General Information

The Near-term Plan recommended improvements are discussed by water system and by water district. A map of each township and the City are provided each labeled as Figure VI.B.4 in Appendix E. All of these recommendations assume implementation of the proposed pressure zone plan along with the other improvements. Implementation of the proposed pressure zone plan will require some new PRV stations or relocation of existing PRV stations. A PRV station is generally required wherever distribution piping crosses a pressure zone boundary. PRV stations located on pressure zone boundaries that are also water district boundaries would be set to only open if downstream pressure becomes abnormally low. These normally closed PRV stations should have a small diameter pipe by-passing the PRV to keep water fresh and prevent sediment build-up on the upstream side of the PRV.

It should also be noted that in some cases pumps may need to be replaced or have the impellers changed to meet differing head conditions associated with the change in pressure zones.

East Bay Township

District 10EB2:

The Holiday Hills Wells (Wells 1 and 2) will need to be supplemented with new wells. New (additional) well capacity will need to be in the range of 265 gpm (if District 10EB2 is still supplemented with water from 20EB1) or 745 gpm if District 10EB2 is to be self-reliant in terms of supply. This new well capacity should also delay any possible need to add additional capacity to the Iron Removal Plant.

The existing English Woods elevated storage tank does not meet 2037 demand requirements for District 10EB2. Consideration should be given to adding additional storage capacity as the need arises. Additional connections with the other two water districts in the Township as shown in the conceptual Near-term and Ultimate-build out plans should be considered.

District 20EB1-N:

Study should be given to providing wells within this District. This is expected to provide an energy savings and pumping costs vis-à-vis the existing plan of using deeper wells located in 20EB1-S. However, this plan may not be feasible to implement in the near future if iron removal would be required.

A second transmission line from 20EB1-S which has all of the wells supplying 20EB1-N is recommended. This could be along Townline Road or Four Mile Road. Other looping and the establishment of emergency connections with the City of Traverse City is recommended.

The Cherry Ridge elevated water storage tank serving 20EB1-N and 20EB1-S is woefully under-capacity. Separate, new ground storage tanks are recommended for these Districts with the northern tank being 1.5 MG and the southern tank being 0.75 MG. Ground storage tanks will cost much less than elevated storage.

District 20EB1-S:
Well and Iron Removal Capacity should be adequate if other improvements are made as recommended above. The existing storage deficiency was discussed above. A transmission line along Hammond Road to the West is recommended along with an emergency connection to the Garfield Township system.

The existing Cherry Ridge tank could be relocated such that the normal high water elevation is 1040, thereby serving Pressure Zone 4 (Z4) including the Windmill Farms Development. This area could ultimately be linked with the Z4 distribution system in the Holiday Hills area (see Ultimate Build-out conceptual plan).

Elmwood Township

General:
It is not certain how soon the rural areas of the southern portion of the Township will develop and how the water system will expand by the year 2037. Another uncertainty is the percentage of overall Township demand that will be served by wells versus City water. However, it does appear that the current agreement with the City to supply 0.75 MGD should be adequate for another 15 to 20 years. There are no other supply/pumping systems capacity concerns for Elmwood Township at this time.

District 30EL2:
This district can continue to be served by City water in the Near-term Plan. Distribution system extensions can be made along Carter, Grandview and Cherry Bend Roads with additional looping as necessary to serve developments in those areas, provide fire flows and serve existing private Type I systems.

District 60EL3:

This would be a new district along Carter Road in Pressure Zones Two and Three. This would be developed along with water districts in the same pressure zones in Garfield Township and the City. The necessary improvements for this shared Water district will be discussed in the following section for Garfield Township.

District 110EL5:

This district includes the Timberlee Development but also much of the rural area of the southern portion of the Township. A new 300,000 gallon ground storage tank serving Pressure Zone 3 is recommended to be located in or near the Timberlee Development. Distribution piping would be adjusted somewhat such that the existing Booster Station at Timberlee would only be serving Pressure Zone 4 areas. Fire hydrants could be added to appropriately-sized water main.

With this storage in place, the existing wells at Timberlee currently have adequate capacity to serve this entire district based on Year 2037 demands. However, it may be more practical to serve the south-east portion of this district with City supplied water or new wells because of its distance from Timberlee. Improvements, including storage, are being recommended for the City and Garfield Township that would make it possible to serve this south-east portion of 110EL5 very easily.

District 120EL1:

This is a rural district in the south-west corner of the Township at higher elevations that is not now served by a public water supply (PWS). Should this area have the need for PWS in the near-term, improvements (including storage) are being recommended for Garfield Township that would make it possible to serve this District very easily.

District 150EL4:

This is a district furthest north in the Township's portion of the Study Area that is not now served by a PWS. Should this area have the need for PWS in the Near-term, water could be piped across the valley from Timberlee, could be pumped from District 30EL2, or could be served by new wells.

Garfield Township

General:

Garfield Township is reaching the limit (5MGD) of its bulk water purchase agreement with the City of Traverse City. The Township should work with the City to update the agreement or seek other supplemental supply to provide the anticipated Year 2037 MDD of 10.5 MGD plus an extra 2-3 MGD for contingency. Garfield Township stands to benefit the most from the proposed pressure zone plan.

Districts 30G1, 30G3, 30G7 and 30G8:

These areas can continue to be served directly from the City water supply as part of Pressure Zone 1 without the need for boosting pressure. The area along Cass Road will no longer need to be served by District 70G2A-W via a PRV because the City will be operating at about 13 psi higher pressure and this area will fall in Pressure Zone 1 with implementation of the Near-term Plan. This will result in energy and pumping cost savings to Garfield Township. The PRV station can be left in place with a setting such that the PRV is normally closed but would open if pressures in 30G1 drop below their normal levels.

District 60G5:

This is a district in Pressure Zones Two and Three that would be developed along with water districts in the same pressure zones in Elmwood Township and the City, namely Water Districts 60G5, 60EL3, 60TC2 and 60TC5. The necessary improvements for this shared Water district would include a new regional storage tank along Cedar Run Road. Supply would come from the City via the Booster Station on Brook Drive near Munson Hospital. The Brook Drive Booster Station would be converted to a dual booster station to separately serve Pressure Zones Two and Three. This means that the booster station would have separate pumps and discharge piping for each pressure zone that it serves. Water from this district will be boosted again to serve Districts 110G4C, 120G6, a portion of 110EL5 and 120EL1. Therefore a new firm capacity of 3.0 MGD will be required. Water main improvements need to be made within the City to move water from East to West across town to supply the Brook Drive Booster Station and other area demands.

The new storage would be ground storage with a capacity of 0.95 MG and a normal high water elevation of 940 to serve Pressure Zone Three. This tank would also serve Pressure Zone Two through a PRV during periods of high demand when the pumps in the dual booster station were not able to meet the required demand. During normal demands, this will save energy costs associated with pumping water to Pressure Zone Three and feeding back down to Zone Two.

Districts 70G2A-E, 80G2B and 85G2C:

The LaFranier Booster Station has just adequate capacity to serve this District and downstream Districts as well to the year 2037. It is recommended that the Traditions Booster Station be moved to a location along Garfield Road to be coordinated with recommended storage improvements. The Booster Station would be converted to a dual booster station serving both Pressure Zones 3 and 4. Based on the proposed pressure zone plan, the City's increased hydraulic grade line should mitigate the suction side pressure deficiencies currently experienced by the LaFranier Booster Station.

Existing storage in District 70G2A-E is currently inadequate. New Pressure Zone 2 storage is recommended along Garfield Road. This would be ground storage with a capacity of 1.4 MG and a normal high water elevation of 855. The existing Birmley elevated storage tank could also be moved to a location along Garfield Road and would perfectly match the required storage capacity for Districts 80G2B and 85G2C. This relocated tank would have a normal high water elevation of 1040 for Pressure Zone 4 serving 85G2C. A new pedestal or berming may be required to provide additional height even if located at the high point along Garfield Road which has an elevation of about 945. This tank would also serve District 80G2B through a PRV during periods of high demand when the pumps in the dual booster station were not able to meet the required demand. During normal demands, this operational scheme will save energy costs associated with pumping water to Pressure Zone Four and feeding back down to Zone Three.

New water main is recommended within these districts to accommodate future growth, the new booster station and storage tank locations and to provide additional looping. In addition, it is recommended that a transmission line be extended east along Hammond Road along with an emergency connection to the East Bay Township system.

District 70G2A-W

The Garfield Booster Station Number One near Cass Road would be modified to be a dual booster station such that it could pump directly to this district in addition to currently pumping to the McRae Hill tank. This will result in significant energy savings vis-à-vis the current scheme of pumping to the McRae Hill tank and feeding back down through a PRV. It is anticipated that roughly 10,150 KwH per year would be saved in the year 2017 and 13,330 KwH in the year 2037. A new transmission line could connect to existing water main somewhere in the area of Wal-Mart or Home Depot.

Limited new storage would be provided for this district for equalization purposes. This would be backed up by the McRae Hill storage which would provide fire and emergency storage. The new storage would be a 0.6 MG ground storage tank with a normal high water elevation of 855 and could be located along McRae Hill Road or some other nearby location of appropriate elevation that is near a significantly-sized water main.

District 90G4A:

This district is served directly from the McRae Hill tank. It is recommended that the existing PRV station at McRae Hill Road and U.S. 31 be re-located to provide better pressures to commercial development south-west of the South Airport/U.S. 31 intersection. Expansions of the existing water system infrastructure can be easily made in this district. There are no other significant recommendations for this District at this time.

District 100G4B:

This District serves Pressure Zones Two, Three and Four in a large area in the southwest corner of the Township. The Silver Pines Road Booster Station will serve this District drawing water from the McRae Hill Tank. Because the McRae Hill tank will be used largely for fire and emergency storage for Zone 70G2A-W an evaluation should be made as to whether the suction piping for this booster station should come directly from the McRae Hill tank, opposite the tank's feed line, to keep water circulating within the tank.

New ground storage would be provided to replace the existing Heritage Estates standpipe tank. It would have a capacity of 1.6 MG and a normal high water elevation of1040 to serve Pressure Zone Four. This tank would also serve Pressure Zones Three and Two within 100G4B through PRV s. Some additional water main in the area of Heritage Estates will be required because Heritage Estates will be in Pressure Zone Five in a different water district with ground storage at a higher elevation. Re-use of the Heritage Estates tank at Timberlee in Elmwood Township should be explored.

District 110G4C:

This district in the western portion of the Township serves Pressure Zones Four and Five. It will also be the source of water for District 120G6 and potentially a portion of 110EL5 and 120EL1 within Elmwood Township. This District along with 120G6 is also well positioned to serve the eastern portion of Long Lake Township if the need arises. This northeast corner of Long Lake Township that is zoned for higher density residential and has several private Type I systems, one of which is required to treat its well water for high nitrate levels.

The decision was made to serve this pressure zone by a new booster pump station near Cedar Run Road that draws water from District 60G5. This was deemed better than drawing water from 100G4B which had already been boosted twice and had traveled far. The booster station will be a dual booster station serving Pressure Zones Four and Five within the District and will have a firm capacity of 2.0 MGD.

A backup booster station would be provided at the new Heritage Estates Tank or a suction line would be run from that tank to the Herkner Road Booster Station which would be converted to a dual booster station to serve both Pressure Zones 5 and 6. In this way water could be moved around the perimeter of the Township in either a counter-clockwise or clockwise direction.

New ground storage will be provided for the District. It will have a capacity of 1.3 MG and a normal high water elevation of 1140 to serve Pressure Zone Five. This tank would also serve Pressure Zone Four within the District through PRV s. The PRV to the area within Pressure Zone Four that is served directly by the new booster station would be set to only open when the pressure in the area dropped slightly below normal during periods of high demand when the pumps in the dual booster station were not able to meet the required demand. During normal demands, this will save energy costs associated with pumping water to Pressure Zone Five and feeding back down to Zone Four.

Some water main extensions are recommended within this district to enable service to new areas and improve looping and general movement of water within the district.

District 120G6:

This district in the northwest corner of the Township will continue to be served by the Herkner Road Booster Station. Depending on growth within this District, a future elevated water storage tank can be placed next to the ground storage tank serving District 110G4C. Additional water main will necessary initially because of changes in the pressure zones and more can be added later as the system is expanded.

Peninsula Township

General:

It does appear that the current agreement with the City to supply 1.0 MGD should be adequate for at least the term of the agreement. The Township recently completed a project to make several changes to the system. This Near-term Plan is based on recommendations for improvements to be made over the next ten years for the purpose of meeting the goals presented earlier.

District 30P1 and 30P2:

These districts would continue to be served directly by the City water supply as part of Pressure Zone 1 without the need for boosting pressure. The upper limit of these districts can be moved to elevation 660 as the City implements the recommended revisions of its pressure zones.

District 40P3:

This district would continue to be served from the City's Huron Hills Booster Station located at the City's WTP which also serves the City's District 40TC3. It is recommended that a new 0.57 MG ground storage tank be provided with a normal high water elevation of 865. An ideal location for this tank would be the high ground on the east side of Mathison Road about 200 feet north of Wakulat Drive where the ground elevation is above 855. With this improvement, all of Districts 40P3 and 40TC3 could be served by gravity from the storage. Only the high pressure zone (District 50P4) would have to be boosted which is a fairly small area relative to the entire service area. This would increase reliability and simplify the control scheme. It would also be a large savings of energy and O&M costs associated with the current configuration in which most of the water used in Districts 40P3 and 40TC3 are boosted a second time via the proposed Carpenter Hills Booster Station at Cherrywood Commons. The new tank would serve districts 40P3 and 40TC3. It would also serve as storage to supply the new Booster Station serving 50P4.

District 50P4:

This District is served by the Carpenter Hills Booster Station at Cherrywood Commons. The existing ground storage would be abandoned or provide equalization storage for suction side of the booster pump station when the gravity storage is in place. If the existing ground storage is abandoned, the water main between the proposed Mathison Road storage tank and the booster station will need to be adequately sized to minimize friction losses such that adequate suction pressure is provided to the pumps.

Traverse City

General:

If Traverse City continues to supply water to Elmwood, Garfield and Peninsula Townships without new supplies being developed, the WTP appears to have adequate capacity based on current projections through to about the year 2032. However, in the interim, it is recommended that additional reliability and redundancy improvements be provided throughout the plant, intake and discharge works such that the entire plant can consistently meet the nominal rated capacity of 20 MGD. Further recommendations for the WTP are provided in Section VI.C below.

The City should continue a program to replace old and under-sized water main. It is strongly recommended that emergency connections be established with the East Bay Township system. The City currently has no backup to its WTP. The Township could provide a very valuable service in the event of the WTP being out of service. This is important not only for the City but for the Townships that rely upon the City for water supply. The emergency connections would also provide an important backup to the East Bay Township system.

District 30TC1:

It is recommended that the HGL be raised for this District and connected districts in the Townships from the existing HGL of about elevation 740 to elevation 770 (see Section VI.B.1.0 above). This proposed increase will accomplish several things for the City:

1) Improve pressures (approximately 13 psi) and fire flows within the City,
2) Enlarge the area both within the City and in the surrounding townships that can be served without the need for boosting pressure via pump stations,
3) Facilitate emergency connections with East Bay Township that would provide adequate pressure to the Township.

This increase in HGL would be accomplished in the following ways. The Barlow ground storage tank would become a dump and pump facility. It would be isolated from the distribution system and water would enter the tank through a PRV station. Water would be pumped out of the tank as necessary with low head pumps that would raise the HGL to elevation 770. In the future, when the Barlow tank needs to be replaced because of age and condition, higher ground can be sought for replacement storage. The City may wish to construct the new tank sooner rather than expending maintenance money on a tank that will eventually become obsolete.

The other improvement that is recommended would be the replacement of the Wayne Hill storage tank. A replacement ground storage tank would be located on higher ground with a normal high water elevation of 770 and a capacity of 1.5 MG to serve year 2037 demands. An alternate to replacing the Wayne Hill tank would be to convert the existing Wayne Hill tank and booster station to a dump and pump facility.

Water Main improvements should continue to be made within the City. Of particular importance will be new transmission mains from the east side of the City to the western limits, to benefit the Brook Drive Booster Station.

District 30TC6:

This is a small Water district within Pressure Zone 1 in the northwest corner of the City in Leelanau County. A connection can be made to serve this area from Water District 30TC1 or it can be served from District 60TC5 through a PRV station.

District 40TC3:

This is a district that is supplied by the Huron Hills Booster Station. Adjustments should be made to PRV and check valve locations to correspond with the new pressure zone plan. This district will be served by the new storage tank located in Peninsula Township (see above description).

Districts 60TC2 and 60TC5:

These districts in Pressure Zones Two and Three would be developed along with water districts in the same pressure zones in Elmwood and Garfield Townships. Improvements for this Water district are described in the section above for Garfield's District 60G5. The Wayne Hill Booster Station will be abandoned in this proposed plan that will greatly simplify distribution system layout, operation and movement of water and reduce energy and maintenance costs.

District 70TC4:

This is a district that would continue to be served via the Garfield District 70G2A-W.

6.0 Ultimate Build-out Plan

6.1 Introduction

The Ultimate Build-out Plan is intended to represent demands and system configurations for when the entire study area has been totally built-out to the density envisioned by the respective zoning maps. Ultimate build-out will happen at different times in different townships and even geographically within each township. Total build out of all areas will only happen after many, many years. The Ultimate Build-out Plan is only developed for the following purposes:

1) To guide the direction of the Near-term Plan,
2) To facilitate computation of population by water district for the Years 2017 and 2037, and
3) To show how the water systems could be configured in the future to serve the entire study area in an efficient manner.

Figure VI.B.5 in Appendix E is a series of maps for each Township showing the basic conceptual framework of the Ultimate Build-out Plan with additional improvements beyond the Near-term Plan. This plan has been developed only for this Study's Level One and Two Townships (East Bay, Elmwood, Garfield, Peninsula and Blair). The City is considered to be essentially already built-out so no computations were undertaken for the City. For Blair Township, conceptual Ultimate Build-out system configuration is suggested but without reference to required capacities or a schedule for implementation.

6.2 Water District Demands by Zone

Ultimate Build-out demand estimates have been made for Average Day Demand (ADD) and Maximum Day Demand (MDD). Maximum Hour Demand (MHD) and Peak Instantaneous Demand (PID) have not been determined because all districts are proposed to have their own storage in the Ultimate Build-out condition. The methodology for determination of ADD and MDD demands is presented here. A summary is provided in Table VI.B.15.

<u>Average Day Demand (ADD)</u>

Development of Ultimate Build-out Demands was accomplished through several steps. The first was to determine the acreage of each type of zoning within each water district. The zoning maps for each township were superimposed on the water district map. For Garfield Township, the Approved Comprehensive Land Use Plan (2002) was used to anticipate future changes to the existing zoning map. The acreage of each type of zoning within each water district was then computed from the superimposed maps.

The second step in the process was to develop GPD/Acre demands for each type of zoning. This was done by selecting various sample developments that have already been built-out and determining existing GPD/Acre demands for the sample developments. A total of 26 sample developments were analyzed representing various types of development. Actual 2006 customer meter data for each customer within the sample areas was used to determine the total ADD for the sample area. The analysis is summarized in Table VI.B.14 below. Maps of the sample areas are provided in Appendix I.

The final step in the process was to multiply the acreage of each zone within each water district by a representative unit demand in GPD/Acre as determined by analysis of the sample areas. By summing the demands for all the zones within each water district it was possible to estimate Ultimate Build-out Demands for each water district. The computational spread sheets with these Ultimate Built-out demands are also provided in Appendix I.

Maximum Day Demand (MDD)

Maximum Day Demands have been computed in accordance with Section VI.B.5.3 and are presented in Table VI.B.15.

Table VI.B.14- Unit Demands for Sample Development Areas

TYPE OF ZONING	Analysis Area (Appendix I)	Acreage	No. of Meters	Water Meters Per Acre	ADD	ADD per Acre
SINGLE FAMILY						
Suburban Single Family Residential	1	81.1	122	1.50	56,139	692
	7	122.5	135	1.10	61,590	503
	20	96.9	138	1.42	82,827	855
	23	98.8	91	0.92	49,851	505
	24	114.5	166	1.45	79,468	694
	Aggregate	513.8	652	1.27	329,875	642
Urban Single Family Residential	4 (Note 1)	157.5	299	1.90	88,431	561
	6	47.0	108	2.30	19,661	418
	16	26.9	53	1.97	13,526	503
	Aggregate	231.4	460	1.99	121,618	526
(Note 3)	Aggregate 2	231.4	459	1.99	104,042	450
Aggregate of all Single Family		745.2	1,112	1.49	451,493	606
Aggregate of all Single Family 2	(Note 3)	745.2	1,111	1.49	433,917	582
MULTI-FAMILY						
Duplexes- Multi-Family Residential	22	19.0	81	4.26	6,952	366
-						
Tightly Spaced- Single Family	12	22.8	100	4.39	12,572	551
(Note 2)	14	14.9	97	6.51	25,596	1,718
	21	15.4	59	3.83	13,232	859
	Aggregate	53.1	256	4.82	51,400	968
-						
Apartments- Multi-Family Residential	2	23.0	100	4.35	20,474	890
	13	10.9	13	1.19	16,457	1,510
	18	38.4	29	0.76	42,672	1,111
	Aggregate	72.3	142	1.96	79,603	1,101
Aggregate of all Multi-Family		144.4	479.0	3.32	137,955.0	955
COMMERCIAL						
Professional & Commercial Office	25	44.7	20	0.45	25,632	573
General Business	15	20.4	37	1.81	17,224	844
Planned Shopping Center	19	69.3	7	0.10	72,197	1,042
Regional Business	3	102.8	123	1.20	131,791	1,282
	Aggregate	237.2	187	0.79	246,844	1,041
INDUSTRIAL						
Industrial	5	26.0	16	0.62	28,296	1,088
	9	40.8	20	0.49	6,284	154
	10	65.7	16	0.24	28,731	437
	11	102.8	24	0.23	105,116	1,023
	17	232.3	59	0.25	53,335	230
	Aggregate	467.6	135	0.29	221,762	474
SCHOOL						
School	8	92.1	3	0.03	7,238	79
	26	99.2	2	0.02	10,574	107
	Aggregate	191.3	5	0.03	17,812	93

Notes:
1) One very high usage residence included
2) Single Family Homes but Multi-Family Zoning
3) Aggregate values without one very high usage residence

6.3 Ultimate Build-out Supply/Pumping Systems Capacity Requirements

The Ultimate Build-out demands and supply/pumping capacity requirements are provided in Table VI.B.15.

6.4 Ultimate Build-out Storage Capacity Requirements

The Ultimate Build-out maximum day demands and storage capacity requirements are provided in Table VI.B.16.

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.15- ULTIMATE SUPPLY/PUMPING SYSTEM CAPACITY REQUIREMENTS
Wilcox/Black & Veatch
Revised: December 20, 2009

Description	Water District	Sub-District	Ultimate ADD	Ultimate MDD	
EAST BAY TOWNSHIP					
Cherry Ridge Wells	20	EB1-N	1.630		
	20	EB1-S	1.530		
		TOTAL	3.160	8.4	
Holiday Hills District Wells	10	EB2	2.330	6.2	
ELMWOOD TOWNSHIP					
Timberlee District (with new storage)	110	EL5	0.675	1.8	(Assume Half)
GARFIELD TOWNSHIP					
Booster #1 (Cass Rd),(Converted to Dual)	70	TC4	0.091		(2037*1.15)
	70	G2A-W	0.922		
	90	G4A	0.560		
	100	G4B	2.510		
		TOTAL	4.083	10.8	
Booster #2 (Lafranier)	70	G2A-E	1.400		
	80	G2B	0.339		
	85	G2C	0.017		
		TOTAL	1.756	4.7	
Booster #3 (Silver Pines Rd)	100	G4B	2.510		
		TOTAL	2.510	6.7	
Booster #4 (Brook Dr)	60	EL3	0.094		
	60	TC5	0.249		(2037*1.15)
	60	G5	0.330		
	60	TC2	0.027		(2037*1.15)
	110	G4C	1.430		
	120	G6	0.170		
	110	EL5	0.675		(Assume Half)
	120	EL1	0.029		
		TOTAL	3.004	8.0	
New Dual Booster Station (Cedar Run Rd)	110	G4C	1.433		
	120	G6	0.170		
	110	EL5	0.675		(Assume Half)
	120	EL1	0.029		
		TOTAL	2.307	6.2	
Booster #5 (Herkner Rd)	120	G6	0.170	0.46	
Booster #6 (Greyhawk) (Eliminated)					
Booster #7 (Traditions-Moved, Dual)	80	G2B	0.339		
(new storage provided)	85	G2C	0.017		
			0.356	0.97	
TRAVERSE CITY					
Traverse City Water Treatment Plant	30	EL2	0.842		
	30	G1	0.776		
	30	G3	0.133		
	30	G7	0.002		
	30	G8	0.015		
	30	P1	0.206		
	30	P2	0.184		
	30	TC1	4.083		(2037*1.15)
	40	P3	0.340		
	40	TC3	0.051		(2037*1.15)
	50	P4	0.182		
	60	EL3	0.094		
	60	G5	0.330		
	60	TC2	0.027		(2037*1.15)
	60	TC5	0.249		(2037*1.15)
	70	G2A-E	1.400		
	70	G2A-W	0.922		
	70	TC4	0.091		(2037*1.15)
	80	G2B	0.339		
	85	G2C	0.017		
	90	G4A	0.560		
	100	G4B	2.510		
	110	G4C	1.430		
	110	EL5	0.675		(Assume Half)
	120	EL1	0.029		
	120	G6	0.170		
	150	EL4	0.252		
		TOTAL	15.908	38.2	
Huron Hills Booster	40	P3	0.340		
	40	TC3	0.051		(2037*1.15)
	50	P4	0.182		
		TOTAL	0.573	1.6	

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
TABLE VI.B.16- ULTIMATE STORAGE REQUIREMENTS
Wilcox/Black & Veatch
Revised: December 20, 2009

Water District	Water Sub-District	ADD	MDD
EAST BAY TOWNSHIP			
NEW NORTH DISTRICT STORAGE (T1)			
20	EB1-N	1.63	
Total		1.63	4.39
Equalization 23.5% Max. Day			1.03
Fire-Corporate Commerce Center			0.63
Emergency- 33% Max. Day			1.45
Total Required Storage			3.11
CHERRY RIDGE DISTRICT STORAGE (T2)			
20	EB1-S	1.53	
Total		1.53	4.13
Equalization 23.8% Max. Day			0.98
Fire-General Commercial			0.30
Emergency- 33% Max. Day			1.36
Total Required Storage			2.64
ENGLISH WOODS (HOLIDAY) DISTRICT STORAGE (T3)			
10	EB2	2.33	
Total		2.33	6.24
Equalization 22% Max. Day			1.37
Fire-Medium Density Residential			0.18
Emergency- 33% Max. Day			2.06
Total Required Storage			3.61
ELMWOOD TOWNSHIP			
NEW TIMBERLEE GROUND STORAGE (T4)			
110	EL5	0.68	(Assume Half)
Total		0.68	1.83
Equalization 27% Max. Day			0.49
Fire-Low Density Residential			0.12
Emergency- 33% Max. Day			0.60
Total Required Storage			1.22
GARFIELD TOWNSHIP			
BIRMLEY DISTRICT STORAGE (T5)			
70	G2A-E	1.40	
Total		1.40	3.78
Equalization 24% Max. Day			0.91
Fire-Light Industry			0.30
Emergency- 33% Max. Day			1.25
Total Required Storage			2.45
NEW GARFIELD DISTRICTS STORAGE (T6)			
80	G2B	0.34	
85	G2C	0.02	
Total		0.36	0.97
Equalization 28% Max. Day			0.27
Fire-Low Density Residential			0.12
Emergency- 33% Max. Day			0.32
Total Required Storage			0.71

McRAE HILL STORAGE (T7)				
70	**G2A-W**	0.92		
70	**TC4**	0.09		
90	**G4A**	0.56		
Total		1.57	4.24	
Equalization 27.5% Max. Day	**(90G4A Only)**		0.42	
Fire-Corporate Commerce Center			0.63	
Emergency- 33% Max. Day			1.40	
Total Required Storage			2.45	
NEW COMMERCIAL CENTER STORAGE (T8)				
70	**G2A-W**	0.92		
70	**TC4**	0.09		
Total		1.01	2.74	
Equalization 25.4% Max. Day			0.70	
Fire (Provided by McRae Hill)			0.00	
Emergency (Provided by McRae Hill)			0.00	
Total Required Storage			0.70	
NEW Z4 STORAGE @ HERITAGE ESTATES (T9)				
100	**G4B**	2.51		
Total		2.51	6.72	
Equalization 21.5% Max. Day			1.44	
Fire-Medium Density Residential			0.18	
Emergency- 33% Max. Day			2.22	
Total Required Storage			3.84	
NEW REGIONAL STORAGE NEAR STONEFIELD DRIVE (T10)				
110	**G4C**	1.43		
110	**EL5**	0.68		(Assume Half)
Total		2.11	5.65	
Equalization 22.5% Max. Day			1.27	
Fire-Medium Density Residential			0.18	
Emergency- 33% Max. Day			1.86	
Total Required Storage			3.32	
NEW NW ELEVATED STORAGE NEAR STONEFIELD DRIVE (T15)				
120	**G6**	0.17		
120	**EL1**	0.03		
Total		0.20	0.54	
Equalization 29% Max. Day			0.16	
Fire-Medium Density Residential			0.18	
Emergency- 33% Max. Day			0.18	
Total Required Storage			0.52	
PENINSULA TOWNSHIP				
NEW PENINSULA/TC GROUND STORAGE (NEW T11)				
40	**P3**	0.34		
40	**TC3**	0.05		
50	**P4**	0.18		
Total		0.57	1.56	
Equalization 27% Max. Day			0.42	
Fire-Medium Density Residential			0.18	
Emergency- 33% Max. Day			0.51	
Total Required Storage			1.11	
TRAVERSE CITY				
COMBINED TRAVERSE CITY STORAGE (T12, T13)				
30	**EL2**	0.84		
30	**G1**	0.78		
30	**G3**	0.13		
30	**G7**	0.00		
30	**G8**	0.02		
30	**P1**	0.21		
30	**P2**	0.18		
30	**TC1**	4.08		
Total		6.24	16.22	
Equalization 18% Max. Day			2.92	
Fire-Corporate Commerce Center			0.63	
Emergency- 33% Max. Day			5.35	
Total Required Storage			8.90	
NEW CEDAR RUN RD REGIONAL STORAGE (T14)				
60	**EL3**	0.09		
60	**TC5**	0.25		
60	**G5**	0.33		
60	**TC2**	0.03		
Total		0.70	1.90	
Equalization 26.5% Max. Day			0.50	
Fire-Medium/High Density Resid.			0.24	
Emergency- 33% Max. Day			0.63	
Total Required Storage			1.37	

C. Water Treatment Plant

1.0 Introduction

The City of Traverse City operates a water treatment plant that serves the City as well as the Townships of Garfield, Peninsula, and Elmwood. The plant treats surface water drawn from the East Arm of Grand Traverse Bay, and utilizes a direct filtration process to meet treated water goals. The facility was originally constructed in 1966, and most recently modified in the early and mid 1990's, including an increase of plant capacity to its current nominal rating of 20 million gallons per day (mgd) via conversion to direct filtration, the addition of standby power generation, and conversion from gaseous chlorine to liquid sodium hypochlorite for disinfection. Recent water demands for the plant have reached 14 mgd (2007 maximum day demand was 14.77 mgd). However, plant staff has noted that the peak hourly rate of operation for the treatment plant in the 2007 season was 18.5 mgd, required in order to maintain target distribution system tank levels. This is indicative of a situation in which the distribution system storage capacity and/or distribution system delivery capacity may not be adequate to supplement a maximum day supply flow in meeting maximum hour demands. The appropriate means of meeting maximum hour demands is to rely upon distribution system storage, so it is recommended that the distribution system improvements recommend in this report be addressed in order to reduce the reliance on the treatment plant in meeting such demand conditions.

2.0 Recent Evaluations

An expansion study of the Traverse City Water Treatment Plant was completed by Tetra Tech-MPS in August 2003. This study identified the most pressing concern/issue with the existing facility to be that the Low Service Pumping capacity was identified to be approximately 20.7 mgd with all pumps in service, meaning that firm capacity is not available to meet the treatment plant's nominal 20 mgd rating. Other unit processes and facilities were identified to be adequate to support the 20 mgd rating. No recommendations were made in relation to condition of existing equipment/facilities and need for replacement/upgrade based on age/condition.

The study concluded that demands would exceed rated capacity by about the year 2019, and recommended a 10 mgd expansion of the plant utilizing membrane filtration, with provisions for an additional 10 mgd expansion at some point in the future. The recommended expansion included (quoted costs are assumed to be in terms of year 2003 dollars):

- New intake structure rated for 20 mgd (initially recommended to be a buried infiltration bed intake, but recommendation later changed to an open crib type) - $4,170,000. (Note – Indicated cost is for buried intake from original report; the associated cost for the revised recommendation for a crib intake was not available.)
- Replacing pumps at the Low Service Pumping Station and adding a second raw water main to the water treatment plant - $2,150,000.
- Water treatment plant process improvements via addition of membrane filtration, including a building to house 20 mgd of membrane filtration, initially install 10 mgd of membrane filtration equipment, addition of fine screening, and additional site piping - $14,444,000.
- Addition of increased high service pumping capability (replacement of one existing pump and addition of one new pump) - $1,660,000.
- Doubling finished water storage volume - $1,700,000.

A review of the report results in the following issues for consideration:

The original report recommendation for a buried intake in the Bay (page 9) was later changed to recommend a crib type intake. This change in recommendation is supported by the current evaluation. Problems with buried intakes have occurred throughout the Great Lakes, related to capacity reduction and inability to effectively clean the infiltration bed. Mention is made of modifying LSPS piping to permit backwashing of a buried intake; however, backwashing requires greater rates of flow than filtering, so it is questionable whether backwashing would have much benefit without a very high rate of flow. Since the load on an infiltration bed is greatest at highest flows, significant flows rates/capacity would be required to ensure intake capacity and backwash flow concurrently on peak days.

The report suggests the reservoir downstream from the clearwell has a baffling factor of 1.0 (page 11). The factor given in the 2007 Sanitary Survey by the MDEQ is 0.7; this is more reasonable. For a facility to have a baffle factor of 1.0, it would have to have perfect plug flow. Any increases in capacity will need to account for reasonable baffling factors in CT calculations.

Microfiltration and ultra filtration do not remove all viruses (page 14, 16), so membrane filtration is not the same as disinfection.

Some statements are made about uprating filters with no supporting explanation (page 18). For example filtering at 5 gpm/sf is said to likely adversely affect the ability of the plant to process flow. Justification for this statement is not made – but may be related to the need for pumping systems capacity increases. It is also not clear why filtering at 5 gpm/sf is suggested to require higher head loss. The plant could operate to the same terminal head loss as that being used at present, but runs would be somewhat shorter, if for no other reason than higher clean bed head loss. It is possible that head loss would accumulate at a faster rate, also causing shorter runs. Nevertheless, if runs were not excessively short, operating at 5 gpm/sf would provide a net increase in daily water production. Also, a statement was made about impaired flocculation efficiency at higher rates of treatment. It is very likely that the only time the total plant would be operated at filter rates above 4 gpm/sf is during summer, when water is warmest in the Bay. Operating rates are very low during winter, providing much more time for alum to react in the flocculation basin or basins in use at that time.

The information on pages 17 and 19 appears unfairly biased in favor of membranes. The report states the average life of membranes as 10 years and the average cost of replacing a module is $600, but does not clarify with the number of modules at the plant. This is further confused by references to "sub-modules" for Memcor membrane filters, but "modules" for Zenon membrane filters. Sufficient data are presented to estimate the number of sub-modules [4 x 8 x 18]. Zenon filters consist of three element modules that make up cassettes, which are manifolded together to make up a train. No data is given on how many cassettes and how many trains. Therefore the cost of a module is not relevant. This cost analysis on page 19 should be carefully analyzed when evaluating expansion alternatives.

The Michigan Department of Environmental Quality (DEQ) completed a Sanitary Survey of the City of Traverse City's Public Water Supply in April 2007, resulting in a "satisfactory" rating. This detailed evaluation resulted in the following primary recommendations related to the reliability of the water treatment plant:

- Evaluate potential addition of a second raw water main from the Low Service Pumping Station to the water treatment plant.
- Evaluate all plant control valves and establish a replacement plan to address obsolete valves/actuators.
- Conduct performance testing on filters 4 and 5 to determine maximum rate during algae bloom events.

- Consider filter media replacement if supported by media analysis.
- Evaluate conversion of all plant chart recorders into SCADA system.
- Evaluate filter controls and establish a replacement plan as required.
- Develop a comprehensive capital improvement/capital replacement plan for the water treatment plant.

The last recommendation above, while not being directed toward any specific issue, can be assumed to be applicable to the following observations made in the MDEQ Sanitary Survey report:

- A second intake is recommended for reliability purposes as well as to support future treatment plant expansion.
- Variable frequency drives are recommended to be added to pumps to address aging control valves.
- Suggestion is made to evaluate a conversion to membrane filtration to address future capacity needs and avoid plant footprint expansion.
- Use of chloramination is suggested to support distribution system quality. This recommendation is not readily attributed to any issue identified in the Sanitary Survey, and may be related to disinfection byproduct (DBP) issues occurring in customer community systems where water age is greatest. Garfield Township does not qualify for a 30/40 waiver under IDSE requirements for DBP's; however they have also not exceeded the 60/80 limits. Please refer to the discussions on distribution system water age, mixing in storage reservoirs, and potential benefits of a reconfigured distribution system, as these items will have a beneficial effect on DBP levels.
- Granular activated carbon is suggested to replace the existing anthracite media and provide taste and odor control (existing carbon feed system is described as in operational).
- Addition of filter to waste to remaining filters is recommended, as well as upgrade of filter controls.
- Low service and high service pumping firm capacity are documented as 19 mgd and 18.5 mgd, respectively – lower than the 20 mgd rating for the treatment process, resulting in a MDEQ facility capacity rating of 18.5 mgd.
- Some equipment (air compressors, backwash pump, surface wash pump, and associated electrical equipment) is located in areas subject to flooding.

A review of the report results in the following issues for consideration:

Page 6: With 27 minutes of flocculation time at 19 mgd, the plant would have 20.5 minutes at 25 mgd; which is likely acceptable for direct filtration in summer months (if uprated for capacity increase, would likely be needed only on hot summer days when water in the Bay is relatively warmer).

Page 7: The reported 9 to 11 feet of water over the media should preclude air binding problems when operating to 10 ft head loss. The likely only potential problem at current situation is if filter-clogging algae formed a mat on the surface and all of the head loss occurred there. With so much depth of water over the media, depending on location of washwater troughs, it might be possible to add some anthracite to filters to deepen them. The distance between both bottom and top of troughs and top of media should be checked to confirm if this is possible.

Page 9 (lagoons and sludge disposal): If the backwash water could be sent to a single lagoon a few weeks before the time when ice is expected to form over the lagoons, this would allow the idled lagoon to be decanted of supernatant, and the lower volume of water and sludge could potentially freeze solid during the winter. This approach was used in Duluth, MN with great success for some years. If the sludge in the lagoon completely freezes, the result would be a layer of material similar in appearance to freeze-dried coffee, perhaps an inch thick, after clear water was decanted in the spring following the thaw. This would involve labor to use a snow blower to clean off the ice once the lagoon had ice thick enough to support the equipment and operator (needs to be balanced vs. safety concerns). The benefit would be lengthening the duration between required trucking of sludge for disposal on the order of several years. However, recent comments from plant staff indicated that water table levels may not allow for such an operation.

Page 30 (filtration): In low flow periods, filters are shut down on a daily basis for a portion of the year. Restarting filters without backwashing first can cause problems if operators are not careful in how this is done. A Crypto outbreak at Carrollton, GA was attributed in part to this practice back in 1987 with much literature on the subject since that time.

Page 31 (Plant piping and Miscellaneous): Operational alternatives exist to filter-to-waste, and should be considered in lieu of the expense of piping and valves to accommodate filter to waste. In any replacement of valve operators, electric valve operators should also be considered (in lieu of air-operated actuators) since the plant has back-up power.

Page 32 (Operations): Plant management may want to consider arranging focused on-site training for increasing staff skills for optimization, focusing on filter optimization. Leveraging some "best practices" can improve overall reliability in treated water quality.

Page 33 (Recommendations – Immediate or ASAP Implementation):

5 - A sample of the original media must be available for the microscopic comparison of media in the filter to check for wear and abrasion; some reference material is needed to estimate the extent of change that has taken place over time

10 - In addition to determining maximum rate at the most severe conditions, it is recommend to also test for 5 gpm/sf at a variety of conditions.

Page 34 (Recommendations – Long Term Implementation):

#2 - Media replacement should be based on the need to do so, which in turn should be based on inspections of filter media made over time. As long as the material meets relevant specifications (e.g., AWWA; Ten States Standards) and is of sufficient depth, its continued use can be considered. If the media is wearing down, its effective size would likely gradually decrease. A decision to invest in media replacement should be well-justified; with the best justification being results of long-term testing that show media has changed to an excessive extent from its original condition of size and shape. As a related comment, it would be wise to core sample the mixed media filter to try to ascertain if any garnet is still remaining in the filter. Loss of fine media can occur and not be readily noticed unless one detects a difference in filtered turbidity for the bed with no garnet versus other beds that still are in the condition close to that which was called for in design and placed during construction.

3.0 Component Facility/Process Capacity, Performance, and Condition

Table VI.C.1 below identifies the existing plant unit sizes, operational parameters, and capacities.

Table VI.C.1

Existing WTP Operational Parameters

Description	Existing Size/Capacity	Comments
Intake		
Type/size	Submerged crib, 36” intake pipe	
Capacity	24 mgd	
Low Service Pumping		
Type/size	Vertical pumps in wetwell (see Section 3.3)	TT-MPS rating based on operational testing
Capacity	17 mgd firm (TT-MPS report) 19 mgd firm (DEQ Sanitary Survey)	
Rapid Mixing		
Number/type	2; in-line (pipe) mechanical mixing	
Flocculation		
Number/volume	2 basins; 23,976 cu ft each	
Detention Time	26 minutes (at 10 mgd per basin)	
Filters		
Number	5	
Type	Rapid rate, dual media (except as noted) with rate controllers (direct filtration)	
Surface Area	700 sf each (divided into two cells)	Filter media support is 24” gravel for filters 1 and 2, 12” gravel for filter 3, and IMS cap for filters 4 and 5
Filter Media	10” anthracite, 20” sand (filters 1, 2) 16.5” anthracite, 9” sand, 4.25” garnet (filter 3) 14” anthracite, 18” sand (filters 4, 5)	
Filter Rate	4.0 gpm/sf (5 filters) 5.0 gpm/sf (4 filters)	DEQ Sanitary Survey indicates maximum filtration rate = 4.7 gpm/sf
Washwater Rate	3,800 gpm max (10.9 gpm/sf for one cell)	
Washwater Rise Rate	25 in/min (one cell)	
Washwater Volume per Wash	30,000 (filters 1 thru 3) to 50,000 gal (filters 4, 5)	
Filter run time	45 hours average, 110 hours maximum, 20 hours minimum (during algae bloom events)	
Surface Wash	Rotating sweeps on all filters	
Filter to Waste	Filters 4 and 5 only	

Table VI.C.1

Existing WTP Operational Parameters

Description	Existing Size/Capacity	Comments
Clearwells		
Clearwells	2; partially buried	
Volume (total)	150,000 gal (Clearwell 1) 77,000 gal (Clearwell 3)	
Volume (operating)	52,000 gal (Clearwell 1) (Oper. depth 7 to 11 feet) 26,000 gal (Clearwell 3) (Oper. depth 7 to 11 feet) 78,000 gal total	
Finished Water Storage		
Number/type	One; partially buried concrete rectangular tank	
Volume	1.5 Mgal	
Volume (operating)	0.7 Mgal	
Volume as % of plant flow	7.5 percent (total); 3.5 percent (operating)	
High Service Pumping		
Type/size	Vertical pumps (see Section 3.4)	
Capacity	20.2 mgd firm (TT-MPS report) 18.5 mgd firm (DEQ Sanitary Survey)	Not clear how listed ratings were developed
Treatment Chemicals		
Coagulation	Alum/polymer commercially mixed product	
Disinfection	Liquid sodium hypochlorite	
Fluoridation	Liquid hydrofluorosilic acid	
Other	Powdered activated carbon	
Lagoons		
Description	Two lagoons for waste washwater and sludge; decant to storm sewer (NPDES permitted); periodic cleaning of sludge	
Power Supply		
Utility Source	Two utility feeds	Single feed from substation to plant
Standby Generator	Available	Can sustain approx. 16

3.1 Treatment Process Description and Performance

Information in this section was prepared based on review of plant data provided by City staff, and on information obtained during a site inspection with plant staff in summer 2007.

A review of water quality and operating data from 1997 through 2006 indicates that the source water quality of the East Arm of Grand Traverse Bay is outstanding. During this time span, the peak turbidity for a day never reached 2.0 ntu. This water is ideal for direct filtration, as the quality is relatively stable. If changes do occur, they are not likely to be sudden, unless a major storm comes in from the north and brings high winds that could upset currents in the bay and elevate turbidity levels. Tourism is an important part of the economy in the Grand Traverse region, and as expected, peak water demand is in the summer months, June through September, when tourism is busiest. Shortest filter runs are not necessarily reported at times of peak demands. Some short runs have happened during months of low demand. Higher numbers of backwashes per month, along with some short filter runs, were noted in 1998, 1999, and 2000, when the number of filter backwashes per month exceeded 50 – see Table VI.C.2 below. Peak raw water turbidity for a given month seldom approaches 1.0 ntu. Peak value for clearwell turbidity for a given day seldom exceeds 0.10 ntu. High values are highlighted in bold font. Filter runs have been longer in the last few years, as compared to the years 1997 through 2001. The reasons for this were explored during a plant visit in summer 2007, but no definitive causes were identified.

Table VI.C.2 - Summary of data on filtration, 1997 – 2006

Year	BW events in 3 highest months	Shortest runs in high BW months	Shortest filter runs of year	Peak raw ntu in year	*Peak day clearwell ntu in year*
1997	Jn, 57; Jl, 60; Ag, 65	<19, <24, <32	My, 4.7; Mr, 10	**Jl, 1.10**	*Mr, Ap, Se, 0.07*
1998	Jn, 61; Jl, 78; Ag, 74	32, 25, <16	Ja, 5.1, 8; Oc,13, 15; Se, 18. 19	Jn, 0.83	*Jl, 0.07*

Year	BW events in 3 highest months	Shortest runs in high BW months	Shortest filter runs of year	Peak raw ntu in year	*Peak day clearwell ntu in year*
1999	Jn, 68; Ag, 72; Sep, 79	26, 21, <23	Mr, 20; Jl, 21; Oc, 22	Jn, 0.90	*Mr, 0.15*
2000	Jl, 72; Ag, 69; Se, 53	<34, <28, <27	Oc, 17; No, 24	Ag, 0.92	*My, 0.07*
2001	My, 46; Jn, 50; Ag, 46	34, 32, 32	Fe, 27; Se, 26	Se, 1.30; Ag, 1.20; Oc, 0.99	*Ag, 0.13; Jl, 0.09, De, 0.09*
2002	Jl, 50; Ag, 35; Se, 32	30, <49, 50	Jn, 43	Oc, 0.82; De, 0.79	*Jl, Ag, De; All 0.09*
2003	Jl, 25; Ag, 19; Se, 19	58, 118, 75	Ja, 10	Ja, 0.82	*Ap, Jl, No; all 0.08*
2004	Jn, 36; Jl, 39, Ag, 24	39, 36, 75	Ap, 58	De, 0.48	*Jl, 0.09*
2005	Jn, 40; Jl, 37; Se, 35	36, 61, <42	Mr, <37; Oc, 43	Jl, 1.30	*Jl, 0.08*
2006	*Jn, 35; Jl, 37; Se, 23*	*50, 54, 47*	*Ap, 59; My, 63*	*Jl, 0.54*	*Jl, 0.05*

3.1.1 Source Water Quality

The historic data indicated that source water quality is excellent. One aspect that may be of more concern is taste and odor (T&O). The Bay is very clear, perhaps in part to presence of zebra mussels. When water temperature is in the range of 60 deg to 70 deg F, geosmin and 2-methylisoborneol (MIB) can be present. This problem may be a result of benthic algae growth on the bed of the bay, if clarity formerly was not sufficient for sunlight to penetrate to this depth. The T&O episode can happen in the August to October time frame. The plant has a feeder for powdered activated carbon, but its use requires manual handling of bags of PAC and this is a very manual-intensive and dirty task. The PAC feeder has not been used in about ten years. The last attempt to combat T&O by feeding PAC was not successful, as the reduction in T&O was only in the range of 30 to 50 percent. Based on the small amount of PAC on hand in the carbon feed room, it is unlikely that PAC could be fed in substantial dosages for the time period when T&O problems may be encountered.

3.1.2 Chemical Feed

An alum-polymer combination is being used for coagulation. This treatment chemical can be used at lower dosages and produces less sludge than alum alone would produce. Disinfection is accomplished with sodium hypochlorite. Chlorine solution is diluted from about 15 percent in the tank truck to 10 percent for storage in a temperature-controlled room. Maintenance problems have occurred with piping and valves, requiring repair or replacement; however, some extent of this is unavoidable due to the aggressive nature of the chemical. Chemical feed pumps have to be kept clean and dry, but they work well.

3.1.3 Pretreatment

Pretreatment at the Traverse City Water Treatment Plant consists of disinfection with sodium hypochlorite, coagulation using a blend of alum and a proprietary cationic polymer, and flocculation. Because turbidity is low and organic matter in this water is not a problem, coagulant dosages are low. Records of past operation show that in July, 2006, the average coagulant dosage was 0.23 mg/L. Raw water flow is split into two streams, and each is independently dosed with coagulant chemical. A Walker in-line motorized flash mixer is used to mix the coagulant for each treatment train. During seasons when water demand is low, only one pretreatment train (coagulation, rapid mix, and flocculation) is used. The train in use is rotated weekly so usage over the long term is uniform for each treatment train. Flocculation is accomplished in two circular basins, each having a retention time of 27 minutes at a flow through the plant of 19 mgd. The units have a center draft tube and center feed into a mixing zone. Water flows down in the mixing zone and then up at the perimeter of the basin, exiting onto a circular launder through holes in the outer wall. Each flocculator is rated at 10 mgd, and at a flow of about 23 mgd, the water level in the flocculation basin goes above the top of the launder. Increasing the area of the holes that allow water to flow into the launder might improve this situation. Also at high flows head loss between the flocculators and filters 1, 2, and 3 is significant. Hydraulic limitations would need to be dealt with if the plant were uprated to 25 mgd.

3.1.4 Filters

Prior to 1964, water was not filtered. In 1964 a treatment plant was built including two dual media filters with a capacity of 4 MGD each. Between 1972 and 1973, a third filter of the same capacity was added. The third filter contained mixed media. Between 1992 and 1993, the last two filters were built. They also are 4 MGD nominally rated filters, with dual media. The two newest filters differ from the others, having higher troughs and lateral block underdrains with IMS caps. Separation of caps occurred early in the use of these filters, and the caps were replaced. In addition, these new filters have electric valve operators, whereas the first three filters have pneumatic operators. The pneumatic operators should be replaced by electric valve operators.

The filters typically are backwashed at 100 hours or if filtered turbidity rises to 0.07 NTU. On the day of summer 2007 facility inspection, the filtered water turbidity readings at the on-line instruments in the pipe gallery were: #1, 0.030 NTU; #2, 0.046 NTU; #3, 0.018 NTU; #4, 0.044 NTU; #5, 0.014 NTU. The turbidimeter at Filter #1 was a Hach 1720E, all others were GLI Model 95 turbidimeters. According to plant staff, little difference is noted in filtered water turbidity from each of the five filters. Auxiliary scour for the filters is accomplished by surface wash. Raw water is used for surface wash, although such a practice is generally unusual for water treatment. The plant is a direct filtration facility and the raw water quality is sufficient for use as surface wash. Further, the backwash continues well after the surface wash interval and all of the water injected during surface wash is flushed from the filter bed. The mixed media filter experiences shorter runs than the other filters. The first three filters built need about 40,000 gallons for backwash, whereas the newest two filters require about 60,000 gallons for backwashing. Water can flow from the treated water reservoir back into the clearwell, which supplies wash water, thereby significantly increasing the washwater supply. Filter runs can be 100 hours long, but from fall until late spring plant production capacity exceeds water demand. During these times when production is low, the plant is operated 16 hours per day. Filters are restarted without being backwashed at the rate of 1 gpm/sf, with the filtration rate being gradually raised until the desired rate is reached. Filtered water turbidity is carefully monitored, and the spikes may reach 0.1 ntu during these startup operations. If filtered water turbidity does not decline within 15 minutes after restart the filter is taken out of operation or backwashed. The minimum operating rate for filters is 1 mgd per filter, or 1 gpm/sf. Rate control is not reliable below this rate.

Filter-to-waste is available for Filters 4 and 5, but it is not used because the capacity for discharge of wasted water is limited. Filters are brought on-line slowly, and this mode of filter starting helps to minimize the initial turbidity spike.

During winter when water demand is low, filters may remain off-line for three or four days. No water quality problems have been experienced as a result of doing this. This is probably a result of the low turbidity in the source water and to the low temperature of the water in winter.

Some media loss occurs during backwash. Anthracite has been replaced two or three times in the past 20 years. Plant inspections were performed in February and March, 2008, to evaluate the gravel profile in Filters #1, #2, and #3. Gravel mounting evaluations indicate areas where there is potential for depressions in gravel. Potential depressions are indicated by observing the depth of penetration to gravel during a 13 inch/minute rise rate. Greater penetration depths indicate shallow areas of support gravel.

In Filter #1, in the bay to the left, looking from the gallery to the windows, the greatest penetration depths ranged from 30 to 32 inches at stations 24, 17, 19, 15, and 10. No comparable penetration depths were measured on the bay to the right. Based on the inspection results, additional investigation in Filter #1 may be needed.

In Filter #2, in the bay to the left, looking from the gallery to the windows, the greatest penetration was at station 30. In the right bay, the greatest penetrations were at stations 19 and 14.

Penetration depths were more uniform in both bays of Filter #3, with no station having a depth that would cause concern.

No original samples of filter media are available for comparison with existing media to assess media wear by examining for rounded edges on angular anthracite media. Examination of the filter media by Utility Service Company and Floran Technologies indicated that it is in very good condition from a structural perspective. Microscopic examination of media from Filter #1 showed that it did not have signs of abrasion. Chemical cleaning revealed that removal of deposits from the media resulted in a weight loss of 1.9% for media from Filter #1 and 1.8% for media from Filter #2. By comparison, the AWWA Filter Material Standard (B100) limits acid solubility for sand at 5%. If the deposits on the media are causing an excessive clean bed head loss, chemical cleaning can remove the deposits. Staff at the Traverse City Water Treatment Plant could check operating records for clean bed head loss when media was relatively new, if such records are available, to determine if a substantial increase in clean bed head loss has taken place over the years due to growth of the deposits on the media. In the absence of old data on clean bed head loss, staff will need to make a judgment about whether clean bed head loss is greater than desired and whether cleaning should be undertaken.

Filters 3, 4, and 5 are equipped with piping to permit within-bed turbidity sampling. Eight lines are provided for each filter, with the top sample line providing filter influent water, six lines providing water from within the filter bed, and one providing filter effluent. If filter uprating were contemplated in the future these sample lines could be used to demonstrate the extent of floc penetration at a higher filtration rate. This ought to add credibility to filtered water quality data obtained during an uprating study.

3.2 Reliability Considerations

The Saturday, July 28, 2007 edition of the Traverse City Record-Eagle included an article about the falling level and rising temperature in Lake Superior. If the Great Lakes in general, and Grand Traverse Bay in particular, experience an increase in overall water temperature, this has the potential to promote algae growth. Temperature of the water in the Bay is not something that can be controlled, but temperature data are collected at the Water Treatment Plant, and if a trend of increasing temperature in source water is noted, plant staff should be watchful for algae and T&O problems in the future.

Problems with tastes and odors thought to be caused by MIB and geosmin have been observed in recent years. The diagnosis of the cause is based on the earthy-musty odor, as no chemical analysis was available to confirm that those are the chemicals responsible. So far the problem has not been really serious. During one episode plant staff tried adding PAC but only at a concentration of 3 ppm and that was not enough to help. Feeding PAC is a difficult and messy process and not something plant operators want to do if it can be avoided.

Traverse City is not unique with regard to occurrence of T&O substances in the source water. A problem of this nature was encountered in Chicago, with their Lake Michigan source, several years ago. In the Journal AWWA, December, 2000 issue Nerenberg, Rittmann, and Soucie reported on use of ozone and biofiltration to eliminate T & O problems caused by MIB and geosmin. The authors reported that the presence of zebra mussels, which are filter feeders, had resulted in increased clarity of Great Lakes waters, with the increased growth of benthic algae in shallow areas. When filamentous green algae die off and decompose, the nutrients released are the types that support the growth of cyanobacteria or actinomycetes that produce MIB and geosmin.

In the metropolitan Chicago area, 23 water treatment plants draw water from Lake Michigan. Of these, all but one had T&O problems caused by MIB and geosmin. The exception to this was a plant the employed ozone treatment followed by biologically active granular activated carbon filtration (BAC filtration). The authors reported that this plant produced drinking water that was free of MIB and geosmin T&O. This in effect provided full-scale proof that ozone followed by BAC filtration can eliminate tastes and odors caused by those chemicals.

If T&O problems become persistent at Traverse City, the decision-makers in Traverse City should consider their community's status as a tourism destination and the impact serious T&O issues could have on tourism activity. A lot of the economy depends on attracting leisure visitors and seasonal residents and having bad T&O problems with drinking water in tourist season could have a negative effect on tourism.

Plant staff have expressed a concern about being able to sustain treated water production beyond approximately 16 mgd, based upon keeping filter rates at or below 4 mgd and needed to have filters out of service for up to 30 minutes during a backwash cycle. However, assuming minimum filter run times of 20 hours (each filter washed twice per day maximum in any 24 hour period), and limiting filter rate to 4 gpm/sf, results in a maximum production of 19.2 mgd (five filters, each operated 23 hours at 4 gpm/sf). Therefore, it does not appear that the filtration process itself is a bottleneck to producing near the plant rated capacity. The preceding calculation assumes that filtration rates are held constant during filter backwash, meaning low service flow is temporarily reduced during a filter backwash; in actual operations it is more likely that the filtration rate of the filters not in backwash is slightly increased during the backwash of a filter. Filter flow rates and backwash procedures should be reviewed to identify how flows are managed during backwashes.

Between 40,000 and 60,000 gallons of water is required whenever a filter undergoes a backwash. This volume could be decreased if the backwash efficiency were increased. Additionally, if less water with the same amount of solids was sent to the lagoons, the settling there would probably be more efficient because of the greater solids concentration. Additionally or alternatively, if the lagoons received less water the filter to waste capabilities of filters #4 and #5 could be incorporated. This could be achieved within the existing filters by incorporating air scour. Systems such as the Aires® Managed Air System by Roberts Filter can be implemented without disturbing plant operations, which makes for a production-friendly improvement. This would also allow the raw water surface wash to be discontinued and optimize raw water use.

3.3 Expansion Considerations

As water use in the Grand Traverse Region continues to grow, production will need to increase at the Water Treatment Plant. One way to defer a large capital expenditure for new facilities is to continue to use the existing filters with an increase in the filtration rate from 4 gpm/sf to 5 gpm/sf.

Source water quality allows for a 5 gpm/sf filtration rate most of the time. Turbidity of the source is low, and dosages of coagulant are not large. The within-filter sample systems present in three of the filters permit collection of filter performance data useful for demonstrating the capability of the filters to operate successfully at 5 gpm/sf. If the hydraulic capacity were available, most of the time the plant could be operated at a filtration rate of 5 gpm/sf instead of the present rate of 4 gpm/sf.

Plant staff has reported that during pumping tests performed in conjunction with the previous expansion study, the flocculation basins exhibited water levels at high pumping rates that may be of concern in any increased flow through the plant. An hydraulic analysis of the plant would be required to determine if any bottlenecks may exist that would need to be addressed in conjunction with an increase in plant capacity by uprating unit processes.

During the summer of 2008, staff has operated Filters #4 and #5 at a 5 gpm/sf filtration rate with diatoms and algae present in the raw water. On July 14, the filter runs at 5 gpm/sf lasted for 9 hours and 12 hours before reaching 10 foot terminal head loss. During the July 9 meeting, plant staff reported that when filters were operated at 5 gpm/sf, filtered water turbidity did not exceed 0.04 ntu and typically was about 0.03 ntu. Thus it is possible to produce very low filtered water turbidity when operating at a 5 gpm/sf filtration rate.

The potential difficulty for operating filters at 5 gpm/sf relates to filter run length, backwash frequency, and the settling characteristics of spent washwater discharged to the washwater lagoons. As indicated in the table on effect of filter run time on net water production below, if 1.0 hour is the interval of time for a filter to be out of service for backwashing, when filter runs are shorter than 20 hours, the time between backwashes decreases to less than 4 hours. During the July 9 meeting, staff indicated that about 4 hours of time is appropriate for settling the spent washwater before it is discharged to the Bay. If settling time is shorter, the total suspended solids (TSS) concentration of the discharge is higher, and the discharge limit on TSS could be exceeded. The table indicates that with all filters operating, the time interval between backwashes is 3.2 hours for 15-hour runs, and only 2.2 hours for 10-hour runs.

Effect of Filter Run Time on Net Water Production at 4 gpm/sf and 5 gpm/sf Filtration Rates									
Run hrs	Hrs + 1 = time interval between start of run#	Number of runs in 120 hrs of operation*, and number backwashes per day	Hrs between filter backwashes	Total hrs of water production from all filters in 24 hours	Backwash water used in 24 hours, gallons, based on 25,000 gallons per BW@	Gallons filtered per day, all filters operating at 4 gpm/sf	Net gallons produced per day at 4 gpm/sf, subtracting backwash water from total production	Gallons filtered per day, all filters operating at 5 gpm/sf	Net gallons produced per day at 5 gpm/sf, subtracting backwash water from total production
25	26	4.62	5.2	115.4	115,500	19,233,300	19,118,000	24,042,000	23,927,000
20	21	5.71	4.2	114.3	142,750	19,050,000	18,907,000	23,812,000	23,670,000
15	16	7.50	3.2	112.5	187,500	18,750,000	18,562,000	23,438,000	23,250,000
12	13	9.23	2.6	110.8	230,750	18,466,700	18,236,000	23,083,000	22,852,000
10	11	10.91	2.2	109.1	272,750	18,183,000	17,910,000	22,729,000	22,456,000
8	9	13.33	1.8	106.7	333,300	17,783,000	17,450,000	22,229,000	21,896,000

Allowance for time out of service for backwashing and returning filter to service
* For all filters operating 24 hrs/day, 120 hrs of filter operation represents the maximum possible hours of uninterrupted operation
@ Based on DEQ Sanitary Survey performed in 2000 by Brian Thurston

As the Traverse City Water Treatment Plant is presently configured, operating all filters with runs of 15 hours duration, or less, can become difficult because of the need to clarify spent washwater sufficiently to discharge it to the Bay and meet water quality limitations. It is important to note that although short runs are more likely to be incurred at a filtration rate of 5 gpm/sf, depending on source water quality, short runs also could happen when operating at 4 gpm/sf if there were, for instance, an algae bloom. The obstacle to increased water production at the plant appears to be the spent washwater treatment system. If the settling characteristics of spent washwater could be improved so it settled in a shorter time, operating the plant during times when runs are shorter should be feasible. Present practice is to discharge spent washwater and allow it to settle in lagoons, without any added coagulant chemical or polymer to facilitate floc formation and improved settling.

Rather than risk a water quality violation by discharging TSS greater than permit limits, plant staff needs to evaluate use of coagulant or polymer to improve the settling characteristics of the spent washwater. Jar tests with turbid spent washwater collected during backwashing should be helpful in identifying the appropriate dosage of treatment chemical to use to enhance settling.

Alternatively or in conjunction with coagulant addition, incorporating air scour into the filtration backwash should also reduce the hydraulic loading on the washwater lagoons. This is discussed in Section 3.2 of this report. It may also be possible to discharge water to the sanitary sewer, which would also assist in reducing hydraulic loading on the washwater lagoons.

The primary purpose of the Water Filtration Plant is to produce drinking water that meets MCLs and the internal goals of the City of Traverse City, and to produce that water in sufficient quantities to meet the needs of the water customers. If the spent washwater treatment and disposal approach is a limiting factor on water production, then addressing that limitation may be the most cost-effective approach to making sure that water production is not limited by an external factor not related to pretreatment and filtration.

An increase to 5 gpm/sf in filtration rate would allow an increase in treatment plant rated capacity to 25 mgd (or slightly less depending on filter backwash duration if held to this rate during filter backwashes as well), and therefore may only be feasible if demands are not expected to exceed much over 20 mgd in the near to mid-term future. Expansion beyond this will require addition of treatment facilities.

The main water quality problem occurs when algae is present, which shortens filter runs and causes T&O problems when algal decay products are metabolized by other organisms, and MIB and Geosmin are produced. The T&O issues may have the greatest likelihood of being an impediment to uprating filters to 5 gpm/sf.

Potential T&O problems could be mitigated using a variety of technologies including granular activated carbon (GAC), ozone, or UV/peroxide. The filter media could be replaced with GAC. However, empty bed contact time is an important design parameter for GAC filters, and higher filtration rates result in lower empty bed contact times for a given filter bed. If GAC filtration were adopted, a key question would be how deep could the beds be, and what contact time could be attained.

If filtration at 5 gpm/sf or GAC filtration were contemplated, using deeper filter beds for filters 1 through 3 would be recommended. Filter media is presently about 1 foot below the bottom of the washwater troughs in these filters. The trough elevation would be raised, and concrete troughs could be replaced with fiberglass troughs. Also lower profile underdrain filter blocks with porous plate caps would replace graded gravel for media support. These changes would provide more room for additional filter media. Filters 4 and 5 have about four feet between the top of the media and the bottom of the troughs, which means adding more media to these filters is even easier to complete.

If improvements to the media filters occur, an effort should be made to include a filter to waste system for all filter systems. This is true even if the existing lagoon system is not immediately improved and additional improvements were required before the filter to waste could be implemented.

It is also possible to improve plant performance by installing an ozone system. Ozone is a strong oxidant that is capable of providing disinfection, providing microflocculation benefits, and oxidizing taste and odor compounds from algal byproducts. Additionally, ozone treatment often results in a reduction to disinfection byproduct formation. If bromine is present in the water source then there are process controls that are necessary to prevent the formation of bromate, which is a regulated disinfection byproduct. Hence, testing and sampling is necessary before an ozone system could be adequately evaluated and designed.

Ozone is introduced into the raw water in an ozone contactor where the oxidation takes place. This oxidation results in disinfection credits and has a tendency to affect organic material such that the potential for chlorine-contact-based disinfection byproducts are oftentimes reduced. The ozone also oxidizes taste and odor causing compounds, resulting in a more aesthetically appealing water. Additionally, it has been well documented that ozone provides the benefit of microflocculation whereby less coagulant is required, after ozone oxidation, to achieve the same degree of flocculation and sedimentation.

Ozone systems are automated and require oxygen, which is usually stored on site in liquid oxygen tanks. Operating an ozone system requires monitoring of temperature, pH, flow rates, and ozone residual concentration. Additionally, an ozone destruct system must be monitored and maintained. Hence, there are a variety of instruments that must be calibrated and maintained.

As an alternative to ozone, an advanced oxidation system using ultraviolet light and peroxide, abbreviated UV/peroxide, could also be used to increase plant performance. Combining UV and peroxide results in the formation of a hydroxyl radical, which is a very potent oxidant. The UV/peroxide process effectively oxidizes a broad spectrum of dissolved organic material. Like the ozone system, the UV/peroxide option provides taste and odor mitigation, and disinfection. The UV lights provide disinfection by disrupting the reproductive capabilities of pathogens. Taste and odor mitigation involves the introduction of peroxide and increase UV light intensity. Because of the additional energy required for taste and odor mitigation, the UV system would be arranged in a matrix whereby portions of the UV system could be turned off when treatment for taste and odor was not necessary.

After the UV/peroxide oxidation process, peroxide residual remains that must be quenched. This is accomplished using chlorine, which then serves as a disinfectant residual for distribution of the finished water. When the UV/peroxide system is being used, chlorine consumption will increase for the water treatment plant.

A system using UV/peroxide consists of UV reactors arranged in parallel with ability to feed hydrogen peroxide upstream for advanced oxidation when taste and odor mitigation is necessary. The hydrogen peroxide system would consist of a storage tank, day tank, and transfer/metering pumps.

Membrane filtration has been suggested as a process worthy of consideration when capacity expansion is needed. Although microfiltration or ultrafiltration would strain out particles and attain very high removals of cyst-sized particles, a membrane process used alone could not provide an answer to T&O issues. Therefore if a production increase is carried out using membranes, T&O problems would have to be dealt with by use of another process such as ozone or UV/peroxide.

Most membranes are oxidant tolerant polymeric membranes, and lately ceramic membranes are being evaluated for drinking water treatment. These membranes are capable of operating in direct membrane filtration mode. Membrane filtration operates more efficiently when there are fewer suspended solids in the water being filtered. Fewer suspended solids correspond to less membrane fouling and lower pressure loss. Additionally, fewer solids results in longer operation between backwash and cleaning cycles. That said, even during conditions when the solids loading may increase, the physical barrier of the membrane system results in low solids filtrate.

The auxiliary equipment for the membrane system consists of blowers, compressors, CIP equipment, pumps, valves, instruments, and controls necessary for operation. Operation of a membrane system is PLC based and highly automated.

Membrane cleaning is required periodically using chemical solutions. These chemical solutions need to be neutralized before they are discharged to the lagoons. Non-chemical backwash streams can be returned to the front of the plant resulting in greater overall plant water recovery.

In addition to the overall maintenance of the membrane system, the membrane elements have a useful life of seven to ten years and require replacement at the end of their useful life.

Whether consideration should be given to increasing the filtration rate in the future will partly depend on the quality of East Bay water with regard to T&O. If filtration through GAC is adopted in the future, the empty bed contact time for filters operated at 5 gpm/sf might not be sufficient for coping with T&O. This determination would need to be made using pilot filters or by operating a full-scale filter at 5 gpm/sf and evaluating removal of T&O.

Based on the projected MDD of 17 mgd for year 2017 and 21 mgd for year 2037, the WTP may be able to delay capital improvements to meet further demands for some time, if T&O problems remain in check. Reliability improvements, and increasing the filtration rate as previously discussed, will allow demands to be met throughout the planning period. The single largest factor affecting the ability to continue to meet projected demands with the existing treatment facilities with minor modifications, will be the situation with T&O. Increasing and/or sustained T&O issues may dictate the need to consider alternative treatment technologies such as GAC, ozone, or UV/peroxide and therefore dictate the need for more immediate treatment process improvements.

Attached below is a table indicating the impacts of the improvements considered.

Process	*Crypto* Mitigation/ turbidity removal	DBP precursor removal	Control of MIB / geosmin	Operational considerations	Adapting to existing plant	Capital Cost Impact	Operating Cost Impact
Direct filtration, dual media, 5 gpm/sf	Poor/ Good	Poor, due to low dose of coagulant	Poor	Need to adequately settle washwater in lagoons limits direct filtration capability if runs are in the range of 12 hours.	No physical changes to filtration needed. Some question about hydraulic capability of plant.	LOW No added costs unless troughs are raised. Some piping/hydraulic improvements.	VERY LOW Costs increase in proportion to water production.
Direct Filtration, GAC media, 5 gpm/sf	Poor/ Good	Good while adsorption capacity remains	Very Good	Need to adequately settle washwater in lagoons limits direct filtration capability if runs are in the range of 12 hours. EBCT for GAC at 5 gpm/sf may be shorter than desired. GAC replacement about every 3 years.	Same hydraulic concerns as direct filtration. Need to raise backwash troughs for deeper GAC beds, likely to need baffled troughs to minimize GAC losses in BW.	VERY LOW Changes to raise troughs, recommend installation of baffled troughs	LOW Vendor indicated GAC replacement cost of $50,000 per filter bed, plus labor for changeout.
Ozone	Excellent/ Very Good	Good Very Good if before GAC	Excellent	Biological filtration after ozone preferred to minimize organics suited for food for bacteria in distribution system.	Need building for ozone generation, plus ozone contact basins, might need higher head on raw water pumps	HIGH Filtration needs to remain in place – smaller footprint than UV/peroxide	LOW Liquid oxygen and energy will cost more than the savings in coagulant use.
UV-peroxide	Excellent/ No added turbidity removal with this process	Uncertain	Excellent	High operating cost for geosmin/MIB, so operate for this purpose only when geosmin/MIB present. Hydrogen peroxide is a safety concern and increases chlorine use. Otherwise use UV only for inactivation of *Cryptosporidium*	Need modest-sized facility for UV reactors and peroxide storage and feed.	MODERATE Filtration needs to remain in place	LOW to HIGH When UV only, costs are low, but when UV/peroxide is needed, costs are high.

Process	***Crypto* Mitigation/ turbidity removal**	**DBP precursor removal**	**Control of MIB / geosmin**	**Operational considerations**	**Adapting to existing plant**	**Capital Cost Impact**	**Operating Cost Impact**
Membranes	Excellent/ Excellent	none	none	Membranes require pump to provide driving force through membranes. Membrane replacement periodically. Membrane washwater and chemical treatment liquid wastes require disposal.	Install membrane equipment within a building. Pumping needed for this process	HIGH Compared to building additional filters, membranes will be feasible.	MODERATE Pumping energy, membrane replacement, and chemicals for cleaning.

In conjunction with any plant expansion, it is also recommended that additional finished water storage volume be provided.

3.4 Raw Water Pumping

The Low Service Pumping Station is located at the shore of the East Bay and pumps raw water through a 30 inch diameter pipeline to the treatment plant. The station is equipped with four pumps, rated as follows:

Table VI.C.3

Low Service Pump Ratings

Pump Number	Rating	Year Installed	Comments
Pump 1	5.7 mgd	1966	
Pump 2	5.7 mgd	1966	
Pump 3	8 mgd	1972	
Pump 4	8 mgd	1993	

Note: Year indicated in table is the date of the construction contract under which the pump was installed.

The station also includes two traveling water screens; discharge of screens is to a sanitary sewer. The station is constructed of a circular caisson, divided into two wetwells.

3.4.1 Reliability Considerations

No significant issues with existing facilities at the Low Service Pumping Station are reported by plant staff. The primary concern is related to current firm pumping capacity and its ability to support the treatment facility rating of 20 mgd. Conflicting reports of actual capacity are provided by the recent Sanitary Survey and a recent expansion report. It appears the Sanitary Survey rating is based on addition of the rated capacities of the pumps, while the expansion study rating was based on actual pump tests. Since the rated capacities of the individual units are not all at the same operating head, the pump test rating is considered more accurate. In order to support the current rated capacity of the treatment plant, pumping units should be replaced in order to provide a firm capacity of 20+ mgd (an incremental amount over 20 mgd should be provided to account for in-plant water use). Doing so will require a hydraulic and structural analysis and preparing a design for the implementation of the new raw water pumps capable of meeting the required firm capacity.

Installing two variable frequency drives on the motors for Pump 3 and Pump 4 would allow for flexibility in raw water flow rate. By installing the drives on two pumps the raw water flow rate could be precisely controlled over the range of raw water pumping capacities, and would be less expensive and require less space than installing four such drives. Currently flow rate is controlled by adjusting valves, which in turn creates flow resistance and wastes energy. However, variable frequency drives alleviate the need for the flow control valves because only the amount of energy necessary to provide the desired flow is consumed.

In addition, the reliability of the Low Service Pumping Station is dependent upon the reliability of the intake and the raw water transmission main.

The intake is a submerged crib type approximately 4,000 feet offshore, connected to the pumping station via a 36-inch diameter pipe. A riser with blind flange approximately 100 feet from the crib is available for use as an emergency inlet in case of problem with the crib. The presence of a single intake can be seen as a single point of failure; however, the condition of the intake, based on periodic diver inspections, is reported as good – similar intakes around the Great Lakes have served reliably in similar conditions and for longer durations. It is important to plan for redundancy of the intake; however, the ability to gain true redundancy is dependent upon providing a second intake that addresses the potential events in which a second intake would be required: water quality issues, human-affected catastrophic event (i.e., fuel spill near intake or boat/ship accident causing damage to the intake crib or pipe), or deterioration and collapse of the crib or pipe due to age. To address the first two situations would mean ensuring adequate separation of a second intake from the existing intake. Ensuring true reliability, therefore, would entail installation of a second intake sufficiently separated from the existing intake and intake pipe, and in the case of an expansion of the treatment plant beyond 24 mgd (existing intake capacity), providing reliability in pumping facilities as well. Any available City property near the Bay shore should be evaluated for use in “landing” a second intake. A small City park exists approximately two blocks north of the existing Low Service Pumping Station (at intersection of Birchwood and Kewaunee) and may be considered. If an intake pipe were brought ashore at this location, a second pumping station could be located farther inland toward the treatment plant as land availability allows.

The secondary intake is a costly improvement to improve redundancy rather than meet current capacity. Therefore, replacing the existing pumps within the existing pumping station should be completed first since replacing these pumps is less costly and is necessary to meet existing capacity.

The raw water transmission main is another single point of failure in the water supply/treatment train, and the addition of a second main would provide redundancy and allow for eventual repair of the existing, 40 year old pipeline. It is also recommended that non-invasive inspection be considered for the existing raw water main in order to gauge the urgency of installation of a second main. The configuration of the Low Service Pumping Station does not lend itself well to connection of a second raw water main directly to the pump discharge header; therefore it is likely that a second main would need to be connected at some point outside of the building.

Standby power is provided to the Low Service Pumping Station from the plant's generator unit.

3.4.2 Expansion Considerations

All four existing pumping slots are currently occupied, thereby making it infeasible to install another pump into the existing facility. However, the existing pumps could be replaced with higher efficiency pumps of greater capacity. The existing intake structure and piping are indicated to be rated for 24 mgd; therefore, expansion of the existing Low Service Pumping Station to support a treatment capacity rating of 24 mgd appears feasible (four pumps each rated for 8 mgd). Expansion of the pumping station beyond a capacity of 24 mgd would be predicated upon the addition of intake capacity, and the ability of the station to support pumping units larger than the largest units already installed (larger units than already installed could cause structural and hydraulic issues are would need to be carefully evaluated). Variable frequency drives should be included for two of the new raw water pump motors for better, more efficient flow control.

A secondary consideration for expansion of the Low Service Pumping Station is the intake to the Low Service Pumping Station and raw water transmission main from the Low Service Pumping Station to the treatment plant. In conjunction with the addition of a second intake and second raw water main for reliability purposes, these facilities would also provide for additional capacity in water supply and pumping. In its evaluation of Traverse City's "baseline capacity" for permitted water withdrawal under PA 33-37 of 2006, the MDEQ set this value at 27 mgd. Therefore, should a new intake be proposed, additional permitting would be required to evaluate the impact of the proposed withdrawal (see the "Water Withdrawal Legislation" section of this report for a discussion on additional permitting requirements put into effect by the referenced laws). If the intake is installed for redundancy purposes and not expansion purposes, it is possible that some of the increased permitting requirements can be avoided.

3.5 High Service Pumping

The high service pumping system takes suction from the plant reservoir and discharges to the distribution system. The high service pumping system is comprised of five pumps rated as indicated in Table VI.C.4.

Table VI.C.4

High Service Pump Ratings

Pump Number	Rating	Year Installed	Comments
Pump 1	3 mgd	1966	
Pump 2	5 mgd	1966	
Pump 3	5 mgd	1966	
Pump 4	5.5 mgd	1972	
Pump 5	7 mgd	1993	

Note: Year indicated in table is the date of the construction contract under which the pump was installed.

The pumps start/stop against slow operating cone valves. All pumps are constant speed. The pumps take suction from a wetwell that is fed from the plant reservoir.

3.5.1 Reliability Considerations

Primary concerns with existing high service pumping facilities include the age of the electrical gear serving the pumping units (c. 1966), and the complexity of the cone valve system for starting/stopping pumps. Firm pumping capacity and its ability to support the treatment facility rating of 20 mgd is also of concern based on the reported system capability of 18.5 mgd reported in the Sanitary Survey, although the recent expansion study reported this capacity to be 20 mgd. It appears the Sanitary Survey rating is based on addition of the rated capacities of the pumps; it is not clear upon what the expansion study rating was based. Since the actual capacity of the system will depend upon system demand conditions, a pump test is not always a true indicator of actual capability of a high service system. In order to identify the current capacity of the high service system, a detailed hydraulic analysis of the pumping system, performed in conjunction with modeling of the distribution system pumping should be performed. This evaluation takes on added importance and significance as the City moves to increase the hydraulic grade line and to provide storage at elevation 770 rather than the approximate existing elevation of 740. This increase in downstream pressure at the high service pumps means that the pumps will operate further to the left on their curves and will have less capacity. This will require a comprehensive evaluation of all aspects of high service pumping and consideration of several alternative solutions.

Due to the age of the electrical gear serving the high service pumps and the age and complexity of the cone valve system for start/stop flow control, it is recommended that the gear be replaced and that either variable frequency drives (VFD's) or soft starts be considered to replace the function of the cone valves. Soft starts have the benefit of reduced cost and less space requirements than VFD's, while VFD's have the benefit of providing increased overall flow control and ability to reduce pump starts/stops by more closely matching demand conditions. An additional pump slot exists in the high service area, so the cost of adding VFD's can also be evaluated against the provision of a sixth pumping unit, sized to provide a wide range of coverage in total output flow.

The addition of a sixth pump can also provide added reliability by allowing for pumping to the distribution system at a flow in excess of treatment plant flow for short periods during high demand conditions. This can allow some flexibility in dealing with unanticipated maintenance on other unit process facilities at the treatment plant, and is contingent upon adequate finished water storage from which to draw.

The condition and on-going maintenance needs of the three oldest pumping units should continue to be closely monitored to gauge the need for replacement of these units.

3.5.2 Expansion Considerations

The presence of the sixth slot for an additional high service pump lends itself to ease of expansion via addition of a sixth pump. Additional capacity can be provide via replacement of the oldest, smallest pumps with larger units as well. As treatment plant capacity is expanded, finished water storage volume should also be expanded to support the increased pumping rate.

Existing high service pumping capacity is adequate to meet the projected year 2017 MDD; however, additional capacity will be required to meet projected MDD in the longer term future. The timing of required capacity improvements will depend upon the actual existing capacity (conflicting information currently exists as previously noted), and should be coordinated with reliability improvements previously discussed.

4.0 Ancillary Equipment

The Traverse City plant was originally constructed in 1966, received some upgrades in the early 1970's, and was most recently modified and improved in the mid-1990's. Therefore, equipment at the plant may be ten, thirty, or forty years old. Depending on equipment type, operational history, and maintenance procedures, the condition of any equipment must be closely monitored as it passes 20 years in age; it may be come obsolete due to technology, lack of spare parts availability, and/or simply wearing out. Conversely, certain equipment such as pumps can well exceed a 20 year useful life via a conscientious program of preventative maintenance and scheduled rebuild and wear component replacement.

The following concerns and issues were identified during the summer 2007 treatment plant visit as affecting the reliability of the water supply and treatment system:

- Filter one through three controls have exceeded their useful life and should be replaced and upgraded.
- The pneumatic operators on filter control valves should be replaced by electric valve operators.
- The filter to waste provisions available on filters four and five are hydraulically limited such that filter to waste is not capable of operating at full rated filtration capacity. The ability to effectively utilize filter to waste is dependent upon being able to ramp up filtration to the filtering rate; thus, the existing filter to waste capability is not likely fully effective. However, filtered water quality has not suffered as a result, and plant staff report that filter to waste is rarely utilized. As previously noted, there are many operational alternatives to filter to waste that have proven effective in controlling the initial turbidity spike; therefore, this is not considered a key reliability concern.
- A potential cross-connection exists in the sodium hypochlorite feed piping between the pretreatment feed points and post-treatment feed points. This should be more closely evaluated and corrected if it does exist.
- The plant SCADA system includes older chart recorders. These should be replaced with new technology “paperless” recorders to enhance data capture and recordkeeping.
- Fluoride storage and feed facilities are located in the same room as coagulant storage and feed facilities. The aggressive nature of hydrofluosilicic acid dictates that it should be in a separate isolated room to avoid damage to and premature failure of, electrical and mechanical equipment in the area.
- The existing carbon system is rarely used due to the dirty and maintenance intensive nature of the feed system. Should PAC remain as the preferred method of T&O control (as compared to GAC filtration or ozone treatment as part of a plant expansion), a system utilizing SuperSacs and automated equipment should be considered.
- Although two utility feeds are routed to the plant, a short reach of the electrical service from the junction of these two services to the treatment plant exists as a single feed. This leaves this reach as a single point of failure, although a standby generator is available in the event of an outage. If electrical service upgrades are required at the plant due to expansion of the treatment facility, the utility feeds should be reconfigured to eliminate the single feed reach.

5.0 Recommended Improvements

The following summary of recommended improvements is based on the evaluations and discussions of this section of the report, incorporating study recommendations as well as considering planned improvements already identified in the City's Water Fund Public Improvements Plan, and recommendations in the DEQ Sanitary Survey.

Table VI.C.5
Recommended Improvements

Description	Report Section V.C Ref.	0-5 Years	5-10 Years	10-20 Years
Treatability Study (including filter uprating and selection of best technology)	3.2-3.3	X		
Plant hydraulic study	3.2-3.3	X		
WTP process and capacity improvements (timing depending on severity of T&O issues)	3.2-3.3		X	X
Low service pump improvements/capacity increase	3.4.1-3.4.2	X		
Second raw water main (pending any non-invasive inspection results)	3.4.1		X	
Second intake and LSPS	3.4.1			X
High service pump improvements (reliability)	3.5.1	X		
High service pump improvements (capacity)	3.5.2		X	
Upgrade filter controls	4.0	X		
Evaluate and implement alternatives to filter to waste	4.0	X		
SCADA upgrade	4.0	X		
Chemical system improvements	4.0	X		
Electrical service improvements	4.0		X	

6.0 Conclusions and Recommendations

The WTP appears to be well-positioned to continue to meet projected MDD through the year 2017. The WTP appears to be well-positioned to continue to meet projected MDD through the year 2017. However, based on the year 2037 planning demands, expansion of capacity will be required sometime beyond the year 2017. In addition, depending on the extent of T&O issues in the future, it is likely that some treatment modifications may be required in the future. Any capacity expansion should be made ensuring ability to address T&O and vice versa.

The 2003 TetraTech-MPS report recommended conversion to membrane filtration to meet future demands. However, this recommendation was based on a projection that the WTP capacity would be exceeded by the year 2019, and therefore was based primarily on capacity factors, and did not necessarily focus on treatment challenges such as T&O. It is now suggested, based on the demand projections of this study, that treatment capacity alternatives be focused primarily on treatment challenges, with the ability to gain additional capacity considered in conjunction. As previously noted, the ability to increase treatment capacity exists via uprating of filters. However, in order to be prepared to deal with T&O issues, a change to the treatment process, involving either GAC filtration or alternative treatment technology would be required, based on the initial alternative analysis previously presented. If considering GAC filtration, empty bed contact time is a key factor, and the higher filter rate may not provide sufficient contact time with the GAC to effectively treat any T&O issues. Alternatives to GAC (and PAC) for T&O control include ozone and ultraviolet (UV) light, sometimes combined with additional oxidation chemical treatment. Ozone treatment typically involves significant capital improvements for contact basins and the ozone generation equipment and support facilities. Unless there are other specific reasons to consider ozone treatment (i.e., need for an alternative disinfectant), ozone can be a costly alternative. Although UV can also serve as an alternative disinfectant, unlike ozone, it is well-suited for use in addressing intermittent and relatively short-term T&O events. Promising results have recently been reported in the use of UB in conjunction with hydrogen peroxide, resulting in a reported 97 percent reduction in MIG and geosmin. Although relatively expensive to operate a UV/H_20_2 system on a continuous basis, it is economically viable for short-term operations.

Therefore, based on projected demands, and a desire to be well-positioned to address T&O issues, the most viable treatment alternatives are:

- GAC filtration within existing filtration facilities – the viability of this option will depend on the effectiveness of the GAC contact available given the required filtration rate (pilot testing recommended to confirm).
- Addition of UV, possibly with additional oxidant, in conjunction with improvements to increase filtration rates.

Confirmation of these alternatives, along with detailed water quality study and development of specific capital and operational costs is out side the scope of this master planning study, and should be done in a specific treatment plant improvements study.

Although well-positioned in general for meeting future projected demands, the WTP is in need of reliability improvements, mainly focused on addressing replacement of older equipment, upgrades to newer technologies, and addressing individual unit capacity issues (primarily low service pumping) in support of the current overall rated WTP capacity.

The City should proceed with initial studies in support of longer term improvements as indicated in "Recommended Improvements", and proceed with implementation of a project encompassing the "0 to 5 Years" improvements items.

D. Level III Townships

The entities within the Level III Category for the purpose of this study (Acme Township, East Bay Water Utilities, Green Lake Township, Long Lake Township and Whitewater Township) are all likely to have public water supplies (PWSs) in the near-term time frame of this study (years 2017-2037). The "Suggested Criteria for Systems Expansion" (Section V.E.) would also apply to the development of new PWSs and should provide guidance as to the areas that might be served by the new PWSs.

For each of these entities it would be feasible to cooperate with the owners of the already have well established nearby water systems. Any new PWSs should be developed based on the guiding principles found in this report (i.e. standardized pressure zones, emergency connections with nearby systems, etc.). As is the case with any new system, good, long-term planning is essential to achieving optimal efficiency and ultimate success.

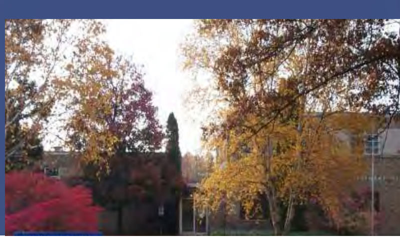
APPENDIX A- GLOSSARY AND ABBREVIATIONS

GLOSSARY AND ABBREVIATIONS

ADD	Average Day Demand
ADDMM	Average Day Demand for the Maximum Month
ASAP	As Soon As Possible
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BAC	Biologically Active Granular Activated Carbon
BAM	Binary Angle Measurement
CCR	Consumer Confidence Report
DBP	Disinfection Byproducts
DBPR	Disinfection Byproducts Rule
DPW	Grand Traverse County Department of Public Works
DEQ	Department of Environmental Quality
EBWU	East Bay Water Utilities
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
GPD	Gallons Per Day
GPM	Gallons Per Minute
GPS	Global Positioning System
H_2O_2	Hydrogen Peroxide
HGL	Hydraulic Grade Line
ICI	Industrial/Commercial/Institutional
IMS	
KwH	Kilowatt Hour
LSPS	Low Service Pumping Station
MCL	Maximum Contaminant Level
MDEQ	Michigan Department of Environmental Quality
MG	Million Gallons
MGD	Million Gallons per Day
MHD	Maximum Hour Demand
MIB	2-methylisoborneol
MiOSHA	Michigan Occupational Safety and Health Administration
MOR	Monthly Operating Report

NPDES	National Pollution Discharge Elimination System
NSF	National Science Foundation
ntu	national turbidity units
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PA	Public Act
PAC	Powdered Activated Carbon
PRV	Pressure Reducing Valve
PWS	Public Water Supply
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SOC	Soluble Organic Carbon
SS	Sanitary Survey by the Michigan Department of Environmental Quality
SWIPP	Surface Water Intake Protection Program
T&O	Taste and Odor
TC L&P	Traverse City Light and Power
TOC	Total Organic Carbon
THM	Trihalomethane
UFW	Unaccounted For Water
UV	Ultra Violet
VA	Vulnerability Assessment
VFD	Variable Frequency Drive
VOC	Volatile Organic Carbon
WHPP	Wellhead Protection Program
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

APPENDIX B- PROJECT SCOPE/WORK PLAN DOCUMENT



SCOPE
Water System Master Plan

Submitted to the
City of Traverse City and Grand Traverse County

November 14, 2006

Submitted by
Wilcox Professional Services, LLC with Black & Veatch

Table of Contents

Project Understanding

STATEMENT OF PROBLEM

In an effort to plan for the future, Traverse City and Grand Traverse County are commissioning the production of a master planning document for their water supply systems. The document will portray the data necessary to meet the Michigan Department of Environmental Quality (MDEQ) reliability study criteria for selected communities as well as examine how the City and its surrounding townships might improve efficiencies and reliability through collaboration and possible emergency interconnections.

Based on the tremendous growth that has taken place in the area over the past 15 years, the multiple jurisdictions believe that preparations should begin for changes that will occur in the next 10-20 years. In addition to growth, local communities face challenges, current and future, brought about by geopolitical realities on state, regional, national and international levels.

The study shall develop a regional planning approach to address issues that range from the purely technical such as capacity of system components to the managerial such as intergovernmental cooperation, standards, and energy and water conservation.

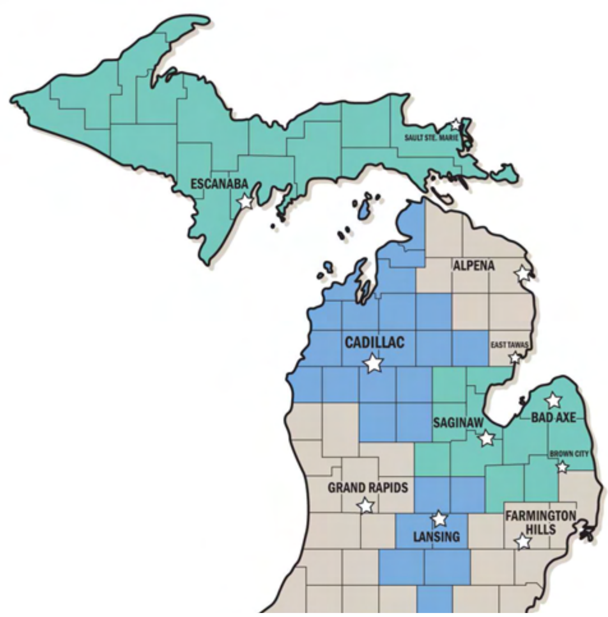
Water Conservation. *The study and report will evaluate water usage and will identify possible measures to implement common-sense approaches to water conservation.*

Energy Conservation. *With ever increasing energy costs, a key component of the study will be to evaluate existing energy consumption and identify ways to conserve energy and help reduce system energy costs.*

PROJECT TEAM

Wilcox Professional Services, LLC (Wilcox)

Wilcox has ten offices throughout Michigan, an office in Indianapolis, Indiana, and two in Arizona. As a Michigan based company, Wilcox has completed many projects for cities, villages, MDOT and county road commissions. The work for this project will managed from the Cadillac office with assistance from our Escanaba Office and sub-consultant Black & Veatch.



Black & Veatch

Black & Veatch Corporation is a leading global engineering, construction and consulting company specializing in infrastructure development in the fields of energy, water, and information. Founded in 1915, Black & Veatch has completed over 2,700 water supply, treatment, and distribution projects for clients throughout the United States and overseas.

Project Approach

GOALS

The project team has developed a set of goals by which the scope has been developed and the project will be driven. These goals are as follows:

- Provide for Public Participation and Input
- Undertake Engineering Master Planning and Reliability Assessment
- Evaluate Opportunities for Water and Energy Conservation
- Consider Potential Future Challenges
- Identify Opportunities for Intergovernmental Cooperation

PROJECT ORGANIZATION

This planning document will tie together the individual planning efforts of the multiple water supplies by making use of studies that have been completed over the last 10 years. The first phase of the work will be the collection of these documents and many other forms of pertinent information that will be useful in the study. The information and raw data will be gathered into a form that lends itself to analysis.

The Wilcox/Black & Veatch team will use many helpful tools in the analysis. This will include synthesis of information into a planning map, statistical analysis of data, relaying results using graphs, figures and tables and finally, computer modeling of water systems.

Citizen participation and input will be a critical element of the project. This will be accomplished through a public meeting and web pages containing project information.

The technical portion of the project will be focused on system and system component capacity and reliability as necessary to fulfill the requirements of Part 12 of the Michigan Safe Drinking Water Act, PA 399 of 1976 as Amended. This information will be presented to the Michigan Department of Environmental Quality on behalf of the study Level 1 governmental entities listed in the following Scope section.

Additional engineering work will include the cursory evaluation of the City's Water Treatment Plant (WTP) in light of previous studies. This will be undertaken to ensure that important opportunities are not overlooked in the best use of this critical resource.

This study will encompass more than engineering with the inclusion of additional master planning effort to address big-picture issues. These components of the study will address challenges brought on by changes in the world as competition increases for scarce resources, as sensitivity to protecting fragile environmental ecosystems is heightened and as the impacts of global terrorism are felt locally. This portion of the project will include the evaluation of opportunities for water and energy conservation. In addition, the study will address factors that can lead to increased intergovernmental cooperation relative to the reliable delivery of water.

The final aspect of the project will be the compilation and presentation of study findings in the final project reporting document.

SCHEDULE

It is anticipated that this project will be undertaken during the course of a full year of study for completion at the end of 2007.

ASSUMPTIONS

The pricing for this proposal is based on the following assumptions:

a. It is assumed that no field work will be required other than reconnaissance visits
b. It is assumed that up-to-date and complete water system maps are available for each system.
c. The computer modeling will be for the purpose of evaluating the skeletized main water transmission infrastructure. The computer modeling will not be meant for the purpose of evaluating fire flows for a particular area. Because the study is intended for master-planning only, no calibration will be undertaken of any proposed modeling.
d. The scope of work shall include four quarterly progress meetings with the project team.
e. The scope of work shall also include one final meeting to present findings to the project team.
f. It is assumed that all base map information is available electronically from the City and Grand Traverse County.

Scope of Services

The scope of services section includes a summary of the level of participation of each of the governmental entities in the study area and a listing of scope/task items.

PARTICIPATION LEVEL

The study has been tailored to the needs of each entity participating in the study. Our understanding of those needs and the scope of work are summarized in the following table. A detailed outline of the scope is provided in Sections I through III following the table. Although the scope is listed in three sections for ease of communicating various aspects of the scope, the three sections are complementary and build upon each other. Therefore, presentation of the study findings will be woven into one report document.

LEVEL	DESCRIPTION (See following section for further detail)	ENTITIES
Level 1	**1) Full reliability study meeting MDEQ requirements** **2) Full scope of technical master planning and regional resource management master planning indicated in outline below.**	• **City of Traverse City** • **Elmwood Twp.** • **Peninsula Twp.** • **East Bay Twp.** • **Garfield Township**
Level 2	**1) Evaluate overall supply, treatment and storage capacities vs. projected 10-year demands.** **2) Identify Opportunities for Valuable Intergovernmental Cooperation.**	• **Blair Twp.**
Level 3	**1) Indicate location of Type I systems on overall planning map.** **2) Identify Opportunities for Valuable Intergovernmental Cooperation.**	• **Long Lake Twp.** • **Green Lake Twp.** • **Whitewater Twp.** • **Tribe/Acme Twp.**

SCOPE BY LEVEL

DESCRIPTION OF SCOPE TASK	LEVEL 1	LEVEL 2	LEVEL 3
I. INITIAL DATA COLLECTION AND GOVERNMENTAL/CITIZEN INPUT			
a. Initial collection of reports and mapping for study area that are available at the City			
b. Review and become familiar with the information collected in I.a.			
c. Confirm Goals/Work Plan for the Study in one Joint City/BPW Meeting			
d. Confirm Goals/Work Plan in one meeting with Each Participating Governmental Entity			
e. Citizen Participation & Input			
1. Assist Team to draft news release			
2. Participate in 1 planning meeting			
3. Participate in 1 citizen involvement meeting			
4. Follow-up Conference Call with Project Team			
5. Prepare summary document of citizen input (Deliverable- D)			
6. Create content for 1 web page for City & County Web Sites (D)			
7. Update web page content twice throughout the project (D)			
f. Refine Work Plan Based on Governmental/Citizen Input (D)			
g. Finalize Project Fees Based on Final Work Plan			

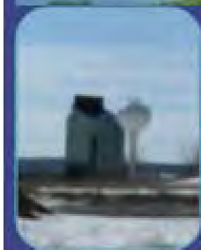
SCOPE BY LEVEL			
DESCRIPTION OF SCOPE TASK	**LEVEL 1**	**LEVEL 2**	**LEVEL 3**
II. TECHNICAL MASTER PLANNING			
a. Create an Area-Wide Planning Map With the Following: (D)			
1. Elevation Contours (about 20' interval)			
2. Individual System Boundaries			
3. Pressure Zone Boundaries			
4. Unserved Area Pressure Zone Boundaries			
5. Skeleton of Each Distribution System (Existing)			
6. Storage Locations, Elevations and Sizes (Existing)			
7. Booster/PRV locations, elevations, capacities (Existing)			
8. WTP location, Capacity			
9. Type I Well locations, capacities			
b. Develop Suggested Criteria for Systems Expansion (1-2 Page Guidance Document) (D)			
c. Research Existing and Projected Population- By System			
d. Collect Data and Evaluate Existing and Projected Demands- By System			
e. Evaluate Fire Flow Demands-By System			
f. Quantify Seasonal Variations in Demand- By System			
g. Develop Reporting Tables for II.c.through II.f. above			
h. Develop Computer Model as an Evaluation Tool: (D)			
1. Obtain Existing Models and Water System Maps			
2. Develop overall skeletal model			
3. Add potential inter-system connections			
i. Collect Information and Review Adequacy of System Components to Meet Demands Regionally			
1. Supply (wells, WTP)			
2. Treatment (See Below for T.C. WTP)			
3. Storage			
4. Distribution (Main Transmission Lines and Inter-System Connection Corridors)			
5. Pumping Facilities/Pressure Reducing Stations			
6. Backup Power			
j. Evaluate the Water Treatment Plant			
1. Perform walkthrough and conduct treatment plant staff interview			
2. Obtain data provided by water utility as necessary			
3. Communicate with City Staff/MDEQ on findings of plant visit and data review.			
4. Review Treatment Scheme & Intake Capacity			
5. Investigate Efficiency Improvements (uprating)			
6. Evaluate Need for Equipment Replacement			
7. Identify Capacity Limiting Components			
8. Identify Vulnerabilities			
9. Prepare Technical Bulletin to Document Findings. (D)			
k. Collect Basic information on private Type I Systems			
l. Prepare Study Document			
1. Meet the requirements of the MDEQ for Reliability Studies			
2. Document Technical Master Planning Findings (D)			

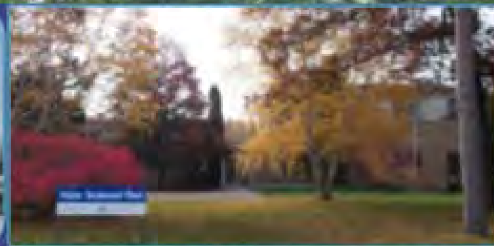
SCOPE BY LEVEL

DESCRIPTION OF SCOPE TASK	LEVEL 1	LEVEL 2	LEVEL 3
III. REGIONAL RESOURCE MANAGEMENT MASTER-PLANNING			
a. Water Conservation			
1. Identify Large Water Users			
2. Identify Potential Strategies for Water Conservation and Awareness			
3. Provide Tech. Bulletin on Strategies for Water Conservation and Awareness (D)			
b. Look for Energy Inefficiencies in Pumping Operations			
c. Identify Potential Future Challenges			
1. Possible Pandemics			
2. Security & Safety Issues			
3. Increasing Energy Costs			
4. Water Withdrawal Legislation (PA 33 through 37 of 2006)			
5. Source Water Protection Programs			
6. Groundwater Protection Plans			
7. Future Water Quality Regulations			
d. Identify Opportunities for Valuable Intergovernmental Cooperation			
1. Cost Efficiencies from Regional vs. Local Redundancies			
2. Cooperation During Emergencies			
3. Review Surface Water/Groundwater Compatibility			
4. Framework for post-project engagement between Agencies/Consultants			
5. Recommend Standards for Facilities at Inter-Governmental Boundaries			
1. Metering			
2. Pumping Facilities			
3. Pressure Reducing Facilities			
4. Controls			
5. Minimum Connecting Pipe Sizes			
e. Recommend Standards for Facilitate Future Inter-Governmental Planning and Cooperation			
1. Modeling Software			
2. Model Calibration			
3. Identification of Connection Corridors			
f. Prepare study report documenting findings (combined with II.l above) (D)			

APPENDIX C- PROJECT WEB PAGE

Grand Traverse Area Water Systems Master Plan





What's New

Link ...

Link ...

Link ...

The City of Traverse City and the Grand Traverse County Board of Public Works have embarked upon an evaluation and planning effort for the region's drinking water supply systems. The City of Traverse City withdraws water from Grand Traverse Bay and treats it in a surface water treatment plant before distributing to City residents, businesses, and industries, as well as to several townships for similar use. Independently, several other townships provide drinking water through their own groundwater supply and/or treatment systems. There also exist many other smaller public water supply systems serving individual subdivisions or developments. Growth and development patterns have greatly influenced the expansion of each of these water systems over the years, and will continue to do so in the future.

A collaborative evaluation effort of the various systems in the area can benefit the region as a whole by ensuring cooperative planning of water supply and distribution, avoiding duplicative efforts by neighboring systems, and improving the overall efficiency of water supply. Such collaborative planning can lead to:

- Effectively meeting short-term peak water demands without need for expansion of supply and/or treatment facilities.
- Management of water supply costs, and therefore, customer rates, via the efficiency of operations and capital improvements.
- Emergency preparedness.
- Long-term sustainability for all parties.

The consultant team of Wilcox Professional Services and Black & Veatch has been retained to lead this project. The consultant team will work closely with City, County, Township, and Tribal representatives in these efforts, and will build on existing planning efforts already completed by each water system. In addition, the team will seek community participation to gain insight to the opinions and ideas of the residents, business owners, and other stakeholders in the region (click on the link to the right to provide comments and/or volunteer).

The project will include:

- Technical planning and evaluation of water supply systems to meet forecasted future demands.
- Regional resource management planning for conservation initiatives, collaboratively meeting future challenges, intergovernmental cooperation, and future collaborative processes.

The project began in early 2007, and is expected to be complete in approximately one year.

Project Purpose

"This projects seeks to improve efficiency and cooperation among the water supply systems of the Grand Traverse Area, with an eye toward reliability, sustainability, and enhancement of the quality of life in the region."

Send Comment to the Project Team

Volunteer for Citizen Involvement

Wilcox

BLACK & VEATCH
Building a world of difference.

APPENDIX D- PUBLIC MEETING AGENDA AND NOTES

THE GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

PUBLIC INPUT MEETING

7 p.m., July 24, 2007

Meeting Room of Traverse Area District Library, 610 Woodmere Ave.

Welcome-

Introduction of Project Team-

Importance of Regional Planning and Cooperation-

Powerpoint Overview of the Project

Q & A about the Project

Discussion Groups

Reporting from Discussion Groups

Incorporation of Ideas into Study

Wrap-up, Thank Participants

GROUP DISCUSSION QUESTIONS

Note: Responses from Group 1 are in Red and Group 2 are in Blue

1. In terms of drinking water, what is clean water?
   a. What factors are important?
      i. Color
      ii. Taste
      iii. Odor
      iv. Well or Bay Water
      v. Pressure
      vi. Volume

   -Color, Taste & Odor: All of these are important. They are pleased with their water whether well or City water. Some issues with low pressure during high usage times.
   -Volume: Fire protection is good.

   b. What factors are not important?

   -Source of the water is not that important

2. How much water do you need?
   a. Drinking
   b. Cooking
   c. Cleaning
   d. Irrigation
   e. Fire Protection

   (no reporting on this question)

3. What is your vision of a future water system?
   a. More water
   b. Less Water
   c. Alternate day irrigation
   d. Conservation

   Discussion about re-use: Hotels, resorts could use water that falls on impervious surfaces for non-drinking uses. This could be a challenge during dry periods. Re-use of gray water? Rainwater or re-use for toilet flushing.
   Ordinances- Businesses have requirements for landscaping and maintaining the landscaping. This landscaping often requires irrigation.

4. Should people be required to connect to a public water system if it available?

   Double-edged sword: You would have to have adequate capacity to serve those that hook up.

   The advantage of a public water system is that it is monitored on a regular basis vs. private wells that are not monitored for years. Public systems include redundancy and are reliable.

5. What questions do you want answered?
[Respondent] moved from San Fransisco about a year ago and asked- “Are you ever concerned about water levels? The water level seems to be going down in bays.
Responses- What public water systems take is very minimal. Lake Superior record low, Michigan and Huron low also. Rest near normal. Impact of dredging? Long term trends on the lakes is up/down. We are in a drought in the Great Lakes. Water withdrawal (out of the Great Lakes watersheds) has become a big issue. We need to practice good conservation to say no to regions outside the Great Lakes that would like some of our water. Good stewardship strengthens our hand in this.

6. What do you like about the public water system?
-Reliability

7. What would you change in the public water system?
-Conservation: Rewards, encouragement? Rebates for water-saving fixtures?

APPENDIX E- MAPS

NOTE REGARDING MAPS

The pocket contains a CD with PDF files of the existing system schematic maps, conceptual near term recommended improvements and conceptual ultimate build out. Proposed pipe sizes are not indicated. These and final pipe replacement locations must be determined through computer hydraulic modeling. The computer hydraulic modeling has not yet been completed as of the date of publishing this report. The modeling results will be issued as an addendum to this report along with updated maps.

APPENDIX F- STORAGE CAPACITY EVALUATION METHOD

Distribution Storage Volume Criteria

Storage within the distribution system permits the source of supply and treatment works to produce water at a constant rate and hold reserve supply in advance of unusual demand. The principal functions of distribution storage are:

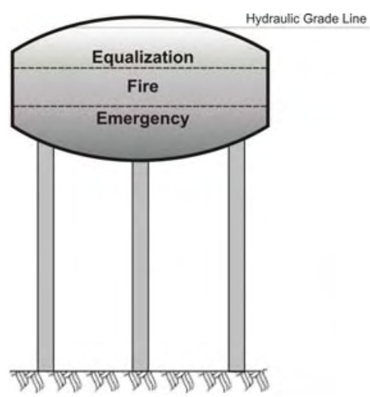
- Equalizing storage (sometimes termed operational storage)
- Fire storage
- Emergency storage

To assure that each of these functions will perform at a moments notice requires that a specific component of the overall storage volume be allocated to each function.

Storage Components

The component parts of distribution storage are illustrated in Figure 1 in a fundamental arrangement within a gravity storage reservoir.

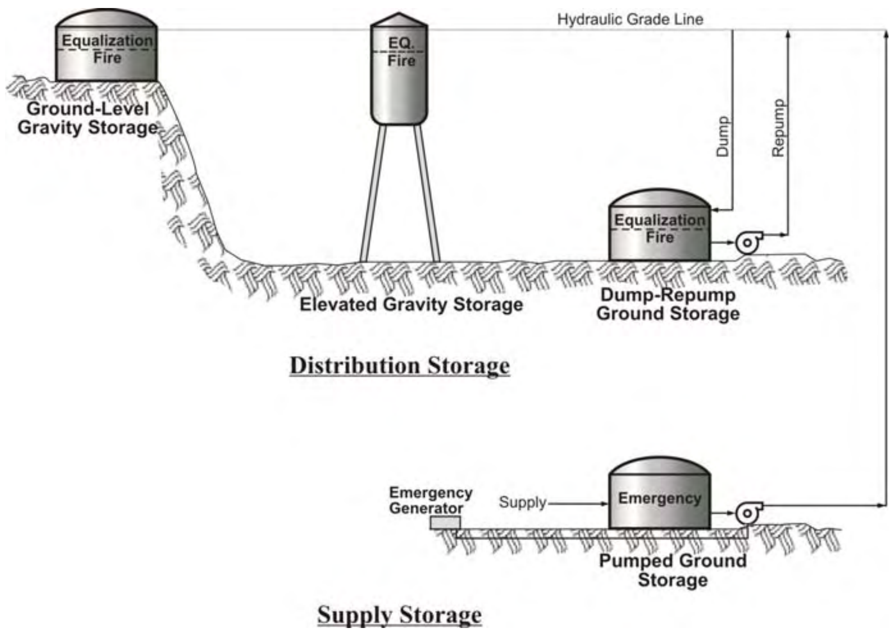
Figure 1
Schematic of System Storage - Fundamental Allocation



Fundamental Allocation in Distribution Gravity Storage

In many water systems, a more complex arrangement of storage is common, consisting of a combination of distribution and supply storage, as well as gravity and pumped storage, as illustrated in Figure 2.

Figure 2
Schematic of System Storage - Complex Allocation



Complex Allocation in Distribution and Supply / Gravity and Pumped Storage

Equalizing Storage

Equalizing storage permits the supply, treatment, pumping and transfer works to be sized for and operate at a capacity equal to the average rate during maximum day, with flow to meet that portion of demand above the average rate supplied from storage. Over the course of a 24-hour day, there are significant variations in the water demand. This diurnal demand variation concept is illustrated by the curve presented in Figure 3. Adding supply, treatment and pumping capacity to the system to meet the peaks in demand above the average rate on maximum day, and thereby avoid the need for equalizing storage, is far more costly than providing equalizing storage for this purpose. Additionally, since daily reservoir turnover (tank draw and refill) is necessary to maintain water quality within distribution reservoirs served by a single inlet-outlet pipeline, providing and effectively utilizing equalizing storage volume is operationally necessary.

The required equalization storage volume can be determined as illustrated by the typical system-wide diurnal curve in Figure 3.

Figure 3
Typical Equalization Storage Requirement

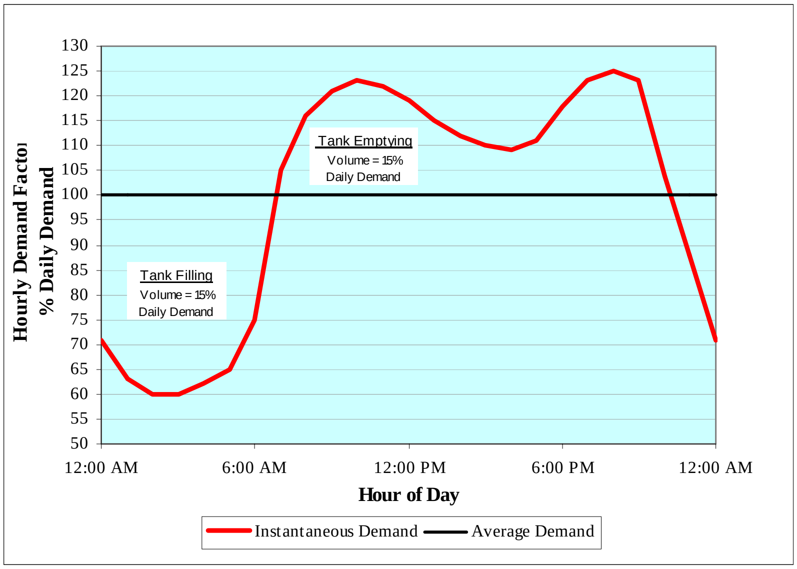
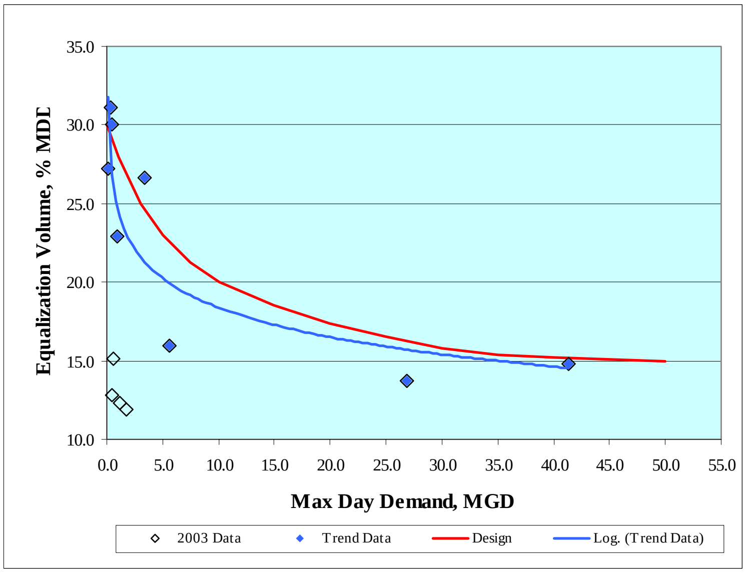


Figure 3 shows a daily average demand curve and a diurnal curve of instantaneous system demand for a typical water system. If supply is provided at the daily average demand rate, the distance between the two curves represents either the rate of tank filling or the rate of tank emptying. The area between the two curves represents the equalization volume required expressed as a percent of the total demand for the day. Figure 3 shows that for this typical case the required equalization volume would be 15 percent of the total demand for the day. However, for all pumping capacities to be sized for maximum day demand rates, each water district must be provided its own required amount of equalizing storage based on the demand patterns within that water district.

Because data for diurnal demand variation were not available for analysis, for this study equalization volume factors commonly found in other systems provided the guidance for setting the design equalization volume factor for the various water districts. The plot of equalization volume percentages versus daily demand for several water systems and water districts within a single water system are presented in Figure 4.

Figure 4
Required Equalization Volume



The trend presented in Figure 4 is consistent with that commonly observed; that is, as the area served and its corresponding demand decreases, the required equalizing storage volume percentage increases. The design line shown on Figure 4 defines the equalization volume percentage used in this report for calculation of required future equalization volumes for each water district.

Fire Storage

The ISO prescribes that the water system should be sized to deliver the required fire flow during maximum day demand for a prescribed duration as presented in Table 1.

Table 1
Required Fire Flow and Duration

Fire flow rate, gpm	Duration, hours
Up to 2,500	2
2,501 to 3,500	3
3,501 and greater	4

Design fire flow goals and associated storage volumes, presented in Table 2, were developed using criteria established by the ISO applied to development and building characteristics common for the various land use types in the various water districts.

Table 2
Design Fire Flow Goals and Storage Volumes

Land Use Category	Fire Flow Goal, gpm	Fire Duration, hrs	Fire Reserve Volume, (MG)
Low Density Residential, 0-2.5	1,000	2	0.12
Medium Density Residential, 2.5-5	1,500	2	0.18
Medium-High Density Residential, 5-8	2,000	2	0.24
Medium-High Density Residential, 8-12 General Commercial Light Industry	2,500	2	0.30
Medium-High Density Residential, 12-30 Business Park Corporate Commerce Center Entertainment Mixed Use Planned Commercial Office Heavy Industry Education Institutional Airport	3,500	3	0.63

Fire storage for the various water districts is based on meeting in each service area the fire flow goal identified previously in Table 2. It is assumed that:

- For each water district the fire storage volume will be the largest required by the land use categories within that water district.
- Only one fire will occur within a water district on any given day.
- The design fire flow will occur during maximum day demand.
- The transmission pipeline network will have the capacity to transfer the fire flow rates from the storage location to any point within the water district.

Because the planning criteria establishes that the design fire would occur during the day of maximum demand, the fire storage volume is additive to the equalizing storage volume. In some areas where the transmission system may be capable of delivering flow rates and volumes greater than the fire flow goal, the volume used in excess of the design fire reserve volume would necessarily come from emergency storage.

Emergency Storage

Emergency storage is used to satisfy system demand during an event that disrupts supply. Such supply disrupting events might include temporary source contamination, equipment failure, power supply interruption, and pipeline breaks. Besides the primary purpose of providing normal supply reliability, emergency storage may be tapped for fire fighting purposes for unusually large fires that consume more than the design fire reserve volume.

The criteria for determining the needed emergency storage volume is more subjective than for equalizing or fire storage. They depend on assumptions about supply system dependability, emergency durations, consequences of supply disruption, and public response during an emergency. With only one source of supply, there might be many components, the failure of which might disrupt the entire supply. On the other hand, for a water system or district with numerous treatment plants and wells providing distributed supply, the likelihood that multiple system components would fail simultaneously to disrupt the entire supply is nil. However, one occurrence, an area-wide power outage, has that capability. Sustained supply during a power outage is the basis for defining emergency storage volume for this report. This report assumes an interruption of supply for an 8 hour period during maximum day demand (33% of MDD) for estimating the necessary emergency storage volume.

Storage Location

Location of storage facilities can greatly affect overall system cost and performance. Key considerations in developing effective placement of future storage include:

- The location and capacities of supply, pumping, transmission and storage facilities.
- The condition of existing storage facilities
- The compatibility of existing storage facilities with future requirements
- The size, shape and topography of the water districts
- The relative economics of constructing additional pumping and transmission facilities versus additional storage facilities.

<u>Gravity Storage</u>. For water districts in which the hydraulic grade line is controlled by gravity storage, where sites are available at the proper elevation it is economically desirable to place a ground-level tank with its overflow at the controlling hydraulic grade line. An example is the Ground-Level Gravity Storage tank shown in Figure 2. Otherwise, sites with lower ground elevations will necessitate use of more costly elevated storage tanks. An example is the Elevated Gravity Storage tank shown in Figure 2.

<u>Pumped Ground Storage</u>. For water districts in which the hydraulic grade line is controlled by high service pumps drawing from ground storage tanks, it is economically desirable to provide as much Supply Storage (fed by water production) as possible and minimize Dump-Repump Storage out in distribution system. This arrangement will minimize the cost of energy lost when the Dump-Repump reservoir is refilled from distribution.

APPENDIX G- CURRENT AND PENDING WATER QUALITY REGULATIONS

WATER QUALITY REGULATORY REVIEW

A. CURRENT REGULATIONS

1. Surface Water Treatment Rule

The Traverse City Water Supply was in compliance with this rule based on information provided in the 2007 Sanitary Survey.

2. Lead and Copper Rule

Based on the 2006 Water Quality Report issued by Traverse City, the water supply is in compliance with this regulation.

3. Phase II, Phase V SOC / IOC Regulations

Based on historical results, the sampling schedule for VOC and SOC contaminants has been reduced. This implies that regulated contaminants have not been detected at concentrations that cause concern. No detects were reported in the 2006 Sanitary Survey for VOCs or SOCs.

4. Total Coliform Rule

No positive total coliform samples were reported in the 2006 Water Quality Report, and no violations of the MCL occurred in 2006.

5. Stage 1 Disinfection Byproducts Rule

Both the 2007 DEQ Sanitary Survey and the 2006 Water Quality Report indicate that TTHM concentrations were less than 0.040 mg/L, and HAA5 concentrations were less than 0.030 mg/L. Specifically TTHMs ranged from 0.0135 to 0.0262 mg/L and HAA5 concentrations were reported to range from 0.008 to 0.009 mg/L in the 2007 Sanitary Survey. The values reported in the 2006 Water Quality Report ranged from 0.014 to 0.025 mg/L for TTHMs and not detected to 0.009 mg/L for HAA5.

The Traverse City Water Treatment Plant is a direct filtration plant, so monitoring for TOC concentrations in raw and treated water is not required, as it would be for a conventional treatment plant. The TOC concentration is not expected to exceed 2 mg/L, as the last sample for this parameter, taken in 2001, had a concentration of 1.59 mg/L. Low concentrations of total *organic carbon result in lower concentrations of DBPs following chlorination, which is what monitoring results show in the Traverse City distribution system.*

6. Interim Enhanced Surface Water Treatment Rule

The 2007 Sanitary Survey reported that the range of treated water turbidity was 0.02 to 0.09 ntu. This range is well under the operating limits presented in the rule.

7. Consumer Confidence Reports Rule

The most recent CCR produced by Traverse City was the 2006 Water Quality Report.

8. Arsenic

Arsenic was not listed in the 2006 Water Quality Report nor in the 2007 Sanitary Survey, but arsenic concentrations are expected to be very low in Grand Traverse Bay.

9. Radionuclides

Monitoring for radionuclides must be done before September 30, 2015, according to the 2007 Sanitary Survey.

10. Filter Backwash Recycling Rule

At the Traverse City Water Treatment Plant the filter backwash is discharged to a lagoon. Supernatant water is discharged to Grand Traverse Bay, and periodically the solids are physically removed after the lagoon is dewatered. No recycle of backwash water occurs, so the Filter Backwash Rule does not apply to this plant.

11. Treatment Chemical Additives

Some chemicals used to treat the raw water may introduce potential contaminants. Treatment techniques for two of these contaminants (acrylamide and epichlorohydrin) have been established. When polymers containing acrylamide and/or epichlorohydrin, which are sometimes used to remove particulate contaminants from water supplies, are used in the treatment process, the utility must certify in writing to the state primacy agency (using third-party or manufacturer's certification) that the combination (or product) of dosage and monomer level does not exceed the following:

Acrylamide: 0.05% dosed at 1 mg/L (or equivalent).

Epichlorohydrin: 0.01% dosed at 20 mg/L (or equivalent).

An alum-polymer coagulant is used at the Water Treatment Plant. Dosages used are very low, but staff need to be sure that acrylamide and epichlorohydrin limits are not exceeded. One way to be sure of this is to use chemicals that meet NSF Standard 60 for direct additives and to avoid exceeding the maximum recommended dosage of the coagulant chemical..

12. Stage 2 Microbial and Disinfection Byproducts Rules

EPA has promulgated a Stage 2 regulation for disinfection byproducts, and a Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). These two rules are closely related, and are referred to collectively as the Stage 2 M-DBP. Like their predecessors, these rules were developed simultaneously in order to balance trade-offs in risk between the control of pathogens and the desire to limit exposure to disinfection byproducts. Both rules were proposed in August 2003, and finalized during early January 2006. Some deadlines for actions have taken place, but other deadlines for taking action are in the future, so these rules are discussed in some detail.

The M-DBP rule is complex, and Traverse City is in a favorable position with respect to this rule because of the excellent quality of its source water and the very low concentrations of DBPs that have been detected during prior monitoring. Traverse City needs to work closely with MDEQ to be sure that the regulatory agency is satisfied that the proper steps are taken to maintain compliance with this rule, due to the complexity of the rule and the 40/30 waiver that has been granted.

a. Stage 2 Disinfectants and Disinfection Byproducts Rule. The Stage 2 DBPR requirements apply to all community water systems and non-transient non-community water systems that add a disinfectant (other than UV) or deliver water that has been disinfected by a primary or residual disinfectant other than UV. This rule utilizes a risk-targeted approach to better identify locations where consumers may be exposed to high levels of disinfection byproducts. Under the Stage 2 DBPR, MCLs for total trihalomethanes and haloacetic acids will remain at the levels established under the Stage 1 rule, i.e., 0.080 mg/L and 0.060 mg/L, respectively. However, monitoring procedures and schedules have been modified to ensure that the data obtained more closely represent actual long-term exposure conditions. Key provisions of the Stage 2 DBPR that relate to Traverse City are summarized below.

***(1) Initial Distribution System Evaluation*.** Initial compliance efforts will focus on identifying points within the distribution system where DBP concentrations are typically highest, and for most public water systems will involve one year of monitoring of TTHM and HAA5 concentrations at additional locations within the distribution system. This monitoring, referred to as the Initial Distribution System Evaluation (IDSE) process, must be conducted in addition to the routine quarterly compliance monitoring required under the Stage 1 DBPR.

The rule includes provisions for exemption from IDSE monitoring requirements, based on low historical distribution system DBP concentrations, and small public water systems (< 500 consumers) may not be required to conduct an IDSE. Following completion of the IDSE, public water systems will recommend new routine compliance monitoring sites to their State/Primacy Agency based on their ISDE study results.

IDSE Compliance Options. Four options are available for public water systems to meet the IDSE provisions of the Stage 2 DBPR:

- Collection of new distribution system DBP data (Standard Monitoring Plan, or SMP).
- Use of qualifying existing distribution system DBP monitoring data or hydraulic modeling data (System Specific Study, or SSS).
- Certification that recent existing DBP monitoring results are less than half of the TTHM and HAA5 MCLs ("40/30 Certification").
- Exemption from IDSE requirements for public water systems serving less than 500 consumers.

Public water systems that have consistently low DBP levels may apply for 40/30 Certification and exemption from the IDSE monitoring provisions of the Stage 2 DBPR. These systems must certify to the primacy agency that every individual compliance sample collected during a specified period of routine Stage 1 DBPR monitoring had TTHM and HAA5 concentrations equal to or less than 0.040 mg/L and 0.030 mg/L, respectively, during eight consecutive calendar quarters beginning not earlier than the dates listed in Table 1. During this same period, the public water system must have had no monitoring violations. The primacy agency may also require that public water systems submit Stage 1 DBPR compliance monitoring results, distribution system schematics, and/or recommended Stage 2 DBPR monitoring sites along with the required monitoring results for eight consecutive quarters.

Table 1
Initial Monitoring Dates for 40/30 Certification Data

If 40/30 Certification is Due:	Eligibility is Based on Eight Consecutive Calendar Quarters of Stage 1 DBPR Monitoring Results Beginning No Earlier Than:
October 1, 2006	January 2004
April 1, 2007	January 2004
October 1, 2007	January 2005
April 1, 2008	January 2005

USEPA recently indicated that public water systems that do not have monitoring results for eight consecutive quarters showing that all samples meet the DBP requirements “in hand” by their IDSE plan submittal deadline may utilize the 12-month IDSE plan review/approval period to continue to collect samples to be used to support a request for 40/30 certification. The public water system must submit its request for this certification, designated a “provisional 40/30 certification request”, along with a Standard Monitoring Plan through USEPA’s Information Processing Management Center (IPMC) prior to the deadline for submittal of their ISDE plan, and must then notify the IPMC when it has generated the required eight consecutive quarters of DBP monitoring data meeting the 40/30 criteria. If the eight consecutive quarters of 40/30 DBP data are not developed prior to the expiration of the 12-month IDSE review/approval period, the public water system would be required to complete the Standard Monitoring Program.

Traverse City has the 40/30 waiver because of low concentrations of DBPs found in its distribution system. Therefore the IDSE does not have to be undertaken by Traverse City.

***Routine DBP Compliance Monitoring Requirements*.**

Because of the 40/30 waiver, routine DBP compliance monitoring will need to be done as specified by the DEQ.

***(3) Operational Evaluation Levels*.** The Stage 2 DBPR requires each system to determine if they have exceeded an operational evaluation level at any monitoring site, which is calculated using their routine quarterly system monitoring results. The operational evaluation level is intended to provide an early warning of potential future MCL violations, which enables the system to initiate measures to remain in compliance. An operational evaluation level is exceeded at any monitoring location where (1) the sum of the two previous quarters’ TTHM results plus twice the current quarter’s TTHM result, divided by 4 to derive an average, exceeds 0.080 mg/L, or (2) the sum of the two previous quarters’ HAA5 results plus twice the current quarter’s HAA5 result, divided by 4 to derive an average, exceeds 0.060 mg/L.
A system that exceeds an operational evaluation level is required to do the following:

- Conduct an evaluation to examine its treatment and distribution operational practices. This evaluation must consider storage tank operations, excess storage capacity, distribution system flushing practices, changes in sources or source water quality, and treatment changes or problems that may contribute to TTHM and HAA5 formation. (The primacy agency may limit the scope of the evaluation if the cause of the operational evaluation level exceedence can be readily identified.)
- Submit a written report to the primacy agency not later than 90 days after receiving the DBP analysis results that caused the exceedence.

Because of low levels of DBPs reported in the past, meeting the Stage 2 DBP MCLs may not prove difficult. If a location in Traverse City’s distribution system does have high DBP *concentrations, distribution system management practices such as connecting dead end water mains to form loops, and using within-tank mixing in distribution system reservoirs, could be implemented. Implementation of Best Available Technology for treatment as described in (4) Best Available Technology below is not expected to be needed.*

(4) ***Best Available Technology*****.** GAC adsorbers and nanofiltration were specified by EPA in the Stage 2 DBPR as Best Available Technology (BAT) for compliance with the LRAA MCLs.

Application of Best Available Technology to meet regulatory requirements for this rule in Traverse City is highly unlikely to be needed.

For consecutive systems (i.e., systems that purchase or otherwise receive some or all of their finished water from one or more wholesale systems), the Stage 2 DBPR specifies that BAT is as follows:

- For systems serving 10,000 or more consumers: (a) improved distribution system and storage tank management to reduce detention time, and (b) use of chloramines to maintain a disinfectant residual.
- For systems serving fewer than 10,000 consumers: improved distribution system and storage tank management to reduce detention time.

If DBP concentrations exceed the MCL values in distribution systems of Garfield Township, improved distribution system and storage tank management need to be implemented. These measures should be implemented before use of chloramines is undertaken.

If DBP concentrations exceed the MCL values in distributions systems of Peninsula Township or Elmwood Township, improved distribution system management practices should be implemented.

(5) Bromate**.**

Ozone is not used at the Traverse City Water Treatment Plant, so this aspect of the regulations does not apply at present. Because of the outstanding quality of water in Grand Traverse Bay, and the fact that this Bay holds fresh water not influenced by salinity sources, bromide concentration is likely to be very low, and if use of ozone were implemented in the future at the Traverse City Water Treatment Plant, bromate probably would not present a regulatory compliance problem.

b. **Long-Term Enhanced Surface Water Treatment Rule.** A long-term Enhanced Surface Water Treatment Rule which extends the IESWTR requirements to systems serving fewer than 10,000 consumers was promulgated in January 2002 and became effective in January 2005.

(This regulation is referred to as the Stage 1 Long-Term Enhanced Surface Water Treatment Rule, or LT1ESWTR.)

As discussed above, the long-term Stage 2 ESWTR (referred to as the LT2ESWTR) was finalized during early January 2006. This rule applies to all public water systems that use surface water or groundwater under the direct influence of surface water. The primary purpose of this rule is to improve control of microbial pathogens, specifically Cryptosporidium. Compliance dates are presented in Table 2.

Table 2
Key Dates for LT2ESWTR Compliance

Activity	Compliance Date vs. Population Served			
	≥100,000	50,000-99,999	**10,000-49,999**	<10,000
Source Water Monitoring Plan Submittal Deadline[1]	07/01/2006	01/01/2007	**01/01/2008**	07/01/2008[2] 01/01/2010[3]
Deadline for Initiating Source Water Monitoring Program (month beginning)	10/01/2006[4]	04/01/2007[4]	**04/01/2008[4]**	10/01/2008[5] 04/01/2010[6]
Deadline for Submittal of Grandfathered Source Water Monitoring Data	12/01/2006[7]	06/01/2007[7]	**06/01/2008[7]**	12/01/2008[8] 06/01/2010[7]
Deadline for Completion of Source Water Monitoring Program	09/30/2008	03/31/2009	**03/31/2010**	09/30/2009[5] 03/31/2011[9] 03/31/2012[10]
Submit Source Water Monitoring Report with Bin Placement (month beginning)	04/01/2009	10/01/2009	**10/01/2010**	10/01/2011[9] 10/01/2012[10]
Deadline for Compliance with Additional Treatment Requirements[11]	04/01/2012	10/01/2012	**10/01/2013**	10/01/2014
Initiate Second Round of Source Water Monitoring (month beginning)	04/01/2015	10/01/2015	**10/01/2016**	10/01/2017[5] 04/01/2019[6]

[1]Including notice of intent to submit previously-collected ("grandfathered") monitoring data
[2]Monitoring plan for *E. coli.*
[3]Monitoring plan for *Cryptosporidium*, if monitoring required.
[4]Monitor *Cryptosporidium*, *E. coli*, and turbidity; minimum of once per month for 2 years.
[5]Monitor source water *E. coli* biweekly for 1 year
[6]Monitor source water for *Cryptosporidium* (if req'd) twice per month for 1 year or monthly for 2 years.
[7]*Cryptosporidium* data
[8]*E. coli* data
[9]If *Cryptosporidium* monitoring required and conducted over 1 year.
[10]If *Cryptosporidium* monitoring required and conducted over 2 years.
[11]2-year compliance extension available (with State approval) if capital improvements required.

***(1) Source Water Monitoring*.** The LT2ESWTR includes an initial period of raw water microbial monitoring, with any additional treatment requirements subsequently established based on microbial contaminant levels present in the supply. Filtered water systems serving at least 10,000 consumers must sample their source water for *Cryptosporidium*, *E. coli*, and turbidity at least monthly over a 2-year period. Specific regulatory compliance requirements will then be established based on the following:

- If monthly samples are collected, classification is to be based on the highest 12-month running annual average.
- If the system conducts monitoring twice per month, classification is to be based on a 2-year mean value of <u>all</u> monitoring data. (This increased monitoring must be conducted at evenly distributed time intervals over the 2-year period.)

This sampling requirement applies to Traverse City's Water Treatment Plant. LT2 testing is scheduled to start in April, 2008.

Schedules for initiation of source water monitoring are staggered based on the number of consumers served. Wholesale systems (systems that treat source water as necessary to produce finished water and then deliver some or all of that finished water to another public water system) must comply with the schedule of the largest system in the combined distribution system. (The combined distribution system is the interconnected system consisting of the distribution system of wholesale systems and consecutive systems that receive finished water.)

Samples are to be collected from the raw water supply prior to any treatment/chemical addition. Treatment bin classifications under the LT2ESWTR, based on average raw water *Cryptosporidium* oocyst concentrations, are summarized in Table 3.

Table 3
Bin Classification for Filtered Systems Under LT2ESWTR

Raw Water *Cryptosporidium* Concentration, oocysts per Liter[1]	Bin Classification[2]
Cryptosporidium < 0.075/L	Bin 1
0.075/L ≤ *Cryptosporidium* <1.0/L	Bin 2
1.0/L ≤ *Cryptosporidium* <3.0/L	Bin 3
Cryptosporidium ≥ 3.0/L	Bin 4

[1]Based on maximum value for 12-month running annual average, or 2-year arithmetic mean if twice-monthly monitoring is conducted.
[2]Systems serving fewer than 10,000 consumers and NOT required to monitor for *Cryptosporidium* are classified as Bin 1.

For water utilities needing additional credits for *Cryptosporidium* removal, the EPA presented a number of options. Those that might apply in Traverse City are shown in Table 4.

Table 4 Microbial Toolbox Options, Log Credits, and Design/Implementation Criteria	
Toolbox Option	***Cryptosporidium* Log Credit**
Treatment Performance Toolbox Options	
Combined Filter Performance	**0.5 log credit for combined filter effluent ≤ 0.15 NTU in at least 95% of measurements each month.**
Inactivation Toolbox Options	
Chlorine Dioxide	Log credit based on CT in relation to CT table.
Ozone	Log credit based on CT in relation to CT table.
UV	Log credit based on validated UV dose table in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions.

Because of the very high quality of water in Grand Traverse Bay, Traverse City is expected to be in Bin 1, and as indicated below, no additional inactivation/removal requirements would apply. Options for additional treatment to gain higher log-removal credits were presented in the Rule, but those are not listed here as they are not expected to apply to Traverse City. Even though it is not likely to be needed, an 0.5 log credit for combined filter effluent ≤ 0.15 NTU in at least 95% of measurements each month would be available to Traverse City if future filtration performance is as good as past performance has been.

If in the future additional protection from Cryptosporidium were desired, application of UV radiation would be the most cost-effective approach.

(2) Use of Existing Source Monitoring Data. With primacy agency approval, systems with at least two years of historical source water Cryptosporidium monitoring data that is equivalent in sample number, frequency, and quality to the data required under the LT2ESWTR may use those data to determine bin placement in lieu of conducting additional monitoring. (These monitoring results are referred to in the LT2ESWTR as “grandfathered” data.) Samples must have been collected at least each calendar month on a regular schedule, started not earlier than January 1999, and the laboratory that conducted the analyses must certify that all applicable quality assurance/quality control requirements have been met. Systems that elect to use historical data in lieu of conducting new monitoring must certify that the samples are representative of the source water and that all results are included in the submittal.

(3) Uncovered Finished Water Storage Facilities**.** Systems using uncovered finished water storage facilities must notify the primacy agency of the use of these facilities not later than April 1st 2008, and must cover any uncovered finished water storage facility or treat the discharge from the uncovered finished water storage facility to the distribution system to achieve inactivation and/or removal of at least 4-log virus, 3-log *Giardia lamblia*, and 2-log *Cryptosporidium* using a protocol approved by the State.

Traverse City has no uncovered reservoirs so this does not apply.

(*4*) ***Disinfection Profiling / Benchmarking.*** Following completion of the initial round of source water monitoring, systems that will need to make significant changes in disinfection practices in order to maintain compliance with the LT2ESWTR and/or the Stage 2 DBPR will be required to develop disinfection profiles and calculate disinfection benchmarks for *Giardia lamblia* and viruses.

Because of the low concentrations of DBPs reported in prior years, changes in disinfection practice at Traverse City are not expected to be needed.
Changes in disinfection practice might be needed for Garfield Township where water remains in the distribution system for a longer time following treatment, thus giving more time for disinfection byproducts to develop..

(5) Compliance Assistance / Guidance Documents. EPA issues guidance documents to assist systems and primacy agencies implement and comply with new regulations. For the LT2ESWTR, EPA has announced that it will publish the following 8 guidance manuals:

- Source Water Monitoring Guidance for Public Water Systems
- Microbial Laboratory Guidance
- Small Entity Compliance Guidance
- Microbial Toolbox Guidance Manual
- Ultraviolet Disinfection Guidance Manual
- Membrane Filtration Guidance Manual
- Simultaneous Compliance Guidance Manual for Stage 2 Rules
- Low-Pressure Membrane Filtration for Pathogen Removal: Application, Implementation, and Regulatory Issues

13. Ground Water Rule

The Ground Water Rule (GWR), proposed in May 2000 and finalized in November 2006, is intended to provide for increased protection against viral and bacterial pathogens in public water systems using ground water sources. The rule addresses risks through a risk-targeting approach that relies on four major components:

1. Periodic sanitary surveys of ground water systems will be required. States must complete the initial survey by December 31, 2012 for most community water systems (CWSs) and by December 31, 2014 for CWSs with outstanding performance and for all non-community water systems.
2. Source water monitoring will be required to test for the presence of *E. coli*, enterococci, or coliphage in the sample. There are two monitoring provisions:
    - *Triggered monitoring* for systems that do not already provide treatment that achieves at least 99.99 percent (4-log) inactivation or removal of viruses and that

have a total coliform-positive routine sample under Total Coliform Rule sampling in the distribution system.
    - *Assessment monitoring* - As a complement to triggered monitoring, a State has the option to require systems, at any time, to conduct source water assessment monitoring to help identify high risk systems.
3. Corrective actions will be required for any system with a significant deficiency or source water fecal contamination. The system must implement one or more of the following correction action options:
    - correct all significant deficiencies,
    - eliminate the source of contamination,
    - provide an alternate source of water, or
    - provide treatment which reliably achieves 99.99 percent (4-log) inactivation or removal of viruses.
4. Compliance monitoring will be required to ensure that treatment technology installed to treat drinking water reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses.

The City of Traverse City does not use ground water, so provisions of this rule will not affect the Traverse City Water Treatment Plant. The Grand Traverse area water systems that utilize groundwater as a source will need to begin planning for compliance with the indicated provisions of the rule.

14. Unregulated Contaminants Monitoring

The Unregulated Contaminants Monitoring Regulation (UCMR) program was developed in coordination with the Contaminant Candidate List (CCL; discussed in Section D below. EPA published a list of unregulated contaminants for the first UCMR cycle (UCMR1) in September 1999. UCMR1 established a tiered monitoring approach, and required all large public water systems and some systems serving fewer than 10,000 consumers to monitor for unregulated contaminants from 2001 to 2005.

Monitoring for unregulated contaminants showed that none were detected in the first round of testing in 2002, except for DBPs formed by chlorination during treatment. The contaminants NOT detected included aromatic hydrocarbons, pesticides, herbicides, and perchlorate.

Monitoring under the second cycle of unregulated contaminants monitoring (UCMR2), as outlined in the January 2007 final rule, must be conducted between 2007 and 2010. UCMR2 includes 25 contaminants and five associated analytical methods, as summarized in Table 5. All systems serving more than 10,000 consumers (based on retail population directly served plus the population served by any consecutive system(s)), and 800 selected systems serving 10,000 or fewer consumers will be required to conduct first tier assessment monitoring for 10 contaminants (List 1 contaminants). A second tier screening survey of 15 additional contaminants (List 2 contaminants) will be conducted by 400 systems serving more than 100,000 consumers, 320 systems serving between 10,001 and 100,000 consumers, and 480 systems serving 10,000 or fewer consumers. USEPA or individual state regulatory agencies will be issuing notification letters to all affected systems. (Systems that purchase all of their water from another system are not subject to the UCMR2 monitoring requirements.) The final rule does not require utilities to conduct repeat monitoring for perchlorate, as originally proposed, using a method that is more sensitive than the method that was available when the first round of unregulated contaminant monitoring was conducted.

Samples must be collected during one continuous 12-month period beginning no earlier than January 2008 and concluding no later than December 2010. For systems with surface water sources, monitoring will be required at 3-month intervals for 4 consecutive quarters, while groundwater systems must monitor twice at 6-month monitoring intervals. While monitoring for most contaminants is to be conducted at the entry point to the distribution system, monitoring for the six List 2 nitrosamine compounds must be conducted at both the system entry point and at a point that reflects maximum system residence time. Monitoring requirements for systems with blended surface and groundwater sources, or with multiple groundwater wells, are more complex. Data must be submitted to UPEPA electronically. For systems serving fewer than 10,000 consumers, USEPA will provide sample collection containers and conduct the analyses. Affected systems must initially provide contact information to USEPA by April 4th, 2007.

Traverse City is participating in this round of unregulated contaminant monitoring.

Table 5 UCMR 2 Contaminants and Corresponding Analytical Methods		
Assessment Monitoring (List 1)		
Contaminant	**Analytical Method**	**Monitoring Location**
Dimethoate	EPA 527	Entry point to distribution system
Terbufos sulfone		
2,2’,4,4’-tetrabromodiphenyl ether (BDE-47)		
2,2’,4,4’,5-pentabromodiphenyl ether (BDE-99)		
2,2’,4,4’,5,5’-hexabromobiphenyl (245-HBB)		
2,2’,4,4’,5,5’-hexabromodiphenyl ether (BDE-153)		
2,2’,4,4’,6-pentabromodiphenyl ether (BDE-100)		
1,3-dinitrobenzene	EPA 529	
2,4,6-trinitrotoluene (TNT)		
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)		
Screening Survey (List 2)		
Contaminant	**Analytical Method**	**Monitoring Location**
Acetochlor ESA	EPA 535	Entry point to distribution system
Acetochlor OA		
Alachlor ESA		
Alachlor OA		
Metolachlor ESA		
Metolachlor OA		
Acetochlor	EPA 525.2	Entry point to distribution system
Alachlor		
Metolachlor		
N-nitroso-diethylamine (NDEA)	EPA 521	Distribution system maximum residence time AND Entry point to distribution system
N-nitroso-dimethylamine (NDMA)		
N-nitroso-di-n-butylamine (NDBA)		
N-nitroso-di-n-propylamine (NDPA)		
N-nitroso-methylethylamine (NMEA)		
N-nitroso-pyrrolidine (NPYR)		
*All perchlorate samples must be collected using the sterile technique required in Methods 314.1, 331.0, or 332.0		

15. Lead & Copper Rule Revisions

In response to widespread concern regarding the discovery of high lead levels at many consumer taps within the District of Columbia, EPA initiated a comprehensive review of the implementation of the 1991 Lead and Copper Rule and targeted seven rule changes. intended to strengthen implementation of the LCR in the areas of monitoring, customer awareness and replacement of lead service lines. These revisions apply only to lead and do not amend the portion of the existing regulation pertaining to copper The revisions do not affect existing action levels, corrosion control requirements, replacement of lead service lines or other provisions in the existing LCR that directly determine the degree to which the rule reduces risks from lead and copper.

Traverse City has reported very low lead levels in its sampling program, so no major impacts from these changes are anticipated.

B. Pending Regulations

1. Radon

EPA proposed new regulations for radon in November 1999, and a final rule is currently scheduled to be issued during May 2009.

This regulation will be of concern to the Grand Traverse area water systems using groundwater as a source. Ground water sources are susceptible to containing radon, but surface waters are not, as if radon did somehow enter surface water, gas transfer at the air-water interface would result in movement of radon from water to air, and radioactive decay would contribute to declining concentrations of radon in both air and water.

C. FUTURE REGULATIONS

1. Drinking Water Contaminants Candidate List

Under the SDWA, EPA must publish a list of contaminants every five years which may require regulation; these contaminants are not currently regulated, but are known or anticipated to occur in public water systems. This list of contaminants is to be used to set regulatory, research, and occurrence-investigation priorities within EPA. The first Contaminant Candidate List (CCL1), which was published in draft form in March 1998, consisted of 50 chemical contaminants and 10 microbial contaminants. EPA subsequently narrowed this list to 19 chemicals and one microbial contaminant which the Agency considered as “high priority” with respect to determination of the need to regulate, and ultimately reduced the list to a total of 9; these contaminants are summarized in Table 6. In June 2003, the Agency announced its decision that no regulatory action is needed for these 9 contaminants, as they were determined not to present a significant public health risk.

Table 6 **Contaminants Included on First** **Drinking Water Contaminant Candidate List (CCL1)**
Acanthamoeba (guidance for contact lens wearers)
Naphthalene
Hexachlorobutadiene
Aldrin
Dieldrin
Metribuzin
Sodium (guidance)
Manganese
Sulfate

A second CCL (CCL2) was finalized in February 2005. The CCL2 consists of the 51 contaminants (9 microbial, 42 chemical, as summarized in Table 7) that remained from the CCL1 following EPA's decision that 9 of the originally-proposed 60 contaminants do not merit regulation. EPA issued preliminary regulatory determinations during April 2007 not to regulated 11 of the 51 contaminants included on the CCL2, with final regulatory determinations expected during Spring 2008. The Agency also announced their decision that two other contaminants included on the CCL2 (perchlorate and MTBE) require additional investigation to determine the risk to public health from human exposure, and that additional comments and information would be requested to assist in this investigation.

Perchlorate is associated with rocket fuel and explosives. It is not likely to be present in the Grand Traverse Bay region and was not detected in the 2002 unregulated contaminant monitoring exercise. MTBE has been used as a gasoline additive. If MTBE had been used in gasoline delivered to Traverse City in the past, it might be found in ground water. Possibly some quantity of MTBE might seep into waters of Grand Traverse Bay, but the dilution effect should be quite large. MTBE causes very unpleasant T&O problems at very low concentrations, but attaining those concentrations in Grand Traverse Bay if MTBE had been used in the region seems unlikely.

Table 7 **Drinking Water Contaminant Candidate List 2**
<u>Microbiological Contaminant Candidates</u>
Adenoviruses
Aeromonas hydrophila
Caliciviruses
Coxsackieviruses
Cyanobacteria (blue-green algae), other freshwater algae, and their toxins
Echoviruses

Helicobacter pylori Microsporidia (Enterocytozoon and Septata) Mycobacterium avium intracellulare (MAC)	
<u>Chemical Contaminant Candidates</u>	
1,1,2,2-tetrachloroethane*	2,4,6-trichlorophenol
1,2,4-trimethylbenzene	2,2-dichloropropane
1,1-dichloroethane	2,4-dichlorophenol
1,1-dichloropropene	2,4-dinitrophenol
1,2-diphenylhydrazine	2,4-dinitrotoluene*
1,3-dichloropropane	2,6-dinitrotoluene*
1,3-dichloropropene*	2-methyl-Phenol (o-cresol)
Acetochlor	
Alachlor ESA & other acetanilide pesticide degradation products	
Aluminum	
Boron*	
Bromobenzene	Nitrobenzene
DCPA mono-acid degradate*	Organotins
DCPA di-acid degradate*	Perchlorate**
DDE*	Prometon
Diazinon	RDX
Disulfoton	Terbacil*
Diuron	Terbufos
EPTC (s-ethyldipropylthiocarbamate)*	Triazines, degradation products
Fonofos*	Vanadium
p-Isopropyltoluene (p-cymene)	
Linuron	
Methyl bromide	
Methyl-t-butyl ether (MTBE)**	
Metolachlor	
Molinate	
*Decision not to regulate announced April 2007. **Decision to seek additional occurrence, exposure, and risk data announced April 2007.	

2. Total Coliform Rule Revisions / Distribution System Rule

As part of the mandated 6-year regulatory review process, EPA announced in July 2003 its intention to revise the 1989 Total Coliform Rule (TCR). While the original TCR protects human health by requiring microbial monitoring in distribution systems, it does not include corrective or protective requirements to reduce contamination of distribution systems by coliforms and other contaminants. EPA therefore intends to strengthen the original TCR by adding requirements to protect distribution systems. These revisions may be expanded into a Distribution System Rule, and may consider issues such as cross connection control, nitrification, impact of biofilms, and the sanitary condition of storage tanks. To assist in this process, the Agency, jointly with several external distribution system experts, prepared two series of “white papers” that address various distribution-related issues. The purpose of these papers, which only present available information and do not reflect EPA policy, is to review available data on potential health risks associated with distribution systems and to identify areas where additional research may be warranted.

The Total Coliform Rule / Distribution System Advisory Committee (TCRDSAC), comprised of 16 members representing utilities, regulators, public health officials, cities, and environmental advocates, was formed to advise the Agency during the development of the TCR revisions. The current schedule for revision of the TCR is as follows:

- Publication of an Agreement-In-Principal by late July 2008
- A Proposed Rule by mid-2010
- A Final Rule in 2011 or 2012

The extent to which distribution system management will be regulated by the new rule is uncertain. Concepts such as eliminating dead end water mains, and improving circulation in mains and in distribution system storage reservoirs seem likely to be encouraged by this rule, if they are not required, as those concepts also are helpful in controlling formation of DBPs in water in distribution systems. The concept of "water age", or the amount of time water resides in distribution systems before it is consumed, might be adopted as a means of maintaining better water quality in distribution systems. The effect of this rule may be felt in Traverse City and probably will be felt by water systems purchasing water from Traverse City because of the longer water age in the outlying systems, as compared to the age of water in Traverse City's distribution system.

3. Atrazine

Atrazine is currently regulated at 0.003 mg/L, but this MCL is scheduled to be revisited. Recent information regarding cardiovascular problems and reproductive issues associated with atrazine would suggest that the current MCL could be lowered somewhat, although potential future MCL values remain to be determined.

Atrazine is used extensively in Corn Belt states. Its use in the Grand Traverse region is limited and problems with atrazine in Grand Traverse Bay are not likely.

4. Endocrine Disruptors

Endocrine disruptors (EDCs) interfere with the natural action of hormones in the body, and are thought to interfere with the reproductive systems of both wildlife and humans. EDCs include pharmaceuticals and personal care products (PPCPs) such as antibiotics, prescription drugs, shampoos, cleansers, etc. Even though the technology to detect these compounds in drinking water is now available, their potentially harmful effects are still largely unknown. To date, the documented levels of these compounds are generally very low, at the low end of the parts per trillion range. Most drinking water standards are set in the mg/L or µg/L range, which are 1,000 to 10,000 times higher than the levels at which EDCs are typically detected at in water supplies. Technologies to remove EDCs from water supplies may involve adsorption, rejection (nanofiltration and reverse osmosis), or oxidation. Some of these options would be very expensive to apply. If EDCs are regulated in the future, additional or replacement treatment processes would be necessary at most treatment facilities. However, much research remains to be conducted in order to develop an adequate understanding of removal capabilities, bed life and optimal carbon types for adsorption systems, etc.

Concerns have been raised about effects of EDCs on fish and other wildlife living in a water environment. Humans do not live in water nor do they take oxygen into their bodies by passing water through gills, so human exposure to EDCs ought to be orders of magnitude lower than the exposure to fish. If concerns about EDCs are raised by persons or organizations in the Grand Traverse region, the differences in the extent of exposure to fish and aquatic animals versus exposure to people needs to be pointed out to put this issue into perspective.

5. New Disinfection Byproducts

While only four disinfection byproducts are currently regulated (total trihalomethanes, HAA5, chlorite, and bromate), hundreds of other known DBPs exist. If other DBPs are determined to affect human reproduction or otherwise cause public health problems, they will likely also be regulated. Byproducts associated with the use of chloramines for secondary disinfection, such as nitrosodimethylamine (NDMA), cyanogen chloride, chloropicrin, and chloral hydrate are of particular concern for systems that use chloramines for maintaining a disinfectant residual and/or control of chlorine-based DBPs. All of these DBPs have been found in systems using chloramines, but typically not at high levels. The health risks associated with these compounds have not yet been established, so it is premature to speculate on potential future regulatory action.

The DBPs that are regulated at the present time are found in low concentrations in treated water in Traverse City. It is likely that because of the high quality of the source water, future DBPs of concern also will be present at low concentrations if they are found in the drinking water in Traverse City.

6. Other Rules

Additional rules are likely to be proposed by EPA, but these will primarily address administrative issues such as reformatting of drinking water amendments, streamlining of public notification requirements, and analytical method updates. EPA presently plans to defer action on regulation of contaminants such as nickel and atrazine, and has indicated that it will reexamine risk assessment and occurrence data on aldicarb and make a determination of what future action is appropriate (the schedule for this action has not been determined at this time).

D. REGULATORY SCHEDULE

EPA's current regulatory promulgation schedule is presented in Table 8. The compliance dates listed in Table 8 are based on EPA's most recent semi-annual rulemaking agenda and on recent comments by officials involved in the regulatory development process.

Table 8
Schedule for Promulgation of SDWA Regulations (as of 11/2007)

Regulation	Proposed	Final	Effective
Fluoride	11/1985	04/1986	10/1987
8 VOCs (Phase I)	11/1985	07/1987	01/1989
Surface Water Treatment Rule	11/1987	06/1989	06/1993
Total Coliform Rule	11/1987	06/1989	12/1990
Revisions (Distribution Requirements)	Mid-2010	2011 / 2012	2014 / 2015[1]
Lead & Copper	08/1988	06/1991	01/1992[2]
Minor Revisions	04/1998	01/2000	01/2001
Additional Revisions / Clarifications	07/2006	10/2007	04/2008
26 Synthetic Organic Contaminants[3], 7 Inorganic Contaminants (Phase II)	05/1989	01/1991	07/1992
MCLs for barium, pentachlorophenol (Phase II)	01/1991	07/1991	01/1993
Phase V Organics, Inorganics	07/1990	07/1992	01/1994
Information Collection Rule (ICR)	02/1994	05/1996	Completed
Consumer Confidence Reports Rule (CCR)	02/1998	08/1998	09/98
Radionuclides (Phase III) – except radon	07/1991	12/2000	12/2003
Radon (delayed, dates uncertain)	11/1999	05/2009	05/2012[1]
Disinfectants / Disinfection Byproducts			
Stage 1	07/1994	12/1998	01/2002[4,5]
Stage 2	08/2003	01/2006	04/2012[6]
Interim Enhanced SWTR	07/1994	12/1998	01/2002[4]
Stage 1 – Long-Term Enhanced SWTR	04/2000	01/2002	01/2005
Stage 2 – Long-Term Enhanced SWTR	08/2003	01/2006	04/2012[7]
Filter Backwash Recycling Rule (FBRR)	04/2000	06/2001	06/2004[8]
Ground Water Rule (GWR)	05/2000	11/2006	12/2009[9]
Arsenic	06/2000	02/2002[10]	01/2006
MCLs for aldicarb, aldicarb sulfoxide, aldicarb sulfone	Delayed, no current schedule		

[1]Assumes regulation in effect 3 years after final promulgation.
[2]Start date for tap monitoring for systems serving more than 50,000 consumers.
[3]MCL, MCLG for atrazine to be reconsidered.
[4]For systems serving more than 10,000 consumers.
[5]Effective 01/2004 for groundwater and small surface water systems.
[6]Phased compliance schedule; 04/2012 is deadline for initiating DBP testing for Stage 2 compliance at revised system monitoring locations (systems ≥100,000 served).
[7]Phased compliance schedule; 04/2012 is deadline for compliance with additional *Cryptosporidium* treatment requirements (systems ≥100,000 served).
[8]Deadline for modifying recycle point location, if required. 2-year extension available if capital improvements required.
[9]Start date for triggered source water monitoring requirements.
[10]Rule originally promulgated 01/22/2001, but delayed by administrative action until 02/22/2002.

APPENDIX H- ANALYSIS OF 2006 CUSTOMER METER DATA

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
2006 DPW CUSTOMER METER DATA- FINAL SUMMARY BY PROPOSED WATER DISTRICT
Wilcox/Black & Veatch
Revised: April 24, 2008

Water District	Billing Class	Data	Total	MDD/ADD Peaking Factor Used	Apartments/ Condo Units	Total Residential Units	Twp. Avg. Household Size	Estimated Served Population (1)	ADD Per Capita	Estimated 2006 Population in Water District	Residential ADD/ Total ADD
010EB2	O	Number of Meters	1								
		ADD 06 (GPD)	11,722								
		-MDD 06 (GPD)	31,929								
		ADD Per Meter 06 (GPD)	11,722								
	R	Number of Meters	358		168	526	2.68	1,410	111	3569	0.930
		ADD 06 (GPD)	156,316								
		-MDD 06 (GPD)	425,798								
		ADD Per Meter 06 (GPD)	437								
010EB2 Number of Meters			359								
010EB2 ADD 06 (GPD)			168,037								
010EB2 -MDD 06 (GPD)			457,727								
010EB2 ADD Per Meter 06 (GPD)			468								
020EB1-N	C	Number of Meters	95								
		ADD 06 (GPD)	220,993								
		-MDD 06 (GPD)	600,770	2.72							
		ADD Per Meter 06 (GPD)	2,326								
	O	Number of Meters	12								
		ADD 06 (GPD)	6,683								
		-MDD 06 (GPD)	18,166								
		ADD Per Meter 06 (GPD)	557								
	R	Number of Meters	597		192	789	2.68	2,115	89	2207	0.452
		ADD 06 (GPD)	188,150								
		-MDD 06 (GPD)	511,485								
		ADD Per Meter 06 (GPD)	315								
020EB1-N Number of Meters			704								
020EB1-N ADD 06 (GPD)			415,825								
020EB1-N -MDD 06 (GPD)			1,130,422								
020EB1-N ADD Per Meter 06 (GPD)			591								
020EB1-S	C	Number of Meters	20								
		ADD 06 (GPD)	37,794								
		-MDD 06 (GPD)	102,743	2.72							
		ADD Per Meter 06 (GPD)	1,890								
	O	Number of Meters	10								
		ADD 06 (GPD)	18,002								
		-MDD 06 (GPD)	48,939								
		ADD Per Meter 06 (GPD)	1,800								
	R	Number of Meters	236		0	236	2.68	632	129	589	0.593
		ADD 06 (GPD)	81,346								
		-MDD 06 (GPD)	221,140								
		ADD Per Meter 06 (GPD)	345								
020EB1-S Number of Meters			266								
020EB1-S ADD 06 (GPD)			137,142								
020EB1-S -MDD 06 (GPD)			372,822								
020EB1-S ADD Per Meter 06 (GPD)			516								
030EL2	C	Number of Meters	22								
		ADD 06 (GPD)	11,733								
		-MDD 06 (GPD)	52,486	2.72							
		ADD Per Meter 06 (GPD)	533								
	O	Number of Meters	1								
		ADD 06 (GPD)	194								
		-MDD 06 (GPD)	867								
		ADD Per Meter 06 (GPD)	194								
	R	Number of Meters	40		0	40	2.51	100	46	1729	0.277
		ADD 06 (GPD)	4,573								
		-MDD 06 (GPD)	20,456								
		ADD Per Meter 06 (GPD)	114								
030EL2 Number of Meters			63								
030EL2 ADD 06 (GPD)			16,500								
030EL2 -MDD 06 (GPD)			73,809								
030EL2 ADD Per Meter 06 (GPD)			262								
030G1	C	Number of Meters	314								
		ADD 06 (GPD)	205,494								
		-MDD 06 (GPD)	559,346	4.47							
		ADD Per Meter 06 (GPD)	654								
	I	Number of Meters	30								
		ADD 06 (GPD)	28,607								
		-MDD 06 (GPD)	77,868								
		ADD Per Meter 06 (GPD)	954								
	O	Number of Meters	3								
		ADD 06 (GPD)	2,095								
		-MDD 06 (GPD)	5,701								
		ADD Per Meter 06 (GPD)	698								
	R	Number of Meters	239		361	600	2.28	1,368	51	1567	0.228
		ADD 06 (GPD)	69,915								
		-MDD 06 (GPD)	190,305								
		ADD Per Meter 06 (GPD)	293								
030G1 Number of Meters			586								
030G1 ADD 06 (GPD)			306,111								
030G1 -MDD 06 (GPD)			833,221								
030G1 ADD Per Meter 06 (GPD)			522								
030G3	C	Number of Meters	26								
		ADD 06 (GPD)	69,360								
		-MDD 06 (GPD)	248,987	2.72							
		ADD Per Meter 06 (GPD)	2,668								
	R	Number of Meters	19		0	19	2.28	43	51	89	0.031
		ADD 06 (GPD)	2,208								
		-MDD 06 (GPD)	7,927								
		ADD Per Meter 06 (GPD)	116								
030G3 Number of Meters			45								
030G3 ADD 06 (GPD)			71,568								
030G3 -MDD 06 (GPD)			256,913								
030G3 ADD Per Meter 06 (GPD)			1,590								

Water District	Billing Class	Data	Total	MDD/ADD Peaking Factor Used	Apartments/ Condo Units	Total Residential Units	Twp. Avg. Household Size	Estimated Served Population (1)	ADD Per Capita	Estimated 2006 Population in Water District	Residential ADD/ Total ADD
030P1	R	Number of Meters	97		0	97	2.45	238	111	516	1.000
		ADD 06 (GPD)	26,265								
		-MDD 06 (GPD)	111,652	3.59							
		ADD Per Meter 06 (GPD)	271								
030P1 Number of Meters			97								
030P1 ADD 06 (GPD)			26,265								
030P1 -MDD 06 (GPD)			111,652								
030P1 ADD Per Meter 06 (GPD)			271								
030P2	O	Number of Meters	1								
		ADD 06 (GPD)	1,296								
		-MDD 06 (GPD)	6,076	4.25							
		ADD Per Meter 06 (GPD)	1,296								
	R	Number of Meters	15		0	15	2.45	37	81	421	0.697
		ADD 06 (GPD)	2,977								
		-MDD 06 (GPD)	13,962								
		ADD Per Meter 06 (GPD)	198								
030P2 Number of Meters			16								
030P2 ADD 06 (GPD)			4,273								
030P2 -MDD 06 (GPD)			20,038								
030P2 ADD Per Meter 06 (GPD)			267								
040P3	C	Number of Meters	1								
		ADD 06 (GPD)	31								
		-MDD 06 (GPD)	94	4.69							
		ADD Per Meter 06 (GPD)	31								
	O	Number of Meters	2								
		ADD 06 (GPD)	4,308								
		-MDD 06 (GPD)	13,170								
		ADD Per Meter 06 (GPD)	2,154								
	R	Number of Meters	238		0	238	2.45	583	140	888	0.950
		ADD 06 (GPD)	81,720								
		-MDD 06 (GPD)	249,861								
		ADD Per Meter 06 (GPD)	343								
040P3 Number of Meters			241								
040P3 ADD 06 (GPD)			86,058								
040P3 -MDD 06 (GPD)			263,125								
040P3 ADD Per Meter 06 (GPD)			357								
050P4	R	Number of Meters	11		0	11	2.45	27	52	660	1.000
		ADD 06 (GPD)	1,395								
		-MDD 06 (GPD)	6,624	3.06							
		ADD Per Meter 06 (GPD)	127								
050P4 Number of Meters			11								
050P4 ADD 06 (GPD)			1,395								
050P4 -MDD 06 (GPD)			6,624								
050P4 ADD Per Meter 06 (GPD)			127								
060G5	C	Number of Meters	37								
		ADD 06 (GPD)	47,268								
		-MDD 06 (GPD)	188,556	4.75							
		ADD Per Meter 06 (GPD)	1,278								
	O	Number of Meters	1								
		ADD 06 (GPD)	52								
		-MDD 06 (GPD)	206								
		ADD Per Meter 06 (GPD)	52								
	R	Number of Meters	2		0	2	2.28	5	30	218	0.003
		ADD 06 (GPD)	138								
		-MDD 06 (GPD)	551								
		ADD Per Meter 06 (GPD)	69								
060G5 Number of Meters			40								
060G5 ADD 06 (GPD)			47,457								
060G5 -MDD 06 (GPD)			189,313								
060G5 ADD Per Meter 06 (GPD)			1,186								
070G2A-E	C	Number of Meters	95								
		ADD 06 (GPD)	85,458								
		-MDD 06 (GPD)	232,536	3.99							
		ADD Per Meter 06 (GPD)	900								
	I	Number of Meters	22								
		ADD 06 (GPD)	96,753								
		-MDD 06 (GPD)	263,269								
		ADD Per Meter 06 (GPD)	4,398								
	O	Number of Meters	15								
		ADD 06 (GPD)	12,023								
		-MDD 06 (GPD)	32,716								
		ADD Per Meter 06 (GPD)	802								
	R	Number of Meters	368		553	921	2.28	2,100	75	3521	0.448
		ADD 06 (GPD)	157,340								
		-MDD 06 (GPD)	428,130								
		ADD Per Meter 06 (GPD)	428								
070G2A-E Number of Meters			500								
070G2A-E ADD 06 (GPD)			351,574								
070G2A-E -MDD 06 (GPD)			956,651								
070G2A-E ADD Per Meter 06 (GPD)			703								
070G2A-W	C	Number of Meters	134								
		ADD 06 (GPD)	249,532								
		-MDD 06 (GPD)	678,696	2.72							
		ADD Per Meter 06 (GPD)	1,862								
	O	Number of Meters	11								
		ADD 06 (GPD)	32,977								
		-MDD 06 (GPD)	89,695								
		ADD Per Meter 06 (GPD)	2,998								
	R	Number of Meters	197		609	806	2.28	1,838	70	1837	0.312
		ADD 06 (GPD)	128,329								
		-MDD 06 (GPD)	349,040								
		ADD Per Meter 06 (GPD)	651								
070G2A-W Number of Meters			342								
070G2A-W ADD 06 (GPD)			410,838								
070G2A-W -MDD 06 (GPD)			1,117,431								
070G2A-W ADD Per Meter 06 (GPD)			1,201								
080G2B	R	Number of Meters	31		0	31	2.28	71	192	202	1.000
		ADD 06 (GPD)	13,573								
		-MDD 06 (GPD)	61,763	2.72							
		ADD Per Meter 06 (GPD)	438								
080G2B Number of Meters			31								
080G2B ADD 06 (GPD)			13,573								
080G2B -MDD 06 (GPD)			61,763								
080G2B ADD Per Meter 06 (GPD)			438								

Water District	Billing Class	Data	Total	MDD/ADD Peaking Factor Used	Apartments/ Condo Units	Total Residential Units	Twp. Avg. Household Size	Estimated Served Population (1)	ADD Per Capita	Estimated 2006 Population in Water District	Residential ADD/ Total ADD
090G4A	C	Number of Meters	14								
		ADD 06 (GPD)	50,191								
		-MDD 06 (GPD)	192,988	4.55							
		ADD Per Meter 06 (GPD)	3,585								
	R	Number of Meters	37		0	37	2.28	84	71	115	0.106
		ADD 06 (GPD)	5,964								
		-MDD 06 (GPD)	22,932								
		ADD Per Meter 06 (GPD)	161								
090G4A Number of Meters			51								
090G4A ADD 06 (GPD)			56,155								
090G4A -MDD 06 (GPD)			215,919								
090G4A ADD Per Meter 06 (GPD)			1,101								
100G4B	C	Number of Meters	5								
		ADD 06 (GPD)	50,297								
		-MDD 06 (GPD)	136,858	3.85							
		ADD Per Meter 06 (GPD)	10,059								
	O	Number of Meters	4								
		ADD 06 (GPD)	6,164								
		-MDD 06 (GPD)	16,771								
		ADD Per Meter 06 (GPD)	1,541								
	R	Number of Meters	547		441	988	2.28	2,253	132	5227	0.840
		ADD 06 (GPD)	296,539								
		-MDD 06 (GPD)	806,891								
		ADD Per Meter 06 (GPD)	542								
100G4B Number of Meters			556								
100G4B ADD 06 (GPD)			352,999								
100G4B -MDD 06 (GPD)			960,520								
100G4B ADD Per Meter 06 (GPD)			635								
110EL5	C	Number of Meters	1								
		ADD 06 (GPD)	10,897								
		-MDD 06 (GPD)	44,168	2.72							
		ADD Per Meter 06 (GPD)	10,897								
	R	Number of Meters	119		63	182	2.51	457	92	1343	0.794
		ADD 06 (GPD)	42,106								
		-MDD 06 (GPD)	170,675								
		ADD Per Meter 06 (GPD)	354								
110EL5 Number of Meters			120								
110EL5 ADD 06 (GPD)			53,003								
110EL5 -MDD 06 (GPD)			214,843								
110EL5 ADD Per Meter 06 (GPD)			442								
110G4C	C	Number of Meters	26								
		ADD 06 (GPD)	16,124								
		-MDD 06 (GPD)	43,935	4.05							
		ADD Per Meter 06 (GPD)	620								
	O	Number of Meters	11								
		ADD 06 (GPD)	35,443								
		-MDD 06 (GPD)	96,574								
		ADD Per Meter 06 (GPD)	3,222								
	R	Number of Meters	265		0	265	2.28	604	187	2251	0.687
		ADD 06 (GPD)	113,287								
		-MDD 06 (GPD)	308,678								
		ADD Per Meter 06 (GPD)	427								
110G4C Number of Meters			302								
110G4C ADD 06 (GPD)			164,854								
110G4C -MDD 06 (GPD)			449,188								
110G4C ADD Per Meter 06 (GPD)			546								
120G6	R	Number of Meters	3		0	3	2.28	7	1	256	1.000
		ADD 06 (GPD)	6								
		-MDD 06 (GPD)	27	2.72							
		ADD Per Meter 06 (GPD)	2								
120G6 Number of Meters			3								
120G6 ADD 06 (GPD)			6								
120G6 -MDD 06 (GPD)			27								
120G6 ADD Per Meter 06 (GPD)			2								
Total Number of Meters			4,333								
Total ADD 06 (GPD)			2,683,635								
Total -MDD 06 (GPD)			7,692,008	4.78							
Total ADD Per Meter 06 (GPD)			619								
								13,971			

NOTES:
1) Number of Residential Meters X Average Household Size for that Township

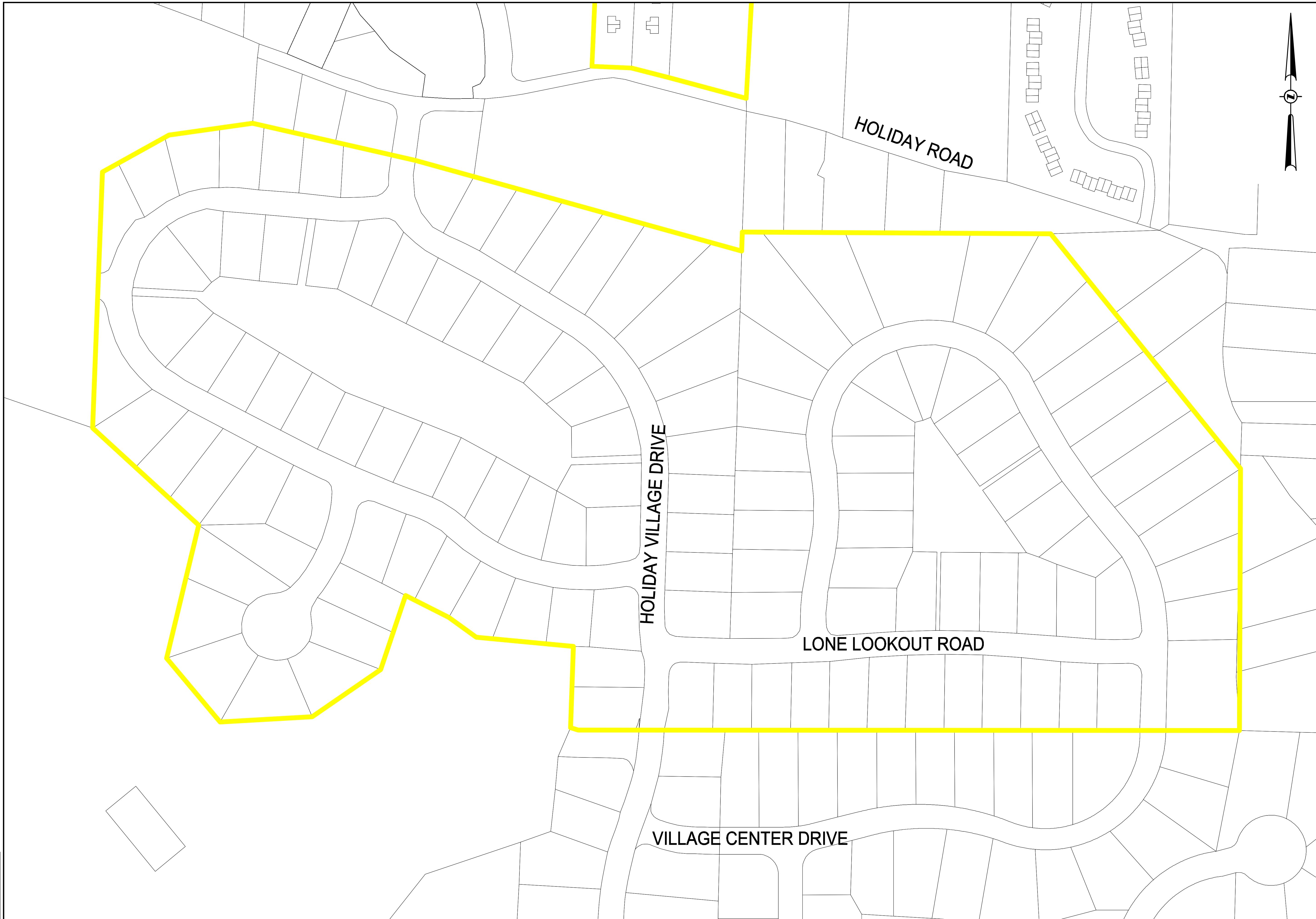
Overall Demand By Billing Class

Billing Class	Data	Total
C	Number of Meters	790
	ADD (GPD)	1,055,171
	ADD Per Meter (GPD)	1,336
I	Number of Meters	52
	ADD (GPD)	125,360
	ADD Per Meter (GPD)	2,411
O	Number of Meters	72
	ADD (GPD)	130,957
	ADD Per Meter (GPD)	1,819
R	Number of Meters	3419
	ADD (GPD)	1,372,148
	ADD Per Meter (GPD)	401
Total Number of Meters		4333
Total ADD (GPD)		2,683,635
Total ADD Per Meter (GPD)		619

Per Capita Demand by Township and Total

Township	Data	Total	ADD Per Capita
East Bay Twp.	Sum of Res. ADD	425,812	
	Sum- Est. Served Pop.	4,157	102.4
Elmwood Twp.	Sum of Res. ADD	46,679	
	Sum- Est. Served Pop.	557	83.8
Garfield Twp.	Sum of Res. ADD	787,299	
	Sum- Est. Served Pop.	8,372	94.0
Peninsula Twp.	Sum of Res. ADD	112,358	
	Sum- Est. Served Pop.	884	127.0
Total Sum of Res. ADD		1,372,148	
Total Sum- Est. Served Pop.		13,971	98.2

APPENDIX I- UNIT DEMAND FOR SAMPLE DEVELOPMENTS/ ULTIMATE BUILD-OUT SUPPORTING INFORMATION



PROJECT LOG	
1 DEMAND ANALYSIS	4\3\08
2	
3	
4	
5	
6	
7	

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 1 OF 27

DEMAND ANALYSIS AREA 1
EAST BAY TOWNSHIP
LOW DENSITY RESIDENTIAL ZONING
AREA = 81.13 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

Wilcox Professional Services
1 Madison Avenue
Cadillac, MI 49601
www.wilcox.us

1

11115.00002

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

DEMAND ANALYSIS AREA 2
EAST BAY TOWNSHIP
HIGH DENSITY RESIDENTIAL ZONING
AREA = 22.95 AC

Wilcox Professional Services
1 Madison Avenue
Cadillac, MI 49601

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 2 OF 27

PROJECT LOG
1 DEMAND ANALYSIS 4\3\08

2

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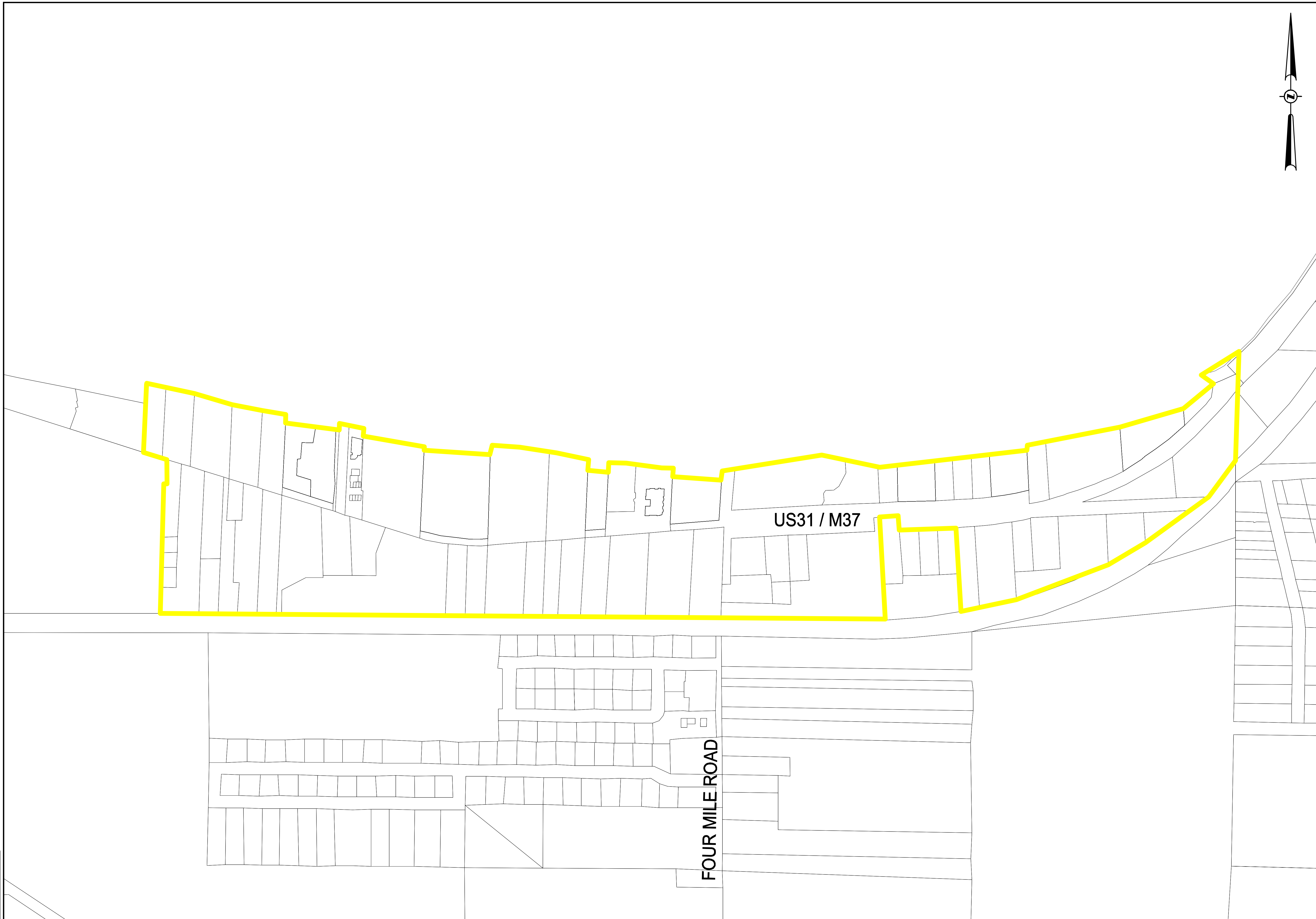

PROJECT LOG

1 DEMAND ANALYSIS 4\3\08

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 3 OF 27

DEMAND ANALYSIS AREA 3
EAST BAY TOWNSHIP
REGIONAL BUSINESS ZONING
AREA = 102.81 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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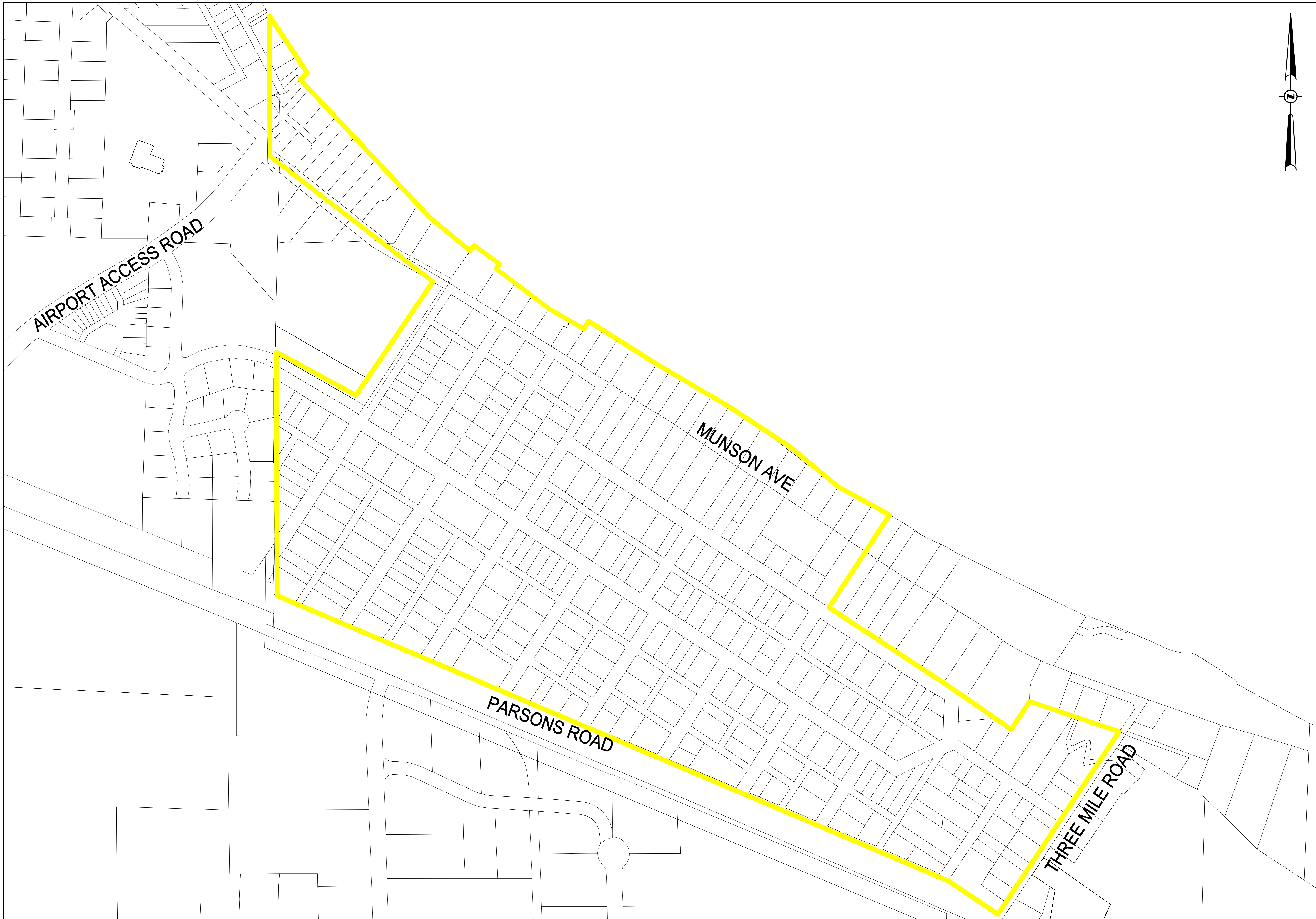

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
2		
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 4 OF 27

DEMAND ANALYSIS AREA 4
EAST BAY TOWNSHIP
LOW DENSITY RESIDENTIAL ZONING
AREA = 157.53 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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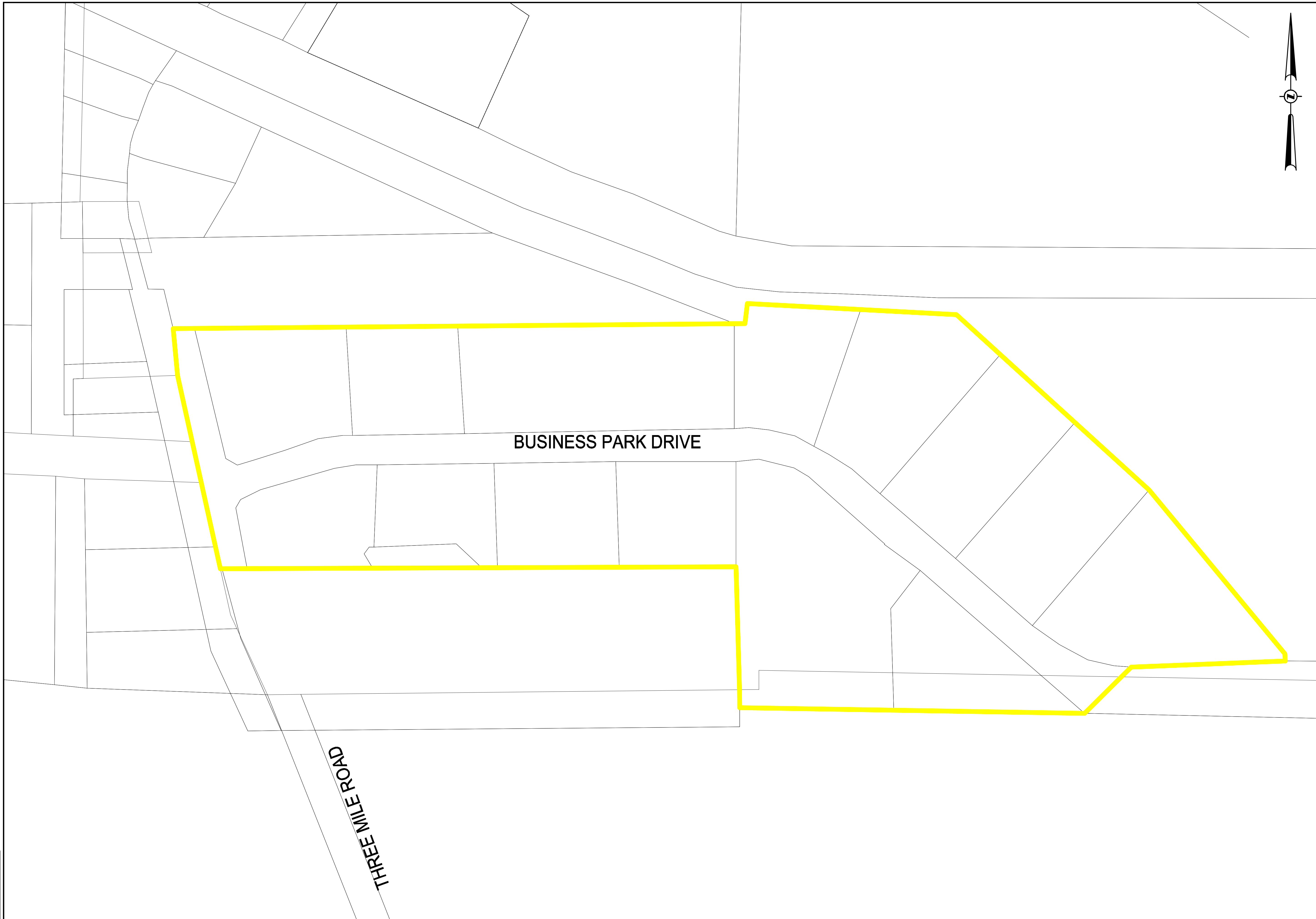

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 5 OF 27

DEMAND ANALYSIS AREA 5
EAST BAY TOWNSHIP
INDUSTRIAL ZONING
AREA = 25.95 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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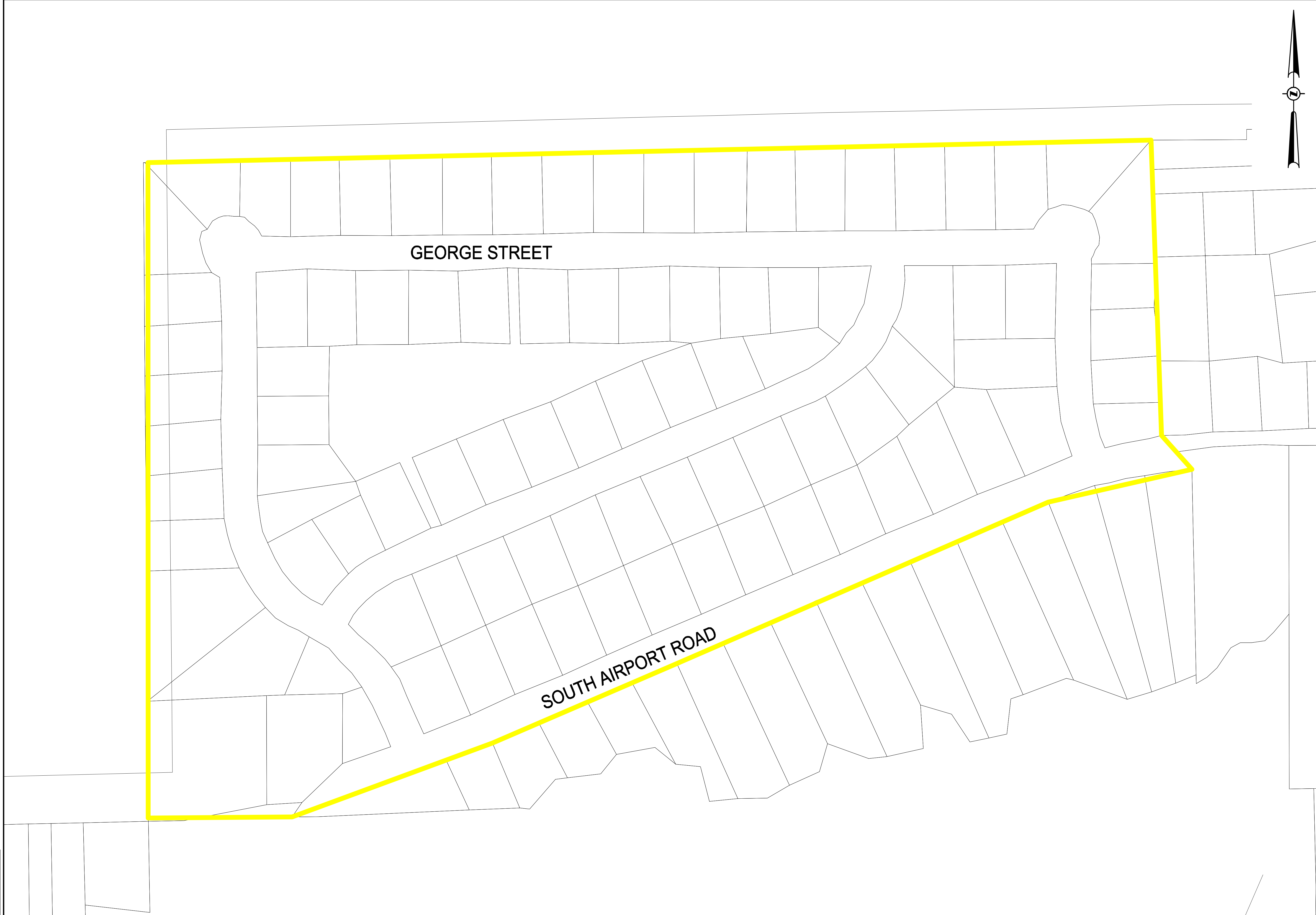

FILE:	
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DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	6 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
2		
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DEMAND ANALYSIS AREA 6
EAST BAY TOWNSHIP
LOW DENSITY RESIDENTIAL ZONING
AREA = 47.02 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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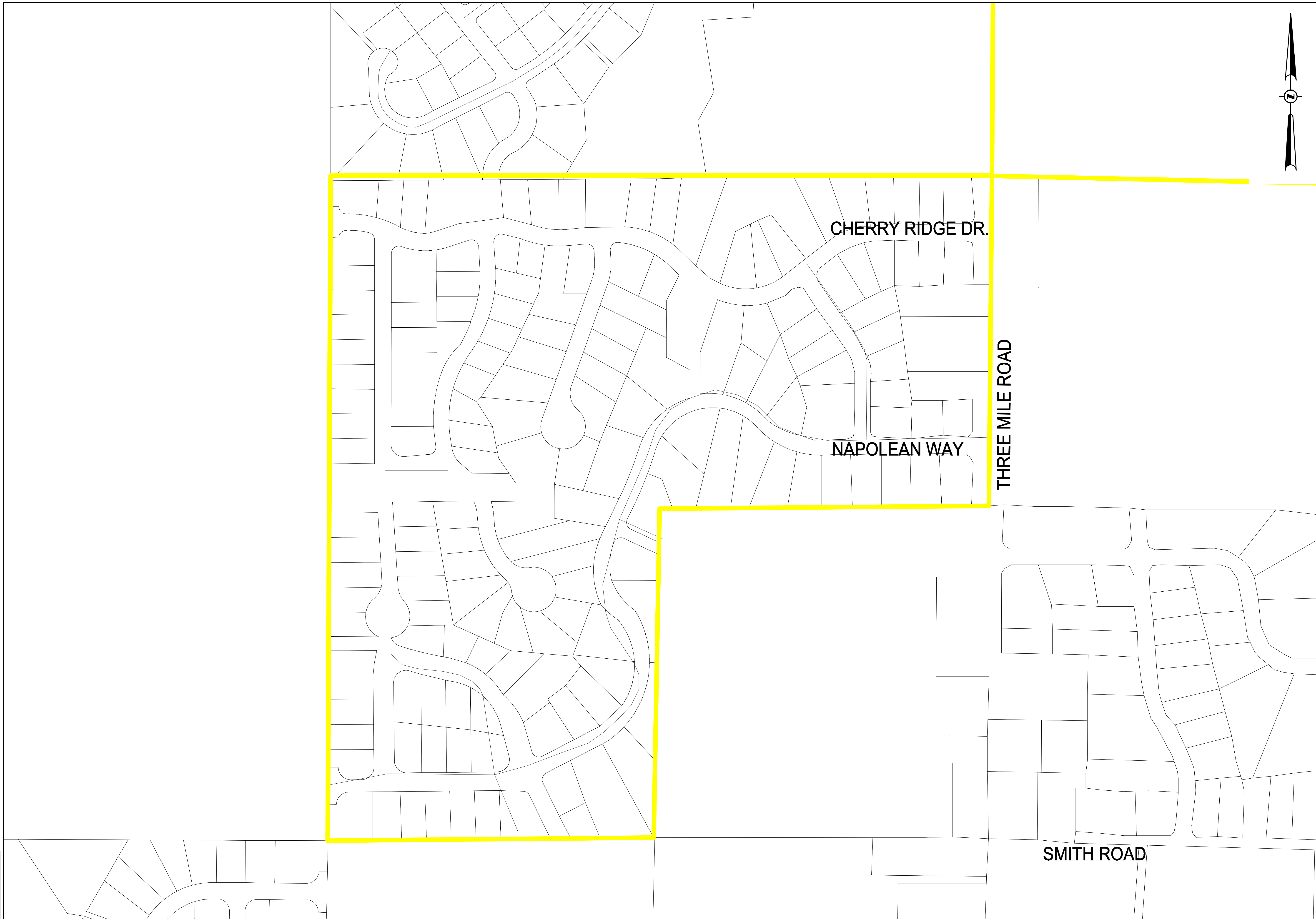

PROJECT LOG

1 DEMAND ANALYSIS	4\3\08
2	
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 7 OF 27

DEMAND ANALYSIS AREA 7
EAST BAY TOWNSHIP
LOW DESNISTY RESIDENTIAL ZONING
AREA = 122.51 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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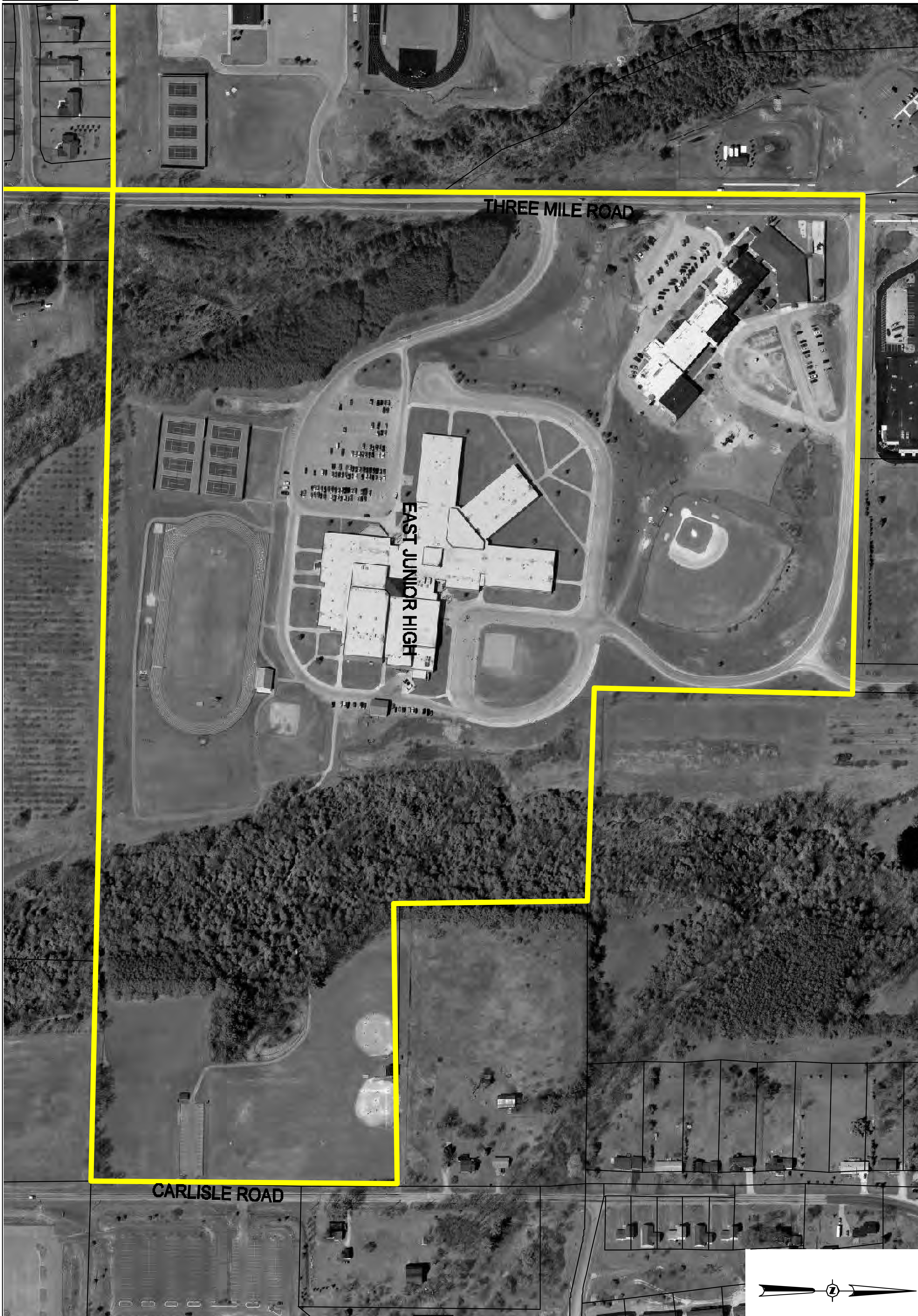

FILE:	PROJECT LOG
PROJECT MGR: JET	1 DEMAND ANALYSIS 4\3\08
DESIGNED BY: JET	2
DRAWN BY: EES	3
SCALE: NONE	4
	5
SHEET: 8 OF 27	6
	7

DEMAND ANALYSIS AREA 8
EAST BAY TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 92.14 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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PROJECT LOG

1 DEMAND ANALYSIS 4\3\08

FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 9 OF 27

DEMAND ANALYSIS AREA 9
GARFIELD TOWNSHIP
INDUSTRIAL ZONING
AREA = 40.81 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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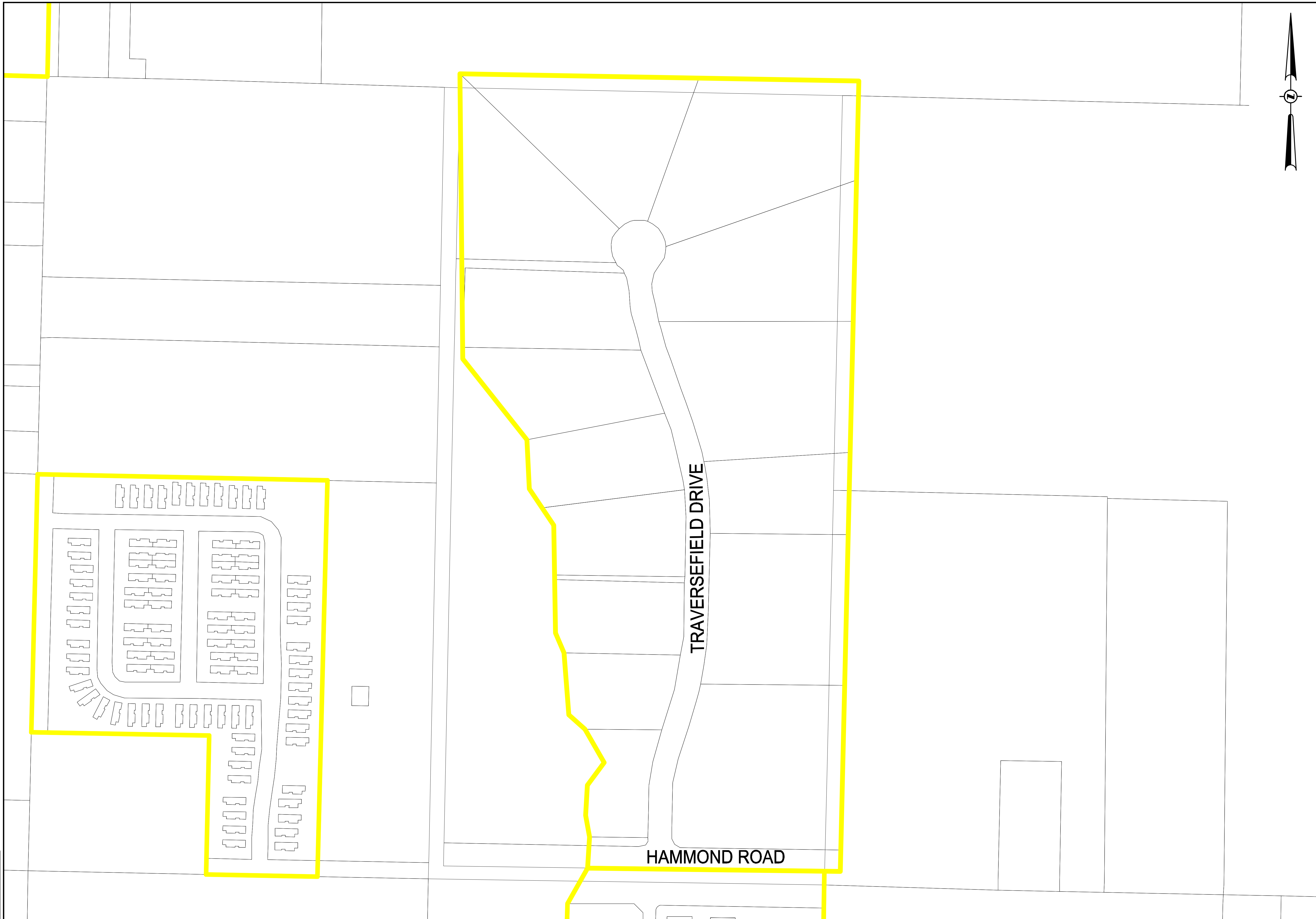

DEMAND ANALYSIS AREA 10
GARFIELD TOWNSHIP
INDUSTRIAL ZONING
AREA = 65.70 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

FILE:		PROJECT LOG	
PROJECT MGR:	JET	1 DEMAND ANALYSIS	4\3\08
DESIGNED BY:	JET	2	
DRAWN BY:	EES	3	
SCALE:	NONE	4	
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SHEET:	10 OF 27	6	
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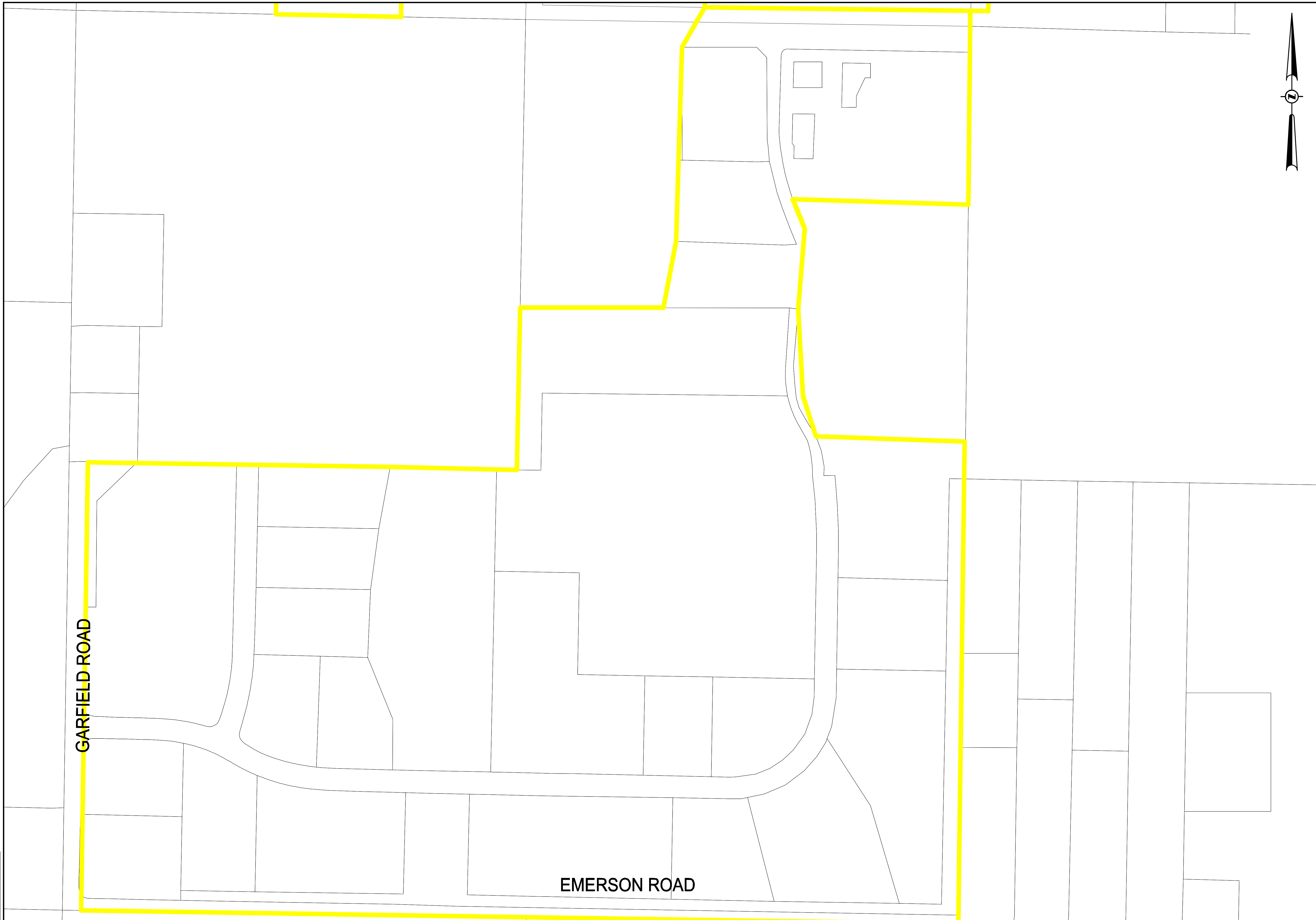

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 11 OF 27

DEMAND ANALYSIS AREA 11
GARFIELD TOWNSHIP
INDUSTRIAL ZONING
AREA = 102.80 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 12 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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DEMAND ANALYSIS AREA 12
GARFIELD TOWNSHIP
MEDIUM DENSITY RESIDENTIAL ZONING
AREA = 22.75 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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PROJECT LOG

1 DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 13 OF 27

DEMAND ANALYSIS AREA 13
GARFIELD TOWNSHIP
PLANNED DEVELOPMENT ZONING
AREA = 10.91 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 14 OF 27

PROJECT LOG
1 DEMAND ANALYSIS 4\3\08

DEMAND ANALYSIS AREA 14
GARFIELD TOWNSHIP
PLANNED DEVELOPMENT ZONING
AREA = 14.89 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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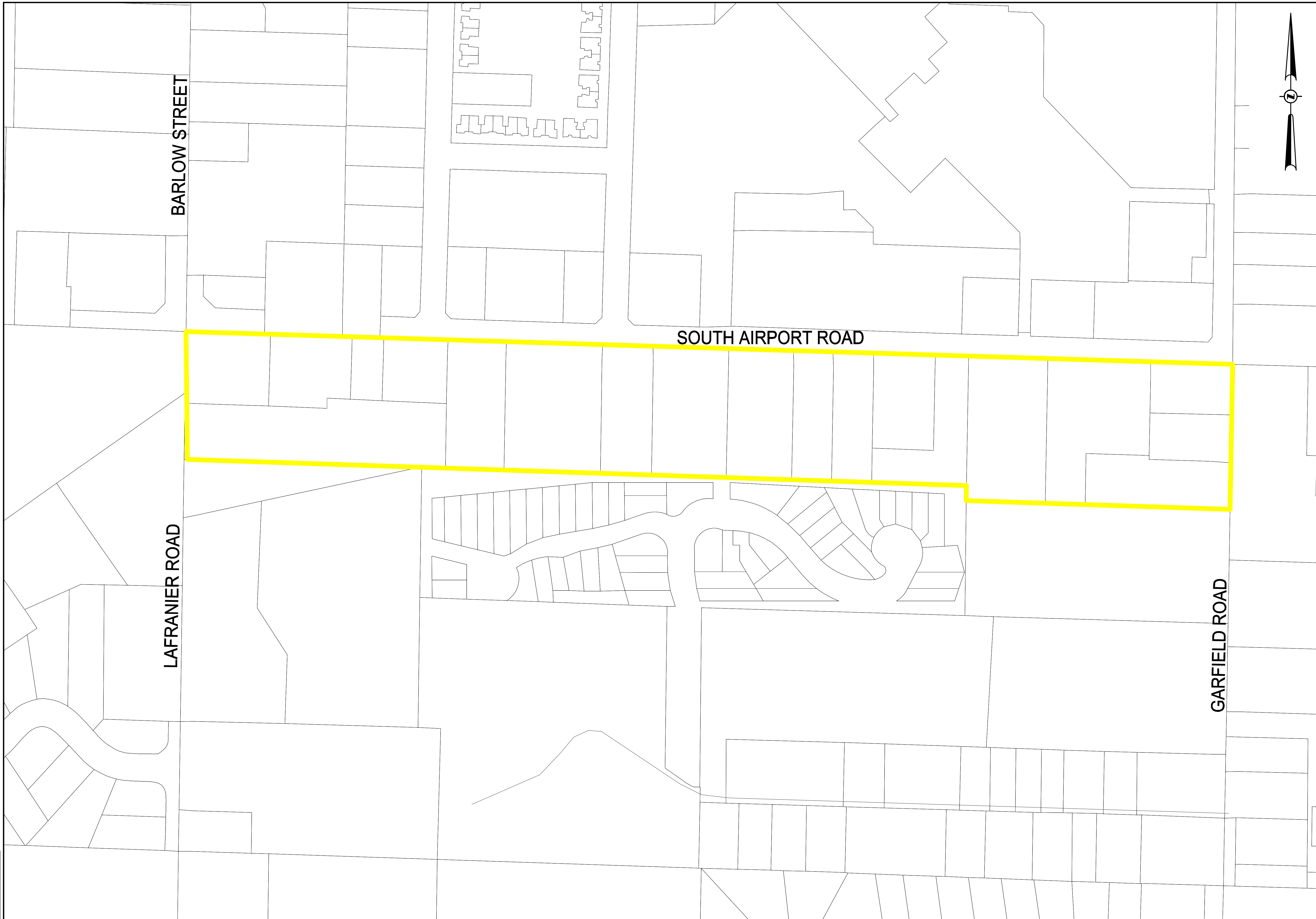

DEMAND ANALYSIS AREA 15
GARFIELD TOWNSHIP
GENERAL BUSINESS ZONING
AREA = 20.40 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

FILE:	
PROJECT MGR:	JET
DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	15 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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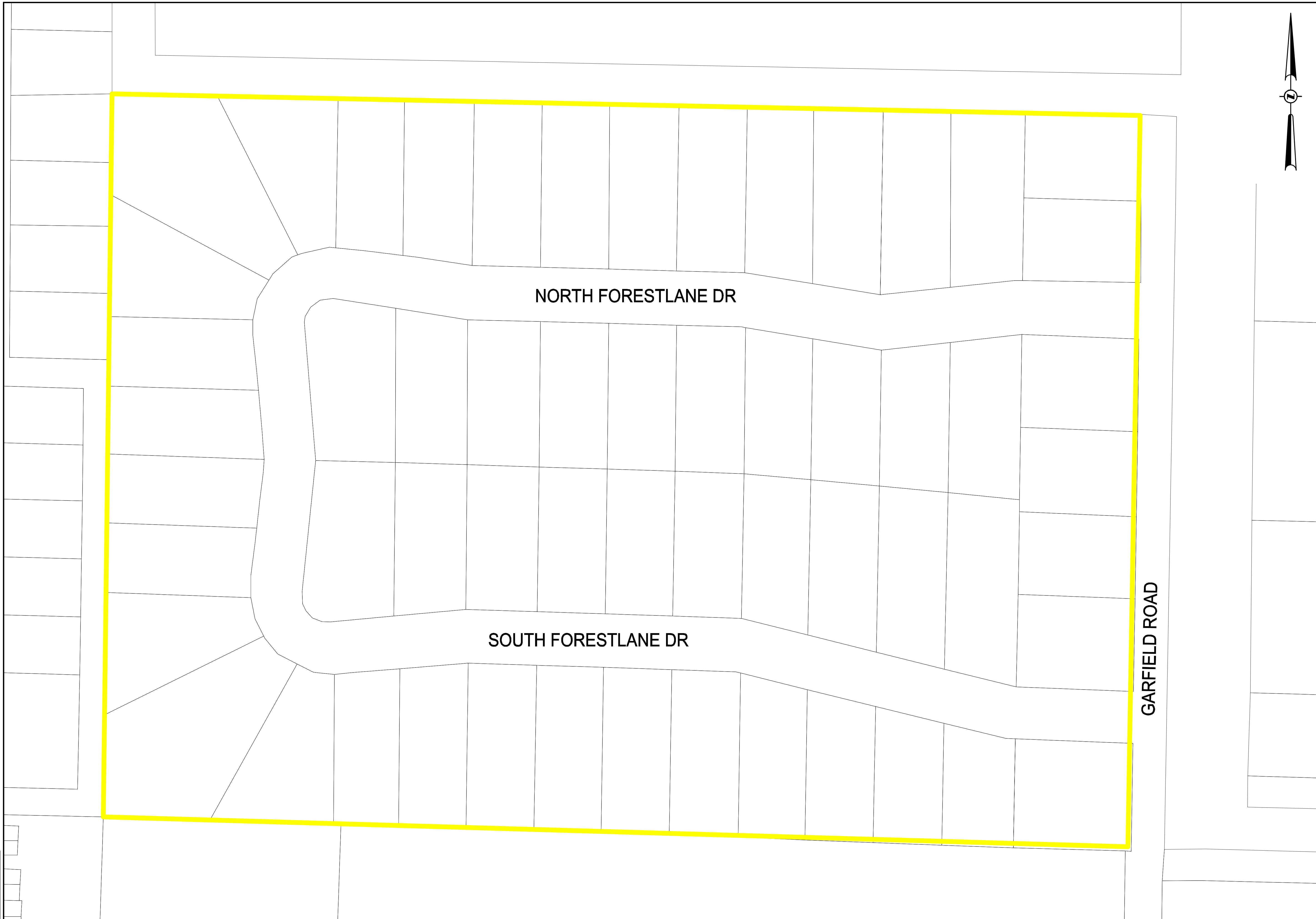

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 16 OF 27

DEMAND ANALYSIS AREA 16
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 26.91 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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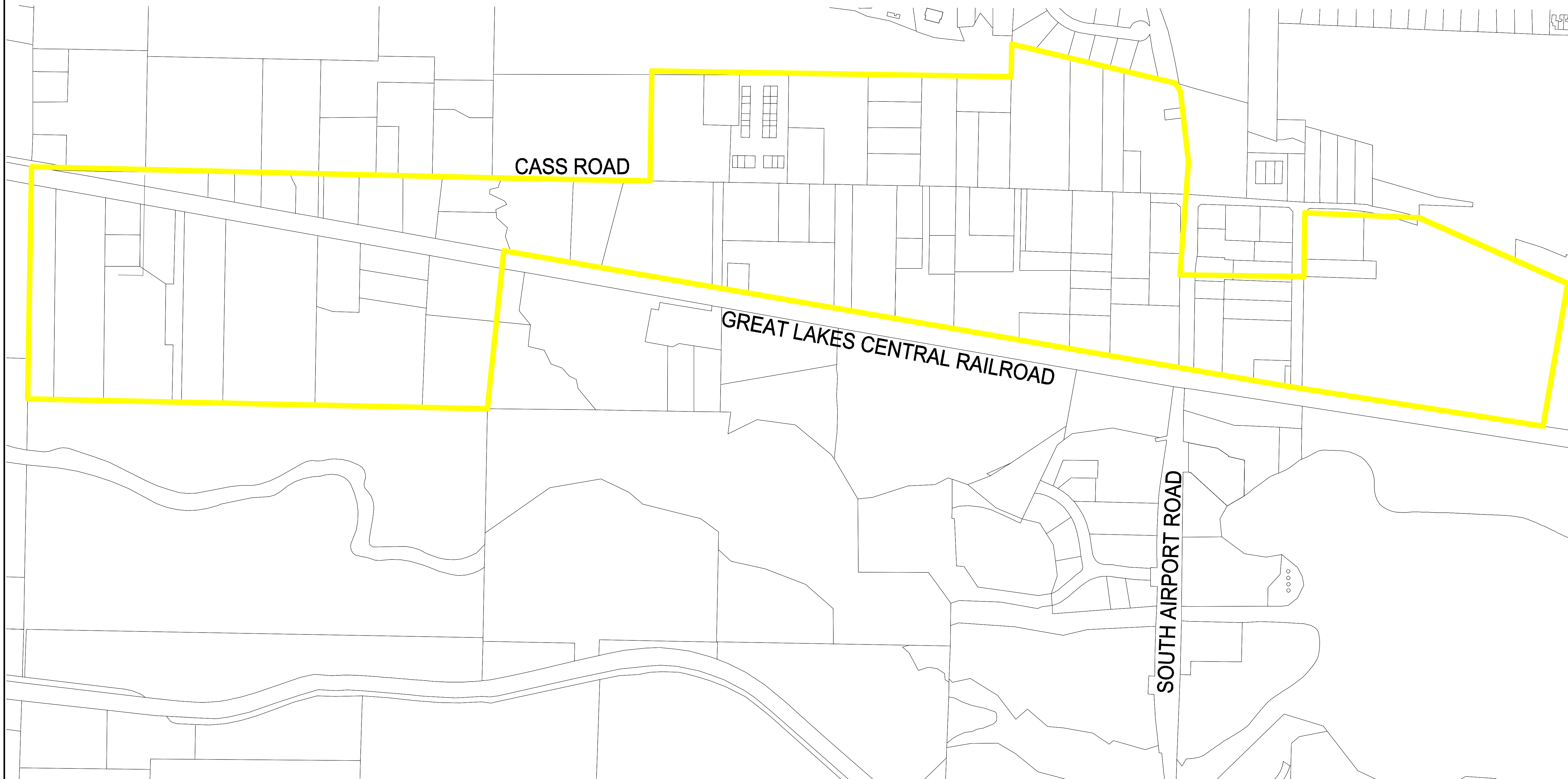

DEMAND ANALYSIS AREA 17
GARFIELD TOWNSHIP
INDUSTRIAL ZONING
AREA = 232.34 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 17 OF 27

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DEMAND ANALYSIS AREA 18
GARFIELD TOWNSHIP
PLANNED DEVELOPMENT ZONING
AREA = 38.41 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EEB
SCALE: NONE
SHEET: 18 OF 27

PROJECT LOG: DEMAND ANALYSIS 4\3\08

18

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GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

DEMAND ANALYSIS AREA 19
GARFIELD TOWNSHIP
PLANNED COMMERICAL ZONING
AREA = 69.29 AC

FILE:	
PROJECT MGR:	JET
DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	19 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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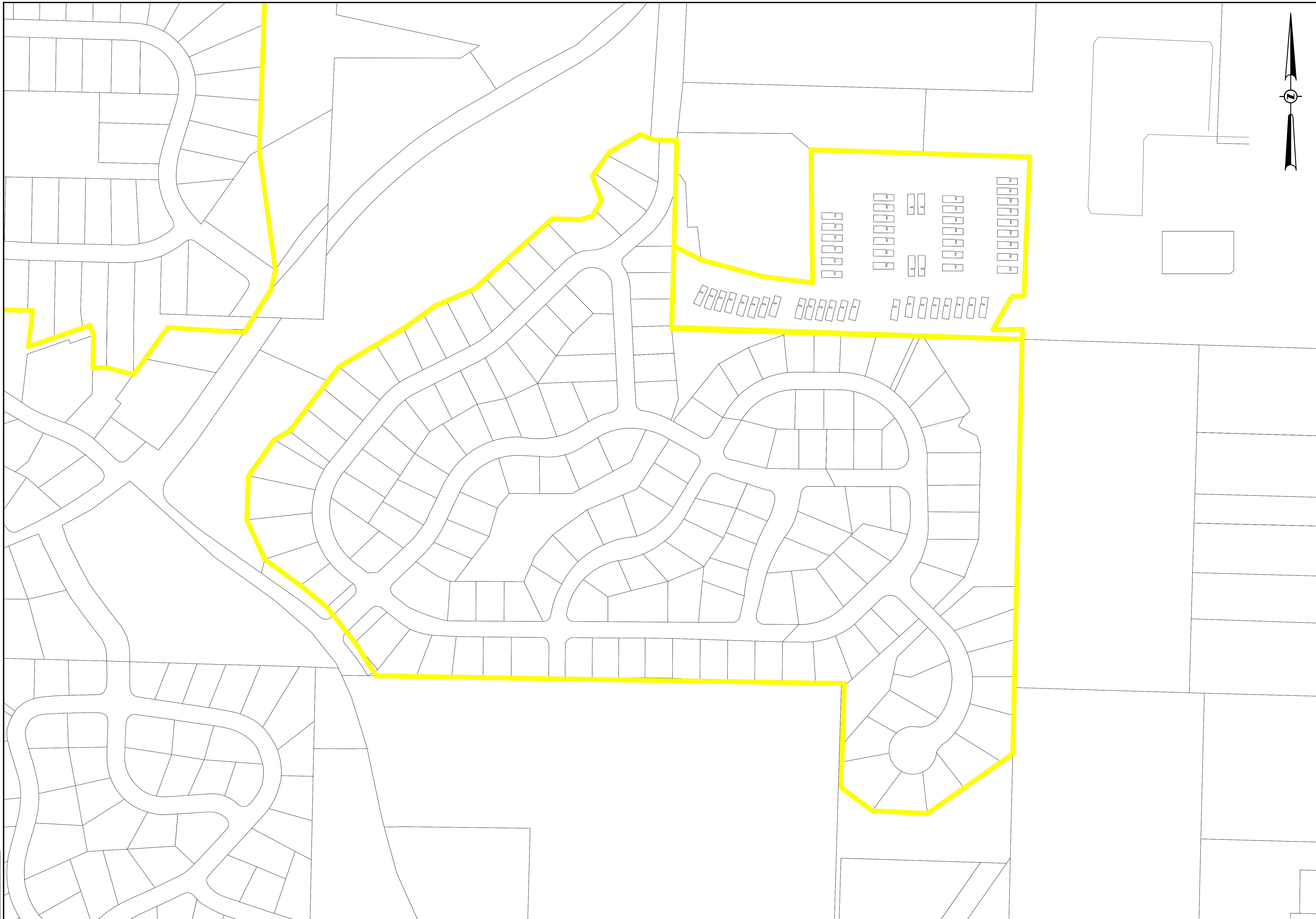

DEMAND ANALYSIS AREA 20
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 96.86 AC

FILE:		PROJECT LOG
PROJECT MGR:	JET	1 DEMAND ANALYSIS 4\3\08
DESIGNED BY:	JET	2
DRAWN BY:	EES	3
SCALE:	NONE	4
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SHEET:	20 OF 27	6
		7

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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FILE:	
PROJECT MGR:	JET
DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	21 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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DEMAND ANALYSIS AREA 21
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 15.37 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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DEMAND ANALYSIS AREA 22
GARFIELD TOWNSHIP
PLANNED DEVELOPMENT ZONING
AREA = 19.04 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

FILE:	
PROJECT MGR:	JET
DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	22 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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FILE:
PROJECT MGR: JET
DESIGNED BY: JET
DRAWN BY: EES
SCALE: NONE
SHEET: 23 OF 27

DEMAND ANALYSIS AREA 23
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 98.79 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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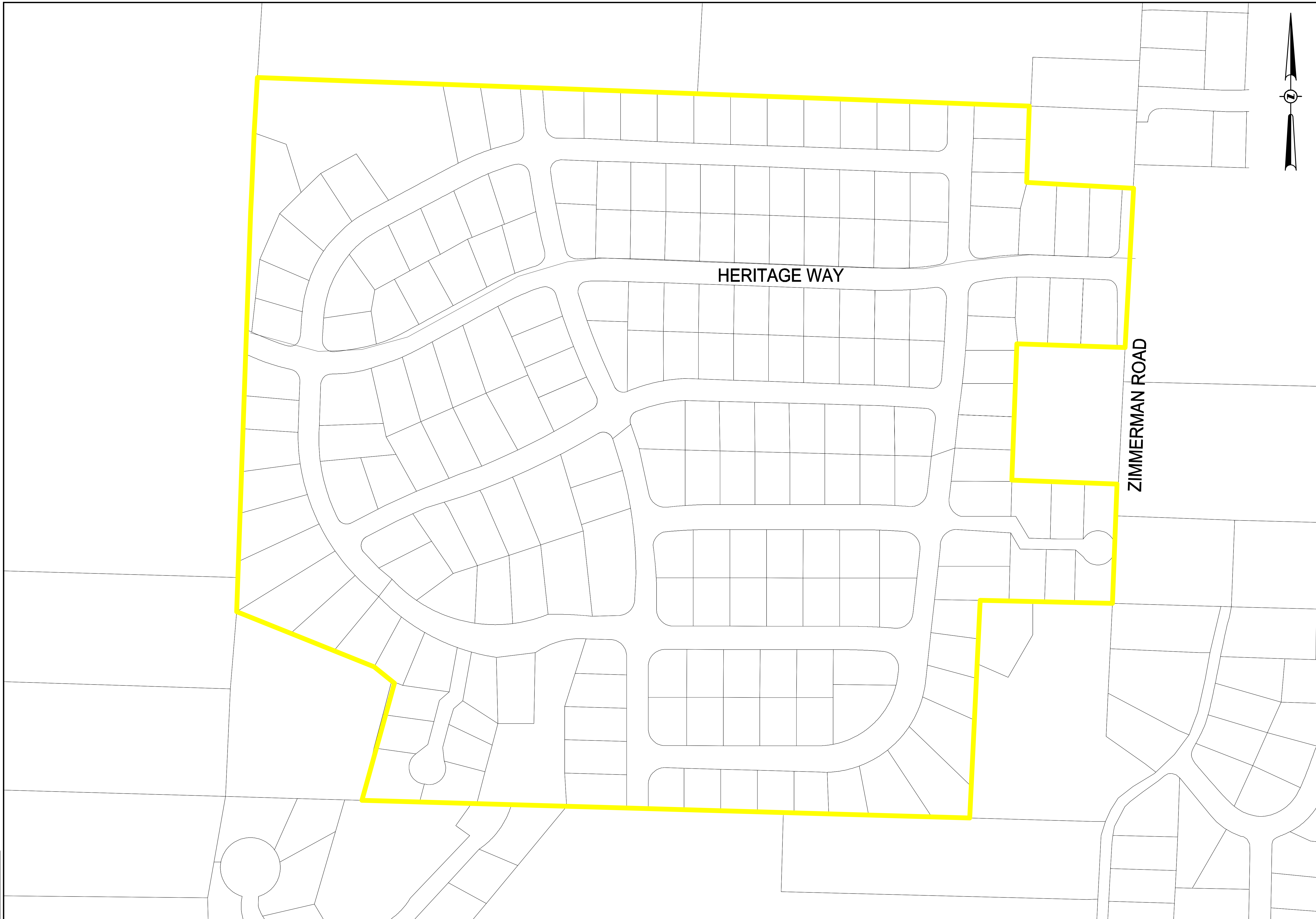

DEMAND ANALYSIS AREA 24
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 114.51 AC

FILE:		PROJECT LOG	
PROJECT MGR:	JET	1	DEMAND ANALYSIS 4\3\08
DESIGNED BY:	JET	2	
DRAWN BY:	EES	3	
SCALE:	NONE	4	
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SHEET:	24 OF 27	6	
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GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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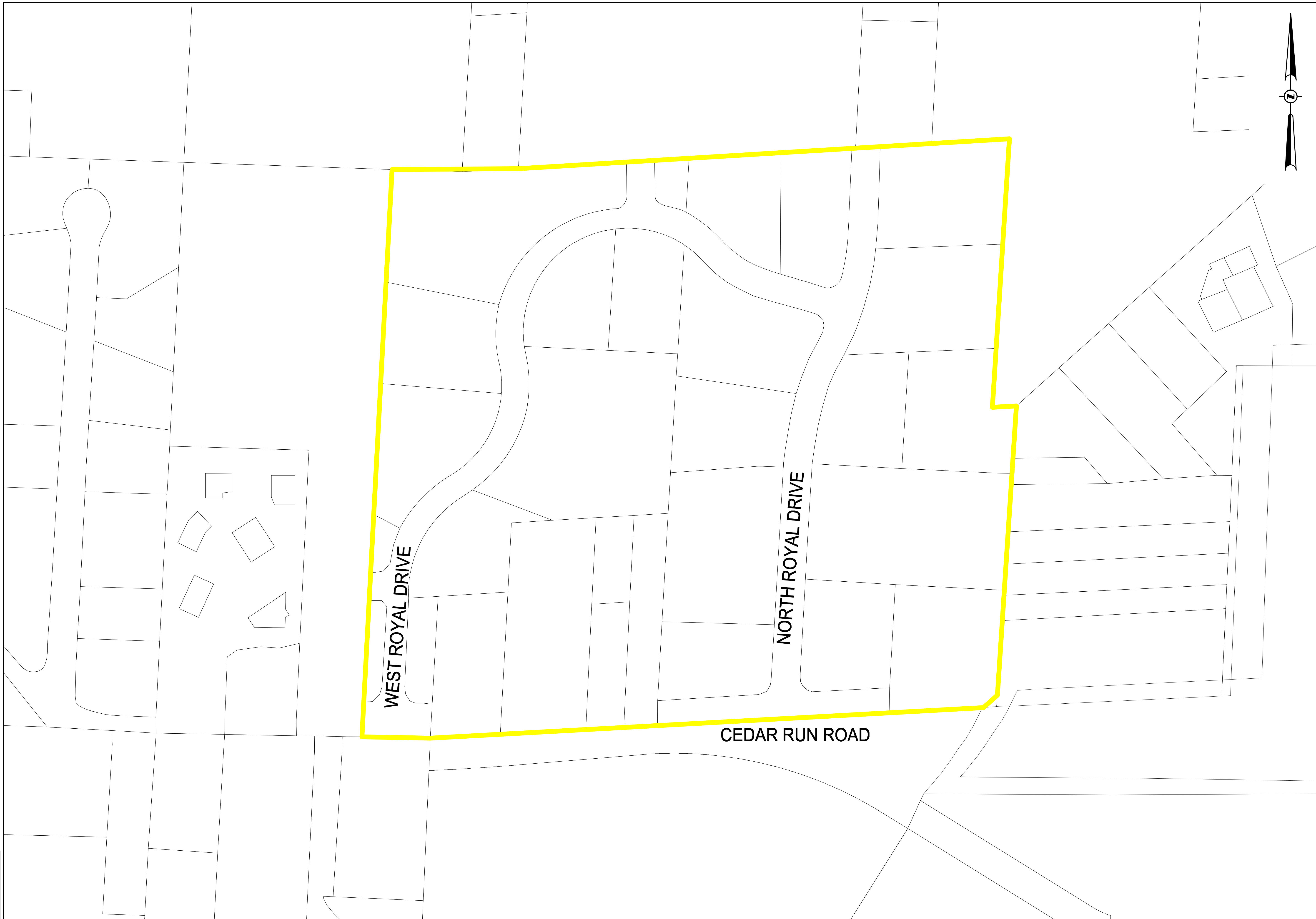

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DESIGNED BY:	JET
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SCALE:	NONE
SHEET:	25 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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DEMAND ANALYSIS AREA 25
GARFIELD TOWNSHIP
PROFESSIONAL OFFICE ZONING
AREA = 44.74 AC

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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FILE:	
PROJECT MGR:	JET
DESIGNED BY:	JET
DRAWN BY:	EES
SCALE:	NONE
SHEET:	26 OF 27

PROJECT LOG

1	DEMAND ANALYSIS	4\3\08
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DEMAND ANALYSIS AREA 26
GARFIELD TOWNSHIP
MODERATE DENSITY RESIDENTIAL ZONING
AREA = 99.21 AC

GRAND TRAVERSE AREA WATER
SYSTEMS MASTER PLAN

DEMAND ANALYSIS DETAIL

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GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
ACREAGE & DEMANDS PER ZONE FOR EACH WATER DISTRICT
East Bay Township
Wilcox/Black & Veatch
Revised: April 24, 2008

ZONING	General ADD/Acre	Residential Units Per Acre	WATER DISTRICT 10EB2 Acreage	10EB2 ADD/Acre	10EB2 ADD for Area	20EB1-N Acreage	20EB1-N ADD/Acre	20EB1-N ADD for Area	20EB1-S Acreage	20EB1-S ADD/Acre	20EB1-S ADD for Area	ADD Township Totals
Rural Residential (assume 2.5A lots)	**150**	**0.40**	485		72,690			0			0	72,690
Low Density Residential	**(see indiv. water district)**	**1.27/1.99**	3,335	642	2,141,006	1,231	450	553,860	895	642	574,654	3,269,520
Moderate Density Residential	**968**	**4.82**	122		117,709	77		74,149	734		710,318	902,176
High Density Residential	**1,101**	**7.00**			0	256		281,526	14		14,864	296,389
Village Center	**844**				0	9		7,680	202		170,572	178,253
Regional Business	**1,282**				0	243		311,911			0	311,911
Professional Office	**573**				0	24		13,580			0	13,580
Industrial	**474**				0	364		172,536	129		61,288	233,824
High Density Residential & Manufactured Housing	**968**	**4.82**			0	223		215,574			0	215,574
TOTALS			3,941		**2,331,405**	2,426		**1,630,815**	1,974		**1,531,697**	**5,493,917**
MDD/ADD					2.68			2.69			2.70	2.61
Maximum Day Demand (MDD)					**6,247,996**			**4,394,035**			**4,130,104**	**14,364,900**
Total Residential ADD					2,331,405			1,125,108			1,299,836	**4,756,349**
Residential ADD/Total ADD					1.00			0.69			0.85	
Per Capita ADD					130			75			130	
Projected Built-out Population					17,934			15,001			9,999	**42,934**

East Bay High Density Residential- Max. 8 units/acre
East Bay Rural Residential- Min. Lot size = 40,000 sft

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
ACREAGE & DEMANDS PER ZONE FOR EACH WATER DISTRICT
Garfield Township
Wilcox/Black & Veatch
Revised: April 24, 2008

		WATER DISTRIC																		
LAND USE PLAN	**General**	**30G1**			**30G3**			**30G7**		**30G8**		**60G5**			**70G2A-E**			**70G2A-W**		
TYPE	**ADD/Acre**	**Acreage**	**ADD/Acre**	**ADD for Area**	**Acreage**	**ADD/Acre**	**ADD for Area**	**Acreage**	**ADD for Area**	**Acreage**	**ADD for Area**	**Acreage**	**ADD/Acre**	**ADD for Area**	**Acreage**	**ADD/Acre**	**ADD for Area**	**Acreage**	**ADD/Acre**	**ADD for Area**
Parks/Recreation	**0**	20		0			0		0		0	44		0	54		0	156		0
Planned Commercial	**1042**	83		86,590	21		21,465		0		0			0			0	150		156,404
Planned Development	**955**	16		15,089	31		29,319		0		0	141		134,942	583		556,670	123		117,656
Professional Office	**573**	20		11,689	5		2,865		0		0			0	29		16,732	18		10,486
Public	**200**	30		5,920			0		0		0			0	4		860			0
Public - Semi	**200**	168		33,640	12		2,320		0		0			0	43		8,680	49		9,840
General Business	**844**	109		91,743	82		68,955		0		0			0	30		24,982	142		119,848
School	**93**			0	1		56	17	1,590		0	77		7,133	15		1,349			0
Industrial	**474**	574		271,839			0		0		0			0	509		241,456	4		1,849
Rural Land	**200**	118		23,580			0		0		0	3		680	161		32,120	501		100,200
Moderate Density Residential	**(see indiv. water districts)**	58	450	26,235	18	450	7,965		0		0	299	450	134,640	485	642	311,434	313	450	140,715
Medium Density Residental	**968**	216		209,282			0		0	16	15,391	55		52,950	202		195,633	257		248,389
High Density Residential	**1101**			0			0		0		0			0			0			0
Local Business	**573**			0			0		0		0			0	16		8,882	29		16,789
TOTALS		2,193		**775,607**	182		**132,944**	22	**1,590**	16	**15,391**	704		**330,344**	2,232		**1,398,796**	1,839		**922,175**
MDD/ADD				2.71			2.73		4.75		4.51			2.72			2.70			2.71
Maximum Day Demand (MDD)				**2,103,462**			**362,310**		**7,550**		**69,410**			**898,934**			**3,775,582**			**2,498,170**
Total Residential ADD				259,097			7,965		0		15,391			188,270			539,187			489,304
Residential ADD/Total ADD				0.33			0.06		0.00		1.00			0.57			0.39			0.53
Per Capita ADD				75			75		75		75			75			75			75
Projected Built-out Population				3,455			106		0		205			2,510			7,189			6,524

GRAND TRAVERSE AREA WATE
ACREAGE & DEMANDS PER ZOI
Garfield Township
Wilcox/Black & Veatch
Revised: April 24, 2008

LAND USE PLAN TYPE	T 80G2B			85G2C			90G4A			100G4B			110G4C			120G6			ADD Township Totals
	Acreage	ADD/Acre	ADD for Area	Acreage	ADD/Acre	ADD for Area	Acreage	ADD/Acre	ADD for Area	Acreage	ADD/Acre	ADD for Area	Acreage	ADD/Acre	ADD for Area	Acreage	ADD/Acre	ADD for Area	
Parks/Recreation			0			0	8		0			0	108		0	95		0	0
Planned Commercial			0			0			0			0			0			0	264,460
Planned Development			0			0	303		289,747	392		374,360	304		290,129			0	1,807,911
Professional Office			0			0	54		30,942	37		21,201			0			0	93,915
Public			0			0			0			0			0			0	6,780
Public - Semi			0			0			0			0			0			0	54,480
General Business			0			0	21		17,724			0			0			0	323,252
School			0			0			0	50		4,659	59		5,441			0	20,228
Industrial			0			0	65		30,620	303		143,480			0			0	689,243
Rural Land	103		20,640	66		13,240	458		91,660	1,134		226,800	743		148,540	782		156,380	813,840
Moderate Density Residential	487	642	312,526	6	642	3,659	21	642	13,610	2,437	642	1,564,554	1,541	642	989,322	21	642	13,675	3,518,335
Medium Density Residental	6		5,808			0	38		36,590	126		122,258			0			0	886,301
High Density Residental			0			0	45		49,215	50		55,160			0			0	104,375
Local Business			0			0			0			0			0			0	25,670
TOTALS	637		**338,974**	72		**16,899**	1,039		**560,109**	4,529		**2,512,473**	2,754		**1,433,432**	898		**170,055**	**8,608,789**
MDD/ADD			2.72			4.48			2.72			2.68			2.70			2.72	2.55
Maximum Day Demand (MDD)			**922,356**			**75,772**			**1,521,517**			**6,723,861**			**3,868,045**			**463,316**	**21,956,190**
Total Residential ADD			338,974			16,899			141,861			1,913,612			1,137,862			170,055	**5,218,476**
Residential ADD/Total ADD			1.00			1.00			0.25			0.76			0.79			1.00	
Per Capita ADD			130			130			130			130			130			130	
Projected Built-out Population			2,607			130			1,091			14,720			8,753			1,308	**48,599**

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
ACREAGE & DEMANDS PER ZONE FOR EACH WATER DISTRICT
Elmwood Township
Wilcox/Black & Veatch
Revised: April 24, 2008

		WATER DISTRICTS											ADD
	General	30EL2			60EL3		110EL5		120EL1		150EL4		Township
ZONING	ADD/Acre	Acreage	ADD/Acre	ADD for Area	Acreage	ADD for Area	Acreage	ADD for Area	Acreage	ADD for Area	Acreage	ADD for Area	Totals
A-1 (Agricultural)	50	744		37,180		0	2,876	143,790	348	17,385	456	22,785	221,140
R-1 Single Family Residential	642	648	450	291,690	97	62,338	1,154	740,932	19	11,941	176	112,735	1,219,637
R-2 Two-Family Residential	968	251		242,581		0		0		0	120	116,063	358,644
R-3 Multi-Family Residential	1101	109		120,119	29	32,149	45	49,105		0		0	201,373
NC (Neighborhood Commercial)	844	2		1,688		0		0		0		0	1,688
C-1 General Business Commercial	844	9		7,934		0		0		0		0	7,934
C-2 General Business Commercial	1042	74		77,525		0		0		0		0	77,525
C-3 Light Commercial	573	35		19,998		0		0		0		0	19,998
C-4 Light Industrial	474	15		7,015		0		0		0		0	7,015
C/R Commercial/Resort (PUD Mixed Use)	968			0		0	429	414,885		0		0	414,885
SC-1 (Shoreline Commercial 1)	844	36		30,131		0		0		0		0	30,131
SC-2 (Shoreline Commercial 2)	450	13		5,805		0		0		0		0	5,805
TOTALS		1,936		**841,665**	126	**94,487**	4,503	**1,348,712**	366	**29,326**	751	**251,583**	**2,565,774**
MDD/ADD				2.71		3.15		2.70		4.27		2.72	2.68
Maximum Day Demand (MDD)				**2,281,466**		**297,231**		**3,641,789**		**125,206**		**685,019**	**6,863,684**
Total Residential ADD				691,570		94,487		933,827		29,326		251,583	**2,000,794**
Residential ADD/Total ADD				0.82		1.00		0.69		1.00		1.00	
Per Capita ADD				75		75		130		130		130	
Projected Built-out Population				9,221		1,260		7,183		226		1,935	**20,365**

GRAND TRAVERSE AREA WATER SYSTEMS MASTER PLANNING STUDY
ACREAGE & DEMANDS PER ZONE FOR EACH WATER DISTRICT
Peninsula Township
Wilcox/Black & Veatch
Revised: April 24, 2008

ZONING	General ADD/Acre	WATER DISTRICT 30P1 Acreage	30P1 ADD for Area	30P2 Acreage	30P2 ADD for Area	40P3 Acreage	40P3 ADD for Area	50P4 Acreage	50P4 ADD for Area	ADD Township Totals
A-1 Agricultural	**50**	33	1,665	113	5,635	648	32,415	56	2,775	42,490
R-1A Rural & Hillside	**450**	14	6,435	103	46,350	220	99,045	47	21,015	172,845
R-1B Coastal Zone	**642**	123	78,645	80	51,103	208	133,729		0	263,477
R-1C Suburban Residential	**642**	187	119,733	127	81,277	117	75,371	246	158,060	434,441
TOTALS		357	**206,478**	422	**184,365**	1,194	**340,559**	348	**181,850**	**913,253**
MDD/ADD			2.72		2.72		2.72		2.72	2.71
Maximum Day Demand (MDD)			**562,397**		**502,251**		**926,660**		**495,409**	**2,474,168**
Total Residential ADD			206,478		184,365		340,559		181,850	**913,253**
Residential ADD/Total ADD			1.00		1.00		1.00		1.00	
Per Capita ADD			75		75		130		130	
Projected Built-out Population			2,753		2,458		2,620		1,399	**9,230**

APPENDIX J- REFERENCES

References

East Bay Township

Water System Reliability Study, 2001
Water System Study & Report, 1997
East Bay Charter Twp Ordinance No. 109 (regulates extension of public water and wastewater services)
Spreadsheet: Existing problems & challenges, prospective threats and challenges, 2007
East Bay Township Comprehensive Plan, 1999
East Bay Township Zone Districts (map), 2003

Elmwood Township

Water Supply Contract Between the Charter Township of Elmwood and The City of Traverse City, 2003
Timberlee Well and Pump Information, Gourdie-Fraser, date?
Basis of Design, Timberlee Water System, 8" production well, Gourdie-Fraser, 2002

Garfield Township

Charter Township of Garfield, Water System Reliability Study, gfa, 2002
Water Supply Contract Between the Charter Township of Garfield and the City of Traverse City, 2003

Peninsula Township

Preliminary Engineering Study for Water & Sewer System Extension to Center & McKinley Roads, gfa 1998
Water System Study and Report, Peninsula Township, gfa, 1997
Pen. Twp Drinking Water Revolving Fund Project Plan, 2007
Water Supply Contract Between the Township of Peninsula and the City of Traverse City, 2003
Peninsula Township Master Plan, 2004
Peninsula Township Master Plan Maps on CD 2007
Peninsula Township Master Plan Maps 2003
Station Design Confirmation (booster station serving Underwood Farms)
2004-2006 Annual Pumpage/Usage Reports - McKinley Rd. booster station
CD with Twp water map, water CADD data, 06 pumping data, Project Plan DWRF
Stauder, Barch & Assoc. Water System Develop Financing Letter - has projected number of users

Traverse City

City of Traverse City Water System Master Plan, McNamee, Porter & Seeley, 1999
Traverse City Water Supply Study, Wolverine?, 1988
Water Consumption Study for Traverse City, City Engineer, 1976
City of Traverse City Water Treatment Plant Expansion Study, Tetra Tech, 2003
Source Water Assessment Report for the Traverse City Water Supply, USGS, MDEQ, 2002
Traverse City Water Treatment Plant Information pages
Spreadsheet: Existing problems & challenges, prospective threats and challenges, 2007
2007 Sanitary Survey, Water Supply Review Form
2000 Sanitary Survey
Fire Insurance Grading Classification, 1994
Fire Insurance Rating Classification, 1981
Traverse City - City Plan, 2002
Downtown Market Analysis for DDA of TC, Economics Research Assoc, 2007
Report on Severn Trent Pipeline Services Master Meter Test, TC Treatment Plant, 2004
WSSN 6640 Coagulation Parameters, 2-97, 5-98, 3-98, 1-05

CD with City of TC Monthly Operation Reports, Chemical, 97-06
Wayne Hill Reservoir Inspection, Dixon, January 2006
Wayne Hill Reservoir Inspection, Dixon, June 2002

Blair Township
Well and Tank Siting Report; To Serve as Water Reliability Study for Blair Township, Gosling Czubak, 2006
Master Water System Plan, Wade Trim, 1995
Blair Township Master Plan, 1995 (?)

APPENDIX K- RECOMMENDED ENGINEERING STANDARDS

Recommended Engineering Standards

Engineering standards are recommended for the sole purpose of facilitating future coordination between systems and master planning efforts. Many of these practices are already being used to some extent making implementation more practical.

Mapping

All existing maps of the Study Area public water systems have been prepared using the software program AutoCAD available through Autodesk, Inc. For now, it is recommended that the most recent version of this software be used. It is also recommended that the water system maps be updated after each water system construction project. Water system maps should be maintained in State Plane Coordinates to match those used by the County and City GIS departments. Continuing integration of water system information into the respective GIS systems is highly recommended.

Modeling

All existing models of the Study Area public water system have been prepared using the software program WaterCAD formerly available through Haestad Methods but now sold by Bentley Systems, Incorporated. For now, it is recommended that the most recent version of this software be used. It is also recommended that design of any significant projects be verified by modeling with updates to the model after the project has been constructed. The models should be based on the coordinates used for the water systems maps. Integration of the water systems models with the GIS systems is recommended such that meter level demand information can be spatially loaded into the models.

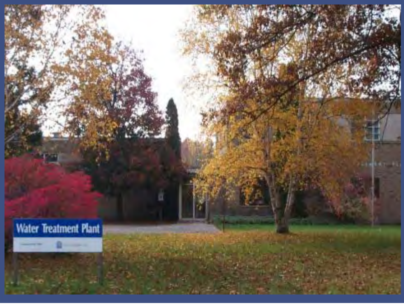
Model Calibration

An excellent reference for computer model calibration is the American Water Works Association Manual M32 entitled *Computer Modeling of Water Distribution Systems,* 2nd Edition, Copyright 2005, ISBN 1-58321-323-6.

Elevations

As the systems adopt a standard set of pressure zones and the systems become better integrated it will be important that design elevations be rather accurate. This is especially true for water storage tanks, PRVs, booster stations, etc. In addition, all designs should be based on a common elevation datum.

APPENDIX L- WATER SYSTEM MODELING



Grand Traverse Area Water Systems Master Plan
Appendix L

Submitted to the
City of Traverse City

Submitted on
February 5, 2010

Submitted by
Wilcox Professional Services, LLC
with Black & Veatch Corporation

I. BACKGROUND AND APPROACH

As part of the Grand Traverse Area Water Systems Master Planning effort a hydraulic model of the various distribution systems, combined into one, was needed to identify existing system deficiencies and plan for future improvements. Existing computer models were obtained from Gourdie-Fraser for East Bay Township, Elmwood Township, Garfield Township and Peninsula Township. The City of Traverse City provided the computer model of their system.

The City hired the Wilcox/Black&Veatch team to update the East Bay Township model to incorporate water system improvements that have taken place over the past few years and to build a model for Blair Township from scratch. Once each of the models was operational as a stand-alone model all of the models were combined into one model that covered all of these systems, some of which are connected to each other. The initial focus was to prepare an existing conditions model for the 2006 maximum day demand (MDD) and then for fire flows coincident with the 2006 maximum day demand.

Once the combined existing conditions model was functioning properly a new model was created to model the Near-term Plan proposed conditions on the basis of both Year 2037 maximum day demands and then for fire flows coincident with maximum day demands. The Near-term Recommended Improvements are improvements that are recommended to be made over the next ten years that will be designed based on projected Year 2037 demands. The Near-term Plan has been developed with the purpose of meeting goals that are briefly re-iterated here:

- Improve systems' reliability and resiliency
- Improve water quality
- Reduce all costs
- Prepare for emergencies
- Position the water systems to accommodate growth as necessary and to meet regulatory capacity requirements

Implementation of the Near-term Plan will position the water systems to meet future challenges while providing high quality water reliably and efficiently. This plan has been developed only for this Study's Level One entities (East Bay, Elmwood, Garfield and Peninsula Townships and the City of Traverse City). For Blair Township, a Level Two entity, conceptual Ultimate Build-out system configuration is suggested in Section VI.B.6.0 but without reference to required capacities or a schedule for implementation. However, the Blair Township system was included in the Near-term Plan computer model for the purpose of demonstrating the feasibility of an emergency connection between the Blair

Township and Garfield Township systems. No other improvements or future demands were included in the Blair Township portion of the model.

Because the models were developed as a basic planning tool, further calibration of the models that were received from Gourdie-Fraser and the City was beyond the scope of this project. The modeling effort focused on improvements required for main transmission lines throughout the region. Smaller pipes on a neighborhood level were not evaluated to the same degree.

This Appendix provides information about modeling methodology, issues discovered during the modeling, deficiencies noted in the systems and areas of low fire flows. As a measure of system hydraulic efficiency the average increase in available fire flows for the proposed conditions model is also presented. In addition, water system maps of available fire flow contours are presented in Figures Append L1 (existing conditions map) and Append L2 (proposed conditions map). Finally, a summary of approximate quantities of improvements is presented at the end of this Appendix.

II. MODELING METHODOLOGY

a. Software

Wilcox used the Bentley Systems, Incorporated WaterCAD V8 XM modeling software with a build number of 08.09.400.34 dated October 24, 2007. WaterCAD provides a graphical interface for layout of pipes, junctions, tanks, pumps, etc.; it can model steady-state or extended period simulations; perform fire flow analyses; and provide a variety of output options such as tables, maps or graphs.

b. Nomenclature

After all of the models were joined together, the various elements of the models (pipes, junctions, pumps, tanks, etc.) were re-named with the following nomenclature:

P-GP005, where:

- P= Type of Element (pipe)
- G= Entity (Garfield Township)
- P= Proposed (not used for an existing element)
- 005= Unique Element Number

The entity abbreviations are as follows:

- B-Blair Twp.
- E-East Bay Twp.
- EL-Elmwood Twp.
- ET-Elmwood Twp., Timberlee
- G-Garfield
- P-Peninsula
- T-Traverse City

c. Corrections to Existing Models

Corrections were made to the existing system models provided to Wilcox/Black & Veatch as they were discovered during the modeling process.

d. Other Modeling Considerations

Hydropneumatic Tanks

Some areas of the existing systems are served by pumping facilities that do not have storage tanks downstream but have hydropneumatic tanks meant to stabilize downstream pressure and reduce pump cycling. The decision was made to not model the existing hydropneumatic tanks. The modeling was carried out under a steady-state condition not considering operational variations over time. If modeled, the initial hydraulic grade line of the hydropneumatic tank would provide the operating point of the pump on its curve. If the demand is much larger than the pump supplies at that TDH (as would be quite likely during fire flows) then the hydropneumatic tank would be seen as supplying the flow to make up the difference. In reality, the pump would have moved quickly to the right on its curve to supply the demand but the downstream pressure would have dropped accordingly. Modeling the systems without the hydropneumatic tanks matches this reality better.

Hazen-Williams Friction Factors “C”

The City should investigate why such low C values have been used in the past for some areas of the system such as Cass Street and Veteran’s Drive north of South Airport Road. There was an inconsistency between what the City and the Garfield Township models had for C values for the water main along Cass Street. The greater value of 80 used (from the City model). All proposed pipe was modeled as ductile iron pipe with a C value of 130.

Reduction of Dead-end Branches

Some skeletonization of dead-end branches was undertaken to simplify the model and improve the overall generation of available fire flow contours for the purpose of evaluating main-line pipes. The WaterCAD routine for skeletonization was undertaken for removal of up to 2 pipes at the end of a dead-end branch for pipes less than 8 inch diameter and less than 200 feet long. This reduced the number of pipes in the model from 2585 to 2489. The demands from the deleted branches were moved to the end of the pipe where the junction remained.

e. Fire Flow Analysis

For systems this size, fire flows in conjunction with maximum day demand have the greatest distribution system demands. Therefore, a distribution system is judged by its ability to provide reasonable fire flows during maximum day demand. For that reason, available fire flows were determined for each junction within the distribution system model (while still maintaining appropriate pressures within the system) for both existing system conditions and with proposed improvements in place. From these computations, WaterCAD is able to generate available fire flow contours. The upper limit for fire flow computations was set within the WaterCAD model at 6,000 gpm. Therefore, it should be kept in mind when reviewing available fire flow contours that no contours above 5,000 gpm are shown.

Design fire flow goals, presented in Appendix F, were developed using criteria established by the Insurance Services Office (ISO) applied to development and building characteristics common for the various land use types in the various water districts. These were used as a guideline to determine the adequacy of the distribution system based on the available fire flow contours resulting from the modeling.

It should be noted that available fire flow as calculated by the model and illustrated by the contours on the enclosed maps will not match tested fire flow from an individual hydrant. Flow from an individual hydrant is highly dependent on the size of the hydrant lead pipe and the makeup/model of hydrant tested. In some areas of the distribution systems there may be a scarcity of hydrants. "Available fire flow" in an area assumes two or more hydrants needed to take advantage of the flow available. In addition, available fire flow contours should only be considered valid where the contours intersect a pipe (however, in the general vicinity of the pipe the contour gives an idea of possible fire flows that are available with an appropriate extension of the system).

III. EXISTING CONDITIONS MODEL

a. Demands

An evaluation was undertaken of the largest users in the systems managed by the Grand Traverse County DPW. These average day demands (ADD) were multiplied by 4.0 to obtain an approximate maximum day demand (MDD). Only 4 users had MDD greater than 55 gpm (Munson Support Services, Grand Traverse Mall, Great Wolf Lodge and Woodcreek Associates). The largest, Woodcreek, was 150 gpm. The largest user for the City had an ADD of 40,617 gallons per day which with a multiplier of 4.0 works out to a MDD of 113 gpm. These demands are not significant when compared to fire flows. Therefore, MDD for each water district was simply spread within the district and no attempt was made to assign demands based on the largest users.

The MDDs that were used are listed in the following table:

Exist. Water District	Description	ADD (MGD)	MDD (MGD)	MDD (GPM)	No. of Junctions	Demand per Junction (GPM)
	EAST BAY TOWNSHIP					
EB1	Cherry Ridge District Minus B#2	0.532	1.342	932	149	6.25
EB2	Holiday Hills District	0.168	0.489	340	58	5.85
EB3	E. Bay Booster #2 (Windmill Farms)	0.021	0.063	44	4	10.94
	ELMWOOD TOWNSHIP					
EL1	Timberlee District	0.053	0.168	117	22	5.30
EL2	Greilickville District-Master Meter	0.017	0.045	31	19	1.66
	GARFIELD TOWNSHIP					
G1	Master Meters - B#2 - B#1 + TC4 -B#4	0.220	0.360	250	109	2.29
G2	Booster #2 minus B#7	0.402	1.124	781	123	6.35
G3	Booster #7 (Traditions) (B#7 Served by B#2)	0.008	0.029	20	24	0.84
G4A	Booster #1 minus B#3 minus TC4	0.700	1.400	972	272	3.57
G4B	Booster #3 minus Booster #5	0.371	1.370	951	195	4.88
G4C	Booster #5 (Herkner Rd) (B#5 Served by B#1 and B#3)	0.016	0.057	40	61	0.65
G5A	Booster #4 minus B#6	0.047	0.145	101	22	4.58
G5B	Booster #6 (Greyhawk) (B#6 Served by B#4)	0.011	0.065	45	13	3.47
	PENINSULA TOWNSHIP					
P1	Total of Master Meters 2-4	0.041	0.126	88	64	1.37
P2	Master Meter #1 minus Peninsula B#1 (P3)	0.020	0.011	8	36	0.21
P3	Peninsula Booster #1 (McKinley Rd)	0.057	0.282	196	66	2.97
	TRAVERSE CITY					
TC1 & TC2	Traverse City (TC) minus TC3 & TC4	3.416	9.118	6,332	534	11.86
TC3	Huron Hills Booster minus Peninsula P1	0.076	0.241	167	17	9.83
TC4	Traverse City Area Served from Garfield G4A	0.110	0.469	326	17	19.16

b. Pump Selection

An attempt was made to match the MDD within a particular water district with a similar pump capacity. Therefore, pumps were turned on or off in the model as necessary to accomplish this. Additional pumps were turned on for the fire flow computations.

c. Results of Modeling Maximum Day Demand

No results of great significance came from the MDD model run. As is already known, an area that experiences low pressures (less than 20 psi) is the suction side of the Lafranier Booster Station. In East Bay Township it was found that the 8 inch pipe from wells 6 and 7 towards the iron removal plant has significant friction losses. If this is corrected in the future, some study should be given to adjusting the pump impellers or restricting flow rate through VFD settings. This change will result in energy savings. The same issue was observed for the 6 inch discharge pipe from East Bay Township Wells 1 and 2.

d. Existing Available Fire Flow Results

Once the MDD model was working effectively, a fire flow analysis was run for the existing conditions. This analysis computed available fire flow demands for each junction within the system. Figure Append L1 is an available fire flow contour map for the existing conditions system. When compared with the fire flow guidance presented in Appendix F, there are several areas where the distribution system does not provide adequate fire flow capacity. This is summarized as follows:

- The Morgan Farms and the northwest area of Incochee Woods
- At the north end of the Elmwood Township system along West Bay
- Along Munson Avenue in East Bay Township. This area was seriously deficient with an available fire flow of about 1,000 gpm when it should be between 2,500 and 3,500 gpm.
- Along South Airport Road in East Bay Township
- At the north end of Holiday Hills District in East Bay Township
- The area served by the Grayhawk Booster Station

The Timberlee system was not included in the fire flow analysis because there are no hydrants built into the system and the system was not designed to deliver fire flows. The Near-term Plan addresses many of the noted fire flow deficiencies as indicated in the following sections.

IV. PROPOSED CONDITIONS MODEL

a. Model Building

The following is a listing of notes from the model building process for the Near-term model:

- Added improvements represented in Figure VI.B.4. Made minor adjustments to Figure VI.B.4 where necessary as the modeling process unfolded.
- Several emergency connections were added at the border between entities where there is currently no connection (East Bay Township/Traverse City, East Bay Township/Garfield Township, Garfield Township/Blair Township). These connections were set up to automatically transfer water in an emergency situation. This was accomplished by adding normally closed PRVs for both flow directions. These were set to open when the downstream hydraulic grade line is 25 feet below the normal pressure.
- The Hazen Williams C value for the 16 inch pipe along Cass Road north of South Airport Road and the 20 inch pipe along South Airport between Cass and Barlow was changed to 130 assuming that any issues pertaining to flow restrictions in these pipes will be addressed. Also the size of pipe for South Airport Road under the Boardman River was corrected to 14 inch.
- Normally closed PRVs were added to pipes crossing pressure zone boundaries that are also water district boundaries.
- PRVs were added to pipes crossing the remaining pressure zone boundaries.
- The initial water level settings in the water storage tanks were set to 5 feet below the nominal pressure district hydraulic grade line.
- Changed Pump Curve for East Bay Well pump 1 to single design point, 150 gpm at 270' head to reflect rated well capacity.
- Changed Pump Curve for East Bay Well pump 2 to single design point, 160 gpm at 270' head to reflect rated well capacity.
- A new, higher tank was added to replace the Barlow Tank (a simplification of the potential dump and pump scheme indicated in the Near-term Plan).
- Added well capacity for the Holiday Hills/English Woods area (605 gpm at 260' TDH).
- Wayne Hill has a high crown that was missed in our earlier pressure zone maps. The area must be Z4 instead of Z3. It would take over 3,200' of water main to bring in Z4 water by gravity. The decision was made to leave the Wayne Hill booster station in place but to somewhat reconfigure piping. The Near-term plan was reconfigured in the Wayne Hill Area.
- PRVs upstream of 30G3 were set to 745, normally closed. This area should be served directly from the City. Master meters at TC/Garfield boundary in Pressure Zone 1 at Silver Lake Road and US 31.

b. Demands

The Near-term model used a design year 2037 MDD as listed in the following table:

Water District	Sub-District	2037 MDD (MGD)	2037 MDD (GPM)	Number of Junctions	Demand per Junction (GPM)
20	EB1-N	1.522	1,057	77	13.73
20	EB1-S	0.705	490	56	8.74
10	EB2	1.287	894	52	17.18
120	EL1	0.020	14	N/A	
30	EL2	0.526	365	19	19.22
60	EL3	0.041	28	1	28.18
150	EL4	0.106	74	N/A	
110	EL5	0.319	222	20	11.08
30	G1	1.431	993	138	7.20
70	G2A-E	1.783	1,238	109	11.36
70	G2A-W	1.914	1,329	123	10.81
80	G2B	0.292	202	27	7.50
85	G2C	0.020	14	N/A	
30	G3	0.322	224	29	7.71
90	G4A	0.576	400	18	22.24
100	G4B	2.462	1,710	98	17.44
110	G4C	1.411	980	151	6.49
60	G5	0.460	320	40	7.99
120	G6	0.176	122	23	5.31
30	G7	0.004	3	N/A	
30	G8	0.020	14	N/A	
30	P1	0.204	142	22	6.45
30	P2	0.185	129	12	10.71
40	P3	0.359	250	62	4.03
50	P4	0.217	151	40	3.77
30	TC1	9.416	6,539	428	15.28
60	TC2	0.104	72	13	5.54
40	TC3	0.178	124	13	9.50
70	TC4	0.269	187	16	11.68
60	TC5	0.589	409	56	7.31

As mentioned earlier, the same demands as were used in the existing conditions model were used for the Blair Township portion of the model.

c. Pump Selection

New pumps were defined as necessary for existing (or new) booster stations. In many cases, existing pumps can be used even when there was a change in total dynamic head (TDH) requirement but the maximum frequency setting in the VFDs may need to be diminished to prevent the pump motors from being overloaded. Comparable to the existing conditions model, an attempt was made to match the MDD within a particular water district with a similar pump capacity. Therefore, pumps were turned on or off in the model as necessary to accomplish this. Additional pumps were turned on for the fire flow computations. Occasionally in the model one new pump definition represents the firm capacity of the booster station instead of multiple pumps with the largest pump turned off.

d. Results of Modeling Maximum Day Demand

A review of friction losses in pipes during the MDD model run resulted in changes being made to several pipes within the Timberlee system from 6 inches to 8 inches. One area of low pressure (less than 20 psi) was observed on the suction side of the Cherrywood Booster Station (relocated from McKinley Road) in Peninsula Township. This is a result of the high elevation of the booster station.

e. Available Fire Flow Results

Even with a significant increase in the underlying MDD, the Near-term model provided a significant improvement in available fire flows. On a junction by junction comparison of 1,767 junctions, the proposed conditions model provided an average of 999 gpm more fire flow per junction than the existing conditions model. Figure Append L2 is an available fire flow contour map for the Near-term Plan system. When compared with the fire flow guidance presented in Appendix F, there are still a few areas where the distribution system does not provide adequate fire flow capacity. These are summarized as follows:

- At the north end of the Elmwood Township system (near West Bay). This is caused by the limitations of an existing 12 inch water main for a significant distance along M-22. This will have to be rectified by replacement of some of this 12 inch water main (or additional parallel pipe) or by transmission service from another direction.
- One development at the north end of the Holiday Hills district in East Bay Township (higher elevations only).
- At the north end of the Peninsula Township water system. This is caused by the limitations existing 12 inch and 8 inch water main for a significant distance along Center Drive. This will have to be rectified by replacement of some of the existing water main.

f. Recommended Further Work

As detailed plans are established for specific projects, further verification can be undertaken for proposed pipe diameters. The diameters of proposed pipe within the model work well for fire flows coincident with the Year 2037 MDD. However, with the Ultimate Build-out Demands in mind, some consideration may be given to up-sizing some of the main transmission pipe.

g. Quantification of Improvements

To facilitate further planning, basic quantities of improvements were derived from the proposed conditions computer model. These are summarized in the following table.

	East Bay Township	Elmwood Township	Garfield Township	Peninsula Township	City of Traverse City	Blair Township
New Water Main Lengths (ft.)						
6"		1,530			1,220	
8"		9,972	2,091	652	531	
10"	1,075		1,638			
12"	2,525	5,117	34,589		5,862	
16"		9,212	44,972	4,284	5,050	
20"	26,926		32,590		2,821	
24"			2,534		24,204	
New Pressure Reducing Valves	9	4	21	7	8	1
New Ground Storage Tanks						
0.3 MG		1				
0.6 MG			2	1		
0.75 MG	1					
1.3 MG			1			
1.4 MG			1			
1.5 MG	1				1	
1.6 MG			1			
4.0 MG					1	
Relocated Storage Tank			1			
New Booster Station			1			
Replace Pump/Motor or Impellers			5			
Relocate Booster Station			1			
New Wells	2					

These quantities are conceptual in nature and are allocated to a specific entity based on their location. However, some cost sharing may be indicated where the improvements are made for the benefit of more than one entity. In addition to these quantities some consideration should be given to the required costs of abandonment, removal or upgrading of existing infrastructure as necessary for undertaking these improvements.

V. SUMMARY AND CONCLUSIONS

The computer modeling demonstrates that the Near-term Plan, as developed over the course of this study, has great promise for meeting the important goals that were laid out early on in the project. A uniform set of pressure zones throughout the region, in conjunction with well planned improvements and system extensions, will be proven in the long term to increase reliability, efficiently move water throughout the systems, provide improved fire flows and be more simple to operate. In addition, they will facilitate connections between systems that are not now connected that may be of vital importance in the case of an emergency. The quantities derived from the proposed conditions model demonstrates that these improvements can be achieved at a modest cost when implemented in phases over the next 10 years and will place the area's water systems on a solid operational basis.

Wilcox

APPENDIX M- RECOMMENDED FACILITIES AT CONNECTIONS BETWEEN WATER SYSTEMS

Recommended Facilities at Connections Between Water Systems

A standard set of equipment should be used where connections between systems are made. These would be standards that are in place for emergency connections or for everyday water service. Many of these practices are already being used to some extent making implementation more practical.

Metering

Meters should be provided at connections between systems. Where two-way flow is not a problem, two-way meters should be provided. Compound Meter arrangements should be provided if necessary to handle the entire range of normal flows but also peak demand and fire flows as well.

Instrumentation

An ideal arrangement would be to monitor flow rate, totalized flow and pressures via telemetry to be able to monitor flows throughout the systems. This would facilitate daily readings of master meters at consistent times to provide data for future planning studies.

Pumping/Pressure Reducing

Adoption of a standardized system of pressure districts should mean that pumping or pressure reducing facilities are not required at connections between adjacent systems.

Minimum Connecting Pipe Sizes

Transmission lines to connect systems should be adequately sized to serve maximum day demands within the respective water districts and their downstream districts based on demands 30 years or more into the future without high friction losses in the pipe. Small diameter lines can be used to by-pass valves at emergency connections to prevent dead-end conditions and keep water fresh within the lines.

Wilcox