Town of Southampton
Water System Master Plan

Completed for

Southampton Water Department

8 Fomer Road
Southampton, MA 01073

Completed by

Comprehensive Environmental Inc.

225 Cedar Hill Street
Marlborough, MA 01752

December 29, 2016

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December 29, 2016

Board of Water Commissioners
Southampton Water Department
8 Fomer Road
Southampton, MA 01073

RE: WATER SYSTEM MASTER PLAN

Dear Board of Water Commissioners:

Comprehensive Environmental Inc. (CEI) is pleased to provide this final report for the water system master plan for the Southampton Water Department (SWD), in accordance with our agreement dated October 14, 2015 (PO dated November 10, 2015).

The final report includes an analyses of system demand, supply, treatment, storage and distribution along with a prioritized capital improvement plan and incorporates comments/discussions from our meetings throughout the project.

We look forward to continuing to work with the SWD on future projects. Please contact me if you have any questions or require any additional information at 508-281-5177.

Sincerely,
COMPREHENSIVE ENVIRONMENTAL INC.

Michael P. Ohl, P.E.
Principal, Project Manager

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Appendices

Executive Summary

The Southampton Water Department (SWD) acting through the SWD Water Commissioners hired Comprehensive Environmental Inc. (CEI) to develop this Water System Master Plan for the Town of Southampton. The plan was developed to identify system deficiencies and establish an implementation plan for any necessary water system improvements. This plan included (1) a Demand Projection phase involving review of historical demands and projection of future water demands based on historical use and population trends; (2) an Infrastructure Evaluation phase providing a comprehensive review and analysis of the Southampton water system to determine its capacity to satisfy a myriad of challenges; and (3) an Infrastructure Prioritization phase developing a plan to address identified deficiencies and prepare for future needs.

The results of the infrastructure evaluation highlighted a supply deficiency as the most critical issue. Additional supply is needed to supplement SWD's existing Glendale Wells #1 and #2 so as to meet SWD's maximum day demands, and to have an approved backup water source in the event SWD's existing Glendale Wells are temporarily out of service. SWD has options for additional sources of supply including a new well (third Glendale Well or well at another site), treatment of raw water from Holyoke Water Works (HWW), and interconnections with potable water from Easthampton, Holyoke, or Westfield.

The results of the analysis indicated that construction of an improved Interconnection with Easthampton (including booster pumping station) should be a first priority. Additional findings showed that Glendale Well 02G has reduced pumping capacity and work should be implemented to regain the full capacity of this well. Subsequent to completing the improved Easthampton Interconnection and regaining full use of existing Glendale Wells # 1 and #2, future possibilities for further supply improvements include a new Glendale Well 03G as originally proposed by SWD, a new Well at another site, or use of the HWW Raw Water Supply.

The storage analysis showed that additional storage is needed to meet the future storage needs and to provide more time to make repairs to the Glendale Well and Pump Station should the need arise. Additional storage located on the opposite end of the system would improve system redundancy and residual pressures in the southern end of the system. The Easthampton Interconnection may alleviate some or all of the storage needs, however, this interconnection is located on the northern end of the system which is not likely to improve residual pressure in the southern end of the system due to hydraulic limitations in the distribution system. Therefore, the SWD may still benefit from construction of a storage tank 0.5 to 1.0 MG capacity in the southern end of the system. The advantages and disadvantages of this should be re-evaluated after completion of the Easthampton Interconnection.

A computer model of the distribution system was developed to evaluate the system hydraulics. Some sections of the system have old 6-inch diameter cast iron water main that is severely tuberculated. System modifications (pipe replacement and/or loops) are needed to meet ISO fire flow requirements at select areas throughout the system.

A capital improvement program was developed through this project. The needed improvements were rated in terms of criticality according to the following factors:

- Project helps meet compliance with current/future regulation,
- Critical system component,
- Mitigates existing/future supply deficiency,
- Helps resolve fire flow deficiency,
- Addresses aging infrastructure,

- Addresses low pressure issues,
- Reoccurring maintenance item frequency.

Order-of-Magnitude Implementation costs were estimated and an initial phased schedule of improvements was developed, for integration with the SWD's overall Water Capital Improvements Debt Service Plan. **Section 6.0** provides a summary of the Capital Improvement Program including prioritization schedule over the 20 year planning period.

As a result of the recommendations for additional supply from this study, the SWD Water Commissioners initiated and completed development of a Memorandum of Understanding (MOU) with the Easthampton Department of Public Works for use of Easthampton potable water to serve as SWD's approved backup water supply. A copy of the signed MOU is attached in Appendix D of this report.

1.0 Introduction

The Town of Southampton retained Comprehensive Environmental Inc. (CEI) to complete a Water System Master Plan. This project was completed in response to a requirement by the Massachusetts Department of Environmental Protection (MassDEP) through a Sanitary Survey conducted in 2014 for the Town of Southampton to develop a Water System Master Plan that identifies system deficiencies and that establishes an implementation plan for any necessary water system improvements.

MassDEP has specifically identified the following issues that were considered in our evaluation and development of the Water System Master Plan.

- Ability to meet system demand under its current Water Management Act (WMA) Permit.
- Need to develop additional sources of supply.
- Need for additional storage.

1.1 Water System Overview

The Southampton Water Department supplies water to approximately 4,012 of the Town's residents. The 2015 average day demand was approximately 0.35 mgd and the maximum day demand was 0.72 mgd. The water system includes:

- One active groundwater supply well (Glendale Well 02G)
- One water storage tank (744,000 gallon capacity located off Wolcott Road)
- One emergency interconnection with the Easthampton Water System (hard piped and valved, but without any metering or booster pumping capabilities)
- One emergency interconnection with the Westfield Water System (hydrant to hydrant)
- Two inactive interconnections with the Holyoke Water Work's Raw Water Pipeline (Pequot Road interconnection and Gilbert Road interconnection)
- One inactive booster pump station (Gilbert Road interconnection with Holyoke Water Work's Raw Water Pipeline)

Figures A-1 and **A-2** in **Appendix A** show the water system with pipe diameters and labels including locations of the water supplies and water storage tanks.

1.2 Recent Projects

Some system improvements have recently been completed by the Southampton Water Department (SWD), including:

- Installation of a MassDEP Chapter 6 compliant sodium hypochlorite chemical feed system at the Glendale Well Pump Station.
- Dismantling of piping and appurtenances at the Gilbert Road and Pequot Road interconnection stations for physical separation of systems, since the Holyoke Water Works Raw Water Pipeline would require treatment if used by the Town.

1.3 Scope of Work

CEI's scope of work for this update was separated into three major phases: (1) Project Startup and Demand Projections, (2) Infrastructure Evaluation and Capacity Assessment and (3) Capital Improvement Prioritization.

The initial phase was critical to the success of the project, in terms of identifying and addressing the specific needs of the Town and establishing the demand projections which form the basis of determining supply source adequacy for current and future demand conditions.

Part of the initial phases included a meeting with Town staff to review the water system and its operation. CEI was already familiar with the Town's water system having completed the recent 2015 Drinking Water Infrastructure Needs Survey and Assessment (DWINSA) for the MassDEP. Historical data and information gained through staff interviews was used to complete this project.

The water demand analysis portion of the project is an important component and is needed to complete the supply evaluation. A system's water demands come from many different consumers including residential, commercial, industrial, agricultural and municipal. Water is also used at water system facilities and throughout the distribution system through flushing, fire fighting, street sweeping, flow testing and more. Additionally, some water will be lost due to unavoidable leaks and breaks. This task includes review of historical demands and estimation of projections of future water demands based on historical use and population trends.

Review of historical water demands included average day, maximum day, minimum day, and peak hour. Recognizing that the Town has distinct areas (residential, agricultural, and commercial/industrial), the demand projections accounted for anticipated varying growth/development rates. Historical water demand data was used to estimate existing "typical" demands. The historical demand data for each category was applied to the potential development projections to estimate future water demands. The future water demand estimates were used to determine if additional supply, storage, treatment or expansion of the distribution system will be needed.

Potential development projections considered previous reports such as the Southampton Master Plan (June 2013). Additionally, new information obtained through the Town was considered in order to establish the development projections, population projections and associated water demands.

The Infrastructure Evaluation and Capacity Assessment phase provides a comprehensive review and analysis of the Town's water system infrastructure to determine its capacity to satisfy a myriad of challenges. These challenges include current demands, future demands, operational limitations, regulatory impacts and water quality (source and distribution). Our evaluation identified potential improvements to address these challenges, recognizing that some challenges may have several solutions, each with advantages and disadvantages. These options are presented as applicable for consideration by the Town of Southampton. This phase included the following tasks:

- Supply/Demand Analysis
    - Comparison of available supply (safe yields, pumping capacities) with current/future demands,
    - Analysis of redundancy or backups (including interconnections with neighboring systems),
    - Completion of source facility audits,
    - Review of Water Management Act (WMA) permit requirements.
- Infrastructure Evaluation
    - Utilize results from hydraulic model prepared and run by others to:
        - Evaluate system pressures.
        - Evaluate hydraulic balancing.
        - Estimate available fire flows and compare with Insurance Services Office (ISO) data,
        - Simulate the effects of system improvements
        - Identify critical flow paths/restrictions to assist with prioritization of improvements.
    - Conduct facility audits of all major water system infrastructure.
    - Identify any deficiencies, needed improvements or repairs and estimate remaining service life of equipment at these facilities.
    - Analyze the ability of existing sources, treatment and storage facilities to meet current and future demands for a 20-year design horizon.
    - Conduct regulatory review of current and anticipated future regulations impacting the Town.

The Capital Improvement Prioritization phase included the following tasks, in order to develop a plan for the Town to develop identified deficiencies and prepare for future development. All of the information obtained in the Infrastructure Evaluation phase was compiled to complete a prioritization of needed infrastructure improvements, recognizing the need for prudent expenditure of available funds. The infrastructure prioritization will include assessment of the following:

- Critical system components in the system,
- Improvements intended to mitigate existing and future system deficiencies,
- Current and future regulations as pertaining to the water system.

Implementation costs (capital and recurring maintenance) were estimated and an initial phased schedule of improvements was developed.

This report includes recommendations to correct deficiencies and meet future needs, a prioritized list of recommended improvements and associated capital costs for these improvements budgeted over a 20 year period.

2.0 Existing System Description

The Southampton Water Department (SWD) was established to provide public water to portions of the Town of Southampton. Components of the early system, including cast iron water mains in the center of Town, are still in service today. The Town's primary source of supply is the Glendale Well 02G. The original Glendale Well 01G is located at Glendale Road and College Highway in the north end of Town and was installed in 1963. In 2002, the Glendale Well 02G was installed about 25 feet away from Well 01G. Due to decreasing capacity in recent years, Well 01G is rarely used. These wells are surrounded by 185 acres of protected land which is owned by the Town. Wells 01G and 02G draw water from the Barnes Aquifer which supplies a combined 21 million gallons of water per day (mgd) to Easthampton, Holyoke, Southampton and Westfield.

Currently the SWD has approximately 1493 service connections and supplies water to approximately 67% of Southampton residents, about 4,031 residents[1]. Average day demands for 2014 and 2015 were approximately 0.329 mgd and 0.348 mgd respectively. The maximum day demands for 2014 and 2015 were approximately 0.652 mgd and 0.720 mgd respectively.

The existing water system includes one active water supply well, one inactive water supply well, one water storage tank, one emergency interconnection with the Easthampton Water System, one emergency interconnection with the Westfield Water System, two inactive interconnections with the Holyoke Water Works (HWW) Raw Water Pipeline, and about 45 miles of water main ranging in size from 2-inch to 12-inch in diameter. The Southampton Water System is classified as a Distribution D-2 system. The system is not classified as a treatment system at this time. **Appendix A** includes maps of the water system (**Figures A-1** through **A-4**).

2.1 Water Supply

The Southampton Water System has one active groundwater supply well and one inactive groundwater supply well as listed in **Table 2-1**. The oldest source, Glendale Well 01G was constructed in 1963. The active source is Glendale Well 02G which was constructed in 2002.

The Glendale Wells are located off of Glendale Road and College Highway. Glendale Well 02G was constructed to increase the total capacity from these supplies to fully utilize the allowable daily maximum withdrawal rate of 0.792 mgd. This well is the primary source of water for the SWD and is relied upon heavily. The Glendale Well 01G is rarely used due to its low and decreasing capacity. In 2014 and 2015, the Glendale Well 02G produced approximately 100% and 91% of the total system supply, respectively, with the remainder obtained through interconnections. Well 02G operation is controlled by the water level in the water storage tank on Wolcott Road. Refer to **Section 2.6** for a description of system operations.

[1] 2014 Annual Statistical Report

Table 2-1. Water Supply Sources

Source	Glendale Well 01G (Well #1)	Glendale Well 02G (Well #2)
PWSID	1276000-01G	1276000-02G
Status	Inactive	Active
Location	Southampton	Southampton
Basin	Barnes Aquifer	Barnes Aquifer
Type	Gravel Packed	Gravel Packed
Date Installed	1963	2002
Approved Pump Rate	550 gpm	550 gpm
Actual Pump Rate	325 gpm	500 gpm
Safe Yield	0.792 mgd	0.792 mgd
Well Depth	140 ft	137 ft
Pump Setting Depth	105 ft	105 ft
Pump Type	Submersible	Submersible
Pump Motor Size	40 HP	75 HP
VFD	No	Yes

Water from the Glendale Well 02G (adjacent to the pump station) is piped into the pump station, discharges through the pump station lower floor for chemical addition and flow metering and then to the distribution system.

The pump station located at the Glendale Wells does not have a backup generator. The SWD has established relationships with the electrical utility to notify them of the critical nature of this supply and the need to restore power quickly to this site.

The SWD also has interconnections with Easthampton, Holyoke Water Works (HWW) and Westfield as described in **Section 2.5**.

The HWW interconnections are to the raw water supply. In 1953, an Act was issued authorizing the City of Holyoke to increase its water supply, through the taking of the waters of the southwesterly branch of the Manham River and lands to install the water transmission main. As part of this taking, the Town of Southampton was granted some water rights and required that the City provide the Town with Y-branches of at least 8-inch diameter and allow the Town to draw from the pipeline without expense to the Town. The Town is allowed to take an amount not exceeding 125 gpd per inhabitant or 625,000 gpd, up to 228 MGY. Any amount greater than this threshold would need to be paid for at a rate to be determined by the City and the Town.

2.2 Water Treatment

The SWD installed a sodium hypochlorite disinfection system at the Glendale Well in 2014. This disinfection system was installed in response to total coliform positive detections within the distribution system. The sodium hypochlorite feed system includes a metering pump, 55 gallon day tank, secondary containment, residual chlorine analyzer and safety interlocks. The SWD purchases sodium hypochlorite in drums and then transfers the solution (as delivered) to the day tank. The SWD does not stock sodium hypochlorite in large quantities due to its rapidly degrading nature.

The SWD also has the ability to activate two interconnections with the Holyoke Water Works (HWW) at Gilbert Road and Pequot Road. In the past, these interconnections required the use of sodium hypochlorite feed systems to disinfect the water before discharging to the distribution system. These facilities are equipped with chlorine contact systems. The contact systems at both stations consist of a 1,350-ft long 24-inch diameter water main at the Gilbert Road facility and 2,200-ft long 14-inch line diameter water main at the Pequot Road facility, to obtain the necessary disinfection contact time. Corrosion control was achieved using bags of soda ash, mixing tanks, and chemical feed pumps. At this time, all of this equipment has been removed from these facilities, as the Town does not actively use the HWW interconnections and the MassDEP required a physical separation from the HWW Raw Water Pipeline.

Disinfection systems are not needed at the emergency interconnection with the Easthampton Water System or the Westfield Water System.

2.3 Storage and Booster Pumping

The SWD has one storage tank located on Wolcott Road in the northeast part of Town. This tank is a 744,000 gallon bolted, glass-fused steel storage tank and was installed in 1991. The storage tank is 81 feet in diameter and 19 feet tall. The storage tank has a water level sensor which controls the Glendale Well 02G pump. In summertime, the well pump is signaled to start when the tank level drops below 12.6 feet and stop pumping when it reaches 15 feet. In the winter, the well pump is signaled to start when the tank level reaches 10 feet and stop when the tank level is at 15 feet. This seasonal adjustment is done to minimize ice formation in the tank.

More information about the tank is presented in **Table 2-2**.

Table 2-2. Water Storage Tank Characteristics

Characteristic	Wolcott Road Tank
Date Constructed	1991
Manufacturer	Statewide Aquastore Inc.
Type	Bolted, Glass-Fused Steel
Capacity	744,000 gallon
Diameter	81 feet
Height	19 feet
Base Elevation	438.2 feet Elev.
Overflow Elevation	457.2 feet Elev.
Typical Operating Levels	10.0-15.0 feet
Mixing	None
Altitude Valve	None

An exterior and interior Water Storage Tank Inspection was completed in May 2011 by Statewide Aquastore Inc. The information about their findings is summarized in **Section 2.6**.

In the past there was a booster pump located at the Gilbert Road interconnection with 42-inch HWW transmission main. The booster pump was used at the interconnection to increase the pressure from 100 psi to 140 psi to overcome the head in the SWD system. The booster pump station was installed in 1975; the pumping equipment included two 10 HP motors with centrifugal pumps rated at 135 gpm. This equipment has been removed from this facility.

2.4 Distribution

The Glendale Well feeds the distribution system from the northern end of Town. The static pressures throughout the system range from approximately 40 pounds per square inch (psi) to 120 psi. The distribution system consists of the original cast-iron pipe from 1932, asbestos-cement pipe from 1960s and 1970s, and PVC pipe installed between 1991 and 1997. New water mains installed are also PVC pipe, which is now the Town's standard pipe material. The water system is 100% metered.

2.5 Existing Interconnections

The SWD has interconnections with the neighboring Holyoke Water Works, Easthampton Water Department, and Westfield Water Department.

Currently the SWD does not supply water to any neighboring towns. The SWD's sole water supply well is supplemented during periods of high demand with water from Easthampton. The hard piped interconnection with the Easthampton Water Department is located at the intersection of Cook Road and Line Street. The hydraulic grade of SWD's water system is higher than that of Easthampton, therefore this interconnection cannot supply the entire system without booster pumping. On occasion, during periods of high demand, water from Easthampton is used to supply a small number of services in the Town. E

The SWD also has the ability to activate two interconnections with the Holyoke Water Works (HWW) at Gilbert Road and Pequot Road. However, this activation would require installation of pipe and appurtenances as well as treatment systems. These interconnections draw unfinished water from the HWW Raw Water Pipeline which is connected to the Tighe-Carmody (Manhan) Reservoir. Both of these connections would require flow pacing, turbidimeters and chlorine analyzers with data recording and alarms to meet Surface Water Treatment Rule (310 CMR 22.20A(2)a) with additional treatment possibly required if the HWW's filtration waiver is not extended to the SWD. Therefore these connections cannot be used without installing the necessary equipment.

SWD has one other emergency interconnections with Westfield's water system, although this interconnection would be hydrant to hydrant.

2.6 Existing System Operations

The operation of the Glendale Well 02G is controlled by the water level in the Wolcott Road storage tank. The well pump is activated when the water level drops below 10 feet in the winter and 12.6 feet in the summer and stops when the water level reaches 15 feet. The storage tank is usually maintained between 10 feet to 15 feet. Historically, the Glendale Well 02G is the only one operated; the original Glendale Well 01G is no longer in use due to its decreasing capacity.

The SWD system may also be operated manually. If needed, when the water level in the Wolcott Road storage tank is low, the operators can turn the well pump off until the water level recovers. Often times the operators override the automated system in an effort to maintain adequate residual chlorine levels in the water coming from the Glendale Well and into the distribution system.

When needed during periods of high demand, the SWD historically purchases water from Easthampton. This interconnection is not metered and can only supply water to a small area of the SWD system, due to hydraulics. The SWD manually isolates the area of the system serviceable by the Easthampton water system without booster pumping and opens the interconnection. SWD operators read the customer meters in this service area at the start of this period. After the period of high demand passes, the interconnection is closed and the service area is opened to the SWD system. At this time the SWD operators again read the customer meters in this service area. This provides the SWD with the volume of water purchased from Easthampton, for billing and water accountability purposes.

3.0 Water Demand Forecast

This Water System Master Plan establishes demand projections which form the basis of determining infrastructure adequacy for current and future demand conditions. The water demand analysis portion of this project is an important component and was needed to complete the supply, treatment, and storage analyses. A system's water demands come from many different consumers including residential, commercial, industrial, agricultural, and municipal. Water is also used throughout the distribution system through flushing, firefighting, street sweeping, flow testing, and more. Additionally, some water will inevitably be lost due to leaks and breaks. The water demand forecast included review of historical demands and an estimation of projected future water demands based on historical use and population trends.

Review of historical water demands included average day, maximum day, minimum day and peak hour. Historical water demand data was used to estimate the following existing "typical" demands:

- Average day demand
- Maximum day demand
- Peak hour demand
- Residential per capita water demand
- Unaccounted for water trends

The future water demand estimates were then used to determine if additional supply or storage will be needed (Refer to **Sections 4 to 5** of this report).

3.1 Historical and Projected Populations

Historic population data for the Town of Southampton was used to estimate future population and its associated future water demands. Historical population data was compiled from the U.S. Census Bureau and Southampton Town Master Plan (2013) (**Table 3-1**).

Table 3-1. Southampton Historical Population Figures

Year	Population Data[1,2]	Percent Change in Population[3]
1940	950	--
1950	1,387	46%
1960	2,192	58%
1970	3,069	40%
1980	4,137	35%
1990	4,478	8%
2000	5,387	20%
2010	5,792	8%
2015	5,924	2%
2020	6,158	4%
2025	6,310	2%
2030	6,462	2%
2035	6,614	2%

[1] Historical population data from Town Master Plan and/or U.S. Census.
[2] Projected population from 2020, 2030 from Town Master Plan. Projected population from 2025, 2035 interpolated from Town Master Plan.
[3]Represents change from previous population data, based upon a 10 year or 5 year interval as shown.

Recent population projections were made by the Pioneer Valley Planning Commission (PVPC) and the UMASS Donahue Institute (UMDI). These projections are presented in **Table 3-2**. The PVPC projection estimates a steady increase in population to a 2030 population of 6,462. Note that the 2035 population of 6,614 was estimated assuming a linear trend projection. The UMDI projection estimates a slow increase in population through 2035. Since the PVPC projections were made specifically for Southampton and account for local development plans, this data was assumed to be more accurate for this study. The PVPC projections indicate that the Town's population will increase by about 10.4% by 2035 from the current population, with each five-year period increasing approximately 2.3% to 3.8% from the prior period.

Table 3-2. Projected Population Estimates for the Town

Year	PVPC Projected Population[1]	UMDI Projected Population
2020	6,158	6,229
2025	6,310	6,401
2030	6,462	6,493
2035	6,614	6,512

[1] Population projections for 2020 and 2030 are from the Town Master Plan. The population projection for 2025 and 2035 were estimated by CEI using the historical linear projection trend.

The SWD provides water service to approximately 67% of the Town's population. The population projections for the Town were assumed to reflect a similar growth in the SWD customer population. **Table 3-3** shows the population projections for the SWD.

Table 3-3. Projected Population Estimates for SWD

Year	PVPC Town Population Projection	SWD Population Projection[1]
2020	6,158	4,126
2025	6,310	4,228
2030	6,462	4,330
2035	6,614	4,431

[1] SWD Population estimated to be 67% of Town Population.

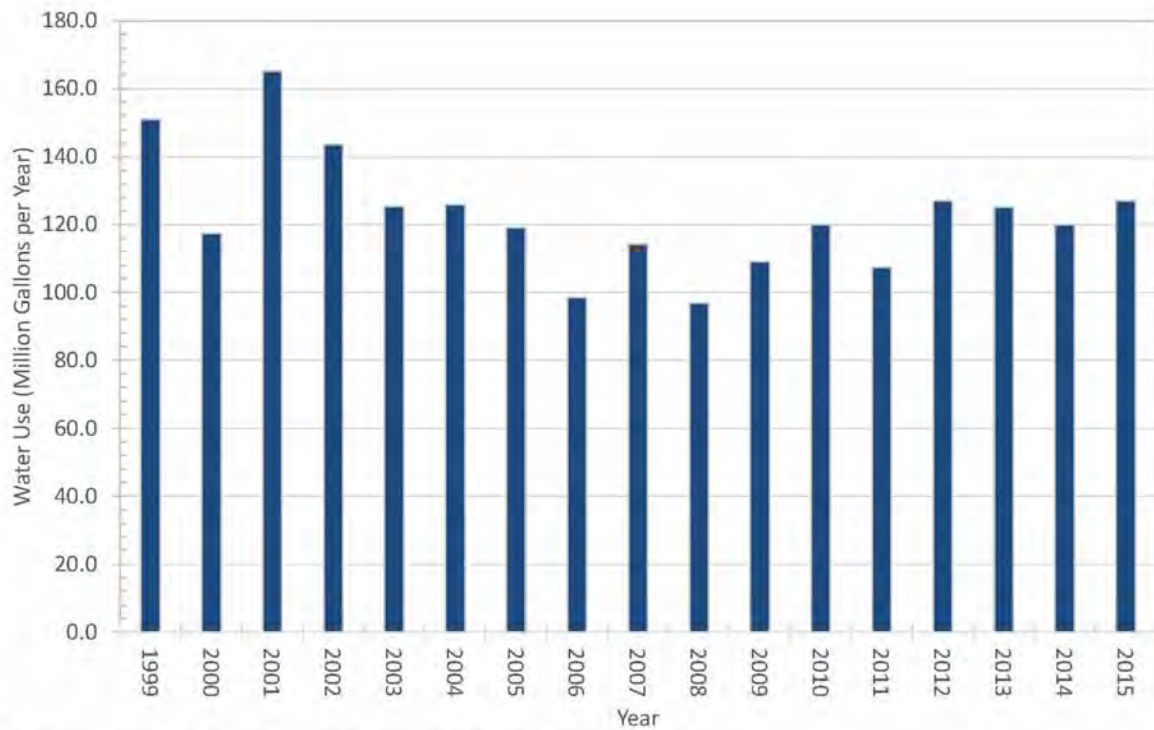
3.2 Water Demands

Historical water system demands were evaluated to estimate future anticipated water demands through the 20-year planning horizon.

3.2.1 Historical System Demands

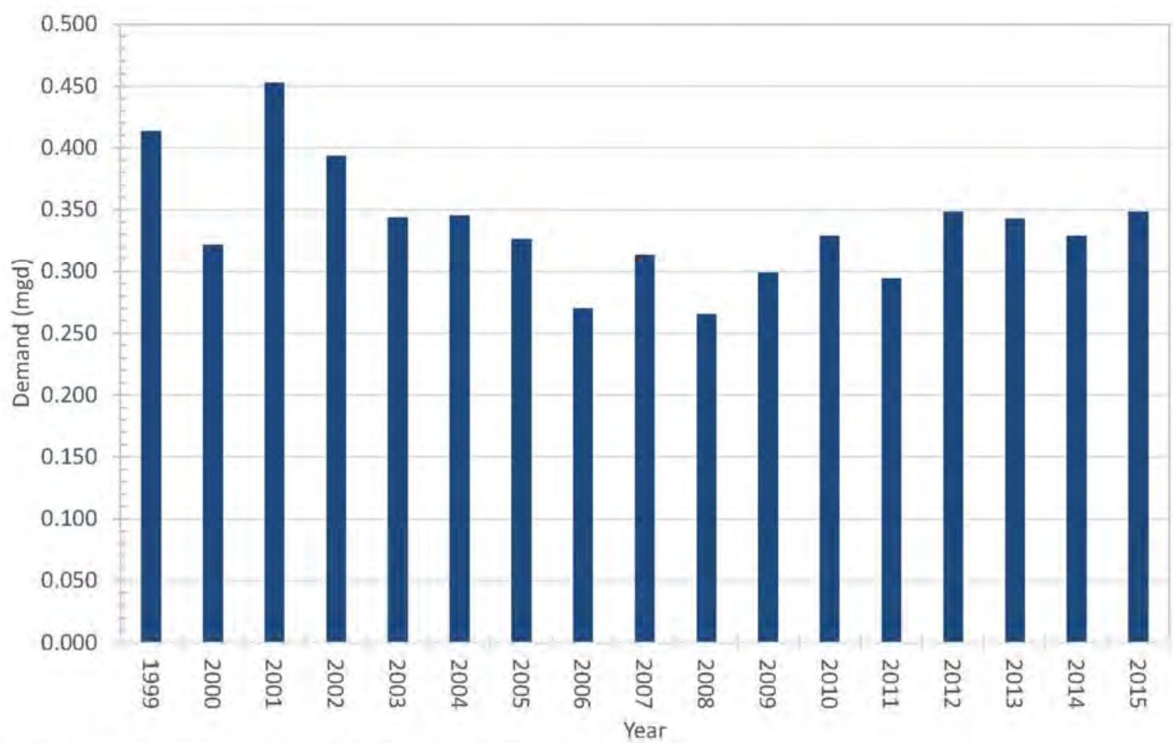
The historical annual water withdrawals from 1999 until 2015 are summarized in **Figure 3-1** (withdrawals noted in million gallons per year or MGY). Annual water withdrawal totals were used to calculate the Average Day Demand (ADD) for the entire system by dividing the annual water withdrawal by the number of days in the year. The ADD data are shown in **Figure 3-2** (ADD noted in million gallons per day or mgd). The ADD represents the total demand of the water system including water used by customers (residential, agricultural/industrial, commercial and municipal/schools), water used by the SWD, and water losses. This analysis also included a review of the Maximum Day Demands (MDD) which are defined as the largest 24-hour demand for the year. Historical MDD is reported on an annual basis by the Town as shown in **Figure 3-3**. Note that the historical MDD does not account for water purchased through the Easthampton interconnection, since the Town does not presently have the ability to meter these water transfers on a daily basis. The monthly average day and monthly maximum day for the years 2014 and 2015 are presented in **Figure 3-4**. The withdrawals for the past five years are summarized in **Table 3-4**.

Figure 3-1. Historical Total Annual Water Withdrawal



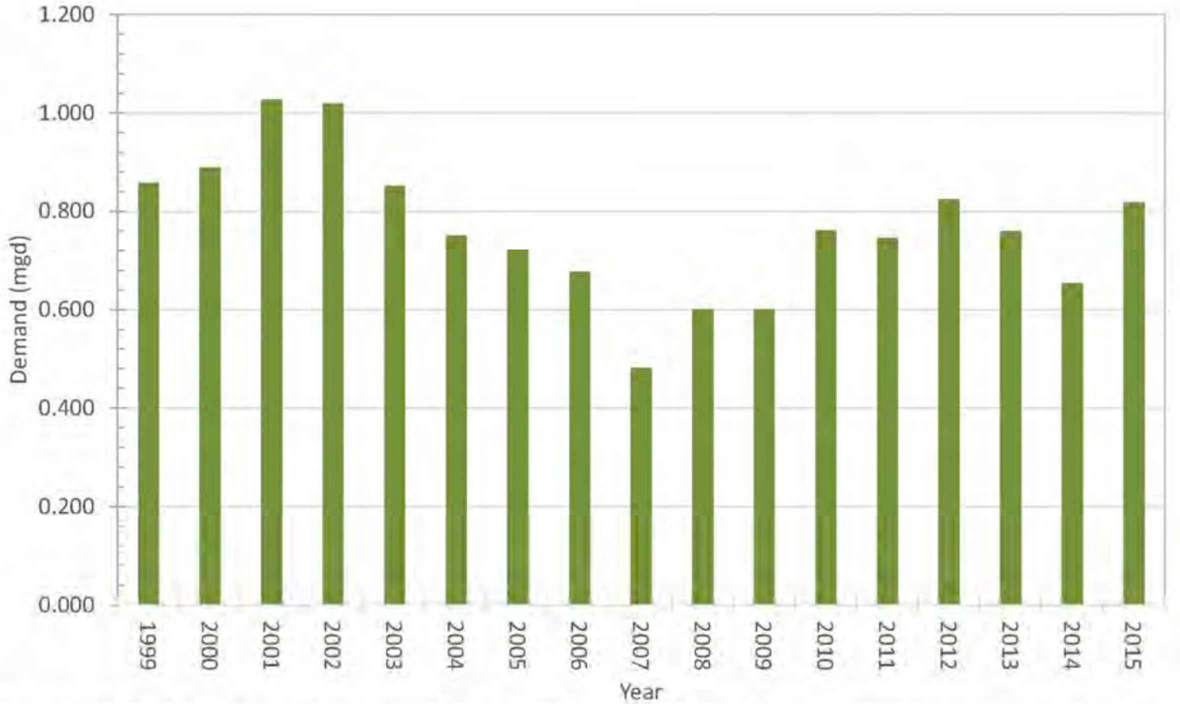
*Historical/actual data as reported in Annual Statistical Reports (ASRs).

Figure 3-2. Historical Annual Average Day Demand



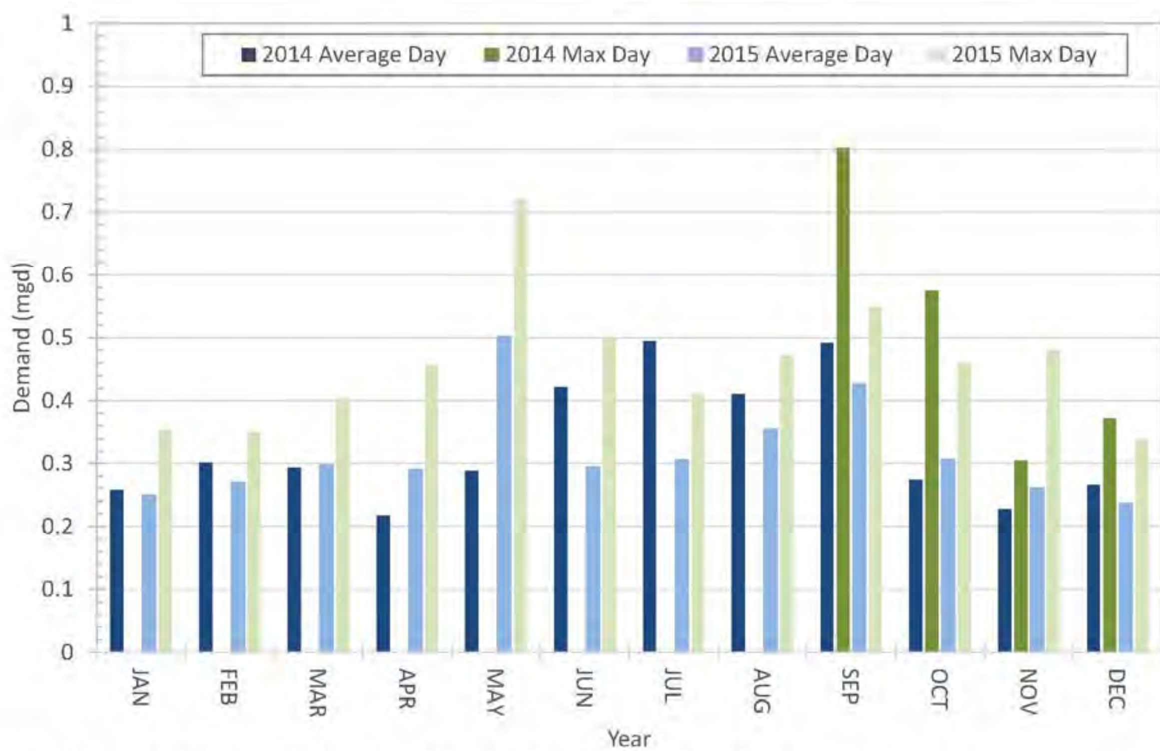
*Historical/actual data as reported in Annual Statistical Reports (ASRs).

Figure 3-3. Historical Annual Maximum Day Demand



*Historical/actual data as reported in Annual Statistical Reports (ASRs). For the years 2011, 2012, 2013 and 2015, the average day purchased from Easthampton was added to the maximum day pumped from Glendale Well.

Figure 3-4. Monthly Average Day and Maximum Day Demands



*Historical/actual data as reported in Annual Statistical Reports (ASRs) and from pumping records.

**Maximum daily pumpage shown starting in September 2014, since SWD began monitoring daily pumpage in September 2014 when the sodium hypochlorite feed system was activated.

3.2.2 Historical Service Demands

The SWD meters 100% of its customers. Any water withdrawal that cannot be accounted for through metering is categorized as unmetered water use. Unmetered use is further separated into Confidently Estimated Municipal Uses (CEMUs) and Unaccounted for Water (UAW). CEMU fluctuate annually based on a host of factors (i.e. fires, flushing, flow testing, etc.) and one year's usage may not be an indicator of future years. UAW includes both real losses (leaks, breaks and tank overflows) and apparent losses (unauthorized consumption, customer metering inaccuracies and data handling errors).

Table 3-4 shows average residential demand per person or Residential Gallons Per Capita Day (RGPCD) for 2006 to 2014 as reported in the Annual Statistical Reports. Across this time period the average RGPCD was approximately 68.7 RGPCD. **Table 3-4** also shows the percent UAW for 2006 to 2014.

Table 3-4. RGPCD and UAW

Year	RGPCD	% UAW
2006	67	3
2007	75	6
2008	63	7
2009	64	9
2010	76	6
2011	70	2
2012	74	6
2013	72	4
2014	57	4

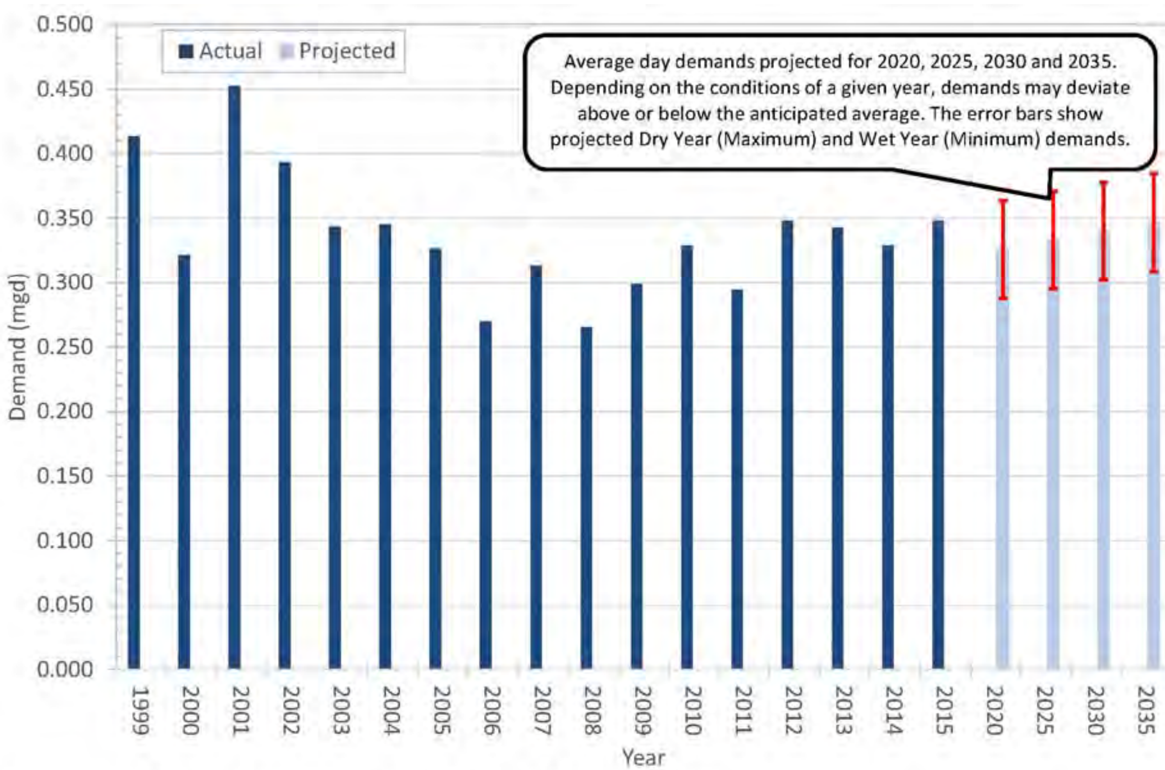
3.2.3 Projected Future Demands

Future water demands will be affected by various factors including population growth, commercial/industrial development and weather patterns. Projected water demands were estimated using the percentage increases that mirror the SWD population projection increases shown in **Table 3-3**. Projected water demands were estimated for (1) the average precipitation year; (2) relatively wet year (higher precipitation) and (3) dry year (low precipitation) events. Weather has a large impact on water usage. Wet years generally correspond with lower water demands and dry periods typically result in increased water usage. It is important for water suppliers to be prepared for both contingencies. Dry years typically result in increased supply pumpage and are critical when evaluating supply availability and redundancy. Wet years can negatively impact revenues since customers use less water.

Figure 3-5 shows historic and projected average day demands through 2035 as summarized in five year increments. As seen in the associated demand projection figures, all projected values were graphed with statistical error bars to account for the potential demand variability in dry and wet climate years. This percent uncertainty was also incorporated in projected maximum day demand in **Figure 3-6** and projected peak hour rates in **Figure 3-7**. Projected peak hourly rates were calculated by multiplying the maximum day demand by an industry accepted rule of thumb of fifteen percent. Peak hour rates reflect that the overall maximum day demand is not equally spread over 24 hours. Peak hour demand reflects typical higher usage in morning and evening. These projected demands are summarized in **Table 3-5**.

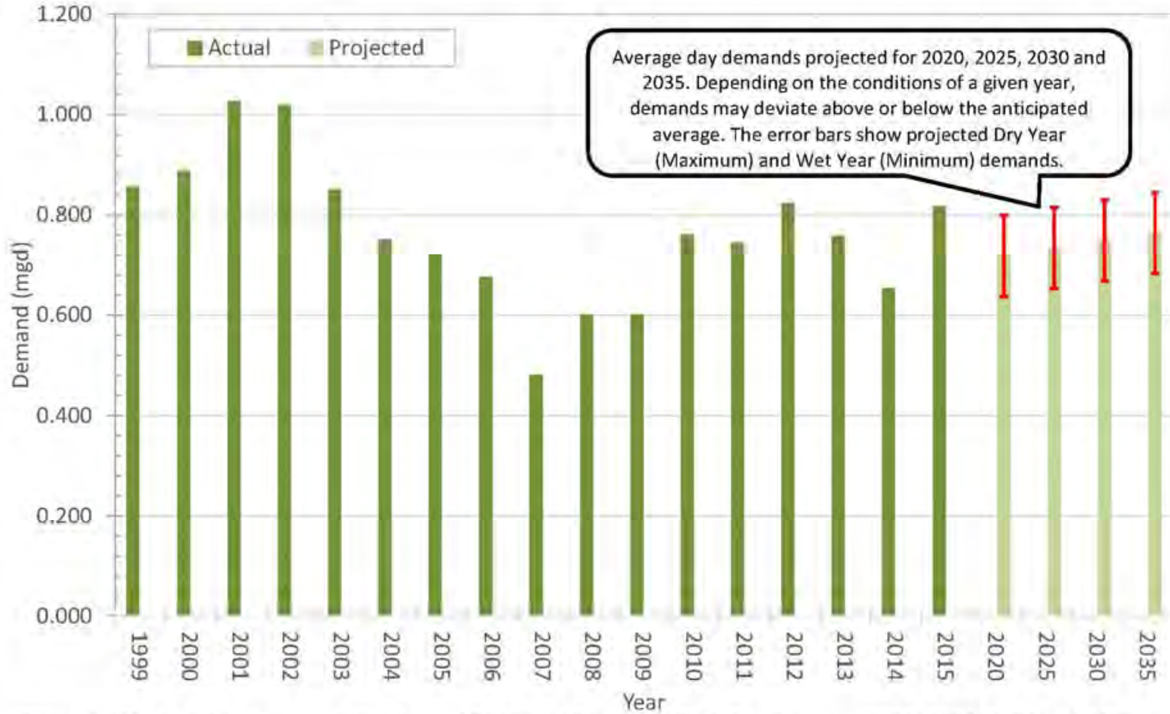
It is anticipated that the increase in water use will be from "in-fill" of water customers within the existing service area. The water distribution system is not likely to be expanded beyond its existing boundaries. An exception to this is if a small amount of private wells that exceed water quality MCLs or guidance levels.

Figure 3-5. Estimated Future Average Day Demands



*Historical/actual data as reported in Annual Statistical Reports (ASRs).

Figure 3-6. Estimated Future Maximum Day Demands



*Historical/actual data as reported in Annual Statistical Reports (ASRs). For the years 2011, 2012, 2013 and 2015, the average day purchased from Easthampton was added to the maximum day pumped from Glendale Well.

Figure3-7. Projected Peak Hour Demand

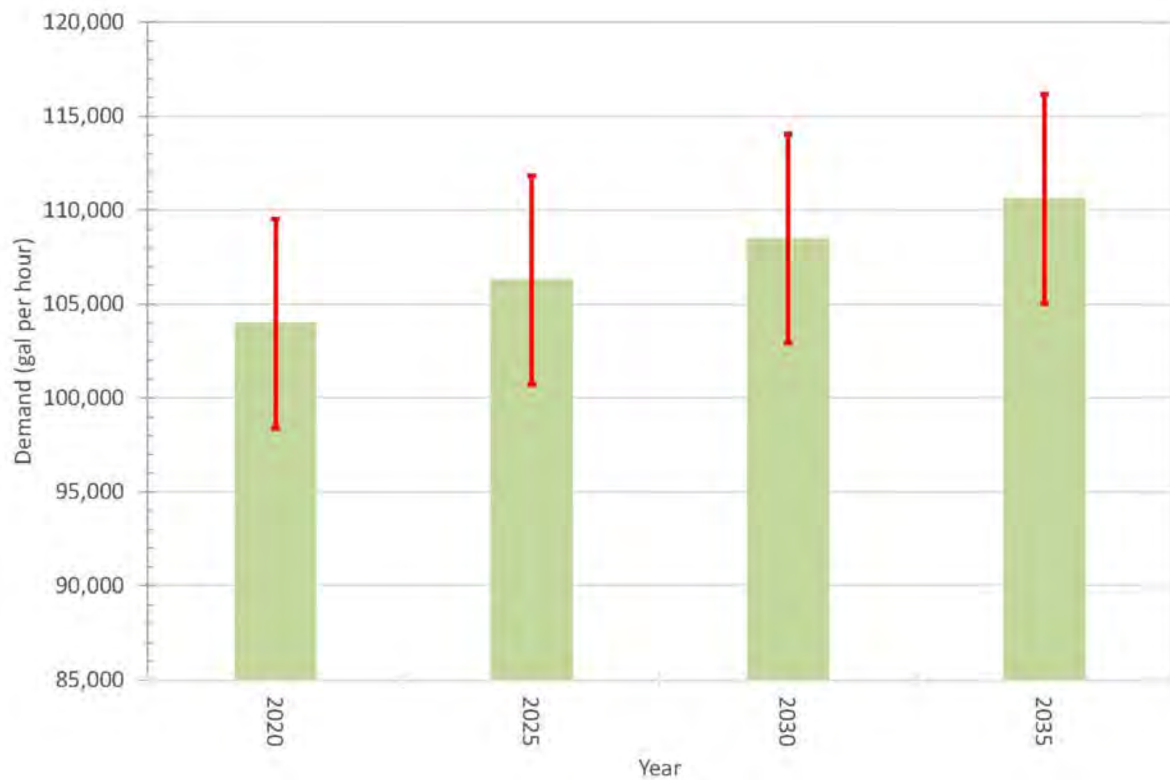


Table 3-5. Projected Demands

Year	2020	2025	2030	2035
Average Day				
Dry Year	0.361 mgd	0.369 mgd	0.377 mgd	0.384 mgd
Average Year	0.326 mgd	0.333 mgd	0.340 mgd	0.347 mgd
Wet Year	0.287 mgd	0.294 mgd	0.301 mgd	0.308 mgd
Maximum Day				
Dry Year	0.797 mgd	0.815 mgd	0.832 mgd	0.848 mgd
Average Year	0.718 mgd	0.734 mgd	0.749 mgd	0.764 mgd
Wet Year	0.632 mgd	0.648 mgd	0.663 mgd	0.678 mgd
Peak Hour				
Dry Year	119,000 gph	122,000 gph	125,000 gph	127,000 gph
Average Year	108,000 gph	110,000 gph	112,000 gph	115,000 gph
Wet Year	95,000 gph	97,000 gph	100,000 gph	102,000 gph

3.3 High Water User Trends

Data on the high water users were collected from the SWD to verify that the demand distribution in the computer model of the distribution system is appropriate. The entire system demand was proportioned throughout the system, with particular focus on assigning the high water demands in the appropriate locations. **Table 3-6** presents the high water users (top 10th percentile) during the 2015 billing year, sorted from highest to lowest usage.

Table 3-6. High Water User Demands

Account No.	Address	Street	Gallons	GPD	GPM
1060.02	15	College Highway	2,550,000	6,580	4.570
1064.01	134	College Highway Unit 1	1,589,150	4,314	2.996
1417	23	College Highway	1,452,000	3,883	2.697
1103.01	134	College Highway Unit 2	1,437,700	3,882	2.696
1560.01	37	Strong Road	1,296,050	4,732	3.286
1104.01	134	College Highway Unit 3	1,279,500	3,445	2.392
1226	8	Nicole Circle	967,346	2,612	1.814
826.01	83	Peqout Road	827,900	2,045	1.420
1062	128	College Highway	747,000	2,021	1.404
565	82	Gunn Road	737,850	1,820	1.264
184	138	College Highway	732,000	1,988	1.380
1228	41	Gilbert Road	646,605	1,783	1.238
1061.02	127	College Highway	635,450	1,668	1.158
2228.01	146	College Highway 2	605,450	1,601	1.112

Account No.	Address	Street	Gallons	GPD	GPM
1102	169	College Highway	564,950	1,454	1.010
1105.01	134	College Highway Unit 4	558,400	1,507	1.046
560	22	Gunn Road	505,300	1,320	0.917
1066.01	146	College Highway 1	429,300	1,155	0.802
131	1	Clark Street	412,350	1,111	0.771
660	37	Hillside Meadows Drive	402,250	1,078	0.749
1242.02	108	Valley Road	388,121	1,068	0.741
1342	10	Kevin Drive	384,150	1,017	0.706
1480	75	Gilbert Road	381,050	1,007	0.699
325	3	Courtney Lane	373,450	999	0.694
1512	26	Bissonnette Circle	366,200	973	0.676
1477.01	94	Gunn Road	364,400	950	0.660
1388.01	26	Katelyn Way	349,100	920	0.639
1451	111	Whiteloaf Road	331,150	890	0.618
1564	8	Birchwood Drive	327,100	1,797	1.248
1554	3	Nicholas Lane	325,500	840	0.583
1461	17	Bissonete Circle	316,400	844	0.586
1251	45	Gilbert Road	312,582	861	0.598
871	34	Pomeroy Meadow Road	310,000	814	0.565
1458	71	Pleasant Street	307,300	824	0.572
1069	116	College Highway Building 1	303,750	823	0.572
1398	5	Kevin Drive	298,350	802	0.557
1369.01	3	Kevin Drive	298,300	795	0.552
1389	6	Whispering Meadow Lane	295,300	791	0.549
1223	73	Gunn Road	288,651	791	0.549
998.02	36	Strong Road	285,300	1,205	0.836
1559	6	Nicholas Lane	282,100	966	0.671
886	75	Pomeroy Meadow Road	278,760	757	0.526
1351	2	Kevin Drive	278,200	728	0.506
1495.01	102	Gunn Road	277,800	750	0.521
1510.01	28	Bissonnette Circle	273,800	719	0.499
1293.02	15	Helen Drive	272,250	715	0.496
1123	116	College Highway Building 3	271,450	732	0.508
162	31	College Highway	269,700	731	0.508
1341.04	6	Kevin Drive	267,450	715	0.496
291.02	49	Cottage Avenue	267,200	664	0.461
1442	24	Bissonnette Circle	265,350	702	0.487
1367.01	4	Kevin Drive	261,050	677	0.470
1487.01	100	Gunn Road	260,950	703	0.488
1411	21	Katelyn Way	259,450	723	0.502
1080	32	Fomer Road	259,150	705	0.490
324	5	Courtney Lane	258,150	692	0.481

Account No.	Address	Street	Gallons	GPD	GPM
1517	5	Pine Meadow Drive	255,200	674	0.468
1078	25	Noreen Drive	254,350	664	0.461
1249.02	14	Wolcott Road	252,704	685	0.476
1504	23	Bissonette Circle	250,150	671	0.466
195	168	College Highway 1	245,300	672	0.467
1472	22	Coleman Rd	242,500	640	0.445
1334.01	24	Katelyn Way	241,050	641	0.445
198	183	College Highway	241,000	644	0.447
900	106	Pomeroy Meadow Road	239,950	642	0.446
329	8	Courtney Lane	239,500	638	0.443
1345.02	71	Gilbert Road	234,850	617	0.429
1311	17	Helen Drive	234,000	622	0.432
1470.01	96	Gunn Road	233,250	629	0.437
636	8	Hillside Meadows Drive	233,150	626	0.435
1168.02	7	College Highway	229,000	603	0.419
934	194	Pomeroy Meadow Road	225,850	602	0.418
1430.02	18	Bissonette Circle	225,700	596	0.414
326	4	Courtney Lane	225,300	606	0.421
407	25	Eastwood Drive	224,400	598	0.415
649	21	Hillside Meadows Drive	223,350	598	0.415
1325	66	Glendale Road	222,600	590	0.410
1448	22	Bissonnette Circle	218,300	578	0.402
643	15	Hillside Meadows Drive	215,850	578	0.402
1216	18	Strong Road	214,100	568	0.394
1282.02	23	Helen Drive	213,000	571	0.397
786	11	Nicole Circle	212,750	568	0.395
1374	8	Kevin Drive	211,000	555	0.386
462	24	Freyer Road	210,850	531	0.369
1368.02	1	Kevin Drive	208,550	556	0.386
1359.01	57	Gilbert Road	208,200	559	0.388
41.02	8	Bluemer Road	207,600	554	0.385
1122	116	College Highway Building 2	207,550	562	0.390
1344	17	Katelyn Way	206,650	547	0.380
1365.01	4	Pequot Road	205,600	541	0.376
963	6	Rosalie Lane	204,250	546	0.379
1333.01	23	Katelyn Way	204,100	546	0.379
1350	6	Brittney Lane	204,000	544	0.378
578	17	Gunn Road Ext	203,050	545	0.379
1283	6	Parc Place 5/8	202,500	726	0.504
1439.01	113	Whiteloaf Road	201,600	538	0.373
1182.01	19	Helen Drive	200,400	536	0.372
349	9	Donna Marie Way	200,100	532	0.369

Account No.	Address	Street	Gallons	GPD	GPM
1219.01	234	County Road	199,700	534	0.371
855	114	Pleasant Street	195,500	521	0.362
689.01	4	Kylene Circle	194,650	520	0.361
1133	107	Pleasant Street	194,300	516	0.358
1390.01	7	Madeline Way	193,400	513	0.357
555	5	Golden Circle	193,300	522	0.362
1256.04	67	Valley Road	193,222	528	0.367
632.01	4	Hillside Meadows Drive	193,100	515	0.358
1013.01	38	Strong Road	192,450	517	0.359
896.01	102	Pomeroy Meadow Road	192,300	512	0.356
1460.01	35	Bissonnette Circle	191,350	511	0.355
1041	107	Valley Road	191,000	514	0.357
24	21	Belanger Road	190,150	478	0.332
1431.02	20	Bissonnette Circle	188,700	500	0.347
833.01	12	Pequot Road	188,650	505	0.351
1258	24	Coleman Road	187,861	514	0.357
806	10	Parsons Way	187,300	501	0.348
1320.01	81	East Street	186,950	498	0.346
1222.01	9	David Street	186,900	498	0.346
1454.01	11	Bissonette Circle	186,600	498	0.346
1248	278	County Road	185,024	501	0.348
1408.01	10	Bissonnette Circle	183,600	490	0.340
645	17	Hillside Meadows Drive	183,550	489	0.339
1270	14	Katelyn Way	183,357	504	0.350
1467	20	Miller Avenue	183,250	468	0.325
532	128	Glendale Road	180,850	483	0.336
1502.01	38	Bissonnette Circle	180,600	484	0.336
1503.01	35	Bissonette Circle	177,950	477	0.331
1239	22	Pomeroy Meadow Rd Unit 22 Irr Pit	177,580	478	0.332
539	5	Glendale Woods Drive	176,900	474	0.329
718	21	Lynn Drive	176,640	462	0.321
473	14	Geryk Court	173,650	462	0.321
1521.01	30	Bissonnette Circle	173,100	459	0.319
1446.01	14	Bissonnette Circle	173,000	459	0.318
265	199	College Highway	172,450	459	0.318
1519.01	31	Bissonnette Circle	171,800	449	0.312
1558	9	Nicholas Lane	171,550	622	0.432
799.01	2	Parsons Way	169,450	456	0.317
994.04	20	Strong Road	169,400	447	0.310
1144	168	College Highway 2	169,100	441	0.306
890	82	Pomeroy Meadow Road	168,100	447	0.310
1271	31	Freyer Road	167,350	447	0.310

Account No.	Address	Street	Gallons	GPD	GPM
1375.01	2	Katelyn Way	166,300	448	0.311
526	105	Glendale Road	166,200	451	0.313
1553	72	Pleasent Street	165,350	437	0.303
250	329	College Highway	165,250	443	0.308
554	9	Golden Circle	164,950	446	0.309
367	14	East Street	163,700	437	0.304
1486.01	7	Bissonette Circle	163,200	432	0.300
876	42	Pomeroy Meadow Road	161,350	432	0.300
910	146	Pomeroy Meadow Road	160,600	432	0.300
1570	76	Glendale Road	141,900	2,344	1.628
1577	8	NICHOLAS LN	119,700	1,330	0.924
1588	1	NICHOLAS LANE	51,250	569	0.395

3.4 Diurnal Demands

Data was collected on hourly tank levels and supply pump operation for a high demand week occurring in May 2015 and an average demand week occurring in March 2015. This data was used to estimate the hourly system demand fluctuation throughout the average and maximum week demand periods. This data was then used to program the computer model of the distribution system to simulate extended operation. **Figure 3-8** shows the gallons per minute system demand for the average demand week. **Figure 3-9** shows the gallons per minute system demand for the maximum demand week.

Figure 3-8. Hourly System Demand – Average Demand Week

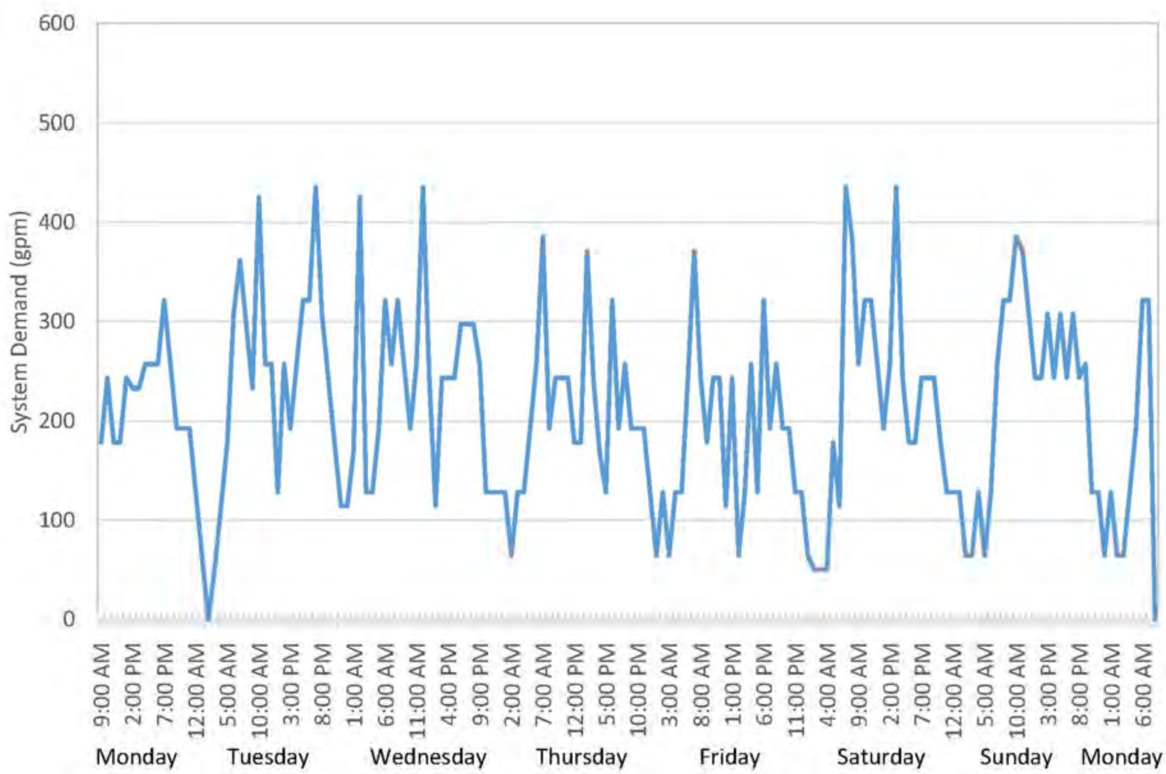
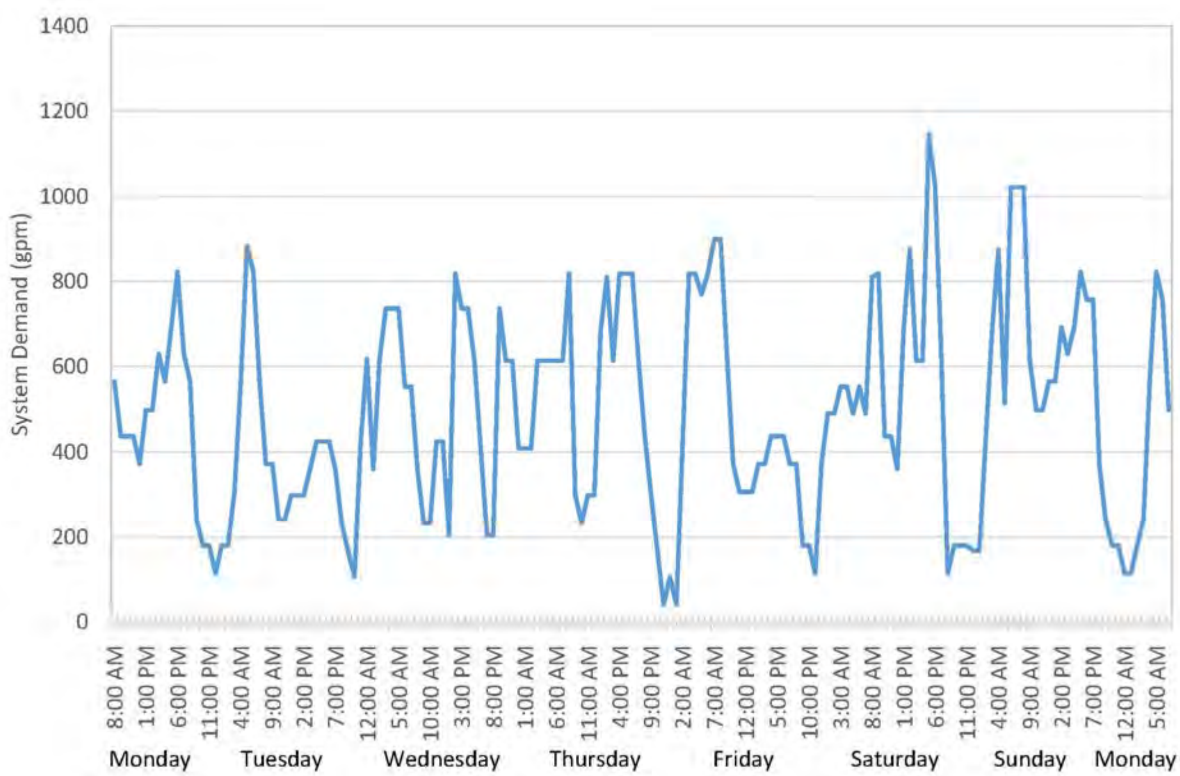


Figure 3-9. Hourly System Demand – Maximum Demand Week



Note that the historical data used to develop Figure 3-8 and Figure 3-9 highlight that there is some water demand at all times, including late night/early morning. These overnight water demands could consist of system losses/leaks and actual customer demands, such as lawn irrigation systems set on timers to operate during these low demand periods.

4.0 Water Supply Evaluation

The water supply evaluation provides a comprehensive review of the existing sources to determine recommended improvements or if additional sources will be needed to satisfy future demand. This task included the following activities:

- Review of supplies and water quality,
- Review of Water Management Act (WMA) permit requirements
- Comparison of available supply (safe yields, pumping capacities) with current/future demands.
- Completion of source facility audits,
- Analysis of redundancy or backups (including interconnections with neighboring systems),
- Evaluation of potential additional sources of supply.

4.1 Water Supplies

The SWD's water system supply includes two groundwater wells. Glendale Well 01G is no longer operated due to its decreased capacity. Glendale Well 02G is the SWD's primary source of public water and is operated on a daily basis. Both wells are located off of Glendale Road and College Highway; they are within 25 feet of each other. The well locations are show in **Figures A1** and **A2** in **Appendix A**. Details about both supplies is provided in **Table 4-1**.

Table 4-1. Water Supply Sources

Source	**Glendale Well 01G (Well #1)[1]**	**Glendale Well 02G (Well #2)**
PWSID	1276000-01G	1276000-02G
Status	Inactive	Primary
Type	Gravel Packed 8-inch diameter 140 ft deep	Gravel Packed 10-inch x 16-inch 146 ft deep
Date Installed	1963	2002
Approved Yield	0.792 mgd 550 gpm	0.792 mgd 550 gpm
Pump Type	Submersible	Submersible
Pump Rate	325 gpm at 105 feet	500 gpm at 89 feet
Pump Motor Size	40 HP	75 HP
Pump Model	Unknown	Gould 7TL C07586 BTS

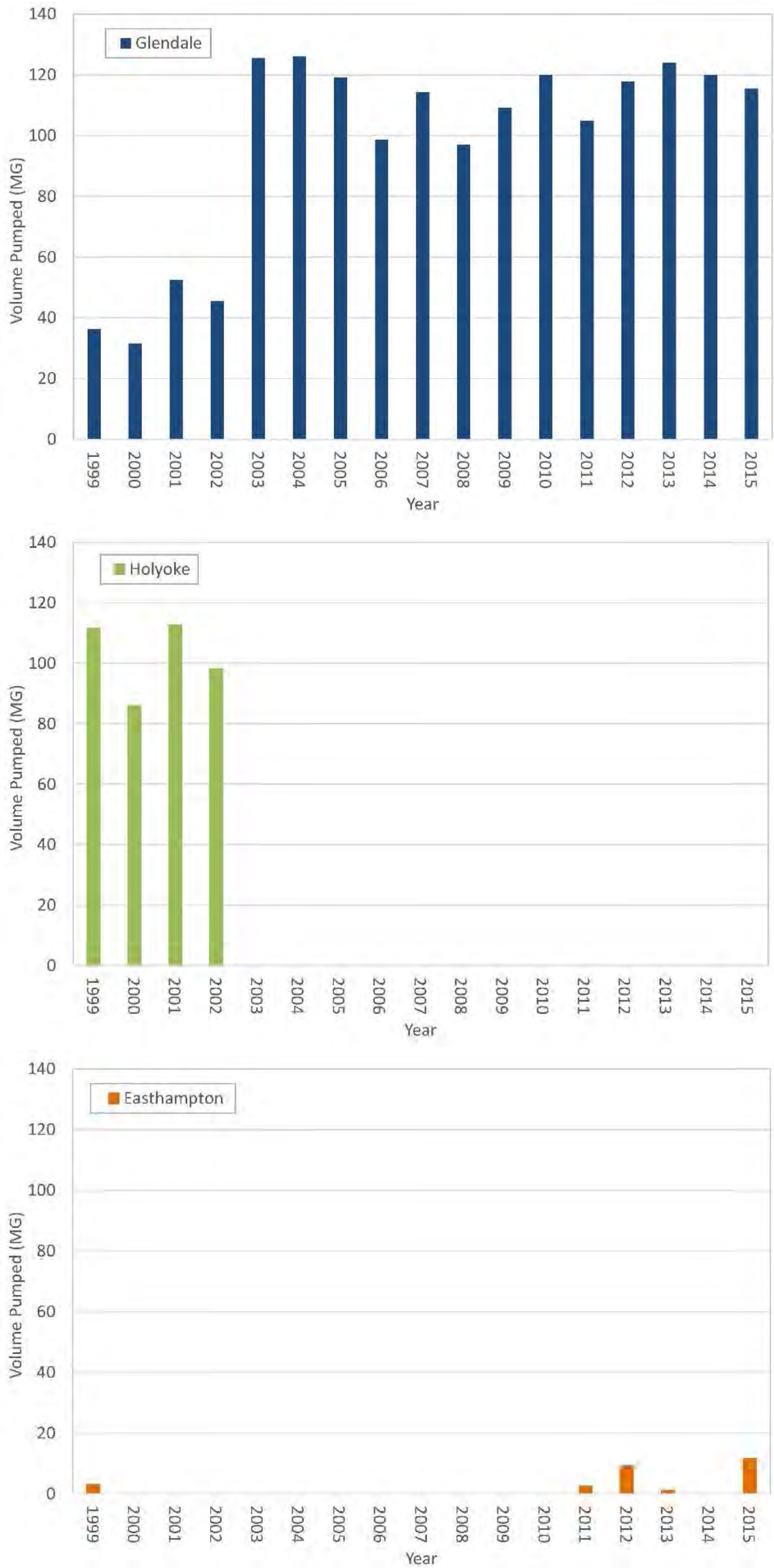
[1] The Glendale Well 01G pump was replaced in 1993 to increase the pump capacity from 220 gpm to 325 gpm.

Glendale Well 02G receives chemical treatment using a sodium hypochlorite chemical feed system on site. The sodium hypochlorite feed system was installed to address repeat total coliform present detections in the distribution system.

The SWD also maintains interconnections with adjacent public water systems in the event that the Glendale Well does not meet the SWD's demands. The other water supplies include two interconnections with the Holyoke Water Works (HWW) System at Gilbert Road and Pequot Road, an emergency hard piped interconnection with the Easthampton Water System at the intersection of Cook Road and Line Street, and finally, an emergency hydrant to hydrant interconnection with the Westfield Water System. Since the HWW interconnection is to untreated raw water, the HWW interconnections are no longer used due to treatment requirements. The Easthampton water system interconnection has been utilized in four of the last five years during periods of high water demand.

Figure 4-1 shows the annual withdrawal from the SWD's sources. The figure demonstrates the shift from a majority of water withdrawal from the HWW water system to primary use of the Glendale Well and occasional withdrawal from the Easthampton water system, starting in 2003 after the Glendale Well 02G was installed.

Figure 4-1. Annual Withdrawal from Sources



4.2 Water Quality

Glendale Well 02G draws water from the Barnes Aquifer. Recent water quality test results are shown in **Table 4-2**. This water is of high quality and requires only minimal treatment for the addition of chlorine to prevent total coliform detections within the distribution system.

Table 4-2. Glendale Well 01G & 02G Composite Raw Water Quality

Parameter	Result	Sample Year	MCL, SMCL, ORSG*
Nitrate	0.81 mg/L	2014	10 mg/L
Nitrite	ND	2014	1.0 mg/L
VOCs	ND	2015	Varies
Iron	ND	2015	0.3 mg/L
Manganese	ND	2015	0.05 mg/L
Sodium	6.1 mg/L	2015	20 mg/L

*Maximum Contaminant Level (MCL), Secondary Maximum Contaminant Level (SMCL) or Office of Research Standards Goal (ORSG)

In the 1980s, both Southampton and Easthampton in the Ponds area near the Pequot Station experienced a Trichloroethylene (TCE) groundwater contamination that impacted approximately 400 households. TCE is a byproduct of industrial degreasers and is a suspected carcinogen. In response to the TCE groundwater contamination, Easthampton constructed a water treatment facility and Southampton completed a 10.5 mile pipeline extension to serve residents on Pequot Road whose private wells were contaminated.

4.3 Water Management Act Permit Requirements

The Massachusetts Department of Environmental Protection (MassDEP) issued Water Management Act (WMA) permits for water supplies approved after 1988. The WMA permits limit the amount of withdrawal for water systems and individual wells. Wells installed before January 1, 1988 were grandfathered as registered wells and do not have individual withdrawal restrictions beyond the safe yields of the wells. The WMA statement does restrict the overall withdrawal of the system.

The SWD's WMA authorized permitted rate for Glendale Wells is 0.36 mgd or 131.4 million gallons per year (MGY). **Table 4-3** provides WMA information on the SWD's source of supply including the sub-basin identification number in which it is located and its current authorized withdrawal volumes.

Table 4-3. Water Management Act Authorized Withdrawals

Source	Glendale Well 01G and02G
MassDEP ID	127600-01G and 02G
Permitted or Registered Source	Permitted
Basin	Connecticut
Sub-basin ID	14080
Daily Average	0.36 mgd*
Total Annual	131.4 MGY
Authorized Maximum Day	0.792 mgd

*SWD shall not withdraw volumes in excess of its authorized annual average withdrawal volume by more than 0.10 mgd. Based on its current permit, this means that the SWD may withdraw an additional 100,000 gpd of average daily flow in excess of its 360,000 gpd permit and still be in compliance with its WMA Permit. Note that this will likely be revised when the new WMA Permit is issued, to a value of 5% in excess of the revised permitted withdrawal limit.

The 2003 WMA renewal included water conservation measures that include:

1. Implementation of a meter installation program for 100 percent metering of all service connections.
2. Annual calibration of master meters.
3. Completion of full leak detection survey every other year.
4. Repair of leaks within seven days of detection.
5. Implementation of a non-decreasing block rate structure.
6. Implementation of measures to fully fund water system operations through water system revenues.
7. Plan to reduce residential water usage to below 80 residential gallons per capita day (RGPCD). Note that the MassDEP standard has been changed to 65 RGPCD as stated in the most recent Sanitary Survey completed in 2014.
8. Confirmation that plumbing code for new construction and building rehabilitation requires use of water saving devices and low flow toilets.
9. Retrofit of public buildings with water saving devices.
10. Adoption of Water Use Restriction Bylaw to allow the SWD the ability to implement non-essential water use restrictions.
11. Water used for main flushing and construction shall be metered.

The SWD’s RGPCD and UAW are shown in **Table 4-4**. The RGPCD has been consistently below the 80 RGPCD threshold stated in the 2003 WMA Permit. The RGPCD has been mostly above the current MassDEP standard of 65 RGPCD, however, this decreased to 57 RGPCD in 2014. The UAW has been consistently been below 10%, which is the water conservation standard that MassDEP is requiring of all water suppliers at this time.

Table 4-4. RGPCD and UAW

Year	RGPCD	% UAW
2006	67	3
2007	75	6
2008	63	7
2009	64	9
2010	76	6
2011	70	2
2012	74	6
2013	72	4
2014	57	4

The SWD currently has an increasing block rate for service charges as shown in the following **Table 4-5**, meeting the requirement of Item 5 above.

Table 4-5. Water Usage Charges

Usage Tier	FY 2016 Usage Charges
Tier 1 – 12,000 gal and Less	$42.00
Tier 2 – 12,001-24,000 gal	$3.50 per 1,000 gal
Tier 3 – 24,001 gal and Greater	$5.00 per 1,000 gal

4.4 Comparison of Supply and Demands

The existing source safe yields, pumping capacity and treatment capacity were compared to the existing and future water demands to determine if there will be adequate supply. The MassDEP Guidelines for Public Water Suppliers Chapter 7 requires that with any supply pump out of service, the remaining pump(s) shall be capable of providing the maximum daily pumping demand of the system. WMA permit constraints were also included in this analysis to determine if an increase in permitted withdrawal rates is or will be needed in the future.

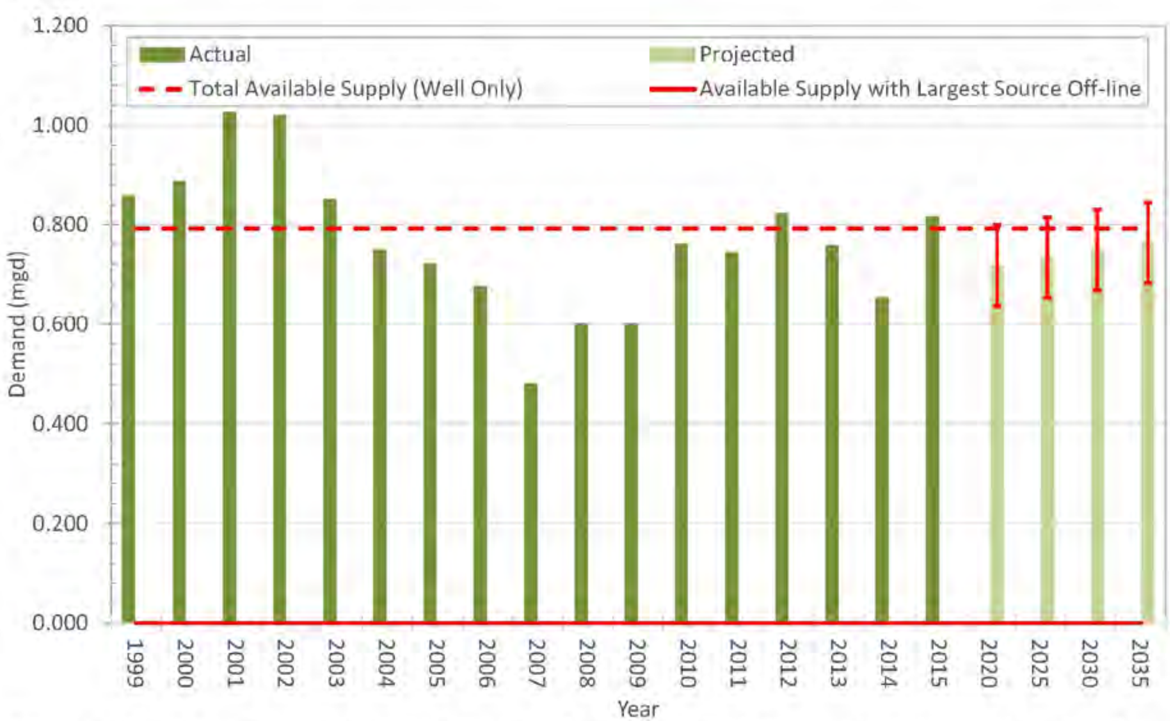
The ability of the source of supply to meet the maximum day demands is based on the pumping capacity of the groundwater well and the pumps. **Table 4-6** shows the safe yields of the sources, facility capacity (pumping and treatment) as compared with the maximum day demands. **Figure 4-2** shows the current and project maximum day demands with the ability of the system to meet the demand with the largest source unavailable.

Table 4-6. Ability of Existing Source to meet Demand

Description	Safe Yield (gpm)	Facility Capacity (gpm)
Glendale Well 02G	550	550
Available capacity with largest source off-line	0	0
2015 Maximum Day Demand	500 gpm (0.720 mgd)	
Available Supply meets Demand?	Yes	
Available Supply meets Demand with largest source off-line?	No	
2035 Maximum Day Demand (Normal)*	512 gpm (0.737 mgd)	
Available Supply meets Demand?	Yes	
Available Supply meets Demand with largest source off-line?	No	
2035 Maximum Day Demand (Dry)*	568 gpm (0.818 mgd)	
Available Supply meets Demand?	No	
Available Supply meets Demand with largest source off-line?	No	

*Projected future demands completed for normal year and potential dry year.

Figure 4-2. Maximum Day Demands and Total Supply Sources

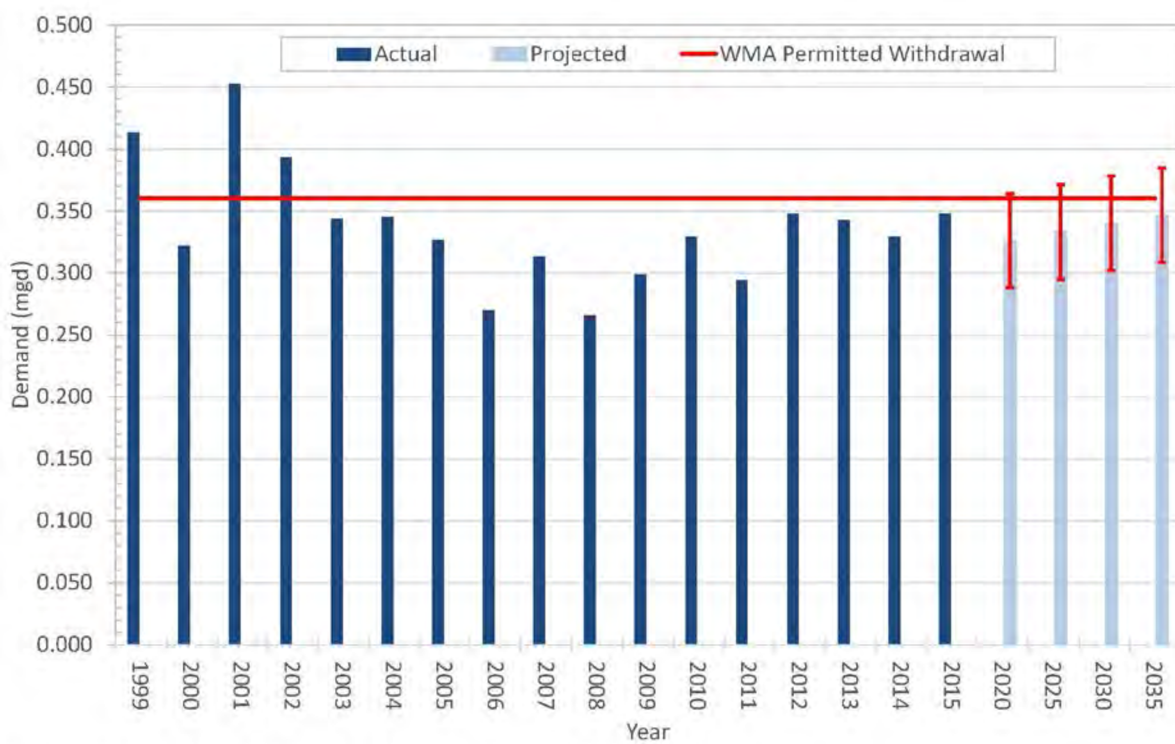


*Historical/actual data as reported in Annual Statistical Reports (ASRs). For the years 2011, 2012, 2013 and 2015, the average day purchased from Easthampton was added to the maximum day pumped from Glendale Well.

The data in **Table 4-6** and **Figure 4-2** show that the SWD has adequate supply to meet current maximum day demands with the total available supply as long as Glendale Well 02G is fully operational and does not lose capacity. The current source of supply will not meet projected maximum day demands in 2030 or 2035 for dry years with higher water demands.

For the SWD's sources, the safe yields of the wells are the same as the WMA Permit authorized maximum withdrawal from individual wells, which helps to meet the maximum day demand. However, the WMA Permit authorized annual average day withdrawal is less than the safe yield of the wells. **Figure 4-3** shows the WMA authorized annual average withdrawal and the projected future average day demand through 2035. The light blue data columns show the projected normal average day demand. The statistical error bars show the projected average day demand (additional) that may occur in a dry year (low precipitation). The data indicates that the current WMA authorized withdrawal (registered plus permitted) of 0.36 mgd may not be sufficient to satisfy the projected average annual day demands through the 20 year planning horizon, should the SWD be required to meet demands during dry years. If the SWD annual average daily withdrawal exceeds 0.36 mgd, the SWD will be required to request approval from MassDEP to increase the permit. Note that the MassDEP will likely require the SWD to comply with the conservation measures and standards outlined in **Section 4.3** of this report before granting a withdrawal permit increase.

Figure 4-3. Projected Annual Average Day with WMA Authorized Withdrawal



*Historical/actual data as reported in Annual Statistical Reports (ASRs).

4.5 Source Facilities

Site visits were completed of the Glendale Well pumping and treatment facilities and Gilbert Road and Pequot Road interconnection stations on March 17, 2016. The following provides a summary of the existing conditions and any observed deficiencies.

4.5.1 Glendale Wells, Pumping and Treatment

The Glendale Well 02G is the primary source of supply. This site includes both Glendale Well 01G and 02G and the associated pumping station and treatment facility shown in **Figure 4-4** and **Figure 4-5**. The wells utilize submersible pumps. The pumping station is two floors. The treatment facility is located in the addition on the front of the pumping station. In the pumping station, the upper level (ground level) houses the variable frequency drive unit (Benshaw), instrumentation and telemetry **Figure 4-6**. The lower level (accessible by ladder) houses piping, valves, flow meter, sample corporations and chemical injection corporation **Figure 4-7**.

Figure 4-4. Glendale Well Pumping Station and Treatment Facility

Figure 4-5. Glendale Well 02G

Figure 4-6. Pumping Station Upper Level

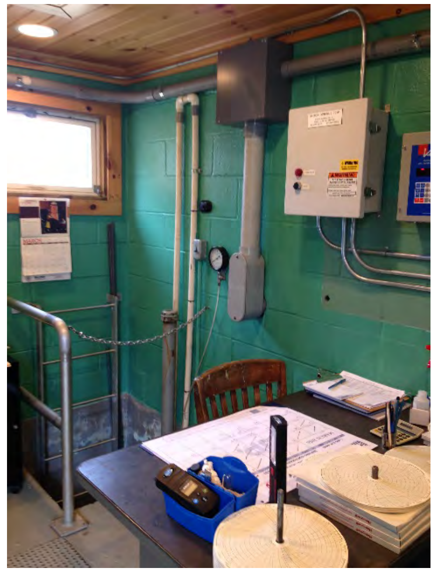


Figure 4-7. Pumping Station Lower Level

The piping for Well 01G remains in place, but this well is not active. The piping from Well 02G is pumped from the well using a submersible well pump, through a 6-inch turbo check valve, pitless adaptor and to the station via a 6-inch diameter ductile iron main. The well is vented and the vent is screened. The well water level is monitored and the well pump shuts down upon low water level in the well. Once inside the station lower level, the Well 02G piping joins the Well 01G piping (Well 01G is valved off) to flow through the orifice plate flow meter as shown in **Figure 4-8**. The finished water sample is taken 100 feet downstream of the facility and piped back to the facility for monitoring of chlorine and grab samples.

Figure 4-8. Chemical Feed and Flow Meter

Flows are recorded using a circular chart located on the upper level. This facility also houses the circular chart for the water storage tank level.

The treatment addition was constructed in 2014 to house a sodium hypochlorite feed system, shown in **Figure 4-9**.

Figure 4-9. Sodium Hypochlorite Feed System

4.5.2 Pequot Road Station

The Pequot Road Station is the site of one of two potential interconnections with the Holyoke Water Works (HWW) and is shown in **Figure 4-10**. This facility was originally equipped with hard piping and valves connecting the SWD system with the HWW raw water transmission main. The facility formerly housed chemical feed equipment for sodium hypochlorite and soda ash. All of this equipment has been removed and the facility has been converted to office and storage space for the SWD as shown in **Figure 4-11**. A future interconnection would require a separate structure for piping and treatment systems and MassDEP approval.

Figure 4-10. Pequot Road Station - Exterior

Figure 4-11. Pequot Road Station – Interior (Former Pipe Area)

4.5.3 Gilbert Road Station

The Gilbert Road Station is the site of another interconnection with the HWW raw water transmission main and is shown in **Figure 4-12**. This interconnection is located at a higher elevation than the Pequot Road Station, so this facility used to house booster pumping equipment in addition to sodium hypochlorite and soda ash feed systems. At this time all of this equipment has been removed as shown in **Figure 4-13**. The SWD maintains the ability to sample SWD system water at this location since it is one of their routine monitoring sites (**Figure 4-14**).

Figure 4-12. Gilbert Road Station – Exterior

Figure 4-13. Gilbert Road Station – HWW Raw Water Pipe Termination

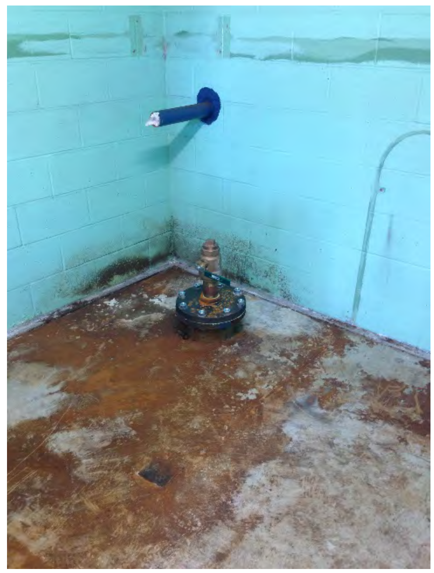


Figure 4-14. Gilbert Road Station – SWD Sample Station

Re-activation of this interconnection would require installation of piping and treatment system and would require MassDEP approval.

4.6 Analysis of Supply Redundancy and Backup Sources

The MassDEP Guidelines for Public Water Suppliers Chapter 7 requires that with any supply pump out of service, the remaining pump(s) shall be capable of providing the maximum daily pumping demand of the system.

The existing source of supply is the Glendale Well 02G which has a design flow of 550 gpm. Therefore, the available pumping capacity of the system is 550 gpm. This supply is able to satisfy the average day demand and needs supplementing in the summer to meet peak demand periods. As described in **Section 4.4**, the SWD supply does not comply with the MassDEP requirement to supply the maximum day demand with the largest source off-line. If a system does not have redundant supplies, MassDEP requires that system to have at least two days of water storage. An analysis of system storage is provided in **Section 6.0** of this report. However, if there were a problem with the Glendale Well that could not be repaired within two days, then the SWD would run out of water and have no viable means of supplying water to the entire system beyond supplementing a small amount of that supply through the Easthampton interconnection.

The SWD currently has emergency interconnections to supplement their sole supply with Holyoke, Easthampton, and Westfield. The interconnection with the Easthampton Water System is an unmetered, 8-inch, hard piped interconnection that can only supply water to a small portion of the SWD due to hydraulic gradeline differences. This is a useful source of supply to supplement high demands, but could not serve the entire system should the Glendale Well be unavailable.

The supply from Holyoke is untreated surface water. The SWD would be required to install treatment systems to utilize this water supply. Currently these interconnections have been disassembled to provide a visible air gap between the two systems.

The interconnection with the Westfield Water System requires a hydrant to hydrant connection. This provides a potential backup for a short-term emergency.

4.7 Potential Additional Sources of Supply

In order to meet maximum day demands going forward and have supply redundancy, the SWD will require additional permanent supply from (1) increasing the existing Glendale Well 02G capacity, (2) permitting and installation of new well, (3) permanent interconnection with Easthampton or (4) treatment of raw water supply from HWW.

4.7.1 Increase Glendale Well 02G Capacity

Glendale Well 02G has an approved pumping rate of 550 gpm (0.792 mgd). However the actual pumping rate is only 325 gpm. The SWD may consider rehabilitating this well to be able to pump 550 gpm to maximize the potential use of this well. The SWD would need to monitor use to remain below the WMA Permit authorized withdrawals, based on the Annual Average Daily Withdrawal from this source.

Advantages to this option include:

1. Regains capacity from existing supply and investment.
2. Source of supply is under the SWD's control.

Disadvantages to the supply include:

1. Does not provide additional capacity to resolve lack of redundancy.

4.7.2 Potential Glendale Well 03G

The SWD could install a third well at the Glendale site, as previously proposed. This well may provide some additional capacity if the safe yield of the Glendale site could be increased, based upon the combination of Well 02G and a prospective Well 03G. This well would provide source redundancy to the existing Glendale Well 02G, should Well 02G require maintenance, depending upon its physical proximity to Well 02G.

Advantages to this option include:

1. SWD owns the Zone I of the well.
2. Source of supply is under the SWD's control.
3. Water quality should be similar to Glendale Well 02G (minimal treatment).
4. Provides source redundancy should Well 02G require maintenance.

Disadvantages to the supply include:

1. Wells would not be pumped concurrently. This option may provide only a small amount of additional capacity if the safe yield can be increased above the existing yield through the permitting process.
2. Wells would be located in the same wellfield and vulnerable to similar emergency issues such as accidental contamination or main break.

4.7.3 Potential New Groundwater Supplies

A test well program was completed by the former Hampton Ponds Water System (now part of the SWD) at a well site near the Pequot Road Station in the 1960s. An 8-inch diameter well was installed and estimated to have a capacity of 500 gpm. A pumping station was designed but never constructed. The project was postponed upon discovery of TCE issues in the area, although the test well was never tested for TCE. There is limited historical record on this well, however, this is a viable potential source of supply for the SWD at this time. The SWD should consider requesting written site approval from the MassDEP for the Pequot Well site before initiating test well work.

Advantages to this supply include:

1. SWD already owns the entire Zone I of the well.
2. Well site is located on the opposite side of the system from the Glendale Well and the water storage tank.
3. Prior pump testing demonstrated a potential yield of 500 gpm.
4. Source of supply is under the SWD's control.

5. If no treatment is required, then construction of this well would not change the SWD's treatment classification.

Disadvantages to the supply include:

1. Test well work was completed in the 1960s, so additional testing work and associated permitting would be required at the same level of effort for any new well site.
2. Potential presence of TCE may require treatment using aeration. Note that the side benefit to this process is that carbon dioxide is also removed, which raises the pH of the water and eliminates the need for a separate chemical to achieve a higher pH for corrosion control. However, public perception may still be negative.
3. Well site proximity to a surface water body would require the completion of Microscopic Particulate Analysis (MPA) testing to determine if the well water is Groundwater Under the Direct Influence (GWUDI) of Surface Water. If the water is GWUDI, then additional treatment meeting the requirements of the Surface Water Treatment Rule would be required.
4. Whether the treatment involves just TCE removal and disinfection or Surface Water Treatment, the SWD would be classified with a Treatment Classification and would likely be required to hire at least one additional operator. The exact level of this classification would depend on the level of treatment.
5. Well site proximity to a surface water body would require water level monitoring and special WMA permit conditions. The MassDEP may limit the ability to pump this well during periods of high demand, even if there is only a perception that pumping of the well may impact the water level in the ponds.

Additional well sites may be available for the SWD to pursue. Maps showing the Town-owned parcels within the MassGIS identified aquifers are provided in **Appendix B**. If the Pequot Well has TCE or is classified as GWUDI, then the SWD should consider test well work at another potential well site. Note that there are Town-owned parcels within the MassGIS identified aquifers.

4.7.4 Permanent System Interconnection with Easthampton

The existing 8-inch diameter valved interconnection with Easthampton is located at the intersection of Cook Road and Line Street. Hydraulics between the two systems allow Easthampton to supply a small area of the SWD without the need for booster pumping. For Easthampton to supply water to the entire SWD system a booster pumping and metering facility is required.

System interconnection facilities can be located in above or below ground structures. If the interconnection could be made without booster pumping, then a simple underground meter vault would be viable. Since booster pumping is required, it is recommended that an above grade structure be constructed to (1) protect pump, instrumentation and electrical equipment, (2) facilitate pump maintenance, (3) simplify accessibility and (4) improve operator safety. Below ground structures, such as vaults, are classified as confined spaces and require specialized equipment, training, permits and insurance for access. Typically, these facilities are not maintained to the same degree as above grade facilities due to the accessibility issues. The exact location of an above grade facility has not been determined.

The SWD has two options for continuing to supplement supply from Easthampton: (1) install a meter vault with no booster pumping and (2) install a booster pumping station with metering. Option 1 allows Easthampton to continue to supplement supply to a small area of the system (current conditions). Option 2 gives the SWD the ability to boost water from Easthampton throughout the entire water system.

Regarding Option 2, the SWD also has options for the location of the permanent interconnection as follows:

Option 2A. Cook Road at Town Line.

1) The existing water main is 6-inch PVC at this location on Cook Road, with a transition to 8-inch PVC on County Road. Some additional piping may need to be installed.
2) The Town does not own property at this location. However, there is undeveloped land just south of the Town line that appears to be suitable for the pump station, south of the Easthampton sewer lift station.
3) Three phase power is available near this location, associated with the Easthampton sewer lift station, but may require an extension depending upon the actual booster pump station location.
4) This is a viable location. The SWD should investigate land availability and associated purchase costs at this location.

Option 2B. Coleman Road at Town Line.

1) The existing water main is 8-inch PVC at this location.
2) The Town does not own property at this location. However, there is the potential to purchase a parcel near Freedom Credit Union.
3) Three phase power is available at this location.
4) Natural gas is available at this location.
5) This is a viable location. The SWD should investigate land availability and associated purchase costs at this location.

Option 2C. College Highway at Big Y.

1) The existing water main at this location is 10-inch ACP.
2) The Town does not own property at this location. However, there is a grass strip in front of the Tractor Supply store that appears to be suitable for the pump station, outside of the right-of-way.
3) Three phase power is available at this location.
4) Property owner is not receptive to the idea of a building in this location at this time. This is not a viable location for an above ground facility.

Option 2D. Pomeroy Meadow at Town Line.

1) Connecting the two systems here would involve a stream crossing.
2) The Town does not own property at this location and there does not appear to be available land to locate the pump station.
3) Three phase power is not available at this location.

4) This is not a viable location.

Option 2E. Glendale Road at Town Line.

1) Connecting the two systems here would involve a stream crossing and installation of about 1 mile of water main.
2) The Town does not own property at this location and there does not appear to be available land to locate the pump station.
3) Three phase power is not available at this location.
4) This is not a viable location.

Based on the above analysis, the SWD has two viable options (Option 2A and 2B) for locating an above-grade booster pump station, but will need to inquiry about land availability at both locations.

Option 1 – Cook Road Meter Vault no Booster Pumping

Advantages:

1. Supplemental/emergency interconnection requires only a meter vault. No building or treatment required.
2. Interconnection does not impact the SWD's treatment classification and would not be required to hire a treatment operator.

Disadvantages:

1. A meter vault without booster pumping provides the SWD with a supplemental supply but not a full redundant supply.
2. All water transfers would require purchase costs from Easthampton; rates to be negotiated (current Easthampton rate is $2.38 per hundred cubic feet).
3. The maximum volume of water that could be provided by Easthampton is unknown and will need to be verified to determine if this supply could meet the entire SWD maximum day demand.

Option 2A – Cook Road Booster Pumping

Advantages:

1. Permanent interconnection requires only a booster pumping station with metering capabilities. No treatment is required.
2. Interconnection does not impact the SWD's treatment classification and would not be required to hire a treatment operator.

Disadvantages:

1. Locating a booster pumping station will be challenging and may require land purchase.
2. All water transfers would require purchase costs from Easthampton; rates to be negotiated (current Easthampton rate is $2.38 per hundred cubic feet).
3. The maximum volume of water that could be provided by Easthampton is unknown and will need to be verified to determine if this supply could meet the entire SWD maximum day demand.

Option 2B – Coleman Road Booster Pumping with Pressure Sustaining Valve

Advantages:

1. Permanent interconnection requires only a booster pumping station with metering capabilities. No treatment is required.
2. Interconnection does not impact the SWD's treatment classification and would not be required to hire a treatment operator.
3. Preliminary hydraulic concerns (impacts to Easthampton distribution system) expressed by Easthampton could be address through use of a pressure sustaining valve to protect Easthampton's water system and limit the amount of water to Southampton during specific high flow conditions.
4. Natural gas is available at this site.

Disadvantages:

1. Locating an above-grade booster pumping station will be challenging and would likely require land acquisition. Preliminary discussion indicate that there is the potential to purchase a parcel near Freedom Credit Union.
2. All water transfers would require purchase costs from Easthampton; rates to be negotiated (current Easthampton rate is $2.38 per hundred cubic feet).
3. The maximum volume of water that could be provided by Easthampton is unknown and will need to be verified to determine if this supply could meet the entire SWD maximum day demand.

4.7.5 Treatment of HWW Raw Water Supply

The SWD has two interconnections with the HWW raw water transmission main at the Pequot Station and Gilbert Road Station. The HWW currently has a filtration waiver for this supply, however, it is unknown whether this waiver will be maintained indefinitely or be granted to the SWD. Water taken from either location would require corrosion control and disinfection treatment, at a minimum, and may require filtration.

In 1953, an Act was issued authorizing the City of Holyoke to increase its water supply, through the taking of the waters of the southwesterly branch of the Manham River and lands to install the water transmission main. As part of this taking, the Town of Southampton was granted some water rights and required that the City provide the Town with Y-branches of at least 8-inch diameter and allowing the Town to draw from the pipeline without expense to the Town. The Town is allowed to take an amount not exceeding 125 gpd per inhabitant or 625,000 gpd, up to 228 MGY. Any amount greater than this threshold would need to be paid for at a rate to be determined by the City and the Town.

This amount of water supply exceeds the existing total annual water demand and annual average day water demand through the 20-year planning period. The maximum per day withdrawal of 625,000 gpd could meet the maximum day demand for a wet year, but is not likely to meet the maximum day demand for a normal year or a dry year, for current demands through the 20-year planning period. The Glendale Well is still the largest source of supply for the SWD. If this source were not available, the SWD would need the water from the HWW and supplement water from Easthampton to meet the maximum day demands.

Advantages to this supply include:

1. SWD legally has access to an ample volume of water available to meet total annual demand and annual average day demand.
2. No cost to purchase the water up to the withdrawal thresholds established. If SWD needs more water, this could be negotiated with HWW, but SWD would have to purchase this additional water.
3. SWD owns land at the Pequot Station large enough for construction of a treatment facility. The parcels are larger and spaced further apart, providing a natural buffer to adjacent parcels, which would allow for the construction of a more utilitarian looking facility. Note that the parcel at the Gilbert Road Station is only one acre, is highly visible and would likely require special architecture to blend with the neighborhood.

Disadvantages to the supply include:

1. Surface water treatment is required for disinfection of the supply and may require filtration now or in the future.
2. Supply does not meet the maximum day demand without supplementing from another source or purchasing additional raw water from HWW.
3. System would change treatment classification requiring more operators with higher grade licenses. If the facility is a 2T, then an operator with at least a 2T license would be required to be the primary operator and the facility would need to be manned 4 hours per day when the facility is in operation. If the facility is a 3T, then an operator with at least a 3T license would be required to be the primary operator and the facility would need to be manned 8 hours per day when the facility is in operation.
4. Surface waters inherently experience seasonal water quality changes that make operation of these treatment facilities more challenging.

4.7.6 Comparison of Options

Each of the options presented above provides advantages and disadvantages. In order to provide a backup supply that can meet the maximum day demand with the Glendale Well off-line, the SWD will need to construct a new source. The interconnection with Easthampton is a valuable backup for use in an emergency and to supplement maximum day demand, but this water may be more expensive over the long-term. Two options for additional supply within the SWD system are a New Well or use of raw water from the HWW transmission main. Both of these options have multiple scenarios depending on the water quality and level of treatment required. The following **Figure 4-15, Figure 4-16** and **Figure 4-17** provide a flow chart that depicts the additional supply scenarios under each option along with order-of-magnitude costs for comparison purposes.

Figure 4-15. New Well – Treatment Scenarios

Scenario 1
- No Treatment
- Estimated Project Cost: $640k - $970k
- Additional Annual O&M Cost: $26k

Scenario 2
- Corrosion Control - KOH Chemical Feed
- Estimated ProjectCost: $890k - $1.45 mil.
- Additional Annual O&M Cost: $56k

Scenario 3
- TCE Removal (Aeration Tower) & Disinfection with Clearwell
- Estimated ProjectCost: $1.31 mil. - $1.87 mil.
- Additional Annual O&M Cost: $51k

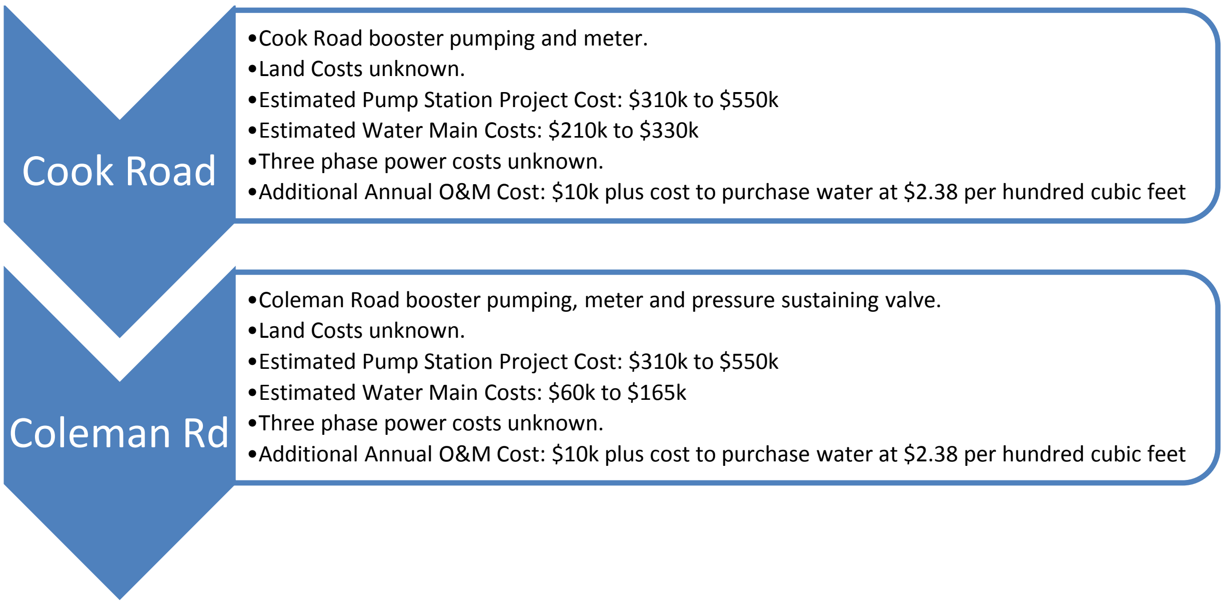
Scenario 4
- GWUDI Treatment - Filtration and Disinfection with Clearwell
- Estimated ProjectCost: $4.27 mil. - $5.51 mil.
- Additional Annual O&M Cost: $148k

Figure 4-16. HWW Raw Water Supply – Treatment Scenarios

Scenario 1
- Corrosion Control & Disinfection with Clearwell
- Estimated ProjectCost: $1.5 mil. - $2.3 mil.
- Additional Annual O&M Cost: $61k

Scenario 2
- Surface Water Treatment - Filtration & Disinfection with Clearwell
- Estimated ProjectCost: $4.9 mil. - $5.9 mil.
- Additional Annual O&M Cost: $148k

Figure 4-17. Easthampton Interconnection Options



4.8 Summary

The analysis of the SWD's supply sources indicate the following:

1. The Glendale Well 02G safe yield capacity meets current average day demands.
2. In the future the WMA Permit withdrawal for total annual pumpage will need to be increased to meet demands especially during dry years, similar to the period from 1999 to 2002.
3. Depending on the year, the Glendale Well 02G safe yield capacity does not meet current or future maximum day demands.
4. The SWD does not meet the MassDEP Guidelines for Public Water Suppliers Chapter 7 requirement that with any supply pump out of service, the remaining pump(s) shall be capable of providing the maximum daily pumping demand of the system.
5. Supply redundancy is poor since SWD has only one source of supply.
6. Unaccounted for Water is below the MassDEP standard of 10%.
7. Residential demand was greater than the MassDEP standard of 65 RGPCD through 2013 and was below this standard in 2014. If residential demand increases above 65 RGPCD, the SWD will be required to take measure to reduce usage.
8. The facility audit of the Glendale Well, pumping station and treatment facility showed that these facilities comply with MassDEP requirements.
9. SWD has options for additional sources of supply to address redundancy issues including a new well, treatment of raw water from Holyoke Water Works and interconnections with neighboring water systems. The various options were evaluated and the advantages and disadvantages of each presented in **Section 4.7**. The options evaluated included:
    a. Metered interconnection with Easthampton.
    b. Booster Pump interconnection with Easthampton.
    c. Additional well at Glendale well site.

d. New well at the Pequot Road Station or other site.
e. Treatment of HWW Raw Water Supply at the Pequot Rd Station

The results of the analysis indicate that construction of an above-grade booster pumping station at an interconnection with Easthampton, followed by construction of either Glendale Well 03G, a New Well at the Pequot Road Station or another site or use of the HWW Raw Water Supply are the most advantageous options.

5.0 Distribution and Storage Evaluation

The scope of this project included updating the water distribution system map to reflect system changes (physical and operational) and then utilize this updated water distribution system map to create a computerized hydraulic model. Changes since the last water system map update in 1998 were incorporated into the model including the primary supply shifting from Well 01G to Well 02G after the construction and use of the new Glendale Well in 2002. Other changes such as sodium hypochlorite addition at the well pump were also analyzed in the hydraulic evaluation.

Fire flow tests were conducted in order to calibrate the updated hydraulic model.

The model was used specifically to:

- Evaluate system pressures,
- Evaluate hydraulic balancing,
- Estimate available fire flows and compare with Insurance Services Office (ISO) data,
- Simulate the effects of system improvements
- Identify critical flow paths/restrictions to assist with prioritization of improvements.

5.1 Distribution System Overview

The Town of Southampton supplies water to a population of approximately 4,012 residents. The water system includes one water supply well with associated pumping and treatment equipment, another water supply well that is rarely used, one water storage tank, and approximately 45 miles of water main ranging in size from 2-inch to 12-inch diameter. Portions of water main were installed in 1932 and are still in service today.

The majority of the water mains are PVC pipe but there are sections of the original cast iron (CI) pipes and asbestos cement (AC) pipe located in the older areas of the water system. The pipe ages are estimated; the CI pipe is the oldest followed by the AC pipe and then the PVC pipes. **Figures A1** and **A2** of the water distribution system showing the water system with water mains color coded by diameter are provided in **Appendix A**. A summary of the length of water main per diameter and per material is provided in **Tables 5-1 and 5-2**.

Table 5-1. Length of Water Main per Diameter

Diameter	Approximate Length (ft)	Percent of Total
6	41,600	18%
8	155,000	66%
10	8,700	4%
12	30,600	13%
Total	235,900	100%

Table 5-2. Length of Water Main per Material

Diameter	Approximate Length (ft)	Percent of Total
Asbestos Cement	28,100	12%
Cast Iron	16,300	7%
PVC	191,500	81%
Total	235,900	100%

The Town has one storage tank which has a capacity of 744,000 gallons located off of Wolcott Road. **Table 5-3** summarizes information on the tank.

Table 5-3. Water Storage Tanks

	Wolcott Road Tank
Status	Active
Material	Glass-Fused Steel
Style	Standpipe
Volume	0.744 MG
Base Elevation	438.2 feet Elev.
Overflow Elevation	457.2 feet Elev.
Height	19 ft
Inside Diameter	81 ft
Gallons per Foot	38,547
Year Constructed	1991

The water level in the Wolcott Road water storage tank controls the operation of the Glendale Well 02G pump. System operations may be controlled manually where an operator starts/stops pumps intentionally or automatically where pumps start/stop based on tank level.

In the winter, the well pump is activated when the water level drops to 10 feet and shuts off when the water level reaches 15 feet. In the summer, the well pump is activated when the water level drops to 12 feet and shuts off when the water level reaches 15 feet. This seasonal adjustment is used to ensure minimal ice formation in the tank during the winter.

5.2 Hydraulic Model

A hydraulic model of the distribution system was developed in WaterCAD to simulate system operations. The model allows for a more quantitative analysis of the most cost-effective options to address the problems associated water demand, total coliform detections, and low pressures.

The model was constructed using the SWD's system map to develop a GIS database with the pipe locations, lengths, diameters, and materials. This information was then imported into the hydraulic model. The following items were addressed in the development of the model:

- Nodes or junctions were created at pipe intersections and pipe size/type changes.

- Elevations were established at each node using MassGIS contour topographic mapping.
- Well, pump and tank and characteristics were inserted.
- System controls were programmed to operate the Glendale Well based on the Wolcott Road storage tank water level.
- Water demands throughout the system and current demand conditions and future/projected demand conditions for the year 2035.
- Calculated system demand for 7 day period during high demand week in May 2015 and average demand week in March 2015.
- Developed diurnal curves for the average and maximum demand weeks.
- Programmed model with average and maximum week diurnal curve data.
- Programmed the model to evaluate the water age throughout the system at hourly intervals over one week period. Setup to show the water age as color coded junctions.
- Programmed the model to calculate the residual chlorine throughout the system at hourly intervals over one week period. Setup to show the residual chlorine levels as color coded junctions.
- Imported background with streets and street names.
- Developed scenarios for:
  - 2015 and 2035 Average Day Demand
  - 2015 and 2035 Maximum Day Demand
  - 2015 and 2035 Peak Hour Demand
  - 2015 and 2035 Average Week Demand
  - 2015 and 2035 Maximum Week Demand
- Calibrated the model against actual fire flow tests completed on December 10, 2015.

Figure C-1 in **Appendix C** provides a map of the hydraulic model.

Flow tests were performed to calibrate the system for existing conditions. The locations for the hydrant flow tests were chosen to represent different geographic regions of the distribution system, representing dead ends in the outer reaches of the system, as well as loops throughout the system. At each test location two or more nearby hydrants were used, one to monitor system pressure and the other to measure flow. The intent of the flow tests is to stress the system and obtain sufficient data to calibrate the model.

As shown in **Table 5-4**, the static pressure represents the system pressure at the test location before imposing the hydrant flow. The residual pressure represents the system pressure at the test location while the hydrant is flowing. Each test was simulated in the model to verify the estimated pipe roughness (Hazen and Williams' C-value or "roughness" coefficient).

Table 5-4. Fire Flow Tests and Calibration Results

Test	Test 1	Test 2	Test 4	Test 5	Test 6	Test 6A	Test 7
Flowing Hydrant (FH) Location	224 Pomeroy Meadow Rd	10 Coleman Road	224 College Highway	313 College Highway	108 Valley Road	225 Brickyard Road	13 Gilbert Road
Residual Hydrant (RH) Location	283 Pomeroy Meadow Rd	36 Coleman Road	233 College Highway	324 College Highway	102 Valley Road	162 Valley Road	2 Gilbert Road
Date Time	12/10/15 9:15 am	12/10/15 9:42 am	12/10/15 10:05 am	12/10/15 10:20 am	12/10/15 10:40 am	12/10/15 11:00 am	12/10/15 11:26 am
Wolcott Road Tank Level (ft)	13.0	12.8	12.7	12.6	12.4	12.3	12.1
Pump Status	Off	Off	Off	Off	Off	Off	Off
Static Pressure at FH (psi)	116	112	100	72	44	88	66
Static Pressure at RH (psi)	120	98	94	78	40	88	68
Flow at FH (gpm)	997	1183	560	451	407	803	780
Residual Pressure at RH (psi)	76	72	58	40	16	50	42
Model FH Junction	J-259	J-279	J-121	J-257	J-207	J-250	J-227
Model RH Junction	J-275	J-278	J-280	J-232	J-208	J-162	J-220
Model Static Pressure at FH (psi)	116	112	100	72	44	88	66
Model Static Pressure at RH (psi)	120	98	94	78	40	88	68
Model Residual Pressure at RH (psi)	77	72	58	42	12	51	44
Model within Calibration Tolerance?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Comments	--	1	2	--	--	--	--

[1] Changed C-value on 6-inch CI on College Highway roughly from Glendale Road to Hillside Meadows Drive to more accurately represent C-value for 85-year-old CI pipe and calibrate model

[2] Changed C-value on 6-inch CI on College Highway roughly from hydrant flow test 5 location to Pomeroy Meadow Road to more accurately represent C-value for 85-year old CI pipe and calibrate model.

Table 5-4. Fire Flow Tests and Calibration Results (Continued)

Test	Test 8	Test 9	Test 10	Test 11
Flowing Hydrant (FH) Location	Pequot Station	4 Belanger Road	26 Eastwood Drive	41 Cold Spring Road
Residual Hydrant (RH) Location	54 Pequot Road	1 Aimee Road	1 Eastwood Drive	33 Cold Spring Road
Date Time	12/10/15 12:03 pm	12/10/15 12:22 pm	12/10/15 12:50 pm	12/10/15 1:20 pm
Wolcott Road Tank Level (ft)	11.9	11.8	11.6	11.5
Pump Status	Off	Off	Off	Off
Static Pressure at FH (psi)	84	78	48	42
Static Pressure at RH (psi)	80	78	76	62
Flow at FH (gpm)	651	508	560	560
Residual Pressure at RH (psi)	30	22	42	52
Model FH Junction	J-277	J-51	J-90	J-202
Model RH Junction	J-244	J-17	J-176	J-201
Model Static Pressure at FH (psi)	84	78	48	42
Model Static Pressure at RH (psi)	80	78	76	62
Model Residual Pressure at RH (psi)	30	26	42	59
Model within Calibration Tolerance?	Yes	Yes	Yes	No
Comments	--	--	--	--

When developing the model, the pipe conditions begin in "like new" condition, with high C-values and fully open valves. As the model is calibrated, adjustments are made to more accurately simulate the field fire flow conditions. If the residual pressure in the model was within a calibration tolerance of 5 psi as compared with actual field conditions, the model was considered to be accurate. The following adjustments were made to accurately simulate the field conditions:

1. Globally changed all C-values for CI pipes from 130 to 40. CI pipe can often experience tuberculation after many years of use with a rough interior surface and reduction of inside diameter, both resulting in lower C-values. All CI pipes in the SWD system were installed around 1932, making them nearly 85 years old. Heavy tuberculation was confirmed by system operators based on visual observations during past pipe repairs and replacement.
2. Changed a portion of water main along Pomeroy Meadow Road near the town line with Easthampton from 8-inch PVC to 5.5-inch PVC. This indicates a partially closed valve somewhere between Wolcott Road and the town line.
3. Changed a portion of water main along College Highway from 6-inch CI pipe to 3-inch CI pipe between Hillside Meadows Drive and Glendale Well. This indicates heavy tuberculation in CI pipe.
4. Changed a portion of water main along College Highway from 6-inch CI to 4-inch CI pipe between Flow Test #4 and Wolcott Road. This indicates heavy tuberculation in CI pipe.
5. Changed a portion of water main along Strong Road from 6-inch CI pipe to 3-inch CI pipe between College Highway and Clark Street. This indicates heavy tuberculation in CI pipe.
6. Changed a portion of water main along College Highway from 6-inch to 3.5-inch between Flow Test #4 and Clark Street. This indicates heavy tuberculation in CI pipe.
7. Changed a portion of water main along College Highway from 6-inch to 3-inch between Clark Street and Flow Test #5. This indicates heavy tuberculation in CI pipe.
8. Changed a portion of water main along Fomer Road from 12-inch PVC to 5-inch PVC. This indicates a partially closed valve somewhere near Flow Test #7.
9. Changed a portion of water main along Gilbert Road from 8-inch PVC to 5-inch PVC. This indicates a partially closed valve somewhere near Flow Test #6A.
10. Changed a portion of water main along Valley Road from 8-inch PVC to 4.5 inch PVC. This indicates a partially closed valve somewhere near Flow Test #6.
11. Changed a portion of water main along County Road from 8-inch PVC to 4-inch PVC. This indicates a partially closed valve somewhere near Flow Test #9.
12. Changed a portion of water main along County road from 8-inch PVC to 4.5-inch PVC. This indicates a partially closed valve somewhere near Pleasant Street.

Figure C-2 in **Appendix C** shows a map of the water system model with notes on changes made to calibrate the model.

5.3 Evaluation of System Pressures

The model was used to evaluate service pressures under average day, maximum day, and peak hour demands. The minimum pressure requirement for water distribution systems has been established in the MassDEP "Guidelines and Policies for Public Water Systems", as 35 psi (pounds per square inch) for all non-emergency conditions and 20 psi for emergency conditions (i.e. fire flows). Average day, maximum day and peak hour demands are non-emergency so the pressure needed during these demand conditions is 35 psi.

Under average day demands (current and future), it was assumed that all pumps were off and that the tank was supplying water to the distribution system and that the tank was at typical low water level (12 ft). This provides for worst-case pressure conditions under this scenario. Based on this assumption, most locations within the system have residual pressures between 40 and 76 psi. The following locations were close to or below a residual pressure of 35 psi:

- Junctions along Valley Road had low pressures of 16 psi
- Junctions at Pequot Station and on Pequot Road had low pressures of 30 psi.
- Junctions along County Road at Aimee Road and Belanger Road had low pressures of 22 psi.

The lower pressures at some of these locations indicated by the model are a result of ground elevations (i.e. Valley Road near College Highway) and others may be the result of a partially closed valve somewhere in the distribution system.

Figures A-3 and **A-4** in **Appendix A** show the water system and highlights areas above the high service elevation of El. 358 ft, as determined by the minimum residual pressure of 35 psi in conjunction with a low water tank level of about 6-inches since the entire volume of the tank is considered usable. These shaded areas are not serviceable by the current water system hydraulic gradeline.

5.4 Evaluation of Hydraulic Balancing

The model was programmed to operate under extended time scenarios. The historical data of hourly tank level and supply pump operation were used to calculate an average and high demand week in 2015 as presented in **Section 2.4**. The calculated system demand data (gallons per hour) was used to establish hourly demand ratios for these typical average and maximum demand weeks. This allows for the model to simulate a changing system demand (hourly) for an extended period (one week) as compared with a static model that only allows for a steady system demand (essentially a single moment in time).

The model was also programmed to simulated existing system operation with the Glendale Well 02G as the primary source. The well pump was programmed to turn on when the water storage tank level drops to 12 feet and the pump shuts off when the water level in the tank reaches 15 feet, simulating normal summer operating conditions.

5.5 Available Fire Flows

The Insurance Services Office (ISO) sets forth requirements for fire flow protection. Needed fire flows are developed based on the use of structures, building material of structures and spacing of structures. Commercial and industrial areas require higher flows that residential areas.

In most cases, residential fire flows for a two story, one or two family dwelling should be between 500 and 1,500 gpm, depending on the distance between dwellings. Other residential structures may require flows up to 3,500 gpm (i.e. multi-story apartment buildings). Commercial and industrial structures can require higher fire flows. It is beyond this assessment to determine the needed fire flows for various structures. Note that the maximum fire flow requirement that a public water system is typically responsible for providing, as defined by the ISO, is 3,500 gpm.

ISO completes an evaluation of fire flow needs and availability periodically. The last evaluation in the Town was conducted in 2004. During that time, several locations were identified with inadequate flows. The hydrant flow summary from the 2004 ISO report is summarized in **Table 5-5**. The minimum pressure requirement for water distribution systems has been established in the MassDEP "Guidelines and Policies for Public Water Systems", as 35 psi for all non-emergency conditions and 20 psi for emergency conditions. Fire flows are considered emergency conditions, so 20 psi must be maintained throughout the system under these conditions. This table also includes the current approximate available flows using the computer model while maintaining 20 psi throughout the system.

Table 5-5 shows that some areas of the water system are able to provide the ISO needed fire flows and some areas are not. Note that when flow tests are done at local hydrants in the system, the available fire flows at 20 psi at the exact test locations are calculated from this field data. This calculation does not account for maintaining 20 psi throughout the water system, so the field test data alone may provide misleading information as to the water system's adequacy for fire flows. The minimum of 20 psi at any point in the water system is needed to prevent potential vacuum conditions that would adversely impact public health and potentially cause pipe collapse. Using the model, the available flows at the various ISO sites were determined while maintaining 20 psi locally and 20 psi throughout the water system. This additional protection impacts a few of the ISO sites and the ability of the water system to provide the ISO needed fire flows.

Table 5-5. ISO Hydrant Flow Summary

		2004 Field Conditions		Model		
Location	ISO Needed Flows (gpm)	2004 Available Flows per ISO (gpm)	2004 Field Conditions Meet Needed Flows?	Available Flows at 20 psi Locally (gpm)	Sustainable Flows maintaining 20 psi throughout system (gpm)	Meets ISO Needed Flows?
College Hwy. south of Easthampton line	3,000	2,400	No	2,570	1,045	No
College Hwy. at Southampton Meadow Apts	3,000	3,100	Yes	3,550	3,400	Yes
Gunn Rd. Ext. at Pomeroy Meadow Rd.	3,000	4,300	Yes	7,150	4,320	Yes
Clark St. at East St.	3,500	1,900	No	2,370	1,630	No
Brickyard Rd. at College Hwy.	2,500	1,200	No	1,250	920	No
Coolidge Dr. at Madison Ave.	750	1,100	Yes	1,160	950	Yes
Strong Rd. at Valley Rd.	1,500	1,100	No	950	480	No
Strong Rd. north of Moose Brick Rd.	1,000	1,200	Yes	1,030	520	No
Pleasant St. north of East St.	1,000	2,400	Yes	1,385	580	No
Pleasant St. at Line Rd.	1,500	1,200	No	1,400	740	No
County Rd. N. north of Donna Marie Way	750	950	Yes	740	460	No
County Rd. S. south of Camp Jahn Rd.	1,750	600	No	660	460	No

5.6 Storage Analysis

Distribution storage is provided to meet peak demand of short duration (hourly fluctuations), minimize pressure fluctuations during periods of demand changes, and to provide the required water for fire flow requirements and short term emergencies. The total volume of the storage facilities is not typically usable. In order for the water in the storage tank to be usable it must be stored above an elevation that corresponds to a minimum pressure requirement at ground elevation at all points in the distribution system. The minimum pressure requirement for water distribution systems has been established in the MassDEP "Guidelines and Policies for Public Water Systems", as 35 psi (pounds per square inch) for all non-emergency conditions and 20 psi for emergency conditions (ie. fire flows). The maximum ground service elevation is the highest elevation within the distribution system that will receive 35 psi.

There is only one pressure zone in the SWD water system. Under normal operating conditions the tanks fluctuate between approximately 10 feet to 15 feet. The tank base is located at El. 438 ft. The overflow is at 19 ft or El. 457.2 ft. When the water level is nearly empty with 1 ft of water at El. 439 feet, the tank can theoretically provide 35 psi static pressures to customers up to El. 357 feet, without additional booster pumping.

Equalization Storage

The equalization storage volume is the storage required to meet the peak hour demands during the maximum day demand period. Equalization storage volume is generally provided by the portion of the tank that is above the water level required for adequate system pressures or 35 psi. A rule of thumb for the needed volume of equalization storage is 15% of the maximum day demand. The 2015 maximum day demand was about 0.720 mgd. Therefore, for the SWD, the equalization storage would be 15% of 0.108 mgd or 108,000 gallons.

Fire Storage

Fire flow storage is that volume of water required to fight a fire within the area serviced by the distribution system. The fire flow storage is based on the maximum fire flow requirement that a public water system is typically responsible for providing, which is defined by the Insurance Service Office (ISO) as 3,500 gpm (gallons per minute) for a duration of 3 hours. Notably, the ISO has identified needed fire flows of greater than 3,500 gpm within the SWD water system. Therefore, the fire flow storage goal is 630,000 gallons. The minimum service pressure recommended during fire conditions is 20 psi. Using the maximum service elevation of El. 357 ft and this pressure, the minimum storage tank water level could theoretically be below the base of the tank which is El. 438 ft. Therefore, for the Wolcott Tank, the entire volume is usable storage for fire storage.

Emergency Storage

In addition to fire and equalization requirements, storage is often provided for emergencies. Emergency storage provides water during short-term emergency situations such as equipment and main failures. The emergency storage requirement rule of thumb is 15 percent of the sum of equalization storage and fire flow storage. The minimum service pressure recommended during emergency conditions is 20 psi.

In addition to the good practice storage design factors described above, the MassDEP Sanitary Survey notes that for community water systems, without a redundant source of supply, two days of water storage is required. The SWD average day demand in 2015 was 348,000 gpd. Therefore two average days is 696,000 gallons which is just below the total storage provided by the tank. Completing this comparison for the maximum day demand of 720,000 gpd, shows that the storage tank could not supply water to meet one entire maximum day. If there were a problem with the Glendale Well on the average day, the SWD would have nearly two days to address the problem, assuming the tank was full to start. If there were a problem with the Glendale Well on the maximum day, the SWD would have less than one day to address the problem, assuming the tank was full to start. Otherwise, the SWD would have to rely on their interconnections as discussed in **Section 4** for any extended supply problems.

Table 5-6 shows a comparison of the needed and available storage volumes.

Table 5-6. Needed and Available Storage Volumes

Storage Characteristic	Volume (Gallons)
Equalization Storage	
Current Available Storage above 35 psi	744,000
Year 2015 Needed Equalization Storage	108,000
Current Storage Meets Equalization Needs?	Yes
Year 2035 Needed Equalization Storage (Normal)	111,000
Current Storage Meets Equalization Needs?	Yes
Year 2035 Needed Equalization Storage (Dry)	123,000
Current Storage Meets Equalization Needs?	Yes
Fire Storage and Emergency Storage*	
Current Available Storage above 20 psi	744,000
Year 2015 Needed Fire & Emergency Storage	740,700
Current Storage Meets Fire & Emergency Needs?	Yes
Year 2035 Needed Fire & Emergency Storage (Normal)	741,100
Current Storage Meets Fire & Emergency Needs?	Yes
Year 2035 Needed Fire & Emergency Storage (Dry)	742,900
Current Storage Meets Fire & Emergency Needs?	Yes
MassDEP Two Day Storage Requirement	
Current Available Storage above 35 psi	744,000
Year 2015 Average Day Demand	348,000
Year 2015 Two Average Day Demand	696,000
Current Storage Meets MassDEP Two Day Demand Requirement for 2015 Demands?	Yes
Year 2015 Maximum Day Demand	720,000
Current Storage Meets 2015 Maximum Day?	Yes
Year 2035 Average Day Demand (Dry)	384,000
Year 2035 Two Average Day Demand (Dry)	768,000
Current Storage Meets MassDEP Two Day Demand Requirement for 2035 Demands?	No
Year 2035 Maximum Day Demand (Dry)	818,000
Current Storage Meets 2035 Maximum Day?	No

5.7 Storage Tank Inspection

The Wolcott Tank was inspected by Statewide Aquastore Inc. in 2011. The inspection was performed with the use of a remote observation vehicle. On the tank interior, both the glass coating and sealer appeared to be in good condition. On the tank exterior, the glass coating and sealer was determined to be in good condition. The report noted that some minor corrosion was observed, but it was not known whether the corrosion was present before the cathodic protection system was installed. According to the test performed at the time of the inspection, the cathodic protection system was performing as desired. Recommendations from the inspection included:

1. Re-inspection of this tank in five years in accordance with recommendations from AWWA Standard D-103.
2. Monitoring of the Cathodic Protection System every 3 to 5 years to ensure it is performing as designed.

5.8 Summary of Distribution and Storage Analyses

This hydraulic analysis included evaluation of system pressures, hydraulic balancing, needed versus available fire flows, and needed versus available storage. The following list summarizes our findings:

- Additional storage is needed to meet MassDEP requirements. For systems without redundant sources of supply, MassDEP requires two days of storage. The SWD meets this requirement for the average day demand in 2015. However, future demands will likely exceed this threshold.
- Additional storage would provide the SWD with more time to make repairs to the Glendale Well and Pumping Station should a problem arise.
- Additional storage located on the opposite end of the system would improve system redundancy and residual pressures in the southern end of the system.
- System modifications (pipe replacement and/or loops) are needed to meet ISO fire flow requirements at select areas throughout the system.

5.9 Effect of Potential Hydraulic Improvements

Hydraulic improvements were simulated in the model to evaluate the benefits to system pressures, hydraulic balancing and fire flows. In particular water main improvements were made in phases to test the ability of these improvements to meet the ISO needed fire flows. The identified water main improvements are proposed to replace the severely tuberculated 6-inch cast iron main and/or to complete pipe loops. **Figure C-3** in **Appendix C** provides a map of these improvements, which are listed in **Table 5-7.**

Table 5-7. Water Main Improvements

Improvement Number	Location	Existing	Proposed Improvement
A	College Highway from Pomeroy Meadow to Park Place	6-inch AC, Repeated and excessive breaks occurred in 2016. Complete project as part of MassDOT road improvements.	1,800 l.f. of 12-inch DI main
B	College Highway from Park Place to Gunn Road Extension		1,200 l.f. of 12-inch DI main
1	College Highway from Fomer Road to existing 10-inch AC pipe	6-inch CIP severely tuberculated	3,850 l.f. of 8-inch PVC main
2	College Highway from Pomeroy Meadow Road to Fomer Road	6-inch CIP severely tuberculated	6,400 l.f. of 8-inch PVC main
3	East Street from College Highway to existing 8-inch PVC pipe	6-inch CIP severely tuberculated	1,950 l.f. of 8-inch PVC main
4	Moose Brook Road from College Highway to existing 8-inch PVC pipe	None	3,150 l.f. of 8-inch PVC main
5	College Highway from Glendale Well 8-inch PVC pipe to existing 6-inch ACP on College Highway	6-inch CIP severely tuberculated	1,760 l.f. of 8-inch PVC main
6	Middle Road and Valley Road from Pequot Road to Valley/Strong intersection	None	6,300 l.f. of 8-inch PVC main
7	East Street to connect the two ends of the existing 8-inch PVC pipe	None	4,850 l.f. of 8-inch PVC main
8	Jonathan Judd Circle 8-inch PVC connection	None	200 l.f. of 8-inch PVC main

The hydraulic model was used to test the ability of Improvements #1-8 to improve fire flows to the ISO sites. These improvements were completed in consecutive steps for the improvements listed in **Table 5-7**. The effect of these cumulative improvements on the available fire flows is shown in **Table 5-8**. Some of these improvements help to meet the ISO needed fire flows.

Table 5-8. Effect of Water Main Improvements on Fire Flows

Location	ISO Needed Flow (gpm)	Flows Available After Water Main Improvements (gpm)*						
		Improvement Number 1	Improvement Number 1-2	Improvement Number 1-3	Improvement Number 1-4	Improvement Number 1-5	Improvement Number 1-6	Improvement Number 1-7
College Hwy. south of Easthampton line	3,000	1,600	1,600	1,600	2,200	2,500	2,800	2,900
College Hwy. at Southampton Meadow Apts	3,000	3,100	3,100	3,100	3,100	3,200	3,200	3,200
Gunn Rd. Ext. at Pomeroy Meadow Rd.	3,000	4,100	4,100	4,100	4,100	4,100	4,100	4,100
Clark St. at East St.	3,500	1,300	1,800	1,900	1,900	2,000	2,100	2,100
Brickyard Rd. at College Hwy.	2,500	1,100	1,600	1,600	1,600	1,700	1,800	1,800
Coolidge Dr. at Madison Ave.	750	1,100	1,700	1,700	1,700	1,800	1,900	1,900
Strong Rd. at Valley Rd.	1,500	1,400	1,500	1,500	1,500	1,900	1,900	1,900
Strong Rd. north of Moose Brick Rd.	1,000	1,400	1,400	1,500	1,500	2,000	2,000	2,000
Pleasant St. north of East St.	1,000	1,300	1,300	1,300	1,600	2,000	2,000	2,000
Pleasant St. at Line Rd.	1,500	1,200	1,200	1,200	1,400	1,600	1,900	1,900
County Rd. N. north of Donna Marie Way	750	490	500	500	500	500	1,000	1,200
County Rd. S. south of Camp Jahn Rd.	1,750	490	500	500	500	500	1,000	1,300

*Available flows while maintaining 20 psi throughout the water system. Note that Improvement Number 8 was not included in this table since it had no impact on the available fire flows at the ISO sites and is a recommended improvement strictly for pipe looping (and water quality) benefits.

6.0 Infrastructure Prioritization and Capital Plan

The evaluations completed for this project identified many needed infrastructure improvements to correct deficiencies and meet future needs over a 20 year period. Prioritization of these projects is required recognizing the need for prudent expenditure of available funds. This capital improvement prioritization program provides the SWD with a road map to follow, while allowing for periodic updating as priorities and other constraints change over time.

6.1 List of Identified Needs

The following provides a list of the needs identified in the previous Sections of this report.

Water Management Act Compliance Needs

WMA-1. Maintain residential demands below 65 RGPCD and UAW below 10%.
- a. Development of a water conservation plan.
- b. Completion of water audits, in-house each year (annual reporting) outside consultant every five years.
- c. Leak detection of entire system should be completed at least every other year.

WMA-2. WMA Permit renewal process to start in November 2016.

Supply Redundancy Needs

WS-1. Additional supply is needed to meet the current and future maximum day demand with the existing supply operating at full capacity.
- a. Regain full capacity of Glendale Well 02G.
- b. Construct permanent interconnection with Easthampton to supplement water supply during peak demand periods.

WS-2. Additional supply is needed to meet the existing and future maximum day demand with the largest supply off-line in accordance with MassDEP Guidelines. Construct new source through development of:
- a. Glendale Well 03G,
- b. New Well at different site or
- c. Treatment of water from HWW.

WS-3. Permanent emergency supply interconnection with the City of Westfield requires piping through a meter vault (currently hydrant to hydrant).

Storage Tank Needs

ST-1. Additional storage is needed to:
- a. Meet future storage needs.
- b. Provide storage redundancy in case of emergency and when tank requires maintenance.

ST-2. Water storage tank inspections every 5 years.

Distribution System and Water Main Needs

DS-1. Investigation of locations with potentially closed and partially closed valves.

WM-A. College Highway from Pomeroy Meadow to Park Place, replace 6-inch AC pipe with 12-inch ductile iron main. Existing pipe suffering from excessive breaks. MassDOT is completing road improvements during 2016, replace main as part of this work.

WM-B. College Highway from Park Place to Gunn Road Extension, replace 6-inch AC pipe with 12-inch ductile iron main. Existing pipe suffering from excessive breaks. MassDOT is completing road improvements during 2016, replace main as part of this work.

WM-1. College Highway from Fomer Road to existing 10-inch AC pipe, replace severely tuberculated 6-inch diameter cast iron main with 8-inch PVC main.

WM-2. College Highway from Pomeroy Meadow Road to Fomer Road, replace severely tuberculated 6-inch diameter cast iron main with 8-inch PVC main.

WM-3. East Street from College Highway to existing 8-inch PVC pipe, replace severely tuberculated 6-inch diameter cast iron main with 8-inch PVC main.

WM-4. Moose Brook Road from College Highway to existing 8-inch PVC pipe, install new 8-inch PVC main to complete pipe loop.

WM-5. College Highway from Glendale Well 8-inch PVC pipe to existing 6-inch AC pipe on College Highway, replace severely tuberculated 6-inch diameter cast iron main with 8-inch PVC main.

WM-6. Middle Road and Valley Road from Pequot Road to Valley/Strong intersection, install new 8-inch PVC main to complete pipe loop.

WM-7. East Street to connect the two ends of the existing 8-inch PVC pipe, install new 8-inch PVC main to complete pipe loop.

WM-8. Jonathan Judd Circle 8-inch PVC connection, install 8-inch PVC pipe to complete pipe loop.

Other Needs

OTHR-1. Provide portable emergency generator for Glendale Well.

OTHR-2. Emergency Response Plan training every year required by MassDEP.

OTHR-3. Development of Capital Improvement Plan (CIP) required by MassDEP Sanitary Survey, to be completed by December 31, 2016 (this project includes CIP).

OTHR-4. Development of Asset Management Plan (AMP) required by MassDEP Sanitary Survey, to be completed by December 31, 2016.

OTHR-5. Written maintenance plan required by MassDEP Sanitary Survey, to be completed by December 31, 2016.

OTHR-6. Develop routine flushing program required by MassDEP Sanitary Survey

OTHR-7. Physically separate the Pequot Road interconnection to provide air gap required by MassDEP Sanitary Survey by March 31, 2015 (project completed).

6.2 Capital Plan and Order-of-Magnitude Costs

As part of developing an overall Capital Improvement Plan, the various needs were ranked in terms of criticality according to the following factors:

- Project helps meet compliance with current/future regulation,
- Critical system component,
- Mitigates existing/future supply deficiency,

- Helps resolve fire flow deficiency,
- Addresses aging infrastructure,
- Addresses low pressure issues,
- Addresses need from future development,
- Reoccurring maintenance item frequency.

Implementation costs were estimated and an initial phased schedule of improvements was developed, for integration with the SWD's overall Water Capital Improvements Debt Service Plan.

The American Association of Cost Engineers (per ANSI Standard Z94.0-1989) has defined levels of accuracy that are commonly used by professional cost estimators. Three categories of accuracy include: (1) order-of- magnitude, (2) budget, and (3) definitive estimates. The estimates of comparative cost presented in this report are considered order-of-magnitude, and were developed with limited engineering detail for comparison purposes. Our cost estimates reflect April 2016 construction costs and are based on work of a similar nature. The costs must be re-evaluated prior to appropriating funds, since construction costs increase steadily each year. Actual project costs may vary from this preliminary estimate as a result of additional engineering detail and other cost-related variables.

The identified capital projects were prioritized/scheduled by implementation time period as follows:

- **Table 6-1** Capital Improvement Projects - Years 1 to 5
- **Table 6-2**. Capital Improvement Projects - Years 6 to 10
- **Table 6-3**. Capital Improvement Projects - Years 11 to 15
- **Table 6-4**. Capital Improvement Projects - Years 16 to 20
- **Table 6-5**. Capital Improvement Projects - Beyond 20 Years

Table 6-1. Capital Improvement Projects – Years 1 to 5

Project	Project ID	Year 1 FY'17 July 2016 - June 2017 Low Range - Order of Magnitude Cost Estimate	Year 1 FY'17 July 2016 - June 2017 High Range - Order of Magnitude Cost Estimate	Year 2 FY'18 July 2017 - June 2018 Low Range - Order of Magnitude Cost Estimate	Year 2 FY'18 July 2017 - June 2018 High Range - Order of Magnitude Cost Estimate	Year 3 FY'19 July 2018 - June 2019 Low Range - Order of Magnitude Cost Estimate	Year 3 FY'19 July 2018 - June 2019 High Range - Order of Magnitude Cost Estimate	Year 4 FY'20 July 2019 - June 2020 Low Range - Order of Magnitude Cost Estimate	Year 4 FY'20 July 2019 - June 2020 High Range - Order of Magnitude Cost Estimate	Year 5 FY'21 July 2020 - June 2021 Low Range - Order of Magnitude Cost Estimate	Year 5 FY'21 July 2020 - June 2021 High Range - Order of Magnitude Cost Estimate	Notes
College Highway from Pomeroy Meadow to Park Place	WM-A	$80,000	$100,000									Work to be completed by Contractor for MassDOT road improvement work. Approx. 1,800 l.f. of 8-inch PVC main. Cost to be covered as part of MassDOT project.
College Highway from Park Place to Gunn Road Extension.	WM-B			$60,000	$80,000							Work to be completed by Contractor for MassDOT road improvement work. Approx. 1,200 l.f. of 8-inch PVC main. Costs do not include paving.
Permanent Interconnection with Easthampton - Design/Permitting	WS-1b	$50,000	$75,000									Permanent interconnection could be meter vault or booster pump station depending on the amount of system to be supplemented by Easthampton. Rage of costs for station located on Coleman Road including associated water main improvements, land purchase and power to site.
Permanent Interconnection with Easthampton - Construction	WS-1b			$380,000	$710,000							
Regain Capacity of Glendale Wellfield	WS-1a			$50,000	$75,000							Well cleaning, pump replacement, electrical upgrades. Wells 01G and 02G.
New Source Study	WS-2					$25,000	$75,000					Investigations into development of new source (Glendale Well 03G, Pequot Well, Other Well, HWW Water)
College Highway from Fomer Road to existing 10-inch AC pipe	WM-1					$420,000	$580,000					3,850 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
College Highway from Pomeroy Meadow Road to Fomer Road	WM-2							$700,000	$935,000			6,400 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
Inspect Water Storage Tank every 5 years	ST-2	$2,000	$5,000									Tank inspection required every 5 years.
Develop Water Conservation Plan	WMA-1a			$10,000	$20,000							Water conservation plan required by WMA Permit with permit renewal.
Complete Leak Detection every other year	WMA-1c	$2,000	$5,000			$2,000	$5,000			$2,000	$5,000	Leak detection of entire system is required every other year.
WMA Permit Renewal and Evaluation	WMA-2			$5,000	$10,000							WMA Permit Renewal process starts in November 2016 with submittal of application, to be followed by Order to Complete and Draft WMA Permit in 2017.
Emergency Response Plan Training	OTHR-2	In-house	In-house									Required every year (in-house training).
Development of CIP List	OTHR-3	Completed	Completed									CIP completed as part of Water System Master Plan.

Table 6-1. Capital Improvement Projects – Years 1 to 5 (cont.)

		Year 1		Year 2		Year 3		Year 4		Year 5		
		FY'17		FY'18		FY'19		FY'20		FY'21		
		July 2016 - June 2017		July 2017 - June 2018		July 2018 - June 2019		July 2019 - June 2020		July 2020 - June 2021		
Project	**Project ID**	**Low Range - Order of Magnitude Cost Estimate**	**High Range - Order of Magnitude Cost Estimate**	**Low Range - Order of Magnitude Cost Estimate**	**High Range - Order of Magnitude Cost Estimate**	**Low Range - Order of Magnitude Cost Estimate**	**High Range - Order of Magnitude Cost Estimate**	**Low Range - Order of Magnitude Cost Estimate**	**High Range - Order of Magnitude Cost Estimate**	**Low Range - Order of Magnitude Cost Estimate**	**High Range - Order of Magnitude Cost Estimate**	**Notes**
Development of Asset Management Plan	OTHR-4	Ongoing	Ongoing									Required by MassDEP by December 31, 2016.
Development of Written Maintenance Plan	OTHR-5	Ongoing	Ongoing									Required by MassDEP by December 31, 2016.
Development of Routine Flushing Program	OTHR-6			$10,000	$20,000							Required by MassDEP.
Physical separation of Pequot Rd Interconnection	OTHR-7	Completed	Completed									Required by MassDEP.
ANNUAL TOTAL		**$134,000**	**$185,000**	**$515,000**	**$915,000**	**$447,000**	**$660,000**	**$700,000**	**$935,000**	**$2,000**	**$5,000**	
FIVE YEAR TOTALS		**$1,798,000**	**$2,700,000**									

*CIP list assumes the construction of a permanent interconnection with Easthampton. If there is a need to pursue a different source, costs will need to be adjusted. This may cause some of the capital projects to be re-scheduled.

**Check with the Highway Department on their paving plan. If streets to be paved, evaluate need to replace water main.

Working Document to be Periodically Reviewed

Table 6-2. Capital Improvement Projects – Years 6 to 10

Project	Project ID	Reoccurring Maintenance Item Frequency	Low Range - Order of Magnitude Cost Estimate (each Occurrence)	High Range - Order of Magnitude Cost Estimate (each Occurrence)	Notes
Inspect Water Storage Tank every 5 years	ST-2	Yes	$2,000	$5,000	Tank inspection required every 5 years.
New Storage Tank - Site Location Study and Design	ST-1		$50,000	$100,000	New storage tank may be needed to meet future demands and provide redundancy for existing tank when off-line. Locate tank on opposite side of system from existing tank. Tank volume approximately 750,000 gal.
New Storage Tank - Construction	ST-1		$750,000	$900,000	
Test Well work at Potential Well Site or Treatment Pilot Study for HWW Water	WS-2a, 2b, 2c		$25,000	$100,000	Potential well sites at Glendale Well 03G, Pequot Well or new site. HWW supply may require water quality testing and pilot testing of treatment methods (2 seasons for suface water).
New Source - Design/Permit	WS-2a, 2b, 2c		$100,000	$400,000	Permitting may involve new source approval process. Design ranges from well with pumping station to treatment facility with filtration.
New Source - Construction	WS-2a, 2b, 2c		$460,000	5500000	Construction ranges from well with pumping station to tretment facility with filtration.
Complete Water Audit	WMA-1b		$15,000	$20,000	Completion of water audit by a consultant is required every 5 years.
Complete Leak Detection every other year	WMA-1c		$5,000	$10,000	Leak detection of entire system is required every other year.
Emergency Generator for Glendale Well	OTHR-1		$75,000	$100,000	Permanent Generator and Automatic Transfer Switch
East Street from College Highway to existing 8-inch PVC pipe	WM-3		$210,000	$290,000	1,950 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
Moosebrook Rd Water Main Loop	WM-4		$350,000	$470,000	3,150 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
		Five Yr Total	**$2,042,000**	**$7,895,000**	

*CIP list assumes the construction of a permanent interconnection with Easthampton. If there is a need to pursue a different source, costs will need to be adjusted. This may cause some of the capital projects to be re-scheduled.
**Check with the Highway Department on their paving plan. If streets to be paved, evaluate need to replace water main.
Working Document to be Periodically Reviewed

Table 6-3. Capital Improvement Projects – Years 11 to 15

Project	Project ID	Reoccurring Maintenance Item Frequency	Low Range - Order of Magnitude Cost Estimate (each Occurrence)	High Range - Order of Magnitude Cost Estimate (each Occurrence)	Notes
College Highway from Glendale Well 8-inch PVC pipe to existing 6-inch ACP on College Highway	WM-5		$190,000	$260,000	1,760 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
Middle Rd & Valley Rd Water Main Loop	WM-6		$950,000	$1,260,000	6,300 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
Inspect Water Storage Tank every 5 years	ST-2	Yes	$2,000	$5,000	Tank inspection required every 5 years.
Complete Water Audit	WMA-1b		$15,000	$20,000	Completion of water audit by a consultant is required every 5 years.
Complete Leak Detection every other year	WMA-1c		$5,000	$10,000	Leak detection of entire system is required every other year.
		Five Yr Total	**$1,162,000**	**$1,555,000**	

*CIP list assumes the construction of a permanent interconnection with Easthampton. If there is a need to pursue a different source, costs will need to be adjusted. This may cause some of the capital projects to be re-scheduled.
**Check with the Highway Department on their paving plan. If streets to be paved, evaluate need to replace water main.
Working Document to be Periodically Reviewed

Table 6-4. Capital Improvement Projects – Years 16 to 20

Project	Project ID	Reoccurring Maintenance Item Frequency	Low Range - Order of Magnitude Cost Estimate (each Occurrence)	High Range - Order of Magnitude Cost Estimate (each Occurrence)	Notes
Inspect Water Storage Tank every 5 years	ST-2	Yes	$2,000	$5,000	Tank inspection required every 5 years.
Permanent Interconnection with Westfield	WS-3		$80,000	$100,000	Meter Vault
Complete Water Audit	WMA-1b		$15,000	$20,000	Completion of water audit by a consultant is required every 5 years.
Complete Leak Detection every other year	WMA-1c		$5,000	$10,000	Leak detection of entire system is required every other year.
East St Water Main Loop	WM-7		$730,000	$970,000	4,850 l.f. of 8-inch PVC main. Assumes installation outside paved roadway.
Jonathan Judd Water Main Extension	WM-8		$10,000	$20,000	Extend 8-inch water main approx. 100 ft to connect to Coleman Rd. Assumes installation outside paved roadway.
		Five Yr Total	**$842,000**	**$1,125,000**	

*CIP list assumes the construction of a permanent interconnection with Easthampton. If there is a need to pursue a different source, costs will need to be adjusted. This may cause some of the capital projects to be re-scheduled.
**Check with the Highway Department on their paving plan. If streets to be paved, evaluate need to replace water main.
Working Document to be Periodically Reviewed