Report

Report on

Water Supply Resiliency
Town of Uxbridge
MVP Action Grant Project

Completed for

Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, MA 01103

Completed by

Resilient Civil Engineering, P.C.
P.O. Box 659
Marlborough, MA 01752

April 29, 2020

ResilientCE
Resilient Civil Engineering, P.C.

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April 29, 2020

Julianne Busa, PhD, SE
Senior Environmental Scientist
Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, MA 01103

RE: Town of Uxbridge, Water Resiliency Study

Dear Ms. Busa:

Resilient Civil Engineering, P.C. (ResilientCE) has prepared this final report summarizing findings for the Town of Uxbridge water resiliency study.

I look forward to working with Fuss & O'Neill and the Town on future projects.

Sincerely,
Resilient Civil Engineering, P.C.

Kristen M. Berger, P.E.
President

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Executive Summary

Water supply within the Town of Uxbridge is obtained through public water suppliers and private wells. Climate change coupled with changes in land use and population pose challenges to the continued supply of potable water using the existing sources. Recent droughts have stressed the ability of the Town's resources to meet public water supply water demands. Environmental challenges in combination with private well contamination due to past land use in select areas of Town and population growth inside and outside of the public water supply system prompted the completion of this study to identify resource vulnerabilities and methods of enhancing resiliency going forward.

The Town's public water supply system provides water to about 60% of the residents through seven gravel packed wells with the remaining 40% of residents obtaining water from private wells. In addition, there are eleven small public water suppliers which include restaurants, commercial and industrial operations each with its own water supply well. Some of the public and private water supply wells have been impacted by contamination from naturally occurring contaminants, such as manganese and iron, and artificially occurring contaminants, such as Volatile Organic Compounds (VOCs). Elevated levels of manganese prompted the Town to remove Blackstone Well 1 from service and several of the small public water suppliers have implemented treatment to remove contaminants including manganese, iron, nitrate and reduce hardness from their wells.

Threats to water quality from land use activities include past land use practices and current waste disposal practices and septic systems. Potential contaminants include those well-known such as VOCs and nitrates and emerging contaminants such as Per- and Polyfluoroalkyl Substances (PFAS). Elevated levels of VOCs within private wells resulted in the expansion of the Town's public water system to connect some properties in the Kempton Road area, while others remain on private wells and rely on individual treatment systems. The MassDEP Bureau of Waste Site Cleanup is responsible for ensuring timely and effective responses for environmental emergencies and assessment and cleanup of confirmed and suspected hazardous waste sites. Hazardous waste sites are often called 21E sites since the Massachusetts General Law Chapter 21E is for the Massachusetts Oil and Hazardous Material Release Prevention and Response Act. The Commonwealth maintains a web-portal with information regarding the cleanup sites. The Town of Uxbridge has 91 sites listed in the portal and the Town of Millville has 19 sites in the portal. Many of these sites are localized and cleaned up without impacting water supplies. A notable exception is the Kempton Road site. Additionally, the Town is aware of two sites used for soil reclamation of materials removed from other locations. These properties are located along South Street and Millville Road. Private wells along Millville Road have been shown to have detectable levels of VOCs. However, it is unclear if this contamination is from the nearby Kempton Road site or the soil importation. MassDEP is involved in sampling and testing additional private wells along Millville Road to assess the extent of the contamination.

It is important that the Town remain informed of land use activities within Town with additional vigilance for water supply protection areas which include both the Zone I and Zone II of public water supply wells and areas with private wells. While public water suppliers are subject to extensive regulatory requirements

on drinking water quality and withdrawal limits, private wells are not strictly regulated and the well owners are responsible for water quality sampling and pumping to maintain an adequate supply of potable water. For private wells, MassDEP recommends sampling for a number of contaminants upon sale of the property or when initially installing the well, then testing for most contaminants every ten years, with sampling for coliform bacteria, nitrate and nitrite once every year.

Nitrate contamination can be from septic systems and use of fertilizers. The regulations for septic system design were based on contributing no more than 5 mg/L nitrate to the groundwater. While the levels of nitrate in the Town's PWS wells are below 5 mg/L, review of proposed developments within the Zone II of the wells is recommended to consider the impacts these new developments will have on the nitrate levels.

Emerging contaminants such as Per- and Polyfluoroalkyl Substances (PFAS) pose additional concerns on maintaining water supply. Draft proposed regulations issued in December 2019 would establish a Massachusetts drinking water MCL of 20 ppt for the sum of six PFAS compounds. The draft regulations also propose standards for soil and groundwater cleanup of PFAS from contaminated sites. The Town of Uxbridge tested its public water supply wells for PFAS through UCMR3 and results were below the laboratory detection limits, i.e. not detected. However, the list of PFAS sampled under UCMR 3 is not identical to the list of PFAS proposed to be included in the Massachusetts drinking water MCL. Re-sampling and testing of the Town's wells will be required. Private well owners should be aware of the proximity of their wells to potential PFAS contamination sites including industrial discharge locations, airports, military bases and fire-fighting training sites and have their well water tested appropriately.

In addition to land use activities, water supply wells are vulnerable to factors resulting from climate change including floods and droughts. Climate change is anticipated to exacerbate the frequency of storms that contribute to flooding of the 100-year flood areas. Notably, the Town's Bernat Wells 4, 5 and 6 are located near the Blackstone River and are within the 100-year flood level while the Blackstone Wells 1, 2 and 3 are outside of the flood level mapping, they are in close proximity to flood areas. Climate change is anticipated to exacerbate the frequency of storms that contribute to flooding of the 100-year flood areas. In addition to water damage to mechanical and electrical systems, flooding can transport contaminants which is the reason the MassDEP requires that the well must be 100 feet or more horizontally from a surface water feature and not located within the 100-year floodplain; if the well is within the 100-year floodplain, the well should be evaluated at the next sanitary survey for flooding or construction issues. The Town should explore ways to protect its water supplies from the risk of flooding including raising the well casings and evaluating additional and/or back-up sources of supply. With regards to private wells, the Town could consider public education regarding flood potential to the private well owners so that they are aware of the risks to their wells and make appropriate provisions.

Droughts are anticipated to become more frequent and severe as climate change continues to increase temperatures, raise evaporation rates and dry soils. Additionally, precipitation events are expected to increase in intensity and when that occurs during dry periods recharge of groundwater aquifers is more challenging since high intensity storms generate greater runoff and provided limited opportunity for

percolation into the ground. Continued withdrawal of groundwater without sufficient recharge will deplete the aquifer and lower the water table. Water supplies in Massachusetts are generally resilient to short term droughts but the risk to water supply increases as these droughts persist for multiple years. The Massachusetts Drought Task Force monitors drought conditions using the U.S. Drought Monitor and other resources. The period from June 2016 to May 2017 was the most recent significant drought event in Massachusetts. The entire state experienced varying intensities of drought conditions. By September 2016, the Uxbridge area was in severe drought and nearby conditions were categorized as extreme drought. Climate studies indicate that the frequency, intensity and duration of heat waves will increase meaning that drought events such as the 2016 event will become more frequent and persist for longer periods. The Town may notice that its gravel packed wells do not recover to the same water level during dry periods when the well pumps turn off due to limited recharge opportunities. The majority of the small PWSs and private well owners have bedrock wells. Bedrock wells can experience the impacts of dry periods more suddenly than gravel packed wells. Often if a well loses water the well owner installs another well that may need to be significantly deeper. Water conservation is one tool available to the Town to mitigate the impacts of droughts. The Town implements outdoor water use restrictions during the summer for customers on the Town public water system. Typically, private wells are exempt from these restrictions, however, communities are beginning to adopt bylaws to require private well owners to comply with the same water conservation requirements as those on public water supply.

Evaluation of water supply vulnerabilities identified methods to improve supply resiliency for public and private wells. In addition to infrastructure improvements at these well sites, the Town could consider additional measures to protect its water supply including the development of a Source Water Protection Master Plan, review of the Groundwater Protection Overlay District Bylaw for conformance with current regulatory recommendations, development of a Water Conservation and Drought Management Plan, update of the Water System Emergency Response Plan, adoption of Private Well Bylaw and evaluation of additional and/or emergency back-up water supply sources.

The supply capacity analysis comparing the Town's current and future water demands with available supplies resulted in findings that the Town's PWS is able to meet the MassDEP requirement that with any individual supply pump out of service, the remaining pump(s) be capable of providing the current maximum daily pumping demand of the system. However, there is very little buffer and without providing treatment for Well 1 or constructing a new well. Ultimately, the Town does not have the supply capacity to meet additional future demands from new development or service area expansion to connect contaminated private wells. Additionally, the Town's unaccounted for water (UAW) exceeds the MassDEP performance standard. UAW includes lost water and reduction of the UAW may result in water savings that could be available for customer water use. The Town could consider completion of a water audit as a first step in addressing the high UAW. The purpose of a water audit is to evaluate water use in relation to water produced in order to reduce water losses and non-revenue water. Decreasing the UAW is typically a multi-year endeavor, concurrent to these efforts, the Town could investigate the potential to develop additional sources of water supply for the Town's PWS to enhance water supply redundancy and resiliency.

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Section 1.0 - Introduction

1.1 Overview

Water supply for the Town of Uxbridge is provided through a combination of public water supply wells and private wells. Components of the public water supply system's infrastructure date back to its formation over 125 years ago. Over that time, the climate has changed along with land use, population and associated water demands. Today the public water supply system provides water to the higher density areas of Town or about 60% of the population with the remaining 40% of the population obtaining water from private wells. Recent droughts have stressed the ability of the Town's resources to meet water demands. That coupled with private well contamination due to past land use in select areas of Town and population growth inside and outside of the public water supply system required the completion of a water demand/supply study to identify resource vulnerabilities and methods of enhancing resiliency going forward.

1.2 Project Approach and Goals

The water supply study task was completed through a combination of meetings with Town representatives, review of historical data (water demand, water quality, well capacities during normal and dry periods), site visits to public water supply source facilities, estimation of future water demands and comparison with available supply. This task involved an initial kickoff meeting with representatives of the Town to discuss recent challenges with water supply and their goals for the future including such factors as providing ample water supply to a growing population, managing water supply and demands to minimize the impact of droughts, identifying resources vulnerable to flooding, expanding the public water supply system to provide water to residents with contaminated wells and/or potentially contaminated wells. GIS data was used to develop maps showing the parcels within the public water supply service area, parcels served by private wells, developed and potentially developable parcels and contamination areas, and location of public water supply wells in relation to flood zones. Water demand projections were estimated for the existing public water supply service area and private well areas based on population projections. The data was also used to identify a potential expanded service area for the public water supply to provide water to areas with private wells vulnerable to contamination. Public water supply source quality data were reviewed to identify current and/or pending regulations which may impact the ability of the Town to use these wells in the future. This task culminated in the completion of a comprehensive water supply analysis that may be used by the Town to identify potential resource shortages and vulnerabilities and provides recommendations for resiliency enhancement.

This water supply study provides the Town with a critical tool for protecting its existing water supply resources and managing those resources in times of drought and during potential flooding events. This project enhances the Town's existing efforts in responding to existing and pending private well contamination from historical land use which may be exacerbated by climate change and future floods. As the Town's public water supply is expanded to include areas of town vulnerable to contamination, this project will provide a valuable resource in managing its existing supply and identifying vulnerabilities to that supply, allowing the Town to make provisions now that will protect these resources into the future.

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Section 2.0 – Water Supply

2.1 Overview

The Town of Uxbridge has a public water supply system (PWS) that provides service to a portion of the population with the remaining residents obtaining water supply from privately owned wells. **Figure A-1** in **Appendix A** provides a map of parcels receiving public water supply and those with private wells. The public water supply wells are more strictly regulated than private wells. The Massachusetts Department of Environmental Protection (MassDEP) Drinking Water Program (DWP) regulates approximately 1,750 Public Water Supplies (PWSs), defined as providing drinking water to 15 service connections or serving an average of at least 25 people for at least 60 days a year. Wells supplying water below this threshold are considered private wells.

Within Uxbridge there is the Town's community water system (Town PWS) and individual small PWSs including the following:

- Bangmas Farm Store and Dairy Barn – 504 W Hartford Ave
- BJs Wholesale Distribution Center – 869 Quaker Hwy
- Blissful Meadows Golf Club - 801 Chocolog Rd
- Faith Fellowship - 647 Douglas St
- Gia Restaurant - 785 Quaker Hwy
- Green Room Billiard Club - 535 Quaker Hwy
- McDonalds - 200 Quaker Hwy
- Quaker Motor Lodge - 442 Quaker Hwy
- Quaker Tavern - 1603, 466 Quaker Hwy
- True Data Products – 775 Quaker Hwy
- West Hill Dam - 518 Hartford Ave E

The small PWSs are required to report water use and water quality to MassDEP similar to the Town PWS. Recently, the Commonwealth began collecting more information on the location and type of private wells but the data is incomplete. However, the Commonwealth does not collect data on water use or water quality for most private wells unless the well has been documented to have an impact from a contamination site; generally, it is the well owner's responsibility to maintain the well and to test the water quality.

2.2 Public Water Supplies

2.2.1 Town PWS

The Town's public water supply or community water system is obtained from seven wells located within the Blackstone River Basin as summarized in **Table 2-1** and shown on **Figure A-1** in **Appendix A** as Community Groundwater Sources.

Table 2-1. Summary Data of Town Wells

Well	MassDEP ID Number	Type	Installation Date	Depth	Capacity	MassDEP Authorized Withdrawal
Blackstone Well 1	2304000-01G	Gravel Packed	1944	72 feet	400 gpm	0.43 mgd
Blackstone Well 2	2304000-02G	Gravel Packed	1946	52 feet	500 gpm	0.44 mgd
Blackstone Well 3	2304000-03G	Gravel Packed	1953	63.5 feet	610 gpm	0.32 mgd
Bernat Well 4	2304000-04G	Gravel Packed	Installed 1946 Acquired by Town in 1989	103 feet	925 gpm	1.33 mgd
Bernat Well 5	2304000-05G	Gravel Packed		66 feet		
Bernat Well 6	2304000-06G	Gravel Packed		103 feet		
Rosenfeld Well 7	2304000-07G	Gravel Packed	2012	69 feet	510 gpm	0.73 mgd

2.2.2 Small PWSs

The Town has eleven small public water suppliers each with an individual PWS identification number and source water. **Table 2-2** lists these PWSs along with the source water and if treatment is utilized. This information was obtained from the PWS Annual Statistical Reports (ASRs). The location of these wells are shown on **Figure A-1** in **Appendix A** as Non-Community Groundwater Sources.

Table 2-2. Summary of Small PWSs

Small PWS Name	PWS ID	Location	Source Water	Pump Rate	Treatment
Bangmas Farm Store and Dairy Barn	2304014	504 W Hartford Ave	Bedrock Well	18 gpm	Ion Exchange for Nitrate Removal and Hardness Reduction; Sodium hypochlorite for Disinfection Corrosion Control
BJs Wholesale Distribution Center	2304013	869 Quaker Hwy	Gravel Packed Well	20 gpm	Softener for Hardness Reduction and Manganese Removal, UV and Sodium hypochlorite for Disinfection
Blissful Meadows Golf Club	2304010	801 Chocolog Rd	Bedrock Well	Unknown	Cartridge Filter for Sediment Removal
Faith Fellowship	2304015	647 Douglas St	Bedrock Well	7 gpm	Softener for Hardness Reduction and Iron and Manganese Removal
Gia Restaurant	2304007	785 Quaker Hwy	Bedrock Well	16 gpm	None
Green Room Billiard Club	2304017	535 Quaker Hwy	Bedrock Well	Unknown	None
McDonalds	2304002	200 Quaker Hwy	Bedrock Well	10 gpm	Softener for Hardness Reduction
Quaker Motor Lodge	2304006	442 Quaker Hwy	Bedrock Well	Unknown	Cartridge Filter for Sediment Removal
Quaker Tavern	2304005	466 Quaker Hwy	Bedrock Well	7 gpm	None
True Data Products	2304012	775 Quaker Hwy	Bedrock Well	7.5 gpm	Softener for Iron Removal
West Hill Dam	2304008	518 Hartford Ave E	Bedrock Well	12 gpm	None

2.3 Private Water Supplies

A substantial portion of the Town obtains water from private wells. Since private wells are the responsibility of the property owner, records on these private wells is incomplete. MassDEP implemented a well database within the past 10 years known as SearchWell. MassDEP acknowledges that it does not include all wells due to lack of local information. Data collected prior to the development of SearchWell program was entered into the database by hand and the data for these older wells is limited. For wells installed after the development of the SearchWell program, the data is more complete but still relies upon the accuracy and level of detail provided by the individual well drillers.

For Uxbridge, the SearchWell database includes approximately 1,050 individual wells with well types including domestic wells, irrigation wells, industrial wells, monitoring wells, cathodic protection wells, closed loop wells, geothermal wells and public water supply wells. Approximately 900 of these wells are indicated as domestic wells. The oldest wells within the database date back to the 1960s. **Figure A-1** in **Appendix A** shows the parcels assumed to have private wells which are developed parcels not served by the Town PWS. **Figure A-2** in **Appendix A** identifies the parcels assumed to have private wells and highlights those parcels with wells recorded in the SearchWell database. **Figure A-2** provides a visual demonstration of the limited data records within the SearchWell database. Therefore, the assumption that developed parcels not served by the Town PWS have a private well was followed for this study.

2.4 Land Use Contamination

Water supply sources in the Town have been affected in some areas by contamination from land use practices. Most notably this has occurred in southeast section of Town originating from a property on Kempton Road in Millville with some wells indicating the presence of Volatile Organic Compounds (VOCs) including Tetrachloroethene (PCE), Trichloroethene (TCE) and Toluene. Routine sampling and testing are done at this site and others within Uxbridge and Millville with data reported to the MassDEP Bureau of Waste Site Cleanup. **Figure A-3** in **Appendix A** identifies the location of the known contamination sites (21E Sites) and private wells impacted by the Kempton Road site. The Town has also identified two sites, shown on **Figure A-3** as a star symbol**,** that are being used for soil landfilling of materials removed from other locations and that material may contain contaminants. More information about the contamination issues is presented in **Section 3.0** of this report.

2.5 Private Wells Regulations

Private wells in the Town are regulated by the Town of Uxbridge Board of Health. The Board of Health relies on information provided by the Massachusetts Department of Public Health (DPH) and MassDEP in regulating private wells. MassDEP offers guides for water quality testing and recommends using a MassDEP certified testing laboratory to conduct the analyses. MassDEP recommends sampling for a number of contaminants upon sale of the property or when initially installing the well, then testing for most contaminants every ten years, while sampling for coliform bacteria, nitrate and nitrite once every year.

2.6 Public Water Supply Regulations

MassDEP regulates public water supplies, defined as providing drinking water to 15 service connections or serving an average of at least 25 people for at least 60 days a year. Public water supplies are subject to numerous regulatory requirements that cover both water quality and water quantity. The following provides discussions on the regulations that affect the supply capacity of the Town's wells.

2.6.1 Water Management Act (WMA) - Town Wells

The MassDEP issued Water Management Act (WMA) permits for water supplies approved after 1988. The WMA Program regulates withdrawals for all entities that withdraw at least 9 million gallons over a 90 day period (i.e. at or above 100,000 gallons per day (gpd) for at least 3 consecutive months) through registrations

and/or permits. The WMA permits limit the amount of withdrawal for water systems and individual wells. Wells with daily withdrawals greater than 100,000 gpd and installed before January 1, 1988 were grandfathered as registered wells and do not have individual withdrawal restrictions beyond the safe yields of the wells. Wells installed after this date were permitted and assigned maximum daily withdrawal limits. Additionally, WMA permits restrict the overall withdrawal of the system.

Table 2-3 shows the Town's wells and indicates which wells are Registered and which are Permitted.

The Town's WMA Permit was renewed in 2010 and is valid through August 2029. **Table 2-4** presents the WMA permit maximum authorized withdrawal volumes over the life of the WMA permit.

Table 2-3. Town Wells WMA Registration and Permit Summary

Well	MassDEP ID Number	Installation Date	MassDEP Authorized Withdrawal	Registered/ Permitted	Basin
Blackstone Well 1	2304000-01G	1944	0.43 mgd	Registered	Blackstone
Blackstone Well 2	2304000-02G	1946	0.44 mgd	Registered	Blackstone
Blackstone Well 3	2304000-03G	1953	0.32 mgd	Registered	Blackstone
Bernat Well 4	2304000-04G	1989	1.33 mgd	Permitted	Blackstone
Bernat Well 5	2304000-05G	1989		Permitted	Blackstone
Bernat Well 6	2304000-06G	1989		Permitted	Blackstone
Rosenfeld Well 7	2304000-07G	2012	0.73 mgd	Permitted	Blackstone

Table 2-4. WMA Permit Maximum Authorized Withdrawal Volumes

Permit Period	Total Raw Water Withdrawal Volumes			
	Permit		Permit + Registration	
	Daily Average (mgd)	Total Annual (MGY)	Daily Average (mgd)	Total Annual (MGY)
Period One 3/1/2010 to 2/28/2014	0.21	76.65	0.87	317.55
Period Two 3/1/2014 to 2/29/2019	0.23	83.95	0.89	324.85
Period Three 3/1/2019 to 2/28/2024	0.27	98.55	0.93	339.45
Period Four 3/1/2024 to 2/28/2029	0.32 (0.36*)	116.80 (131.40*)	0.98 (1.02*)	357.70 (372.30*)

Another important factor of the WMA Permit is stringent water conservation goals. The residential demand goal is defined as 65 residential gallons per capita per day (RGPCD). The unaccounted for water (UAW) goal is established as 10 percent. UAW is defined as the residual resulting from the total amount of water supplied to a distribution system as measured by the master meters, minus the sum of all amounts of water measured by consumption meters in the distribution system and minus confidently estimated and documented amounts used for certain necessary purposes such as water main flushing.

The Town was required to meet the RGPCD and UAW goals starting in 2011. Should the Town not meet these performance standards, the permit notes that MassDEP will consider the Town to be achieving functionally equivalent compliance if the Town:

1. Complies with the Water Conservation requirements included in the permit;
2. Implements the required limits on non-essential outdoor water use; and
3. Makes demonstrable efforts to finance, implement and enforce a MassDEP approved compliance plan.

The WMA permit also imposes limitations on summer withdrawals and requires efforts to offset the impacts of increasing withdrawal volumes. The limits on seasonal non-essential water use may be triggered by calendar (May 1st through September 30th) or by monitoring streamflow in the Blackstone River with low streamflow levels triggering conservation requirements.

2.6.2 Water Quality Regulations - Town Wells

Public water supply wells are regulated by the MassDEP DWP. Water quality testing is required on a routine basis in accordance with various water quality regulations. The water quality for the Town's wells was obtained from the Massachusetts Energy & Environmental Affairs (EEA) data portal. Review of this data shows that the Town's wells have similar water quality challenges to other wells in the region. The water is acidic with low alkalinity requiring pH and alkalinity adjustment for corrosion control. Additionally, some of the wells contain levels of manganese, iron and sodium exceeding regulatory standards and/or guidelines, the details of which are presented as follows.

Iron and manganese are minerals in drinking water which when present at elevated levels cause aesthetic and nuisance issues as follows: (1) stain laundry and water use fixtures; (2) clog household water filters; (3) prompt customer complaints; (4) support growth of iron and manganese bacteria, non-health related bacteria that clog strainers/pumps/valves; and (5) may increase the number of positive coliform detections in the distribution system. The United States Environmental Protection Agency (USEPA) and MassDEP regulate iron and manganese in drinking water as a Secondary Maximum Contaminant Level (SMCL) of 0.3 mg/L and 0.05 mg/L respectively to protect public welfare and promote increased customer satisfaction. Levels above SMCL lead to loss of customer confidence in water quality/health, resulting in customers seeking alternative supplies.

The USEPA and MassDEP have established a Health Advisory Level for manganese of 0.3 mg/L. Over a lifetime, EPA recommends that people drink water with manganese levels less than 0.3 mg/L and over the short term, EPA recommends that people limit their consumption of water with levels over 1 mg/L,

primarily due to concerns about possible neurological effects. Additionally, EPA recommends that children up to 1 year of age should not be given water with manganese concentrations over 0.3 mg/L.

MassDEP requires corrective action plans for wells with manganese equal to or greater than 0.3 mg/L. Corrective actions include removing the source from service or implementing treatment removal.

Manganese within the water from Blackstone Wells 1, 2 and 3 has been detected at levels exceeding 0.3 mg/L as shown in **Table 2-5** and **Figure 2-1**. Additionally, levels in Well 1 exceeded 1 mg/L and the average level continued to exceed 0.3 mg/L, therefore the well was taken off-line/out of service. More recent samples from Wells 2 and 3 have indicated levels are less than 0.3 mg/L. The levels above 0.05 mg/L result in discolored water and staining fixtures/laundry while levels equal to or greater than 0.3 mg/L trigger the health concerns.

Table 2-5. Summary of Manganese Data – Town Wells

Well	Manganese Range	Average Manganese
Blackstone Well 1	0.0 – 1.25 mg/L	0.676 mg/L
Blackstone Well 2	0.0 – 1.26 mg/L	0.130 mg/L
Blackstone Well 3	0.0 – 0.50 mg/L	0.130 mg/L
Bernat Well 4	0.0 – 0.074 mg/L	0.010 mg/L
Bernat Well 5	0.0 – 0.077 mg/L	0.022 mg/L
Bernat Well 6	0.0 – 0.072 mg/L	0.019 mg/L
Rosenfeld Well 7	0.0 – 0.085 mg/L	0.057 mg/L

Iron within the water from the Town's wells has been detected at levels exceeding the SMCL of 0.3 mg/L as shown in **Table 2-6** and **Figure 2-2**. Average levels of iron have been below 0.3 mg/L, however, Blackstone Well 2 shows a recent increase in iron. These levels may result in discolored water and staining fixtures/laundry but are not as problematic as the manganese levels.

Table 2-6. Summary of Iron Data – Town Wells

Well	Iron Range	Average Iron
Blackstone Well 1	0.0 – 0.354 mg/L	0.163 mg/L
Blackstone Well 2	0.0 – 0.443 mg/L	0.078 mg/L
Blackstone Well 3	0.0 – 0.447 mg/L	0.174 mg/L
Bernat Well 4	0.0 – 0.316 mg/L	0.035 mg/L
Bernat Well 5	0.0 – 0.223 mg/L	0.025 mg/L
Bernat Well 6	0.0 – 0.617 mg/L	0.069 mg/L
Rosenfeld Well 7	None detected	None detected

Some of the wells also contain sodium which has a MassDEP Office of Research Standards and Goals (ORSG) of 20 mg/L. Currently, there is no mandatory MCL for sodium. ORSG limits offer guidance for contaminants in the absence of MCLs. MassDEP does not require finished water to meet the ORSG for sodium, however, water suppliers with levels higher than this are required to include public notification in their annual consumer confidence reports. **Table 2-7** and **Figure 2-3** present the levels of sodium. The source of the sodium in these wells is likely from deicing agents contained in snowmelt and stormwater runoff from roadways. Levels have been detected within all of the Town's wells above the ORSG requiring public notification through annual reporting.

Table 2-7. Summary of Sodium Data – Town Wells

Well	Sodium Range	Average Sodium
Blackstone Well 1	32 – 58 mg/L	45 mg/L
Blackstone Well 2	32 – 61 mg/L	48 mg/L
Blackstone Well 3	42 – 60 mg/L	51 mg/L
Bernat Well 4	18 – 33 mg/L	26 mg/L
Bernat Well 5	26 – 32 mg/L	29 mg/L
Bernat Well 6	25 – 32 mg/L	28 mg/L
Rosenfeld Well 7	46 – 57 mg/L	50 mg/L

Figure 2-1. Manganese Data – Town Wells

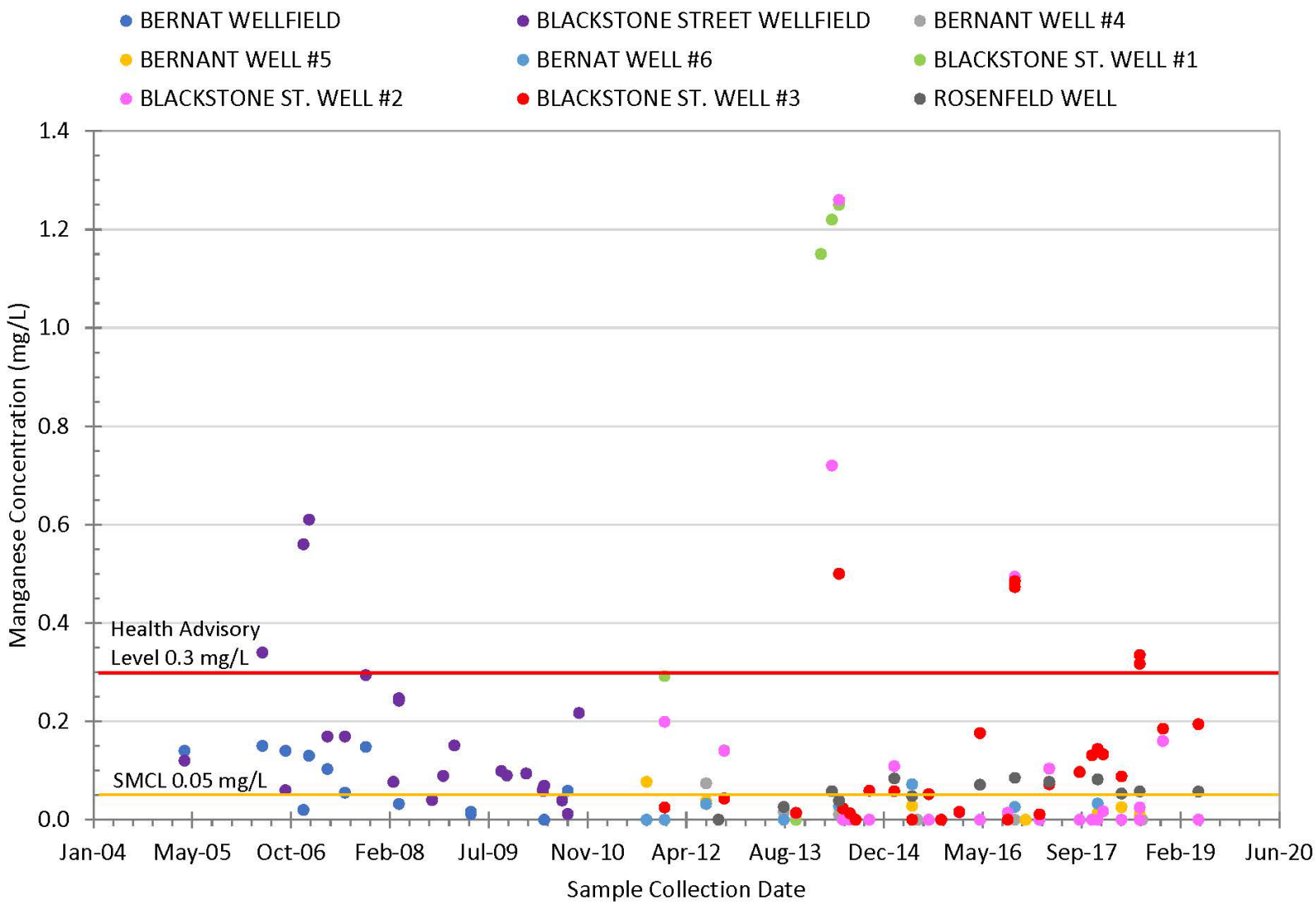


Figure 2-2. Iron Data – Town Wells

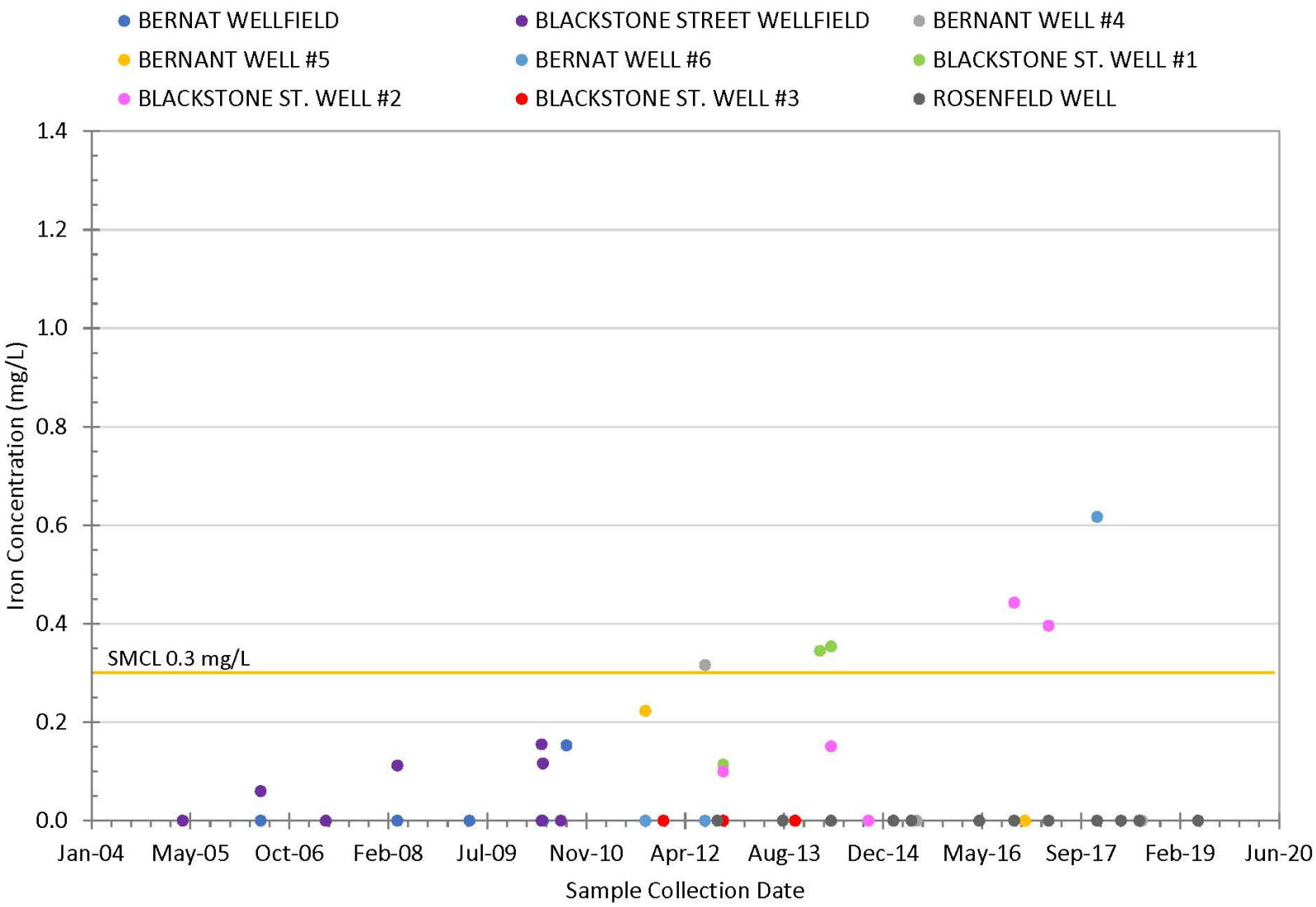
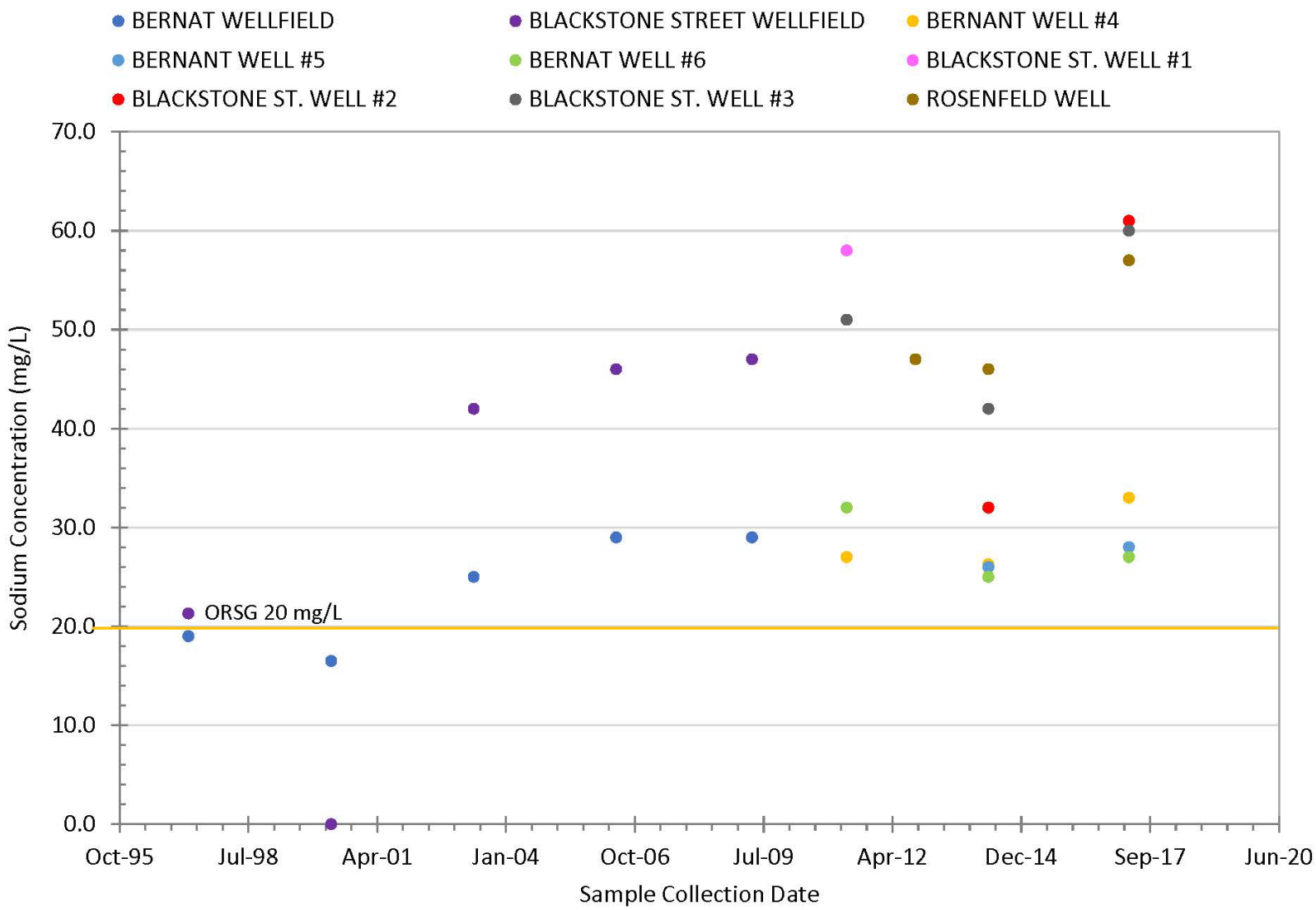


Figure 2-3. Sodium Data – Town Wells



2.6.3 Water Regulations – Small PWSs

Small system public water supply wells are also regulated by the MassDEP DWP. None of these small PWSs have a WMA permit. Additionally, the MassDEP confirmed that there are no non-PWS entities that hold a WMA permit; these are water consumers that use water for non-potable purposes such as irrigation for farms or golf courses in excess of 100,000 gpd.

Water quality testing is required of the small PWSs on a routine basis in accordance with various water quality regulations. Similar to the Town's PWS, the water quality for the small PWS wells was obtained from the Massachusetts Energy & Environmental Affairs (EEA) data portal. The following summarizes the data and notes contaminants that are close to or greater than regulatory limits and guidelines and identifies the treatment systems, if any, currently in place at these establishments.

- Bangmas Farm Store and Dairy Barn – 504 W Hartford Ave
    - This location has one well with data collection dates between the years 2008 - 2019.
    - Results for raw water detected the presence of:
        - Nitrate: 0 to 19 mg/L, the MCL is 10 mg/L.
    - Results for finished water detected the presence of:
        - Chloride: 192 mg/L, the SMCL is 250 mg/L.
        - Manganese: 0 to 0.16 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Methyl Tertiary Butyl Ether (MTBE): 0 to 4 ug/L, the MCL is 70 ug/L.
        - Nitrate: 0 to 20 mg/L with more recent year results less than 1 mg/L.
        - Sodium: 4 to 136 mg/L, the MassDEP goal is 20 mg/L.
    - Comparison of the finished water data with the raw water data indicate a nitrate removal treatment system is in use. The annual statistical report (ASR) confirms that the PWS is using ion exchange for nitrate removal and hardness reduction along with sodium hypochlorite addition for disinfection.

- BJs Wholesale Distribution Center – 869 Quaker Hwy
    - This location has one well with data collection dates between the years 2005 - 2019.
    - Results for raw water detected the presence of:
        - Iron: 0.6 to 7.85 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.28 to 0.62 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
    - Results for finished water detected the presence of:
        - Iron: 0 to 0.19 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0 to 0.016 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Sodium: 20 to 36 mg/L, the MassDEP goal is 20 mg/L.
    - Comparison of the finished water data with the raw water data indicate an iron and manganese removal treatment system is in use. The ARF confirms that the PWS is using a softener for hardness reduction and manganese removal along with ultraviolet (UV) and sodium hypochlorite for disinfection.

- Blissful Meadows Golf Club - 801 Chocolog Rd
    - This location has one well with data collection dates between the years 2002 - 2019.
    - Results for finished water detected the presence of:
        - Sodium: 7 to 9.4 mg/L, the MassDEP goal is 20 mg/L.

- Faith Fellowship - 647 Douglas St
    - This location has one well with data collection dates between the years 2013 - 2019.
    - Results for raw water detected the presence of:
        - Iron: 5 to 5.96 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.56 to 0.72 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
    - Results for finished water detected the presence of:
        - Iron: 0 to 5.5 mg/L with an average of 0.46 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0 to 0.66 mg/L, with an average of 0.046 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Sodium: 40 to 43 mg/L, the MassDEP goal is 20 mg/L.
    - Comparison of the finished water data with the raw water data indicate an iron and manganese removal treatment system is in use. The ASR confirms that the PWS is using a softener for hardness reduction and iron and manganese removal.

- Gia Restaurant - 785 Quaker Hwy
    - This location has one well with data collection dates between the years 2008 - 2019.
    - Results for finished water detected the presence of:
        - Iron: 0.07 to 0.37 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.009 to 0.039 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Sodium: 39 to 76 mg/L, the MassDEP goal is 20 mg/L.

- Green Room Billiard Club - 535 Quaker Hwy
    - This location has one well with data collection dates between the years 2017 - 2019.
    - Results for finished water detected the presence of:
        - Chloride: 245 mg/L, the SMCL is 250 mg/L.
        - Sodium: 81 mg/L, the MassDEP goal is 20 mg/L.
        - Radon: 7,923 picoCuries per liter (pCi/L), the MassDEP goal is 10,000 pCi/L.

- McDonalds - 200 Quaker Hwy
    - This location has one well with data collection dates between the years 2017 - 2019.
    - Results for raw water detected the presence of:
        - Chloride: 280 to 390 mg/L, the SMCL is 250 mg/L.
        - Hardness: 260 to 400 mg/L
        - Iron: 0 to 0.215 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0 to 0.06 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.

        - Sodium: 68 to 110 mg/L, the MassDEP goal is 20 mg/L.
    - Results for finished water detected the presence of:
        - Chloride: 290 to 350 mg/L, the SMCL is 250 mg/L.
        - Hardness: 0 to 12 mg/L
        - Iron: 0 to 0.17 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0 to 0.075 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Sodium: 50 to 310 mg/L, the MassDEP goal is 20 mg/L.
    - Comparison of the finished water data with the raw water data indicate a water softener system to reduce hardness and remove iron is in use. Note that these systems add sodium to the finished water. The ASR confirms that the PWS is using a softener for hardness reduction.

- Quaker Motor Lodge - 442 Quaker Hwy
    - This location has one well with data collection dates between the years 1998 - 2019.
    - Results for raw water detected the presence of:
        - Iron: 0 to 5.5 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.02 to 0.35 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
    - Results for finished water detected the presence of:
        - Iron: 0 to 0.34 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.013 to 0.3 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Sodium: 65 to 204 mg/L, the MassDEP goal is 20 mg/L.
    - Comparison of the finished water data with the raw water data indicate an iron and manganese removal treatment system is in use. The ASR reports that the PWS is using a cartridge filter for sediment removal but does not indicate a specific iron and manganese removal treatment system.

- Quaker Tavern - 1603, 466 Quaker Hwy
    - This location has one well with data collection dates between the years 2012 - 2019.
    - Results for finished water detected the presence of:
        - Manganese: 0.093 to 0.58 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L.
        - Radon: 2,840 to 12,000 pCi/L, the MassDEP goal is 10,000 pCi/L.
        - Sodium: 170 to 280 mg/L, the MassDEP goal is 20 mg/L.

- True Data Products – 775 Quaker Hwy
    - This location has one well with data collection dates between the years 2005 - 2019.
    - Results for raw water detected the presence of:
        - Iron: 0.1 to 2.3 mg/L, the SMCL is 0.3 mg/L.
        - Manganese: 0.035 to 0.11 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L
        - Sodium: 73 to 110 mg/L, the MassDEP goal is 20 mg/L.

- Results for finished water detected the presence of:
  - Iron: 0 to 0.148 mg/L, the SMCL is 0.3 mg/L.
  - Manganese: 0.01 to 0.1 mg/L, the SMCL is 0.05 mg/L and Heath Advisory Level is 0.3 mg/L
  - Sodium: 93 to 298 mg/L, the MassDEP goal is 20 mg/L.
- Comparison of the finished water data with the raw water data indicate an iron and manganese removal treatment system is in use, likely a water softener since the sodium level is greater in the finished water than the raw water. The ASR confirms that the PWS is using a softener for iron removal.

- West Hill Dam - 518 Hartford Ave E
  - This location has three wells with data collection dates between the years 1994 - 2019.
  - All data are below the regulatory limits.

2.7 Summary

Water supply within the Town is obtained through both public wells and private wells. PWSs include the Town municipal system and several small water systems. The MassDEP Drinking Water Program (DWP) regulates approximately 1,750 PWSs, defined as providing drinking water to 15 service connections or serving an average of at least 25 people for at least 60 days a year. Therefore, the small PWSs include businesses located within Town boundaries.

PWSs are subject to regulations that cover both water quantity and water quality. While all PWSs are required to meter their water use and report that use to MassDEP on an annual basis, only withdrawals greater than 100,000 gpd are subject to the Water Management Act that puts limits on withdrawal amounts. All PWSs are required to comply with water quality regulations. Private wells are not subject to the same level of regulations as PWSs and it is the well owner's responsibility to maintain and test their well.

The Town's wells and small PWS wells have similar water quality challenges as other wells within this region. Select wells contain elevated levels of iron, manganese and sodium.

Manganese within the water from the Town's Blackstone Wells 1, 2 and 3 has been detected at levels exceeding 0.3 mg/L. Additionally, levels in Well 1 exceeded 1 mg/L and the average level continued to exceed 0.3 mg/L, therefore the well was taken off-line/out of service. More recent samples from Wells 2 and 3 have indicated levels are less than 0.3 mg/L. The levels above 0.05 mg/L result in discolored water and staining fixtures/laundry while levels equal to or greater than 0.3 mg/L trigger the health concerns.

Iron within the water from the Town's wells has been detected at levels exceeding the SMCL of 0.3 mg/L. Average levels of iron have been below 0.3 mg/L, however, Blackstone Well 2 shows a recent increase in iron. These levels may result in discolored water and staining fixtures/laundry but are not as problematic as the manganese levels.

Some of the Town's wells also contain sodium which has a MassDEP Office of Research Standards and Goals (ORSG) of 20 mg/L. Currently, there is no mandatory MCL for sodium. ORSG limits offer guidance

for contaminants in the absence of MCLs. MassDEP does not require finished water to meet the ORSG for sodium, however, water suppliers with levels higher than this are required to include public notification in their annual consumer confidence reports. The source of the sodium in these wells is likely from deicing agents contained in snowmelt and stormwater runoff from roadways. Levels have been detected within all of the Town's wells above the ORSG requiring public notification through annual reporting.

Some of the small PWSs' wells contain elevated levels of iron, manganese, nitrate, sodium, chloride and radon. As a result, these PWSs treat their water supply to remove some of these contaminants.

While water quality data for private wells is not public information, it is likely that many private wells have similar water quality challenges as the PWS wells and are able to implement readily available treatment systems to remove the naturally occurring contaminants.

In addition to the naturally occurring contaminants, both PWS wells and private wells within the Town are at risk from contamination from climate change (flooding and droughts) and land use activities (21E sites and land filling sites). Most notably this has occurred in the southeast section of Town originating from a property on Kempton Road in Millville with some wells indicating the presence of Volatile Organic Compounds (VOC's) including Tetrachloroethene (PCE), Trichloroethene (TCE) and Toluene. Routine sampling and testing are done at this site and others within Uxbridge and Millville with data reported to the MassDEP Bureau of Waste Site Cleanup. More information about the contamination issues is presented in **Section 3.0** of this report.

Section 3.0 –Supply Vulnerabilities

3.1 Overview

Public water supply wells and privately-owned wells are vulnerable to factors associated with climate change including floods and droughts as well as human activities such as contamination from land use practices and equipment failure from aging infrastructure. This Section provides findings of a supply vulnerability analysis of the groundwater sources within the Town.

3.2 Public Water Supply Infrastructure

The Town's water system includes seven wells each with a dedicated pump station, three chemical feed treatment facilities, two water storage facilities, two booster pump stations, approximately 62 miles of water main ranging in size from 2-inch to 20-inch diameter, an emergency interconnection with the Whitinsville Water Company and includes three pressure zones: Low Service Area, High Service Area and East Street Service Area. The water system has approximately 3,096 service connections with the majority 2,965 classified as residential, 88 commercial, 15 municipal/institutional/non-profit, 2 industrial and the remaining classified as other. The system also includes the main office and garage facility and a supervisory control and data acquisition (SCADA) system for semi-automated and remote operation of facilities.

On August 27, 2019 representatives of the Town's Water Division and ResilientCE met and visited each pumping station and chemical feed treatment facility. The following provides a summary of each facility and notes needed infrastructure improvements.

3.2.1 Blackstone Wells and Water Division Office

The Blackstone Wells 1, 2 and 3 are located near the Water Division office and garage facility located at 105 Blackstone Street. The Blackstone Wells are the oldest wells in the system with Well 1 constructed in 1944, Well 2 constructed in 1946 and Well 3 constructed in 1953. These wells are gravel packed wells each with a dedicated pump station. The pump stations are constructed of brick with flat roofs and vinyl siding. Each station houses a vertical turbine pump of fabricated underground head type with the motor and electrical panels located on the first floor and the discharge piping located on the lower/below grade level accessible by a plated opening and ladder. The well pump motors and variable frequency drive units were upgraded in 1998. The chemical feed equipment was installed within the existing garage/maintenance building to provide corrosion control using potassium hydroxide, sequestering with blended phosphate and disinfection using sodium hypochlorite. The facility is equipped with an emergency generator to power the office, pump stations and chemical treatment facility in the event of a power failure. **Figures 3-1 through 3-9** show photographs of these facilities.

The following condition issues are noted at these facilities:

1. Well 1 is off-line due to elevated levels of manganese. A corrective action plan is needed to determine how this well will be managed into the future, ie. replace the well or implement manganese removal treatment.

2. The three pump station buildings are generally in good condition; however, each requires roof replacement.
3. Well 1 is accessible via a bridge along a dam which is in deteriorating condition and creates a shallow pond adjacent to the wells. Refer to **Figures 3-2 and 3-4**. Well 1 is also accessible from Blackstone Street using a fire road located to the south of the site, providing a backup means of access and egress.
4. Each well is located proximate to surface water making it vulnerable to flooding especially since part of each pump station is below ground elevation. Refer to **Section 3.5** for evaluation of flood risks.
5. The garage provides limited space for vehicle and equipment/material storage and maintenance. Some parts and equipment are kept outside due to space limitations. Access to the chemical feed equipment is challenging given the small space allotted for this equipment in the garage. A new facility is needed for Water Division offices and garage to provide a centralized location for this equipment.

Figure 3-1. Blackstone Wells 2 and 3 and Garage

Figure 3-2. Blackstone Well 1

Figure 3-3. Well Pump Station First Floor Level

Figure 3-4. Blackstone Well 1 Access Bridge and Dam

Figure 3-5. Chemical Feed Treatment, Parts Storage and Garage

Figure 3-6. Potassium Hydroxide Chemical Feed System

Figure 3-7. Sodium Hypochlorite Chemical Feed System

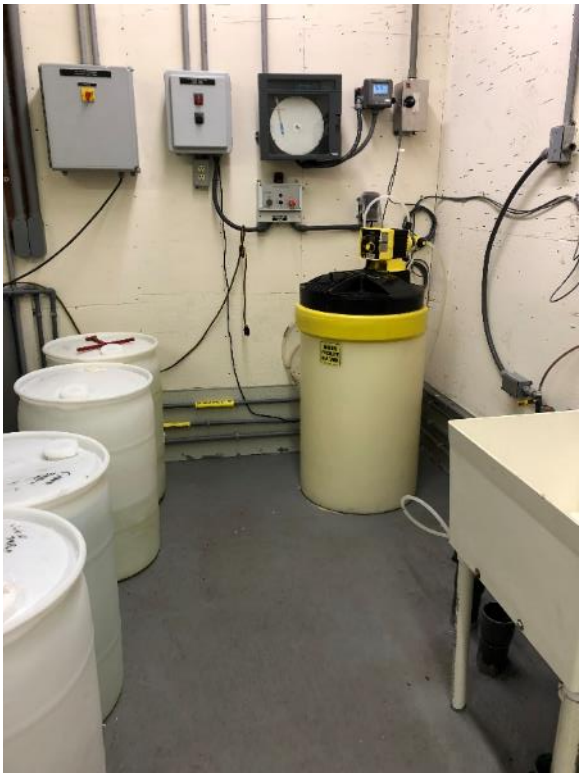


Figure 3-8. Phosphate Chemical Feed System

Figure 3-9. Water Division Office

3.2.2 Bernat Wells

The Bernat Wells 4, 5 and 6 and chemical treatment facility are located off of South Main Street. Access to the well pump stations requires crossing a culvert that is in deteriorating condition (the culvert crossing is between the treatment facility and the wells). Failure of this culvert would compromise access to the well facilities. The Blackstone River is in close proximity to the wells and associated flood risk is discussed in **Section 3.5**. Each well is equipped with a dedicated pump station. Each station houses a vertical turbine pump of fabricated underground head type with the motor and electrical panels located on the first floor and the discharge piping located on the lower/below grade level accessible by a plated opening and ladder. The pump station buildings are constructed of brick and were originally installed in 1946. The Town acquired these wells in 1989 after an extended pump test was conducted in 1988. The chemical treatment facility houses chemicals for corrosion control using potassium hydroxide, sequestering with blended phosphate and disinfection using sodium hypochlorite. An emergency generator is provided on-site. **Figures 3-10 through 3-15** provide photographs of these facilities

The following condition issues are noted at these facilities:

1. The facilities are in good condition, however, they are in close proximity to the Blackstone River and are subject to flood risks especially since part of each pump station is below ground elevation. Refer to **Section 3.5** for evaluation of flood risks.
2. Access to the well pump stations requires crossing a culvert that is in deteriorating condition (the culvert crossing is between the treatment facility and the wells). Failure of this culvert would compromise access to these facilities.

Figure 3-10. Bernat Well Pump Station

Figure 3-11. Bernat Pump Station Access Drive Culvert

Figure 3-12. Bernat Chemical Treatment Facility

Figure 3-13. Bernat Chemical Feed Room

Figure 3-14. Bernat Chemical Storage Area

Figure 3-15. Bernat Chemical Storage Area

3.2.3 Rosenfeld Well

The Rosenfeld Well 7 is located at 308 Quaker Highway. This facility was constructed in 2012 and houses the well, pump systems and chemical feed treatment systems. The pump, motor and discharge pipe are above finish floor. The facility includes chemical feed systems for potassium hydroxide, phosphate and sodium hypochlorite. An emergency generator is provided on-site. **Figures 3-16 through 3-20** provide photographs of this facility. The facility is in good condition and no deficiencies were noted.

Figure 3-16. Rosenfeld Well Pump Station Exterior

Figure 3-17. Rosenfeld Well Pump

Figure 3-18. Phosphate Feed System

Figure 3-19. Sodium Hypochlorite Feed System

Figure 3-20. Potassium Hydroxide Feed System

3.2.4 Booster Pump Facilities

The East Street Booster Station is located along East Street and the Farfard Booster Station is located along Crownshield Ave. These booster stations provide water to the East Street Service Area and the High Service Area respectively.

The East Street Booster Pump Station is located within a below ground structure; electrical panels are located within a fence area above ground. The station has two pumps: one capable of 50 gpm and the other 150 gpm that operate continuously since the system is not equipped with a storage tank. The need to operate these pumps continuously makes this area of the system more vulnerable to loss of water/pressure.

The Farfard Booster Pump Station boosts water to fill the Richardson Street Tank. There is a check valve between the pressure zones such that once water is pumped into the High Service Area it cannot flow back to the Low Service Area. The facility houses three 175 gpm pumps and has an emergency generator on-site. The facility was upgraded in 2004.

The following condition issues are noted at these facilities:

1. Evaluate the need to improve the East Street Service Area to provide water storage which will allow the pumps to rest and provide enhanced system resiliency.

Figure 3-21. East Street Booster Pump Station Exterior

Figure 3-22. East Street Booster Pump Station Interior

Figure 3-23. Farfard Booster Pump Station Exterior

Figure 3-24. Farfard Booster Pump Station Interior

3.3 Public Water Supply and Private Well Water Quality

The water quality for the Town's public supply wells was obtained from the Massachusetts Energy & Environmental Affairs (EEA) data portal. As presented in **Section 2.6.2** a review of the water quality data showed that the wells have elevated levels of manganese, iron and sodium. The iron and manganese are natural occurring elements while sodium entered the water supply from road deicing activities.

Private wells are vulnerable to similar contamination as the public water supply wells. Private wells in the Town are regulated by the Town of Uxbridge Board of Health. The Board of Health relies on information provided by the Massachusetts Department of Public Health (DPH) and MassDEP in regulating private wells. MassDEP offers guides for water quality testing and recommends using a MassDEP certified testing laboratory to conduct the analyses. MassDEP recommends sampling for a number of contaminants upon sale of the property or when initially installing the well, then testing for most contaminants every ten years, while sampling for coliform bacteria, nitrate and nitrite once every year.

3.3.1 Threats to Water Supply Water Quality

Threats to water quality come from climate change factors such as floods and droughts and human activity including contamination from land uses. The MassDEP Source Water Assessment and Protection (SWAP) report indicates that the Town's public supply wells have a susceptibility rating of high vulnerability to contamination due to the absence of hydrogeologic barriers that can prevent contaminant migration. Infrastructure such as public roads make the wells more vulnerable to contamination. It is noted that pesticides, fertilizers and road salt should not be used or stored within the Zone I of the wells (approximate 400 feet radius around the wells). Activities within the Zone II of the wells also pose a threat and include septic systems, household hazardous materials, heating oil storage, stormwater, roadways, railroad corridors, agricultural activities, commercial facilities including dry cleaners and paint shops, industrial facilities and fire-fighting training facilities. **Figure A-3** in **Appendix A** shows the Wellhead Protection Zone I and Wellhead Protection Zone II for the public water supply wells. While the SWAP report was focused on public water supply wells, private wells are vulnerable to similar contamination threats. The Town should consider development of a Source Water Protection Master Plan to identify potential threats to water supplies and strategies to prevent contamination from land use activities.

3.3.2 Threats from Septic Systems

As referenced in the SWAP report, the wells are vulnerable to contamination from septic systems located within the Zone II of the wells. The Town monitors the public water supply wells for bacteria, nitrate and nitrite on a routine basis. Private well owners are encouraged to test their wells for bacteria, nitrate and nitrite once a year, however testing is at the discretion of the well owner and testing is not reported to the state.

For the Town's wells, levels of nitrite have consistently been below the laboratory detection limit. However, the nitrate samples collected in 2019 showed that the Blackstone Wells had nitrate of 1.4 mg/L while the Bernat Wells and Rosenfeld Well contained less than 1 mg/L nitrate. The maximum contaminant level (MCL) for nitrate is 10 mg/L, so levels are below the MCL. The MCL was set to protect infants and

small children since nitrate is reduced to nitrite in the body and nitrite decreases the oxygen carrying capacity of the blood (blue baby syndrome). When public water systems have wells greater than half the MCL or 5 mg/L, the MassDEP requires more frequent monitoring (quarterly instead of annual). The levels of nitrate do not appear to be worsening in these wells. However, it is important to conduct the routine monitoring. Note that the regulations for septic system design were based on contributing no more than 5 mg/L nitrate to the groundwater. Nitrate is also added to groundwater by use of fertilizers. Review of proposed developments within the Zone II of the wells is recommended to consider the impacts these new developments will have on the nitrate levels.

The Town also tests the wells, storage tanks and distribution system for bacteria each month. In 2016 there was a positive detection of E. coli bacteria that required implementation of a boil water order while disinfection measures and investigations into the source of the bacteria were conducted. The boil order was lifted once bacteria testing was negative. The Town has continued to chlorinate the water supply since this event. While the source of bacteria during this event was not determined to be from septic systems, there is this potential therefore it is important that the proper regulations with regards to septic system design be followed.

3.3.3 Threats from Land Use

Both public water supplies and private wells are at risk from contamination threats posed by land use. These threats include identified land use contamination sites discussed further in **Section 3.4** and emerging contaminants such as Per- and Polyfluoroalkyl Substances (PFAS) discussed in the following **Section 3.3.4**. Contamination threats are exacerbated by the impacts of climate change including both droughts and floods, presented in **Sections 3.5** and **Section 3.6**, that change the transport of these contaminants and may accelerate the impacts.

3.3.4 Emerging Contaminants

The USEPA and MassDEP routinely evaluate the risk emerging contaminants have on water supply. Emerging contaminants are newly detected and/or recently been found to pose a health risk. The USEPA uses the Unregulated Contaminant Monitoring Rule (UCMR) to collect data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water Act (SDWA). As requested by the USEPA, the Town has participated in the UCMR program.

Emerging contaminants in UCMR 3 include Per- and Polyfluoroalkyl Substances (PFAS). PFAS are a group of different chemicals. These are individual contaminants with unique chemical structures. These substances have existed since the 1950s. Laboratory technology is now able to detect PFAS at levels one millionth of the levels used to regulate most chemical contaminants. PFAS are measured and reported as nanograms per liter (ng/L) and 1 ng/L is equal to 0.000001 milligrams per liter (mg/L). PFAS have adverse health impacts since they can accumulate and build up in the body over time. PFAS were specifically developed to repel other substances and to last a long time. This had advantages for the products in which they are used such as coatings for cookware, food packaging (ie. microwave popcorn bags and pizza boxes), clothing and carpets and fire-fighting foam. The problem is that PFAS have entered the environment and are now in water supply sources where they are doing what they were designed to do, lasting a long time

and being resistant to removal using conventional water treatment techniques. The PFAS sampled in UCMR 3 included perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), and perfluorobutanesulfonic acid (PFBS).

Studies are still ongoing into the health impacts of the various PFAS and these studies take time. The results of studies are used to help establish maximum contaminant levels (MCLs). MCLs are based on the health impacts of the contaminants, how widespread the contaminant is and the ability to remove the contaminant from water supply.

The USEPA issued a lifetime Health Advisory of 70 parts per trillion (ppt) or 0.07 micrograms per liter (ug/L) for the combination of two PFAS chemicals known as PFOS and PFOA.

In 2018, the MassDEP established an Office of Research and Standards Guideline (ORSG) level for drinking water that extended the USEPA advisory to include the following three PFAS chemicals: PFNA, PFHxS and PFHpA. In January 2020, MassDEP updated the ORSG to include an additional compound called PFDA.

As of January 2020, the MassDEP ORSG is 20 ppt for the total sum of PFOS, PFOA, PFNA, PFHxS, PFHpA and PFDA. The MassDEP recommends the following:

1. Consumers in sensitive subgroups (pregnant women, nursing mothers and infants) not consume water when the level of the six PFAS substances, individually or in combination, is above 20 ppt.
2. Public water suppliers take steps expeditiously to lower levels of the six PFAS, individually or in combination, to below 20 ppt for all consumers.

Draft proposed regulations issued in December 2019 would establish a Massachusetts drinking water MCL of 20 ppt for the sum of six specific PFAS. The draft regulations also propose standards for soil and groundwater cleanup of PFAS from contaminated sites.

The Town of Uxbridge tested its public water supply wells for PFAS through UCMR3 and results were below the laboratory detection limits, i.e. not detected. However, the list of PFAS sampled under UCMR 3 is not identical to the list of PFAS proposed to be included in the Massachusetts drinking water MCL. Re-sampling and testing of the Town's wells will be required.

Private well owners should be aware of the proximity of their wells to potential PFAS contamination sites including industrial discharge locations, airports, military bases and fire-fighting training sites and have their well water tested appropriately. MassDEP has prepared revisions to the Massachusetts Contingency Plan (MCP) which are the regulations governing the notification, assessment, cleanup and closure of oil and hazardous material disposal sites to include new standards for PFAS and finalization of these revisions is pending.

3.3.5 Town Efforts to Protect Water Quality

The Town has implemented programs to protect the quality of water resources including water supply through the following programs:

- Establishment of Zone I and Zone II protection areas for public water supply wells,
- Adoption of Groundwater Protection Overlay District Bylaw
    - Note that the Town should review this bylaw to verify conformance with current MassDEP recommendations.
- Conducted household hazardous waste programs to collect automotive wastes, latex based paints, oil/solvent based materials, household cleaning chemicals and compounds, lawn and garden supplies and pool chemicals.
- Adoption of stormwater bylaws,
- Conducted public education on pet waste collection, lawn care and leaf collection and disposal,
- Maintaining website pages dedicated to stormwater and best management practices,
- Compliance with EPA and MassDEP stormwater management programs,
- Conducted Planning Board review of applicable construction projects for adherence to regulations,
- Conducted Conservation Commission review of applicable construction projects for adherence to regulations.

The Town should consider development of a Source Water Protection Master Plan to provide a holistic plan that encompasses these separate efforts making water supply protection a Town-wide priority.

3.4 Land Use Contamination Sites

The MassDEP Bureau of Waste Site Cleanup is responsible for ensuring timely and effective responses for environmental emergencies and assessment and cleanup of confirmed and suspected hazardous waste sites. Hazardous waste sites are often called 21E sites since the Massachusetts General Law Chapter 21E is for the Massachusetts Oil and Hazardous Material Release Prevention and Response Act. The Commonwealth maintains a web-portal with information regarding the cleanup sites. The Town of Uxbridge has 91 sites listed in the portal and the Town of Millville has 19 sites in the portal. **Figure A-3** in **Appendix A** identifies the location of the sites and a table summarizing these sites is provided in **Appendix B**. Many of these sites are localized and cleaned up without impacting water supplies. A notable exception is the Kempton Road site in Millville near the Uxbridge-Millville town line which has impacted private wells in the area.

The contamination at the Kempton Road property was identified by the MassDEP in 1991 after reports of the presence of high levels of chlorinated hydrocarbons (1,1,1-TCA, TCE and PCE) in the soil and groundwater in the area. Extensive testing by the MassDEP resulted in findings that PCE was the dominant contaminant and that other chlorinated hydrocarbons, ketones and BTEX were present locally. The contamination area was capped and routine testing of groundwater in the area continues to today. The Town of Uxbridge extended the Town's public water system for water supply to the affected area which at the time did not have as much development as it does today. Hydraulic restrictions prevent the Town from connecting all properties in this area until water system improvements can be made. Select houses in this area without public water supply utilize private wells with household treatment systems. The Town should

continue to keep informed of the contamination sampling and work with residents and the State to identify opportunities to connect these properties to the Town's PWS.

The Town is aware of two sites used for soil reclamation of materials removed from other locations. These properties are located along South Street and Millville Road. Only a sampling of the soil being disposed of is tested. It was discovered that some of the soils contained contaminants and the Town worked to stop the soil importation at both the South Street and Millville Road sites, however, the material already imported remains at these sites. Consequently, nearby residents are concerned that their private wells could be contaminated by the materials.

Private wells along Millville Road have been shown to have detectable levels of TCE and PCE. However, it is unclear if this contamination is from the nearby Kempton Road site or the soil importation. MassDEP is involved in sampling and testing additional private wells along Millville Road to assess the extent of the contamination.

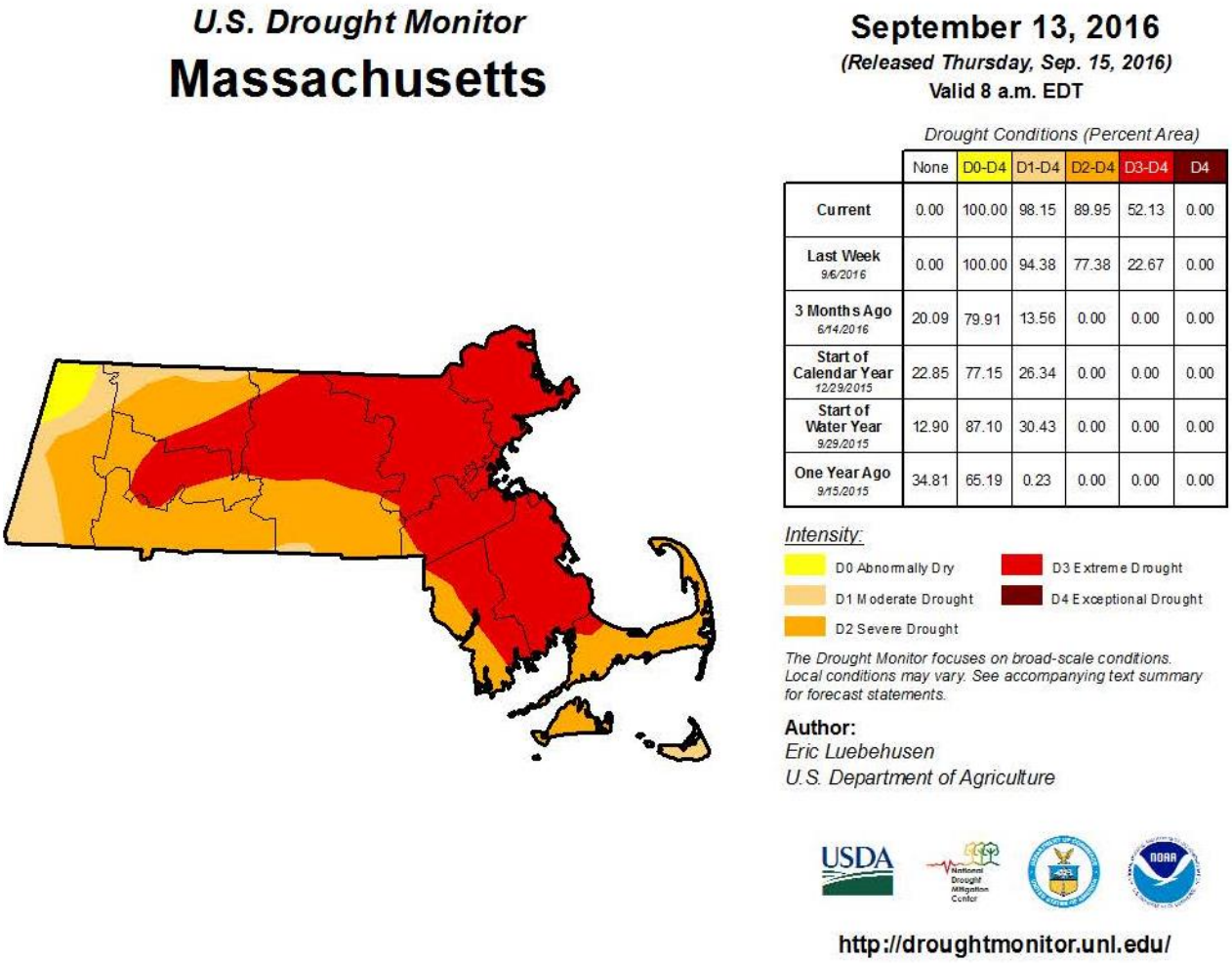
Land use activities have a direct impact on water quality. It is important that the Town remain informed of land use activities within Town with additional vigilance for water supply protection areas which include both the Zone I and Zone II of public water supply wells and areas with private wells. The Town should review its zoning bylaws and Groundwater Protection Overlay District Bylaw. Additionally, the Town should evaluate infrastructure needs to expand the Town's PWS to connect those properties with contaminated private wells.

3.5 Drought Risks

Public wells and private wells are vulnerable when droughts occur. Continued withdrawal of water without adequate replenishment will result in lowering of the water table that can reduce pumping capacity and eventually cause loss of supply.

The Massachusetts Drought Task Force monitors drought conditions using the U.S. Drought Monitor and other resources. The period from June 2016 to May 2017 was the most recent significant drought event in Massachusetts, as shown in **Figure 3-25**. The entire state experienced varying intensities of drought conditions. By September 2016, the Uxbridge area was in severe drought and nearby conditions were categorized as extreme drought.

Figure 3-25. U.S. Drought Monitor Report for September 2016

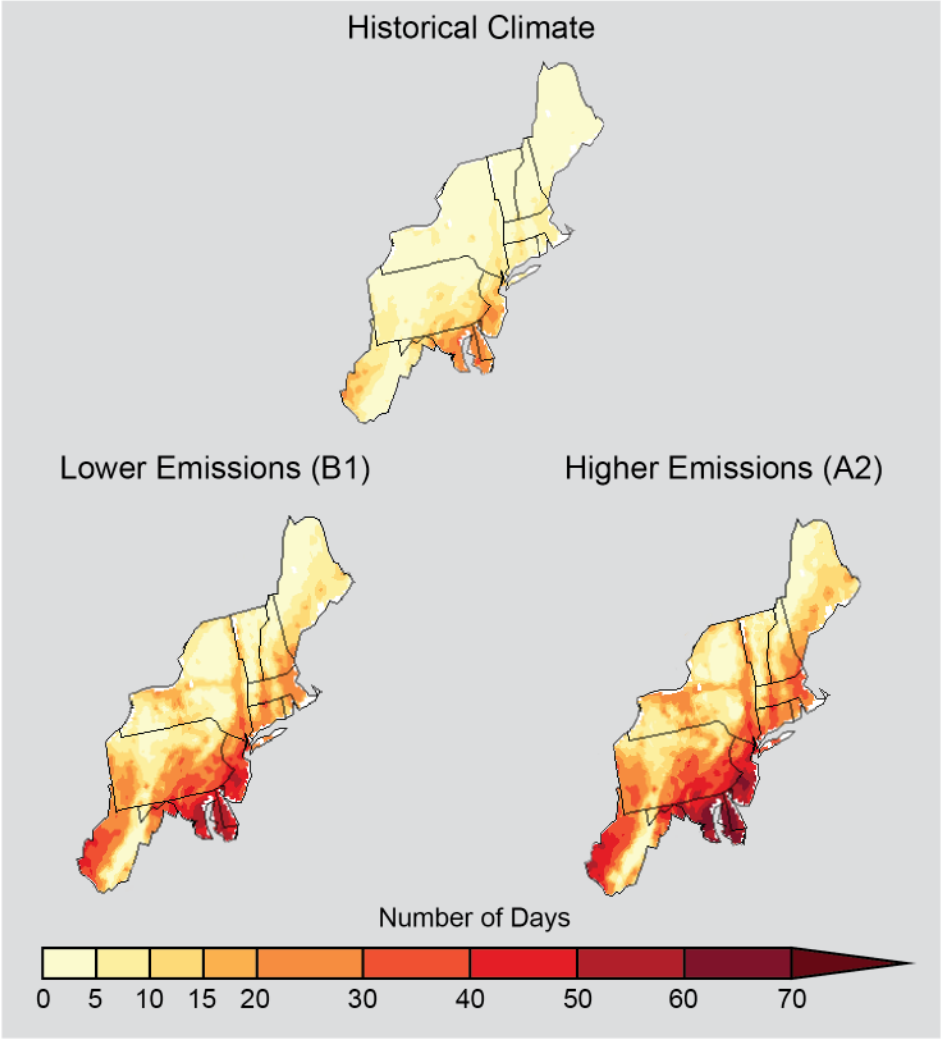


Droughts are anticipated to become more frequent and severe as climate change continues to increase temperatures, raise evaporation rates and dry soils. Additionally, precipitation events are expected to increase in intensity and when that occurs during dry periods recharge of groundwater aquifers is more challenging since high intensity storms generate greater runoff and provide limited opportunity for percolation into the ground. Continued withdrawal of groundwater without sufficient recharge will deplete the aquifer and lower the water table.

Figure 3-26 shows the projected number of days per year with a maximum temperature greater than 90°F averaged between 2041 and 2070, compared to 1971-2000, assuming continued increases in global emissions (A2) and substantial reductions in future emissions (B1). Both scenarios indicate that the frequency, intensity and duration of heat waves will increase meaning that drought events such as the 2016 event will become more frequent and persist for longer periods. Water supplies in Massachusetts are generally resilient to short term droughts but the risk to water supply increases as these droughts persist for multiple years.

Figure 3-26. Projected Increase in the Number of Days over 90°F

Averaged between 2041 and 2070, compared to 1971-2000 (Historical Climate), assuming continued increases in global emissions (A2) and substantial reductions in future emissions (B1). Source: NOAA NCDC Cooperative Institute for Climate and Satellites – NC, Climate Change Impacts in the United States: The Third National Climate Assessment report, Chapter 16, 2013.



The Town may notice that its gravel packed wells do not recover to the same water level during dry periods when the well pumps turn off due to limited recharge opportunities. Additionally, bedrock wells can experience the impacts of dry periods more suddenly than gravel packed wells. The majority of the small PWSs and private well owners have bedrock wells. Often if a well loses water the well owner installs another well that may need to be significantly deeper.

Water conservation is one tool available to the Town to mitigate the impacts of droughts. As presented in **Section 2.6.1**, the Town retains a Water Management Act (WMA) permit for its water supplies. The WMA permit includes provisions to limit the withdrawals from these sources including (1) upper limit caps on maximum day withdrawals, (2) annual average day caps on total water use, (3) performance standards for

residential water use and unaccounted for water (lost water) and (4) limitation on summer withdrawals by implementing non-essential water use restrictions. These provisions are included to encourage water conservation and enhance environmental stewardship.

Private wells are not subject to the water conservation requirements included within the Town's WMA Permit. However, MassDEP encourages the adoption of a Private Well Bylaw that would require private well owners to comply with the same water conservation requirements as those on public water supply. Recognizing that the private wells draw from the same aquifer as the public water supply wells, this is something that the Town should consider to protect water supply.

The Town should consider development of a water conservation and drought management plan to provide a holistic approach to protecting both public and private water supplies within the Town. The plan should be made available to the public to educate all water consumers on methods of protecting both the quantity and quality of the water supplies.

Another method to help mitigate the impacts of droughts is to have sufficient back-up water supply through redundant wells and interconnections with neighboring water systems, provided the neighboring system has the water supply resiliency to provide water during periods of water shortages.

In addition to droughts caused by weather conditions, water supply wells can be impacted by withdrawals from neighboring wells. During the public meeting on September 30, 2019, a resident mentioned an experience that one of his neighbors, on Hartford Ave West, lost water supply in their private well after a new development was constructed across the street. The additional draw on the aquifer in this area intercepted water and starved the private well. Fortunately, the Town's PWS extended close to this parcel and the resident was able to connect to the PWS for water supply. Bedrock wells are especially vulnerable to this type of event. The Town can help lessen the risk of these occurrences by conducting plan reviews for new developments and requiring the developers to conduct analyses of the potential impact of their proposed water use on nearby private wells.

3.6 Flood Risks

The Blackstone River runs through the Town's east side generally in a north to south direction. The Mumford River and West River enter the northern portion of the Town before connecting to the Blackstone River. Additionally, there is Lackey Pond in the northwest corner of Town. Both Lackey Pond and the Mumford River are fed by Whitins Pond in Northbridge. There are also numerous small brooks and ponds. All of these waters have the potential to cause flooding that could adversely impact water supply sources.

Figure A-4 shows the locations of the PWS Community Groundwater Sources, Non-Community Groundwater Sources and parcels having private wells along with the FEMA designated flood zones.

The Blackstone Wells 1, 2 and 3 are located adjacent to a small surface water (Meadow Brook). The Bernat Wells 4, 5 and 6 are proximate to the Blackstone River. The pump station for each well is constructed with two floors. The lower floor, below grade, houses well discharge piping and the upper floor, at ground level,

houses electrical equipment. Should water flood the area surrounding the pump station(s), water entering the ground level floor would submerge the entire lower floor and potentially contaminate the well(s).

The Blackstone Well 1 and Bernat Wells 5 and 6 are in areas that FEMA flood mapping has designated as having 1% Annual Chance of Flooding. Blackstone Wells 2 and 3 and Bernat Well 4 are located just outside of the area mapped as 1% Annual Chance of Flooding. Rosenfeld Well 7 is outside of the mapped FEMA flood areas. The wells for the small PWSs also appear to be outside of the mapped FEMA flood areas.

Areas designated as 1% Annual Chance of Flooding are defined as areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year and this is also referred to as the base flood or 100-year flood. Areas designated as 0.2% Annual Chance of Flooding are those areas between the limits of the 100-year flood and the 500-year flood.

Essentially, the current mapping shows that three of the Town's seven wells have a 1% chance of being impacted by flooding in any year. Additionally, the flood mapping is approximate, the wells that are close to the flood mapped areas (Wells 2, 3 and 4) may experience flooding.

The MassDEP Guidelines for Public Water Suppliers, Chapter 4, states that "the well must be 100 feet or more horizontally from a surface water feature and not located within the 100-year floodplain; if the well is within the 100-year floodplain, the well should be evaluated at the next sanitary survey for flooding or construction issues." Generally, the MassDEP requires wells that are located within the 100-year floodplain to have a well casing that extends a minimum of 18-inches above the ground or flood elevation level.

Climate change is anticipated to exacerbate the frequency of storms that contribute to flooding of the 100-year flood areas. The Town should explore ways to protect its water supplies from the risk of flooding including raising the well casings and evaluating additional and/or back-up sources of supply. Additionally, the Town's Water System Emergency Response Plan should include methods to prepare in advance of flooding and to mitigate the impact of flooding on the water system.

Figure A-4 also shows the parcels with private wells in relation to the flood mapped areas. The exact locations of the private wells on these parcels are unknown. However, the number of parcels impacted by flooding are limited. The Town could consider conducting public education regarding flood potential to the private well owners so that they are aware of the risks to their wells and make appropriate provisions.

3.7 Water Supply for Fire Protection

The Town noted that there are areas of the public water system with low pressure, such as in the East Street area, that limit fire protection capabilities. Water supply at specific areas of the public water system are a function of water available at sources and storage tanks and hydraulics of the system. This study did not include a hydraulic evaluation, however, a hydraulic analysis is being conducted by others. The results of this analysis may be used to identify system improvements needed to increase water pressure and/or water availability at specific locations.

For areas without access to the public water system, the Town has a couple of cisterns for fire water supply. It was noted by the Fire Department that as new development occurs additional cisterns should be considered.

3.8 Summary

Public water supply wells and privately-owned wells are vulnerable to factors associated with climate change including floods and droughts as well as human activities such as contamination from land use practices and equipment failure from aging infrastructure. The following summarizes findings of the supply vulnerability analysis:

1. Blackstone Well 1 is off-line due to elevated levels of manganese. A corrective action plan is needed to determine how this well will be managed into the future, ie. replace the well or implement manganese removal treatment.
2. Blackstone Wells 1, 2 and 3: The three pump station buildings are generally in good condition; however, each requires roof replacement.
3. Blackstone Well 1 is accessible via a bridge along a dam which is in deteriorating condition and creates a shallow pond adjacent to the wells.
4. Blackstone Wells 1, 2 and 3: Each well is located proximate to surface water making it vulnerable to flooding especially since part of each pump station is below ground elevation. Note that the well casing should extend above the flood elevation level to mitigate the impacts of the 100-year flood.
5. Main Office and Garage: The garage provides limited space for vehicle and equipment/material storage and maintenance. Some parts and equipment are kept outside due to space limitations. Access to the chemical feed equipment is challenging given the small space allotted for this equipment in the garage. A new facility is needed for Water Division offices and garage to provide a centralized location for this equipment.
6. Bernat Wells 4, 5 and 6: The facilities are in good condition however, they are in close proximity to the Blackstone River and are subject to flood risks specially since part of each pump station is below ground elevation. Note that the well casing should extend above the flood elevation level to mitigate the impacts of the 100-year flood.
7. Bernat Wells 4, 5 and 6: Access to the well pump stations requires crossing a culvert that is in deteriorating condition (culvert crossing located between water treatment facility and well pump stations). Failure of this culvert would compromise access to the well and pump facilities.
8. East Street Booster Pump Station: Evaluate the need to improve the East Street Service Area to provide water storage which will allow the pumps to rest and provide enhanced system resiliency.
9. Develop a Source Water Protection Master Plan for a holistic approach to protecting public and private water supplies. The plan should be made available to the public to educate all water consumers on methods of protecting both the quantity and quality of the water supplies.
10. Review the Groundwater Protection Overlay District Bylaw to verify conformance with current MassDEP recommendations. Consider enhancement of these bylaws to provide additional provisions to protect against groundwater contamination.
11. Develop Water Conservation and Drought Management Plan protecting both public and private water supplies within the Town. The plan should be made available to the public to educate all water consumers on methods of protecting both the quantity and quality of the water supplies.

12. Update the Water System Emergency Response Plan to account for potential flooding of the water supply wells/pump stations.
13. Adopt a Private Well Bylaw that would require private well owners to comply with the same water conservation requirements as those on public water supply.
14. Review proposed developments and consider their potential impact on public and private water quality and quantity.
15. Continue to keep informed of the contamination sampling in the Kempton Road area and work with residents and the State to identify opportunities to connect these properties to the Town's PWS. Evaluate infrastructure needs to expand the Town's PWS to connect those properties with contaminated private wells.
16. Encourage private well owners to test the water quality of their wells in accordance with MassDEP recommendations. MassDEP recommends sampling for a number of contaminants upon sale of the property or when initially installing the well, then testing for most contaminants every ten years, while sampling for coliform bacteria, nitrate and nitrite once every year.
17. Keep informed of emerging contaminants such as Per- and Polyfluoroalkyl Substances (PFAS). Conduct testing in accordance with MassDEP recommendations.
18. Investigate the potential to develop additional sources of water supply for the Town's PWS to enhance water supply redundancy.
19. Evaluate the hydraulics of the public water system to enhance fire protection capabilities at areas with low pressure and/or flow.
20. Consider installation of fire supply cisterns in areas without access to the public water system as new developments are proposed.

Section 4.0 –Water Demands and Supply Capacity

4.1 Overview

Part of water supply resiliency requires evaluation of water demands and available supply capacity. This Section presents the current and recent water demands of the Town's wells and private wells. Supply capacity is a factor of the safe yield of the wells, regulatory restrictions and water quality. The safe yield is defined as the maximum dependable withdrawal that can be made continuously from a water source including ground or surface water during a period of years in which the probable driest period or period of greatest water deficiency is likely to occur; provided however, that such dependability is relative and is a function of storage and drought probability. The safe yield of a source is determined through the new source approval process and those limits are referenced in the Town's Water Management Act (WMA) Permit. Comparison of recent and past water use with available supply capacity is necessary to understand the impact future demands will have on water supply capacity.

4.2 Town Public Water Supply Water Use

The MassDEP DWP requires public water suppliers (PWSs) to report their water use annually through Annual Statistical Reports (ASRs). Information reported includes total system monthly water use as metered by production source meters located at the wells, individual monthly source use, metered water use by customer classification and estimation of unaccounted for water (water lost to leaks, theft, etc.). Data from the ASRs was used to evaluate the Town's PWS water use over the past 20 years.

The Town's PWS withdrawal from all of its wells is shown in **Figure 4-1**. Water use has decreased over more recent years when compared with the use 20 years ago. Note that the time period from 1998 to 2000 was unusually dry so some of the difference may be due to increased summer water use during periods of drought. Additionally, reduction in demand has been experienced by many water suppliers due to the increased use of water saving fixtures and appliances. The annual withdrawals range from 246 to 294 million gallons per year (MGY) with an average of 271 MGY. This equates to an average day demand ranging from 0.67 to 0.81 million gallons per day (mgd) and average of 0.74 mgd.

The total monthly water withdrawals are shown in **Figure 4-2**. Withdrawals during the growing season (April through September) are on average about 1.4 times the withdrawals during the non-growing season (October through March). Generally, the non-growing season demands are reflective of indoor water use which is considered necessary use. The surplus used during the growing season for non-essential purposes is the focus of the requirements in the Town's WMA Permit for water conservation and seasonal limits on outdoor water use from May 1st through September 30th.

Comparison of the annual average day demand and maximum day demand are shown in **Figure 4-3**. For the Town, the maximum day demand occurs during the growing season and is an average of 2 times greater than the average day demand. A maximum day to average day ratio of 2 is typical for a water system with mostly residential customers that use their residence year-round.

Figure 4-1. Total Annual Water Withdrawal – Town PWS Wells

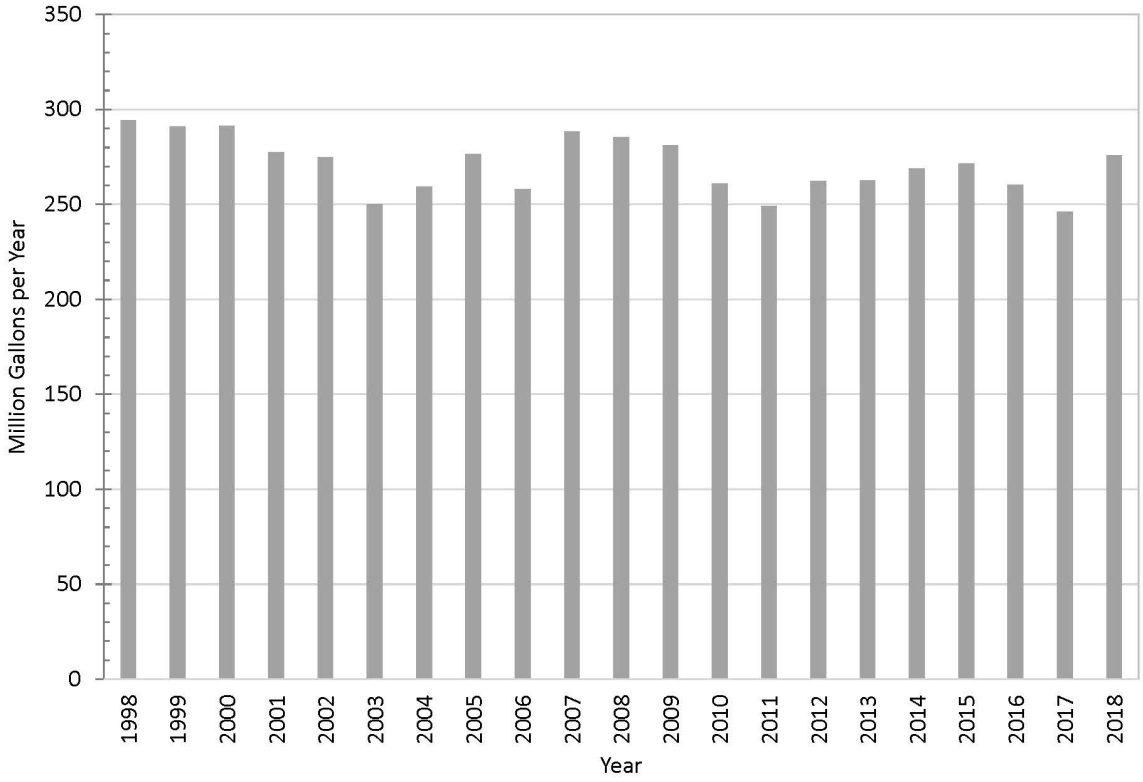


Figure 4-2. Total Monthly Water Withdrawal – Town PWS Wells

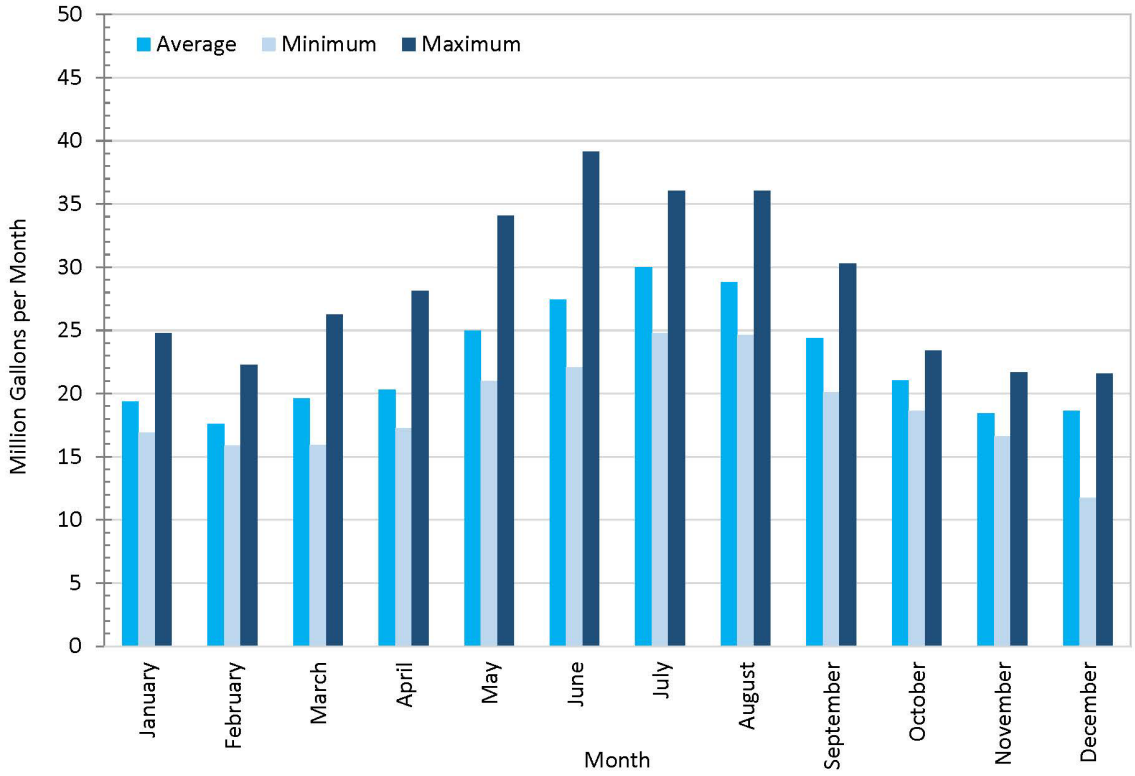
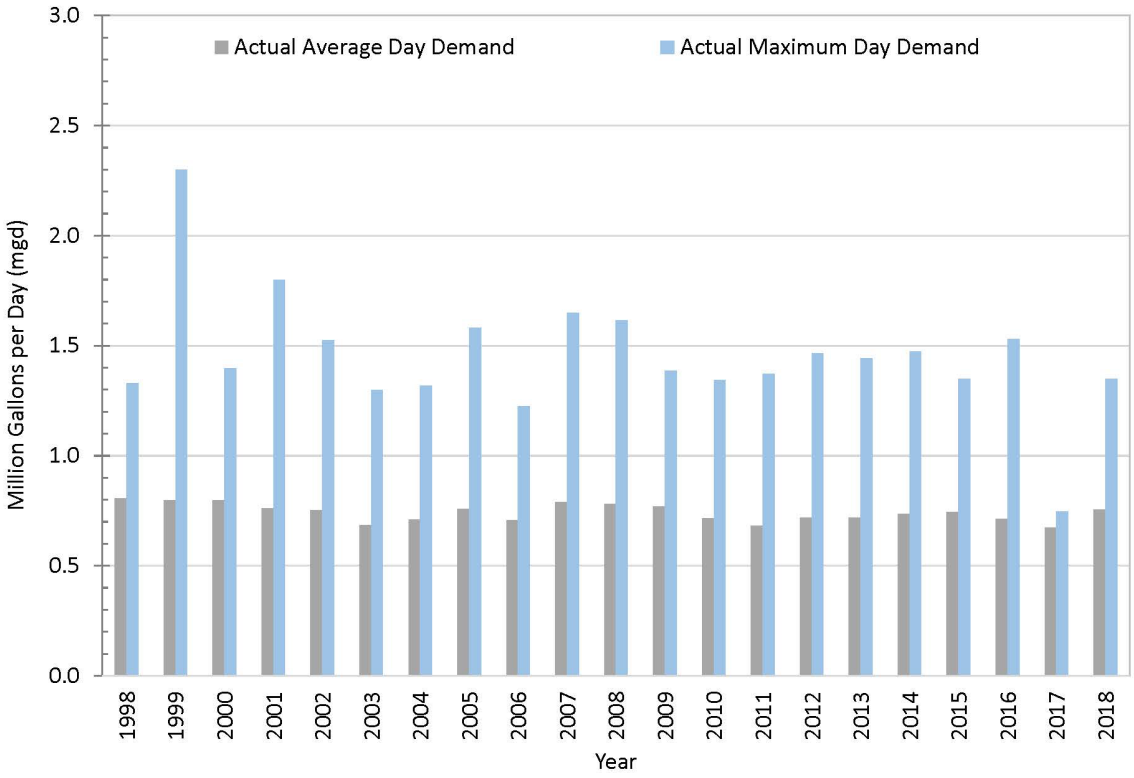


Figure 4-3. Average Day Demand Compared with Maximum Day Demand – Town PWS Wells



The ASRs include reporting of withdrawals or water pumped from the combined total of sources and individual sources for the entire time period evaluated (1998 – 2018). Starting in 2006, MassDEP required reporting of the metered and non-metered water consumption, to begin tracking water use efficiency. **Figure 4-4** shows the metered and non-metered water use occurring from 2006 through 2018. The metered use ranges from 70 to 88 percent of the total annual withdrawal and averages 81 percent. The non-metered use ranged from 12 to 30 percent of the total annual withdrawal and averages 19 percent.

For the metered water use, reporting of customer classification was required beginning in 2009. **Figure 4-5** shows the metered use by customer classification for the period of 2009 through 2018. Approximately 90 percent of the metered use is by residential customers.

As summarized in **Section 2.6**, the Town's WMA Permit includes performance standards for residential water use as less than or equal to 65 residential gallons per capita per day (RGPCD) and unaccounted for water of less than or equal to 10 percent. **Figure 4-6** shows the RGPCD for the period 2007 through 2018. The Town's RGPCD was consistently below the required performance standard indicating that residential customers are complying with water conservation requirements **Figure 4-7** shows the unaccounted for water (UAW) for the period 2007 through 2018. UAW has been greater than the performance standard each year since 2008 and averages 18 percent and was nearly 25 percent for 2018.

Figure 4-4. Metered versus Non-Metered Use – Town PWS

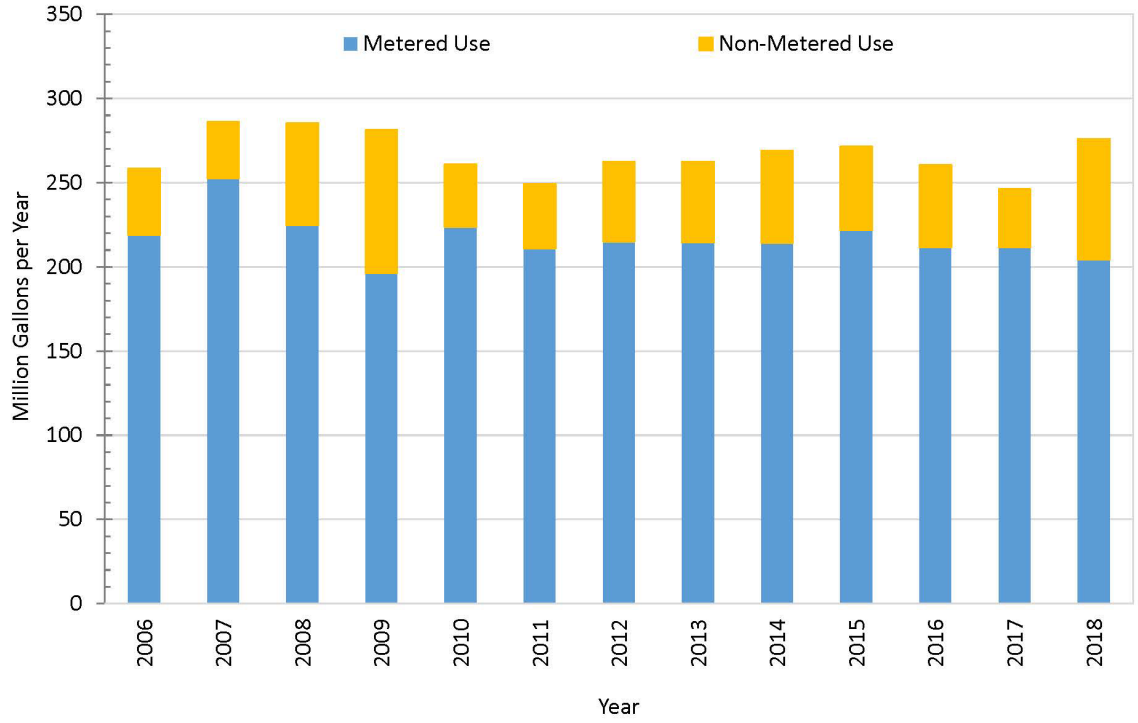


Figure 4-5. Metered Use by Customer Classification – Town PWS

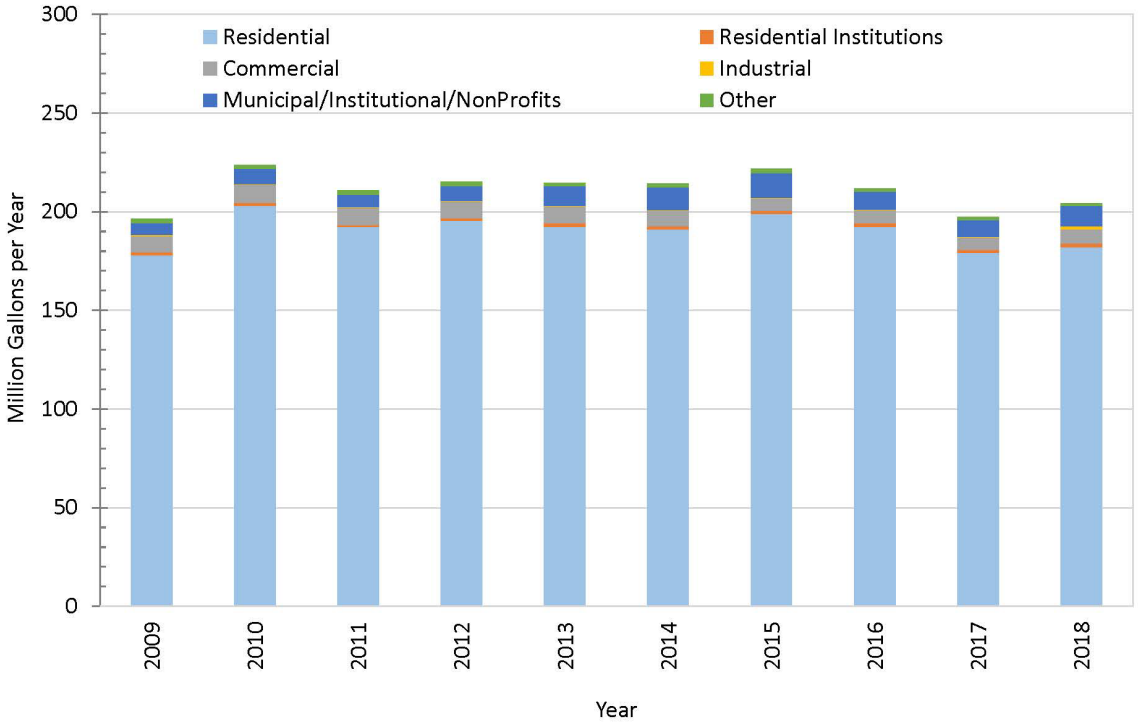


Figure 4-6. Residential Per Capita Water Use – Town PWS

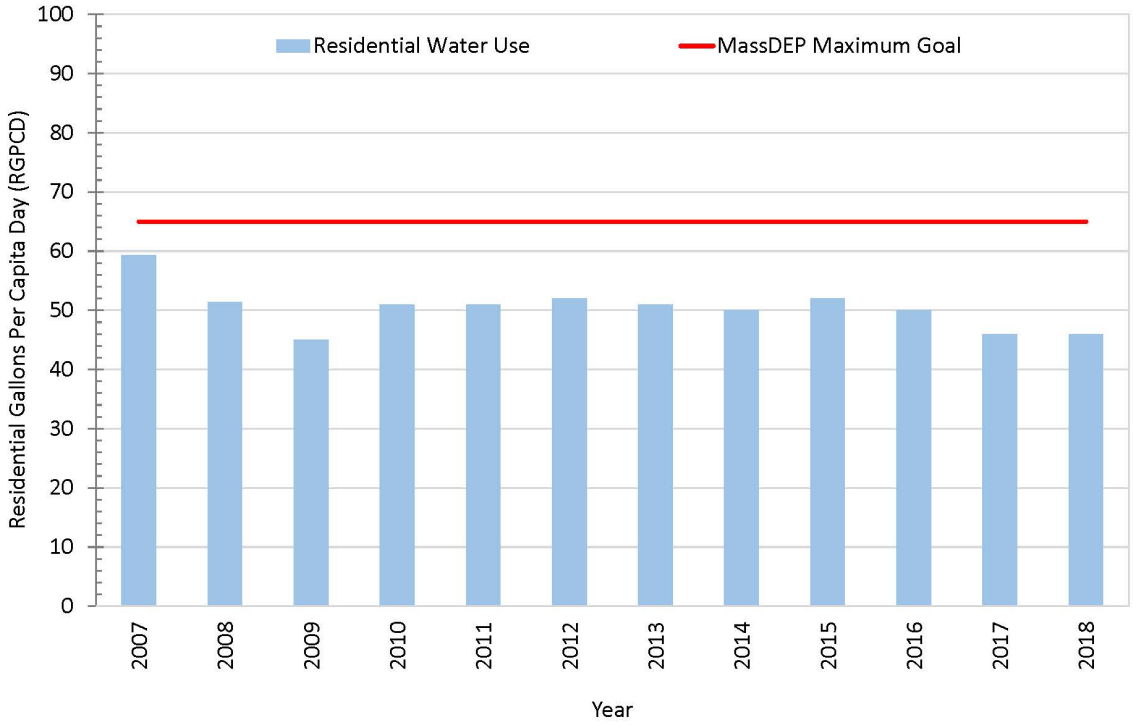
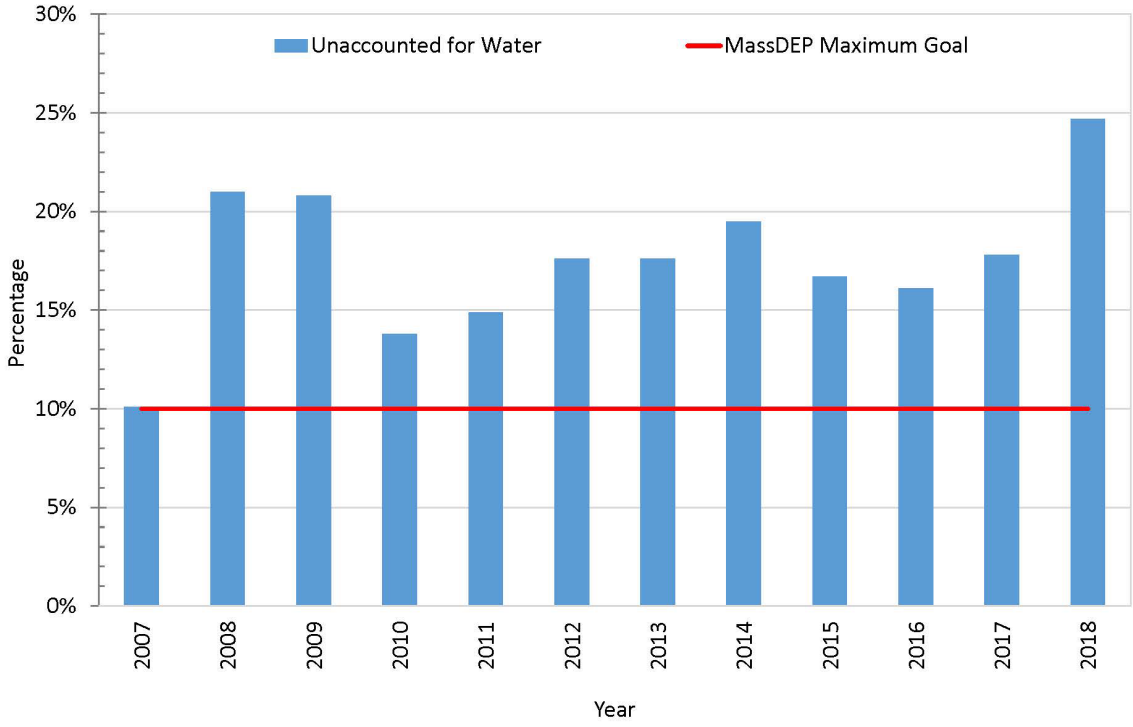


Figure 4-7. Unaccounted for Water – Town PWS



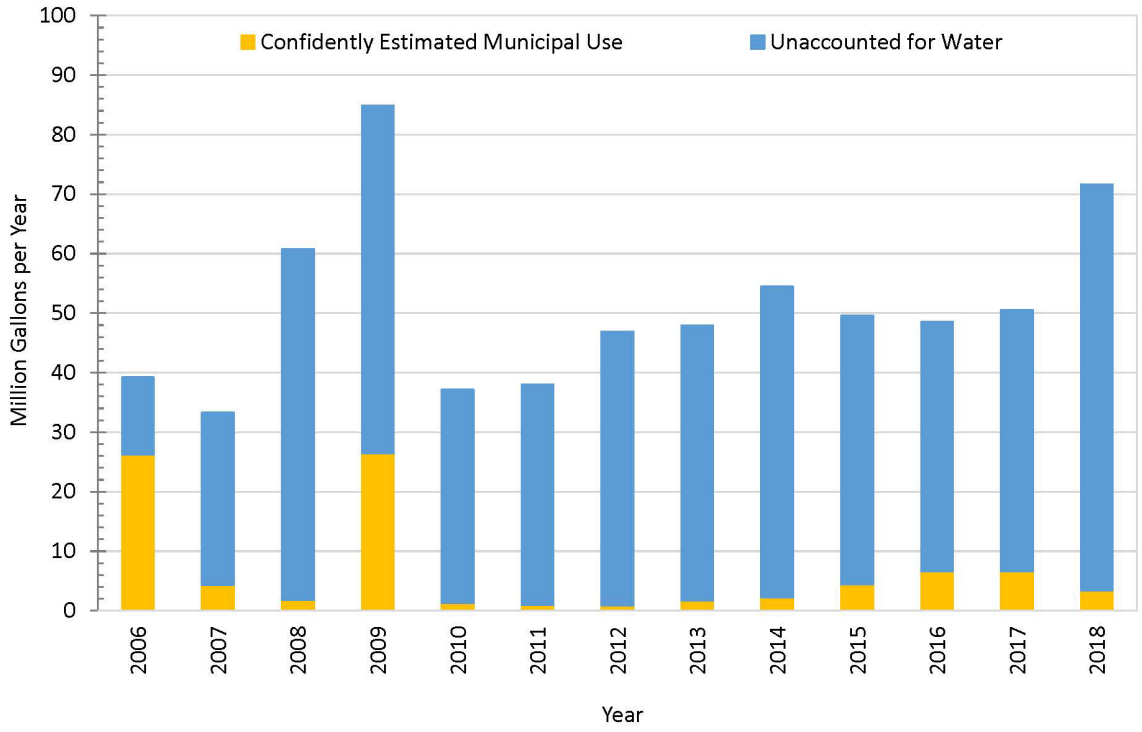
The unaccounted for water (UAW) is a portion of non-metered water use. UAW is defined as the residual resulting from the total amount of water supplied to a distribution system as measured by the master meters, minus the sum of all amounts of water measured by consumption meters in the distribution system and minus confidently estimated and documented amounts used for certain necessary purposes.

Non-metered use water use includes water used for purposes that cannot reasonably be metered but may be estimated and includes the following:

- Production/source meter testing and calibration adjustments
- Flow testing and flushing
- Main construction
- Main, service and hydrant leaks and breaks
- Tank maintenance
- Tank overflows
- Bleeders
- Fire protection and training
- Sewer and stormwater system flushing
- Street sweeping

The MassDEP allows for a portion of non-metered use to be categorized as confidently estimated municipal use (CEMU) and the remaining portion is the UAW as shown in **Figure 4-8**. The CEMU must be documented and submitted to MassDEP for review and acceptance. For the Town, the CEMU averages approximately 14 percent of the non-metered use with the remaining 86 percent being UAW.

Figure 4-8. Non-Metered Use – Town PWS



The UAW is essentially lost water. Water losses may be "real" or "apparent." Real losses are physical water losses between the source and service meters such as main and service leaks, tank overflows and breaks. Apparent losses are paper losses associated with meter inaccuracies, errors in data handling and water theft. Some amount of water losses are inherent to all water systems and are termed unavoidable real losses that may be cost prohibitive to eliminate. However, the Town's UAW is greater than 10 percent so efforts to reduce water losses should be taken. The Town could consider completion of a water audit as a first step in addressing this issue. The purpose of a water audit is to evaluate water use in relation to water produced in order to reduce water losses and non-revenue water.

4.3 Supply Capacity Analysis – Town PWS

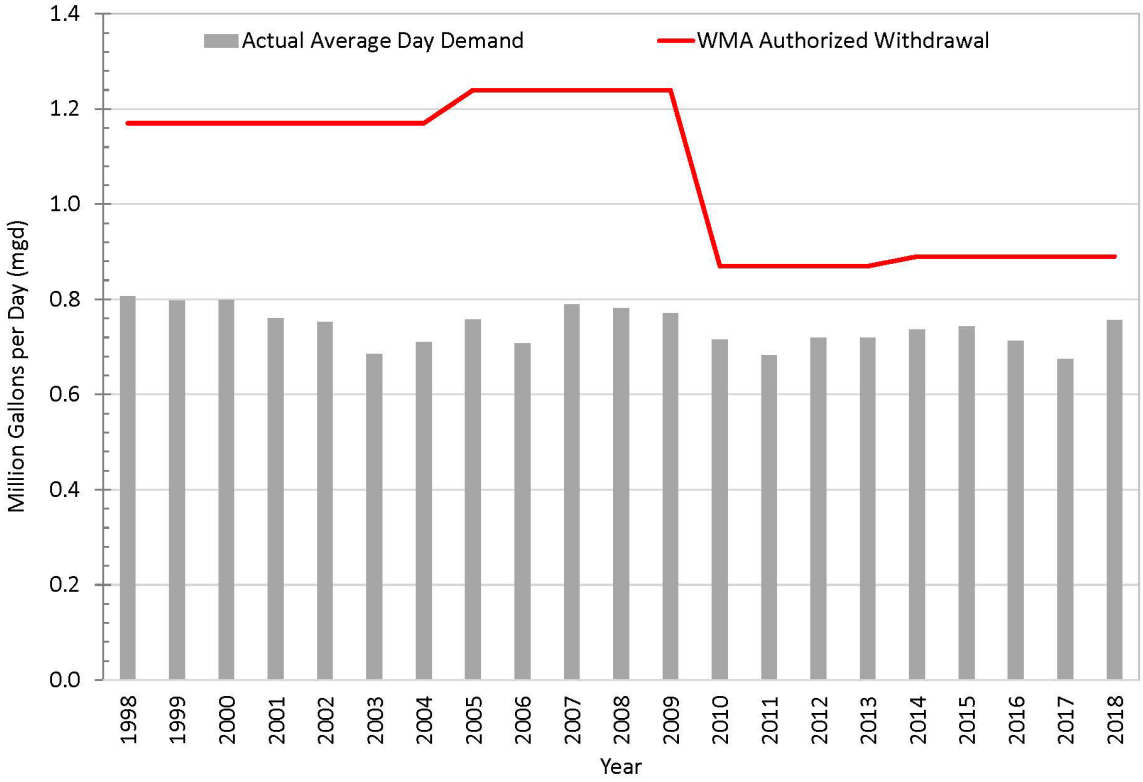
Analysis of the ability of the existing supply to meet system demands involves evaluation of the following:

1. Ability of the system to supply annual average day demand while remaining within the WMA Permitted Authorized Withdrawal rate.
2. Ability of the system to meet the MassDEP Guidelines for Public Water Suppliers Chapter 7 which requires that with any individual supply pump out of service, the remaining pump(s) shall be capable of providing the maximum daily pumping demand of the system.

Ability of the system to supply annual average day demand while remaining within the WMA Permitted Authorized Withdrawal rate

As presented previously in this Section, the Town's annual average day demand ranges from 0.67 to 0.81 million gallons per day (mgd) and averages 0.74 mgd. The fluctuation in annual average day demand is directly related to the summer weather conditions. Dry summers result in higher usage than wet summers. **Figure 4-9** shows the average day demand along with the WMA permit authorized withdrawals. The Town's WMA permit was renewed in 2010 with lower permitted withdrawals as previously presented in **Table 2-3**. The current WMA permit authorized withdrawal is 0.87 mgd and the actual withdrawal in 2018 was 0.76 mgd; the Town currently has a small buffer in the permitted withdrawal of less than 0.1 mgd to accommodate additional demand without having to apply for a new WMA permit to request additional withdrawals. However, the WMA permitted withdrawal increases for the period March 1, 2019 through February 28, 2024 to allow an additional 0.04 mgd and increases again for the period March 1, 2024 to March 28, 2029 to allow an additional 0.05 mgd. There is also a 5% buffer factor of 0.04 mgd which can be applied to the permit provided the Town meets certain permit requirements.

Figure 4-9. Average Day Demand in Comparison with WMA Authorized Withdrawal



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

The Town's maximum day demands have averaged 1.45 mgd over the past 20 years with a high maximum day demand of 2.30 mgd occurring in 1999. As previously noted, several years in the late 1990s and early 2000s were unusually dry resulting in increased demands for many water suppliers. As a result of that drought period, the state formed the Drought Advisory Task Force and now issues drought advisories on a routine basis. The drought conditions also prompted the MassDEP to incorporate water conservation measures in the WMA permits and to encourage public water suppliers to have redundant supply options to enhance supply resiliency.

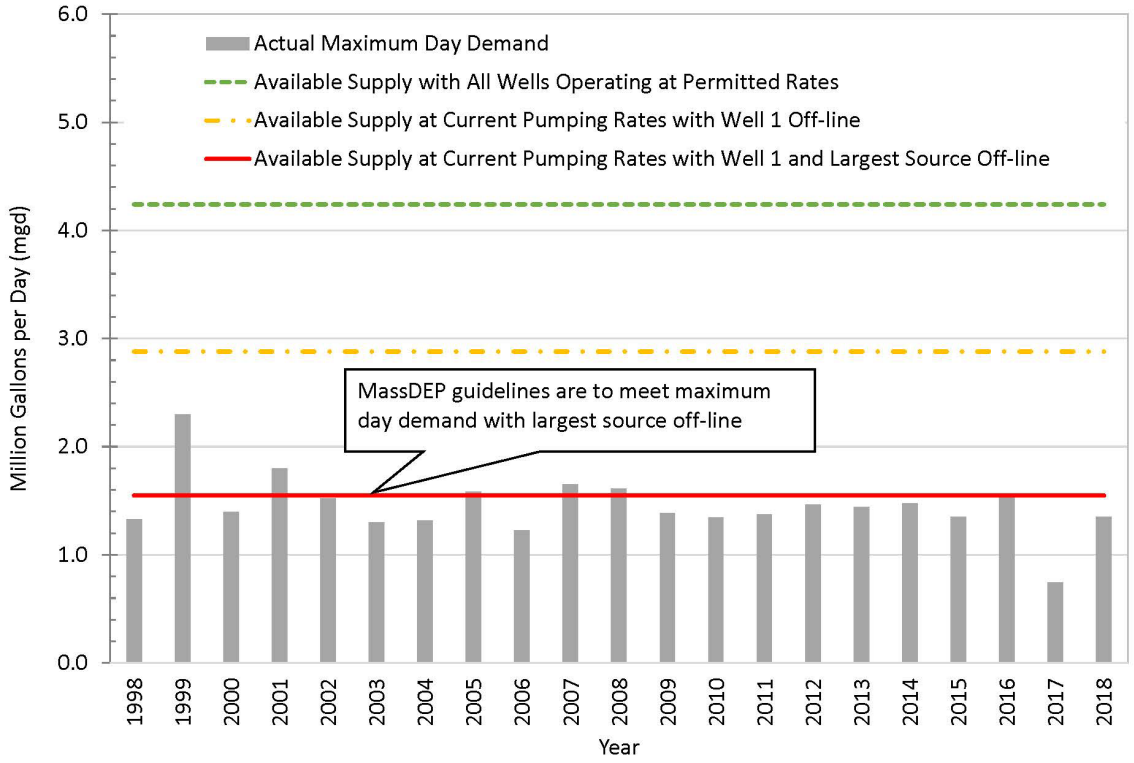
Figure 4-10 shows the Town's maximum day demands along with threshold lines representing:

1. available supply with all wells operating at permitted rates
   a. Note that this threshold is not currently possible given the status of Well 1 and actual pumping ability of the remaining wells, some of which are not currently able to sustain the permitted pumping rates

2. available supply at current pumping rates with Well 1 off-line;
   a. Well 1 is currently off-line for water quality reasons.

3. available supply at current pumping rates with Well 1 and the largest source off-line
    a. Since Well 1 is off-line for water quality reasons, this analysis must be done considering only the currently remaining available supplies. This demonstrates that the Town does not have the supply capacity to meet additional demand without a new source or treatment of Well 1.

Figure 4-10. Maximum Day Demand in Comparison with MassDEP Supply Requirements



The WMA permit also includes maximum day pumpage from the individual wells. The goal is to stay within these withdrawal limits. **Figures 4-11 through 4-17** show the maximum day withdrawals for each of the wells. Note that the Water Division has pumped some of the wells at rates higher than the Approved Gallon per Minute (gpm) Pumping Rate. To maintain daily withdrawals within permitted limits, variable frequency drive (VFD) units coupled with modifications to the SCADA system to integrate a maximum flow rate for each supply will help to limit the possibility of the well pumps operating above the permitted rates.

Figure 4-11. Maximum Day Withdrawals – Well 1

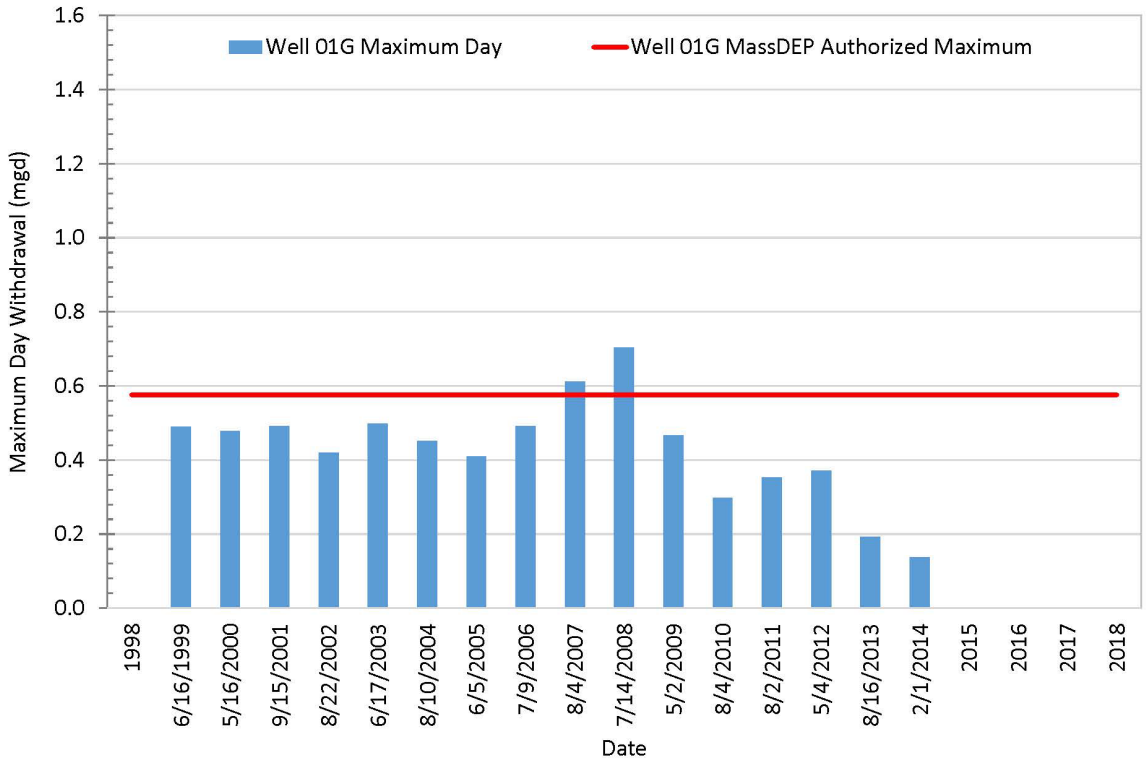


Figure 4-12. Maximum Day Withdrawals – Well 2

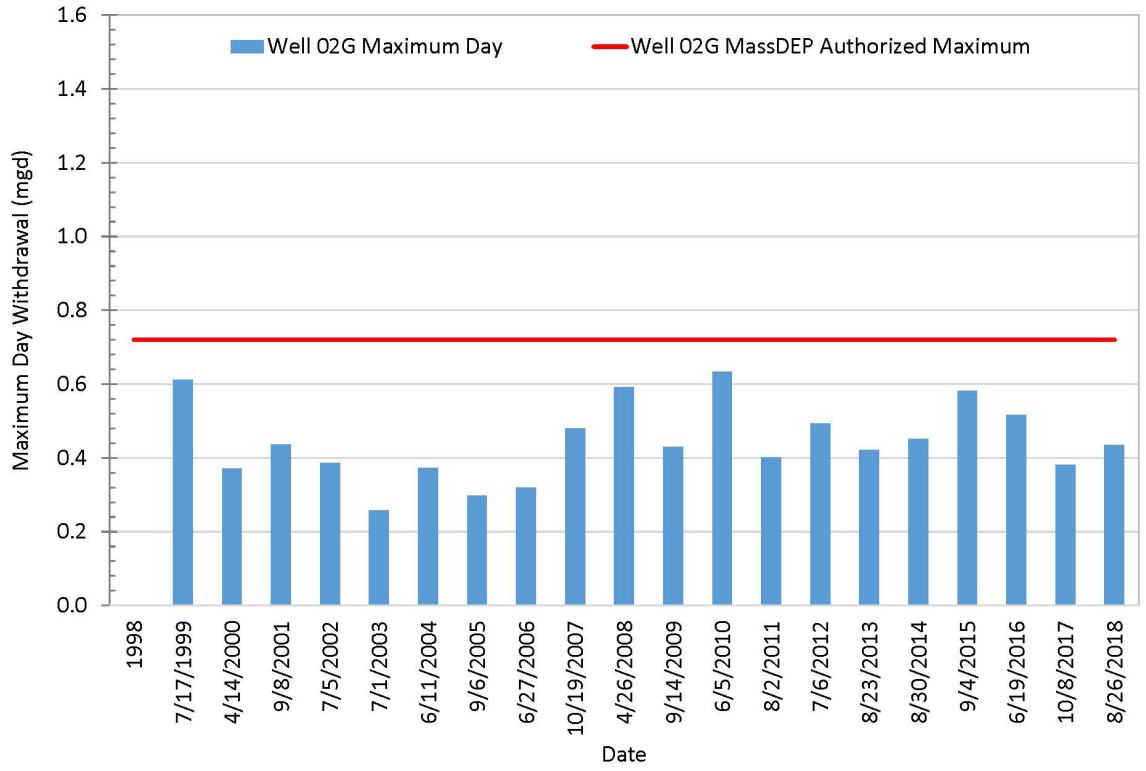


Figure 4-13. Maximum Day Withdrawals – Well 3

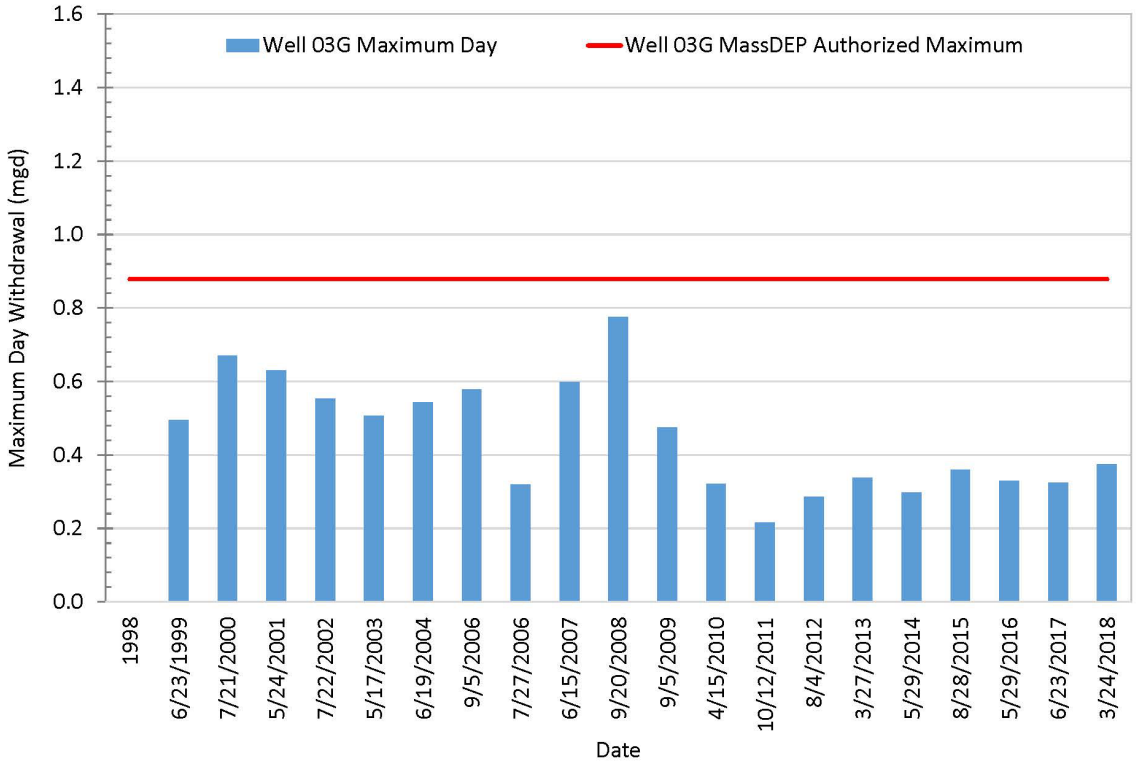


Figure 4-14. Maximum Day Withdrawals – Well 4

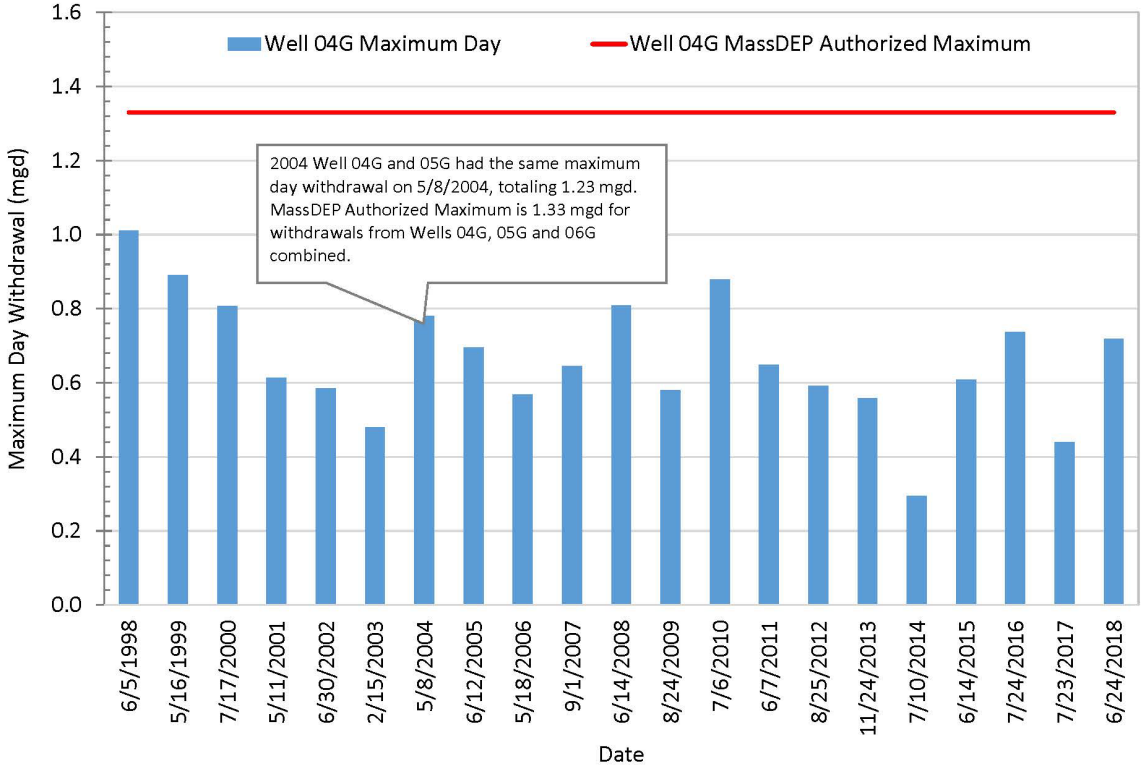


Figure 4-15. Maximum Day Withdrawals – Well 5

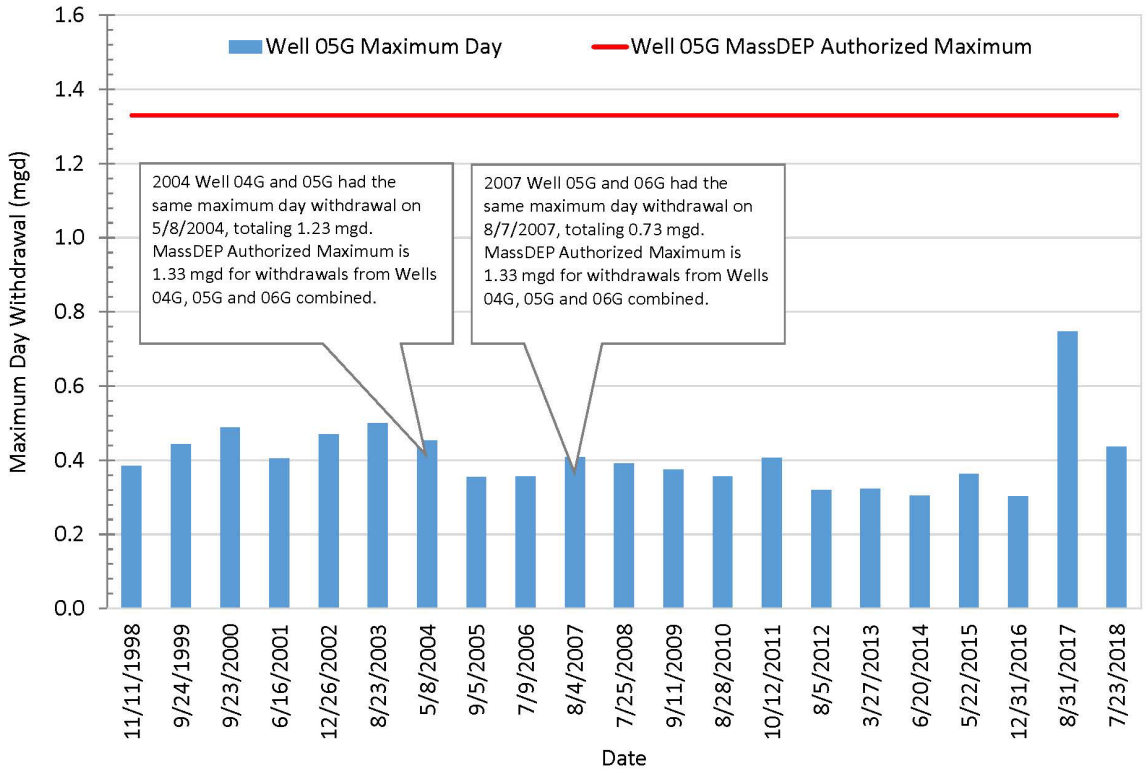


Figure 4-16. Maximum Day Withdrawals – Well 6

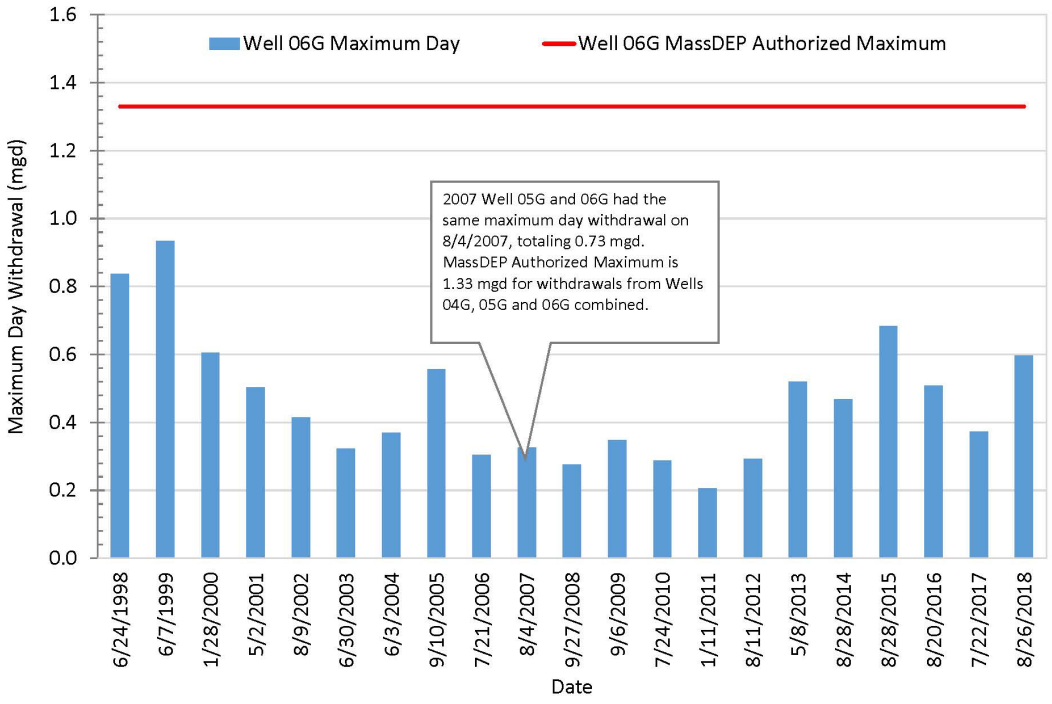
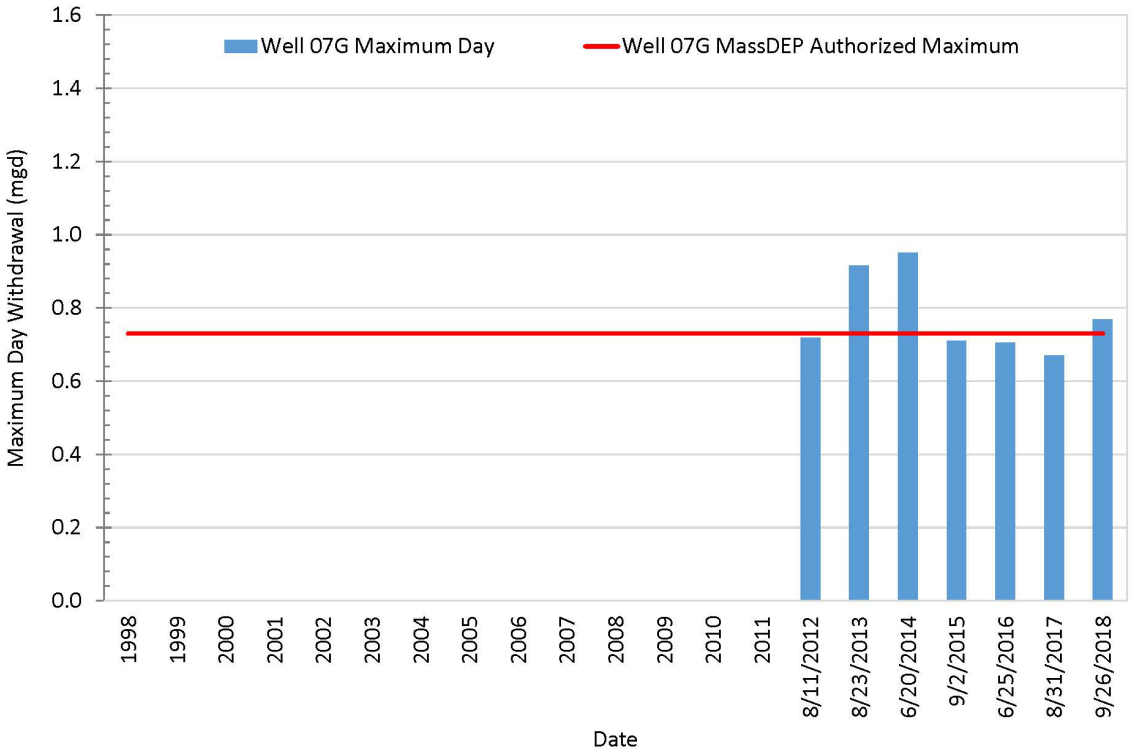


Figure 4-17. Maximum Day Withdrawals – Well 7



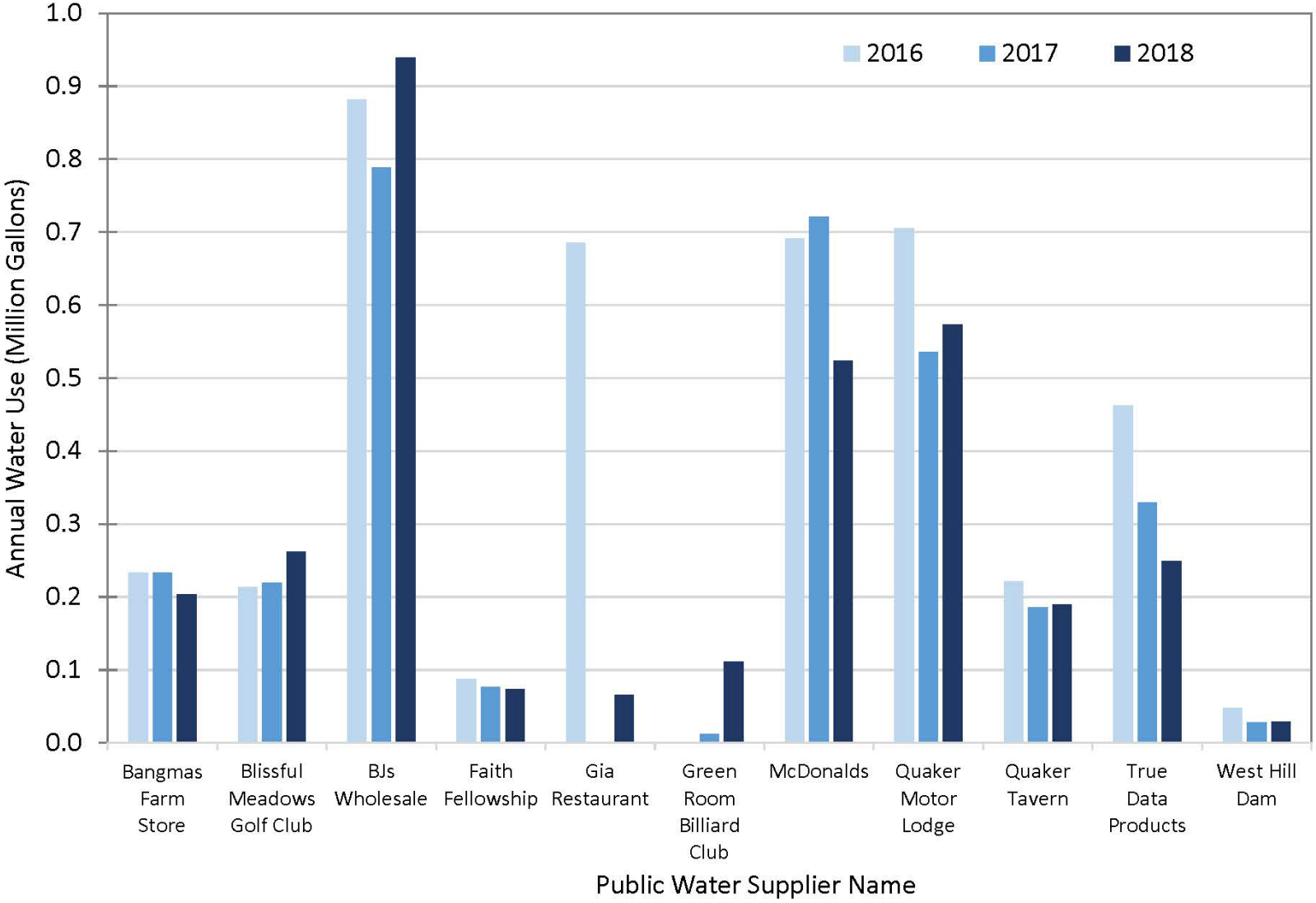
4.4 Small PWS Water Use

The small PWSs within the Town are also required to meter and report their water use to MassDEP through the ASRs. However, the data they report is more limited than that required by the Town for the municipal PWS. Small PWSs report their monthly water use by source and total use for the year and no additional details. ASRs for the years 2016, 2017 and 2018 were obtained for each of the eleven small PWSs.

Figure 4-18 shows the annual water use for each of the small PWSs for the years 2016, 2017 and 2018. When added together, the water use by these small PWSs totals about 3.1 to 4.3 million gallons per year (MGY). For comparison, the Town's public water system uses about 246 to 294 MGY with an average of 271 MGY.

Estimating the average use per day, these small PWSs have a combined water use of about 0.01 million gallons per day (mgd). This is a small percentage when compared to the Town's municipal PWS having a total average day demand ranging from 0.67 to 0.81 mgd and average of 0.74 mgd.

Figure 4-18. Small Public Water Supplier Water Use



4.5 Private Water Supply Water Use

Private water supply water use is not reported to the state or local government and is not typically metered. For this analysis, this use must be estimated based on industry standards. Note that private water supplies are those smaller than the threshold for designation as a public water supplier (PWS) which is defined as providing drinking water to 15 service connections or serving an average of at least 25 people for at least 60 days a year. As discussed in the prior Section, there are eleven small PWSs within the Town, the remaining developed parcels not served by the Town's PWS are assumed to have private wells.

Figure A-1 provides a map identifying parcels assumed to have private wells. **Table 4-1** provides a summary of the number of parcels by use category that are assumed to have private wells.

Table 4-1. Summary of Number of Parcels Assumed to have Private Wells

Parcel Use Category	Number of Parcels
Residential, Single Family	1,397
Residential, Condominium	8
Residential, Two-Family	17
Residential, Three-Family	2
Residential, Multiple Houses on one parcel	14
Commercial, Trucking Terminal	3
Commercial, Storage	6
Commercial, Farm Building	2
Commercial, Small Retail (under 10,000 sf)	3
Commercial, Eating and drinking establishments	4
Commercial, Automotive sales	1
Commercial, Automotive supplies sales	3
Commercial, Automotive repair	10
Commercial, Fuel service	1
Commercial, Gasoline service station	1
Commercial, Other motor vehicle sales and service	2
Commercial, General office building	2
Commercial, Medical office building	2
Commercial, Bus transportation facility	1
Commercial, Gymnasium and athletic club	1
Commercial, Archery, Billiards, other indoor facilities	1
Industrial, Buildings for manufacturing	8
Industrial, Warehouses for storage of manufactured products	8
Industrial, Office building	1

For residential parcels, water use is estimated based on the industry standards. The MassDEP has established a goal for residential water use as 65 gallons per person per day (GPCD). As shown in **Figure**

4-6, the Town's residential water use is more efficient than this goal and is approximately 50 GPCD. However, to be conservative, the 65 GPCD was used for estimating residential water use.

The second factor involved in estimating water use per residence is the number of persons within a household. For the Town of Uxbridge, the Central Massachusetts Regional Planning Commission (CMRPC) literature reports that the mean number of persons per household is 3 (Source: CMRPC, Community Snapshot).

Table 4-2 provides a summary of the residential parcels with private wells and the estimated number of persons per parcel use category and estimated water use.

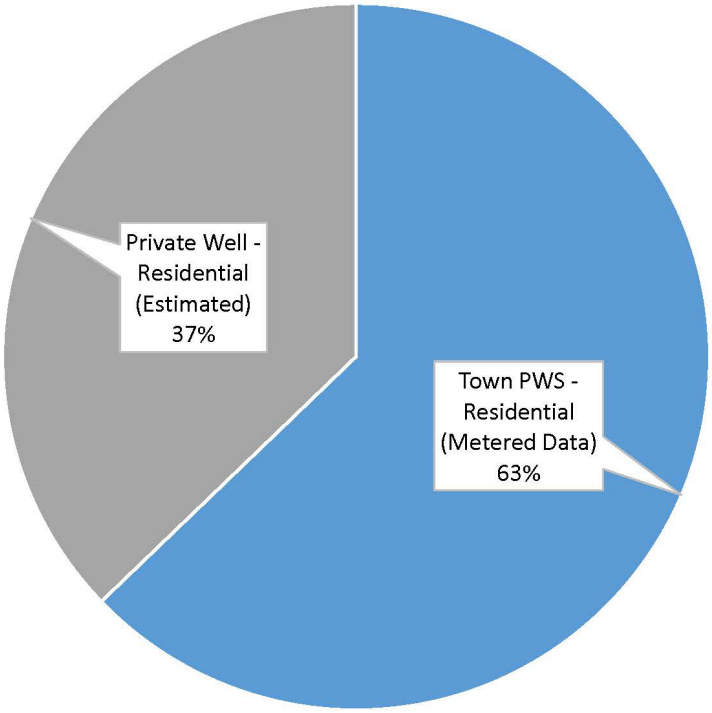
Table 4-2. Estimated Residential Water Use by Private Wells

Parcel Use Category	Number of Parcels	Estimated Number of Persons*	Estimated Water Use (gpd)**
Residential, Single Family	1,397	4,191	272,415
Residential, Condominium	8	192	12,480
Residential, Two-Family	17	102	6,630
Residential, Three-Family	2	12	780
Residential, Multiple Houses on one parcel	14	56	3,640
Total Residential with private wells	--	4,553	295,945

*Number of persons estimated based on the mean of 3 persons per household. For condominium, the assumption is there are up to 24 persons per condominium, the most they could have before being designated as a PWS.
**Estimated water use is based on 65 gallons per person per day (GPCD) times the estimated number of persons.

The Town's municipal PWS has a total average day demand ranging from 0.67 to 0.81 million gallons per day (mgd) and average of 0.74 mgd and the residential portion of that water use is about 0.5 mgd. As shown in **Table 4-2**, the estimated average day water use for residents with private wells is approximately 0.30 mgd. Comparing the residential use for the PWS (0.5 mgd) with the residential use by private wells (0.3 mgd), the Town's municipal PWS serves about 63% of the Town's residents with the remaining 37% receiving water from private wells as shown in **Figure 4-19**. This estimate agrees with the estimate reported in the Town's ASR which had estimated providing service to about 60% of the Town's population.

Figure 4-19. Comparison of Residential Water Use



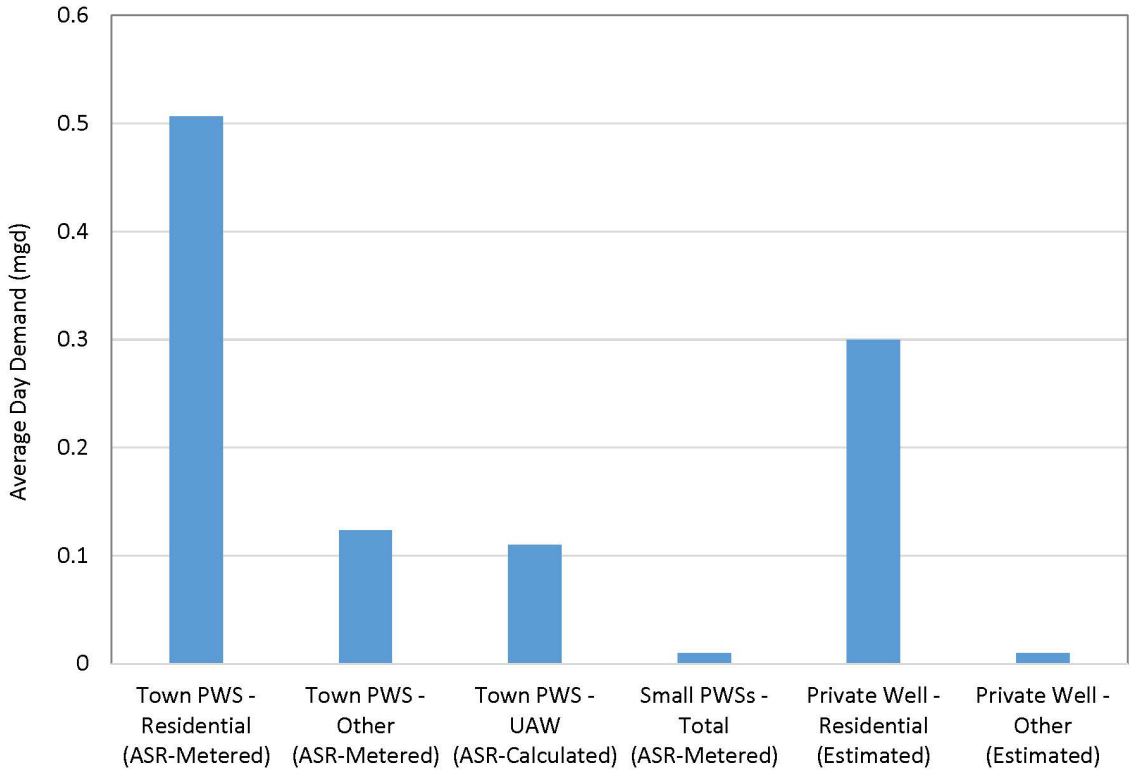
Non-residential private well water use by commercial entities that are not classified as small PWSs exist within the Town as listed in **Table 4-1**. Water use for these entities was estimated to be slightly less than the metered use of the classified small PWSs and represents a small portion of the water use within the Town when compared with the residential water use.

Another group of water consumers that could exist within the Town are entities that use water for non-potable water purposes such as for irrigation of farms and golf courses. The MassDEP confirmed that there are no non-PWS entities that have WMA permits. If any of these non-potable water consumers are present within the Town, the assumption is that they use less than the WMA permit threshold of 100,000 gpd. Estimations of these water consumers was not included in this analysis since it was assumed to be a small percentage of the total water use within Town and within the margin of error of the residential water estimates.

4.6 Summary

This Section presented the recent and past metered water use by the Town's PWS and small PWSs and estimated water use for developed parcels with private wells. **Figure 4-20** shows a summary of the average day demands for the various water consumer entities. The majority of the water use within the Town is for residential purposes (public water and private wells).

Figure 4-20. Comparison of Water Use



The Town's PWS metered water use was compared with available supply capacity to understand the impact current and estimated future demands will have on the Town's water supply capacity. The water demand and capacity analysis resulted in the following findings:

1. Approximately 63 percent of the Town's population is served by the Town's PWS, while approximately 37 percent obtain water supply through private wells.
2. The Town's maximum day demand to average day demand ratio of about 2.0 is typical for a water system with mostly residential customers that use their residence year-round.
3. The Town's PWS has a residential water use that is less than the MassDEP maximum threshold of 65 residential gallons per capita per day (RGPCD). This implies that the Town's water customers are using water efficiently and attempt to conserve water during the growing season.
4. The Town's PWS has an unaccounted for water (UAW) which exceeds the MassDEP maximum threshold of 10 percent. The Town should consider completion of a water audit as a first step in addressing the high UAW. The purpose of a water audit is to evaluate water use in relation to water produced in order to reduce water losses and non-revenue water.
5. The Town currently has a small buffer in the WMA permitted withdrawal of less than 0.1 mgd to accommodate additional demand without having to apply for a new WMA permit to request additional withdrawals.
6. The Town's PWS is able to meet the MassDEP requirement that with any individual supply pump out of service, the remaining pump(s) be capable of providing the current maximum daily pumping demand of the system. However, there is very little buffer and without providing treatment for

Well 1 or constructing a new well, the Town does not have the supply capacity to meet additional demands.

7. The Town has pumped some of the wells at rates higher than the Approved Gallon per Minute (gpm) Pumping Rate. To maintain daily withdrawals within permitted limits, variable frequency drive (VFD) units coupled with modifications to the SCADA system to integrate a maximum flow rate for each supply will help to limit the possibility of the well pumps operating above the permitted rates.

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Section 5.0 –Public Water Supply Service Area Expansion

5.1 Overview

The Town's public water supply system currently has 3,412 service connections and serves about 60% of the residential population. The water system customer base may be expanded through (1) build-out or in-fill connection of customers or connection of properties within or adjacent to the existing service area not currently connected, (2) expansion of the service area to connect properties, such as those properties with contaminated private wells.

5.2 PWS Service Area Build-out

Build-out or in-fill customer expansion occurs within the boundaries serviceable by the existing water system area. For this analysis, developable properties would be connected and developed parcels not currently connected would be connected. Additionally, parcels adjoining the existing water system area within 500 feet of an existing water main were considered potential in-fill customers.

Figure A-5 provides a map showing the potential in-fill service expansion. There are 158 developable and potentially developable residential parcels, 12 developable and potentially developable commercial parcels and 6 developable and potentially developable industrial parcels.

5.3 Kempton Road Contamination Area Expansion

The Kempton Road contamination area is a high priority issue for the Town. The Town's water system was previously expanded to connect some of the properties subject to contamination in this area. Further expansion would be required to connect additional properties.

Figure A-6 provides a map showing the possible Kempton Road contamination area public water system expansion. Within the area outlined in red, there are 178 parcels already connected to the public water supply, 172 parcels with private wells, 53 parcels that are developable and 21 parcels that are undevelopable. This possible expansion of the public water system is contingent on the results of hydraulic studies, further evaluation and testing of private wells and funding availability.

5.4 Other Potential Contamination Area Expansion

As identified in **Section 3.4**, there are additional sites within the Town identified with land use contamination issues. **Figure A-3** in **Appendix A** identifies the location of the sites. Many were localized and already cleaned up without identified impacts to drinking water supplies. Additionally, the Town is aware of two sites used for soil reclamation of materials removed from other locations. These properties are located along South Street and Millville Road. The Town will review and consider information as it is made available with regards to private well contamination and potential expansion of the public water system, contingent on hydraulic and supply capacity and funding.

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Section 6.0 –Population Projections and Future Water Demands

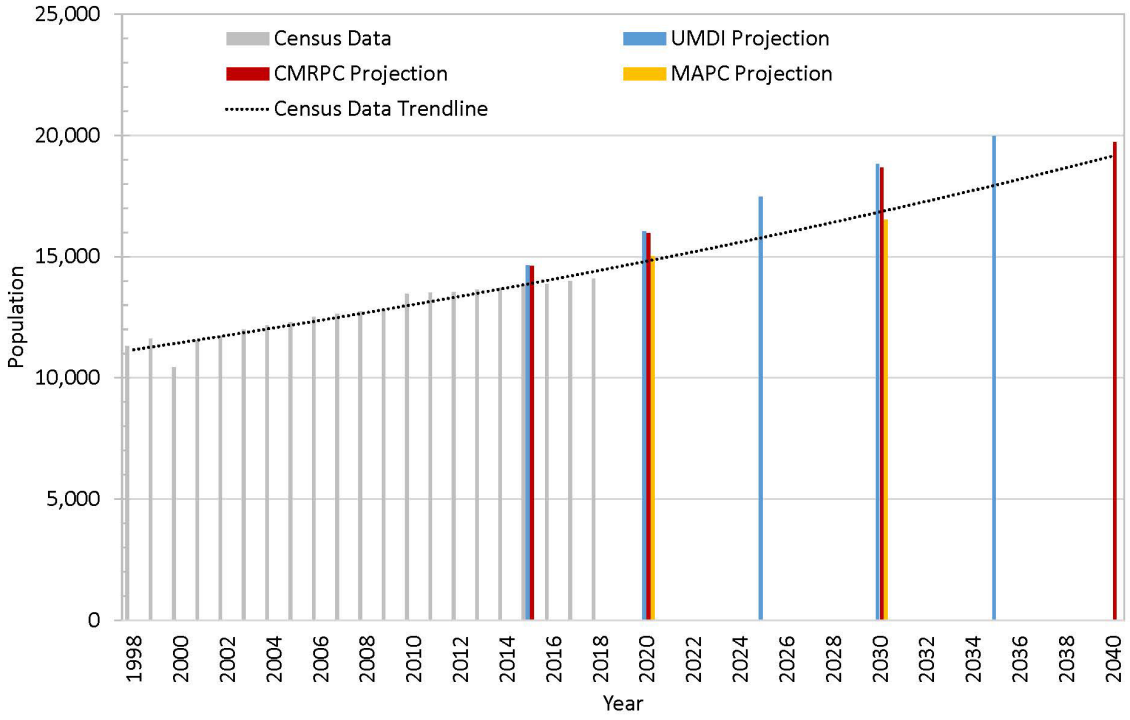
6.1 Overview

Future water demands are an important part of water supply resiliency planning. Estimating these future demands provides the Town with a tool for authorizing new service connections, initiating the process to identify additional sources and planning system expansions.

6.2 Population Projections

Population projections for the Town of Uxbridge have been completed by planning agencies including the Central Massachusetts Regional Planning Commission (CMRPC), Metropolitan Area Planning Council (MAPC) and the University of Massachusetts Donahue Institute (UMDI). The 2018 population estimate was 14,095. The projections from the CMRPC estimate the 2040 population to be 19,722. As shown in **Figure 6-1**, this value is close to the exponential trendline developed from the historical census data. The projections by the UMDI and CMRPC for the years 2020, 2025 and 2030 appear to track high when the 2015 projected population is compared with the 2015 census data. Therefore, the census trendline will be used for the water demand projections for this analysis.

Figure 6-1. Population Projections - Town of Uxbridge



The Town population projections, shown in **Figure 6-1,** include residents with PWS connections and private wells. The population of the Town PWS service area can be estimated from the number of residential service connections times the average household size. For the Town of Uxbridge, the Central Massachusetts Regional Planning Commission (CMRPC) literature reports that the mean number of persons per household is 3 (Source: CMRPC, Community Snapshot). For 2018 the number of water services was 3,412 and the corresponding population is estimated to be 10,236 which is about 73% of the total Town population of 14,095.

Table 6-1 presents the population projections for the Town, existing PWS service area with in-fill only and expanded PWS service areas. Based on the current parcels identified as developable and potentially developable within the existing PWS service area, most of the potential development is outside the boundaries of this service area. For the existing PWS service area, the residential demand projections were based on the developable and potentially developable parcels available. There are 158 developable and potentially developable residential parcels within the PWS service area. For the purposes of this analysis, these parcels were assumed to accommodate single family homes. Assuming the mean number of persons per household, the buildout within the existing PWS service area would add approximately 474 people to the existing customer base. It is assumed that this increase would occur progressively over a 20-year planning period. For the expanded PWS service area to connect the Kempton Road area, there are about 172 residential parcels currently with private wells and another 53 developable parcels. The population estimates presented in **Table 6-1** assume 3 persons per household and that the Kempton Road area expansion would occur by the year 2030.

Table 6-1. Population Projections - Town and PWS Service Area

Year	Town	Existing PWS Service Area with In-Fill Only*	Expanded PWS Service Area to include Kempton Rd Area**
2018 (actual)	*14,095*	*10,236*	*Not applicable*
2020 (estimated)	14,830	10,279	10,279
2030 (estimated)	16,870	10,495	11,011
2040 (estimated)	19,200	10,710	11,385

*In-fill population based on developable and potentially developable parcels identified in Section 5.

**Expanded service area population based on expansion of the PWS to connect parcels in the Kempton Road area as identified in Section 5. Population includes the population within the existing PWS service area. Assumes expansion to Kempton Road area by 2030 to connect the 172 parcels with private wells and the estimate for 2040 assumes the additional 53 developable parcels are connected.

Table 6-2 presents the population projections for the Town and the population with private wells for the various PWS service area alternatives. The population with private wells was determined to be the difference of the Town population and the population within the PWS service area.

Table 6-2. Population Projections – Town and Private Wells

Year	Town	Population with Private Wells while maintaining Existing PWS Service Area	Population with Private Wells with Expanded PWS Service Area – Kempton Rd Area
2018 (actual)	*14,095*	*3,859*	*Not applicable*
2020 (estimated)	14,830	4,551	4,551
2030 (estimated)	16,870	6,375	5,859
2040 (estimated)	19,200	8,490	7,815

6.3 Town PWS Service Area Water Demand Estimation

As described in Section 5, the water system customer base may be expanded through (1) build-out or in-fill connection of properties within or adjacent to the existing service area not currently connected, (2) expansion of the service area to connect properties, such as those properties with contaminated private wells. Future water demands within the PWS service area are a function of (1) developable and potentially developable parcels within the PWS service area, (2) potential connection of parcels on the edges of the PWS service area and (3) expansion of the PWS service area.

The residential demand projections were estimated for the existing PWS service area and the expanded PWS service areas and are a factor of the population projections as shown in **Table 6-1**. The residential per capita water use is anticipated to remain below the WMA permit performance standard which has averaged about 51 gallons per capita day (gpcd) for the past five years.

The existing non-residential water usage is anticipated to remain stable. Additionally, the Town has developable and potentially developable commercial and industrial parcels within the PWS service area. Notably, the Town has host agreements with several marijuana businesses including cultivators as listed in **Table 6-3.** The cultivation facilities require more water than typical commercial developments and as such are highlighted in this section. Water use estimates were provided as part of Cultivate's application which requested water supply from the Town PWS. Phase 1 water use was estimated to be 12,536 gallons per day (gpd) for an approximately 75,015 sq. ft. facility. Final buildout water use was estimated to be 25,072 gpd for an approximately 128,932 sq. ft. facility. That is approximately 61 to 71 gallons per sq. ft. per year. For comparison, an efficient office building's water use should be about 15 to 20 gallons per sq. ft. per year.

Table 6-3. Proposed Marijuana Businesses

Business	Address	Type	Status
Gibby's Garden, LLC	660 Douglas St, Uxbridge	Microbusiness (Tier 1: up to 5,000 sq. ft.)	Final License
Mainely Productions, LLC	660 Douglas St, Ste 600, Uxbridge	Product manufacturer and cultivation	Submitted Application
Cultivate	Campanelli Business Park, Douglas St, Uxbridge	Product manufacturer, cultivator, transporter and treatment center (Phase 1 Tier 9: 70,001-80,00 sq. ft., Complete Tier 11: 90,001 – 100,000 sq. ft.)	Submitted Application
Blackstone Valley Naturals, LLC	660 Douglas St, Ste 400, Uxbridge	Microbusiness (Tier 1: up to 5,000 sq. ft.)	Provisional License
Deep Roots, Inc.	420 West St, Uxbridge	Cultivator and processing facility	Submitted Application
Baked Bean, LLC	540 Quaker Hwy, Uxbridge	Product manufacturer	Provisional License
Natures Medicines, Inc./ Xiphias Wellness, Inc.	1045 Quaker Hwy, Uxbridge	Cultivation and processing (Tier 4: 20,001-30,000 sq. ft.)	Provisional License
Grass Appeal, LLC	79 River Rd, Uxbridge	Product cultivation and processing	Submitted Application
Bare Naked Greens	290 Millville Rd, Uxbridge	Product manufacturer, cultivator, transport	Submitted Application

One method the Town can use to offset the water demand increases is to reduce the unaccounted for water (UAW). As presented in **Section 4**, the UAW has been greater than the performance standard each year since 2008 with an average of 18 percent and reached nearly 25 percent in 2018. Therefore, the water demand projections were estimated assuming the UAW continues at current levels and for reduction in the UAW to the performance standard of 10 percent.

Table 6-4 presents the water demand projections for the PWS service area with the UAW at current levels. **Table 6-5** presents the water demand projections for the PWS service area with the UAW reduced to 10 percent.

Table 6-4. Water Demand Projections – PWS Service Area with Current UAW

	Existing PWS Service Area with In-Fill Only	Expanded PWS Service Area with In-Fill and Kempton Rd Area
Year	Average Day Demand*	
2018 (actual)	*0.756 mgd*	*Not applicable*
2020 (estimated)	0.779 mgd	0.779 mgd
2030 (estimated)	0.825 mgd	0.851 mgd
2040 (estimated)	0.841 mgd	0.875 mgd

*Average day demand is the total pumpage for the year including metered and non-metered water use divided by 365 days. The maximum day demands are assumed to be two times greater than the average day demand as presented in Section 4.2.

Table 6-5. Water Demand Projections – PWS Service Area with Reduced UAW

	Existing PWS Service Area with In-Fill Only	Expanded PWS Service Area with In-Fill and Kempton Rd Area
Year	Average Day Demand*	
2018 (actual)	*0.756 mgd*	*Not applicable*
2020 (estimated)	0.703 mgd	0.703 mgd
2030 (estimated)	0.748 mgd	0.774 mgd
2040 (estimated)	0.770 mgd	0.804 mgd

*Average day demand is the total pumpage for the year including metered and non-metered water use divided by 365 days. The maximum day demands are assumed to be two times greater than the average day demand as presented in Section 4.2.

6.4 PWS Supply Capacity

The existing source safe yields and pumping capacities were compared to the existing and future water demands to determine if there will be adequate water supply. The supply capacity for the current demands and existing supplies was presented in **Section 3**. **Section 6** accounts for the future demand projections. The WMA permit accounts for authorized withdrawals through February 2029 and provides a stepped increase in 5-year increments for authorized withdrawal amounts, reaching a total of 1.02 mgd by the year 2029. **Figure 6-2** presents the existing and future average day demands for the PWS service area in-fill scenario in comparison with the WMA permit authorized withdrawals. **Figure 6-3** presents the existing and future average day demands for the PWS service area in-fill and Kempton Road area expansion scenario in comparison with the WMA permit authorized withdrawals. The projections assume that the Kempton Road expansion occurs by 2030 to connect the existing 172 parcels with private wells in this area and the remaining 53 developable parcels connect to the public water system by 2040. Both figures indicate that the existing WMA permit would accommodate these increased demands.

Figure 6-2. Comparison of Average Day Demand with WMA Permit – PWS Service Area with In-Fill

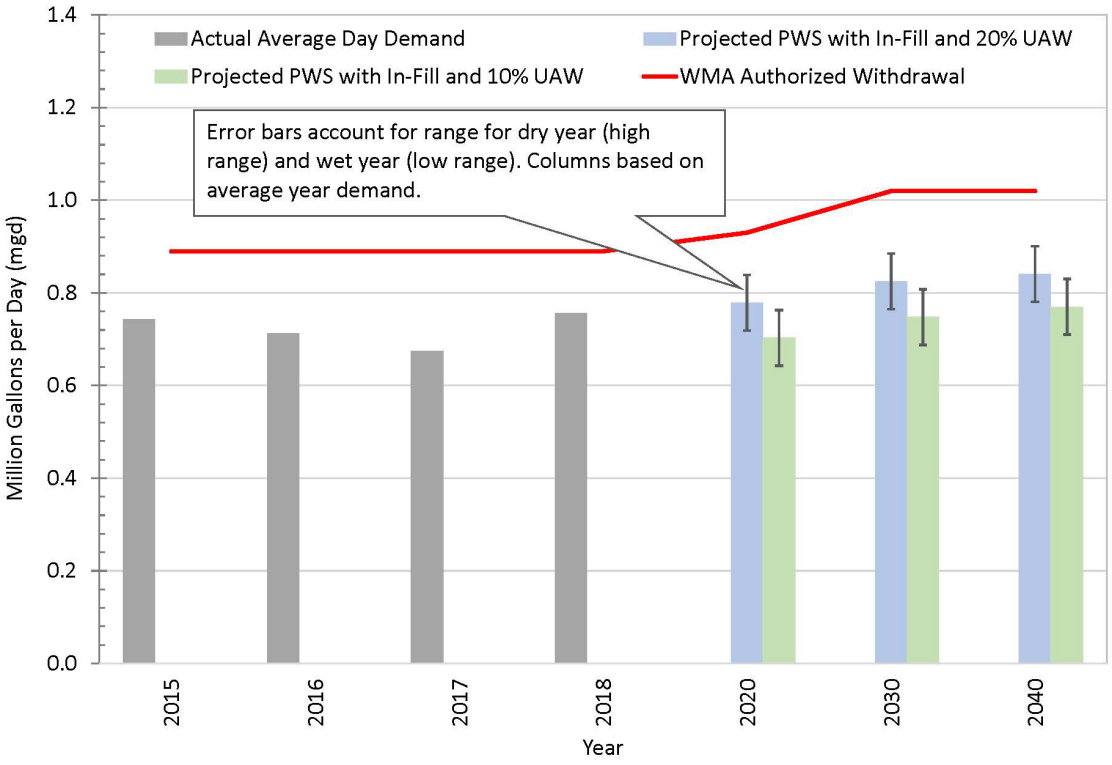
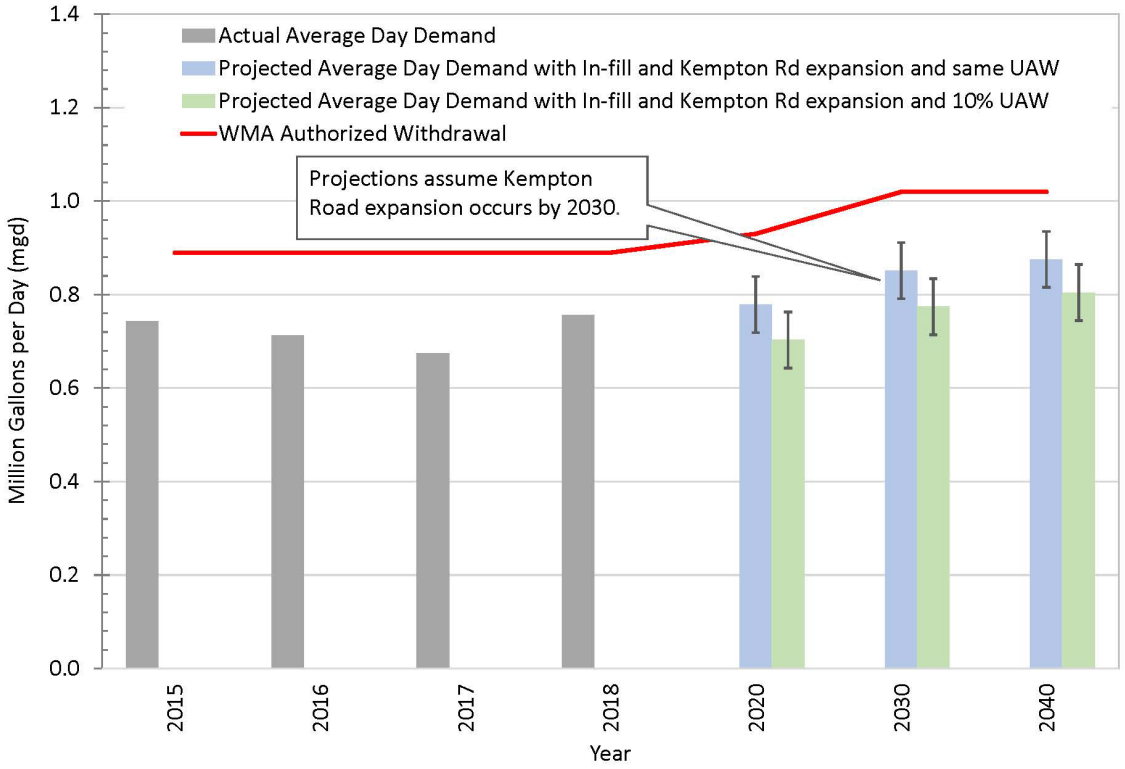


Figure 6-3. Comparison of Average Day Demand with WMA Permit – PWS Service Area with In-Fill and Kempton Road Expansion



The other supply capacity factor to consider is the impact of the future maximum day demands on the existing supplies. 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. **Figure 6-4** presents the existing and future maximum day demands PWS service area in-fill scenario in comparison with the available supplies. This figure shows that, on average, the maximum day demands will increase to levels greater than the available pumping with the largest source off-line, assuming Well 1 remains off-line and the UAW remains at current levels. **Figure 6-5** presents the existing and future maximum day demands PWS service area in-fill and Kempton Road expansion scenario in comparison with the available supplies. These figures indicate a moderate increase in the demands by 2030 which further indicates that additional supply will be needed to accommodate the Kempton Road area expansion.

Figure 6-4. Comparison of Maximum Day Demand with Available Supplies – PWS Service Area with In-Fill

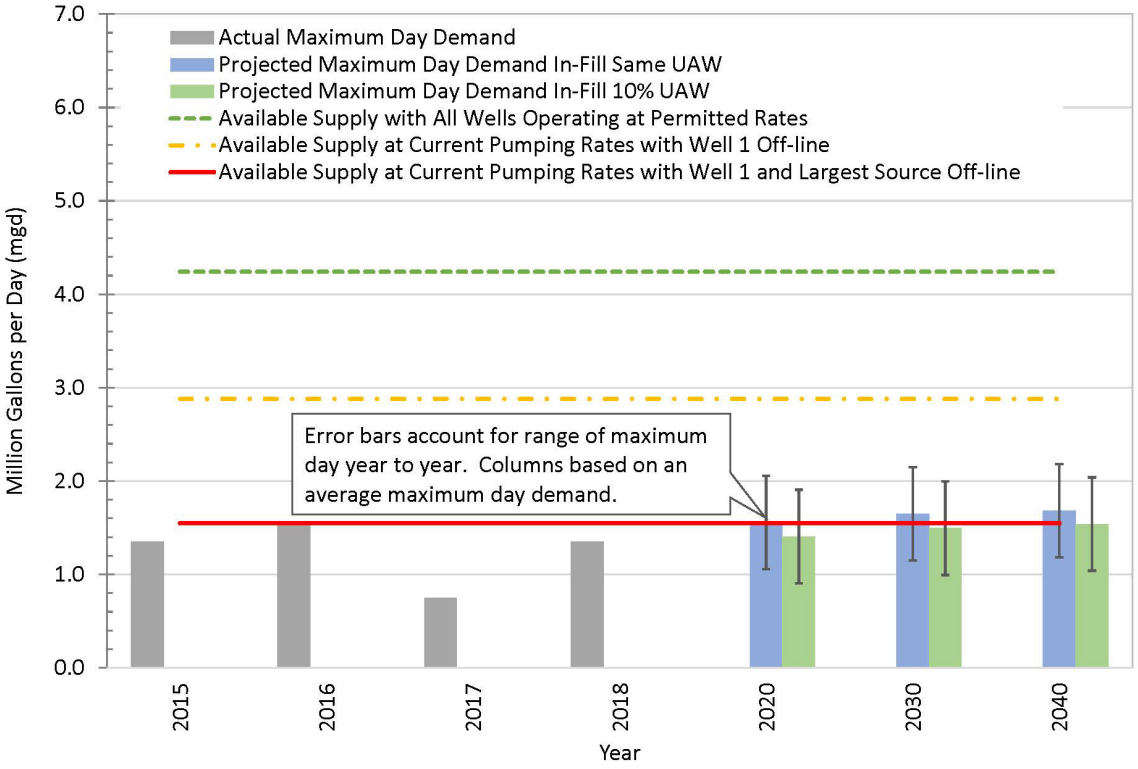
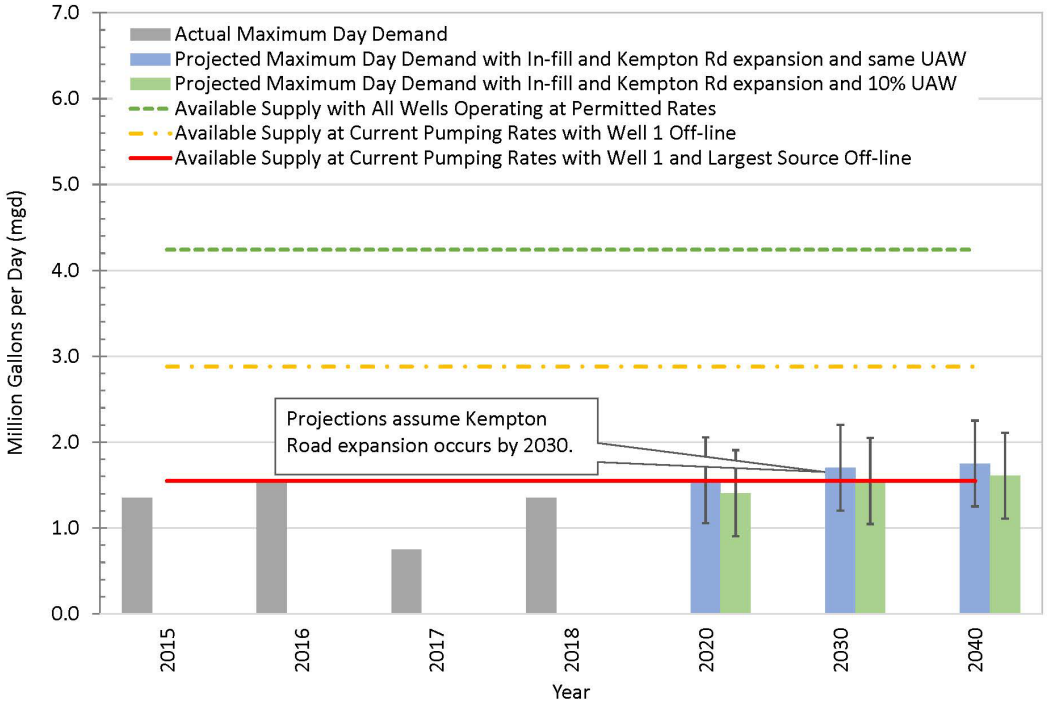


Figure 6-5. Comparison of Maximum Day Demand with Available Supplies – PWS Service Area with In-Fill and Kempton Road Expansion



6.5 Summary

The water demand projections for the existing service area and the expanded service area to connect the Kempton Road area parcels impacted or potentially impacted by contamination indicate that the existing WMA permit would accommodate these increased demands, however, the Town will require additional water supply to meet maximum day water demands. 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. Since Blackstone Well 1 is currently off-line for water quality reasons, this analysis was completed assuming Blackstone Well 1 and the Bernat Wells were off-line. Such a scenario could occur as a result of a significant flood event given that the Bernat Wells are located within the 100-year flood zone. Therefore, expansion of the Town's water system to connect in-fill services or the Kempton Road area will require additional water supply.

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Section 7.0 –Options for Additional Supply

7.1 Overview

For the Town's public water system, additional sources of supply will be needed to accommodate future demands. Potential sources of supply include (1) treatment of water from the existing Blackstone Wells, (2) installation of new source supply well(s) and (3) interconnection with neighboring water system(s).

7.2 Treatment of Blackstone Wells

Blackstone Wells 1, 2 and 3 contain elevated levels of manganese and, to a lesser extent, iron, as summarized in **Section 2.6**. The levels of manganese in Well 1 prompted the Town to remove this well from service. Manganese in Wells 2 and 3 continues to increase and there is concern that these wells could be removed from service similar to Well 1. In order to fully utilize these wells going forward, a water treatment facility capable of manganese and iron removal would be needed.

Selection of a treatment process to remove iron and manganese from a particular water supply depends on several factors including:

1. the amount of iron and manganese present in the raw water;
2. other contaminants in the water such as arsenic, hydrogen sulfide, and organics;
3. treatment goals;
4. treatment flow rate;
5. site size;
6. operator availability;
7. capital costs; and
8. operations and maintenance costs.

Treatment of both iron and manganese can be achieved through different methods ranging from sequestering to physical removal through use of processes such as pressure filtration, membranes, ion exchange and biological filtration.

7.2.1 Sequestering

Many water systems manage iron and/or manganese levels through sequestering. Sequestering involves the addition of a chemical, typically a phosphate blend, to react and bind the iron and manganese in water to prevent oxidizing on contact with air or chlorine and help prevent staining of fixtures. The sequestering chemical helps to keep the iron and/or manganese in the dissolved or "in solution" form, to prevent the iron and/or manganese from precipitating out of solution which is when the aesthetic issues occur. Note that sequestering is only effective for iron up to about 0.6 mg/L and manganese up to about 0.1 mg/L and sequestering agents fail at higher temperatures in hot water tanks. Additionally, sequestering does not remove iron and manganese from the water, so the potential health impacts remain.

7.2.2 Pressure Filtration

Pressure filtration involves the use of oxidation and adsorptive type media for iron and manganese removal. Several other Massachusetts public water suppliers currently use pressure filtration with anthracite over manganese oxide coated media such as the traditional Greensand or newer GreensandPlus. The traditional Greensand media has effectively been superseded with the newer media called GreensandPlus. GreensandPlus is more robust than traditional Greensand with greater capacity to treat higher levels of iron and manganese and reduced risk of operational problems such as crushing of media and mudball formation. GreensandPlus is manufactured by Inversand and may be used by any filter system supplier. There are other proprietary media such as that by Layne and Pureflow, which may only be used when packaged with their entire filter system. An oxidant is typically added in front of the pressure filtration system such as chlorine or potassium permanganate, to oxidize the dissolved ferrous iron to insoluble form ferric hydroxide, Fe(OH)3(s), and the dissolved manganese to insoluble form manganese oxide, MnO2(s). The precipitates Fe(OH)3(s) and MnO2(s) will then be filtered out primarily in the anthracite media layer located within each pressure filter. Any remaining dissolved manganese is removed through media adsorption in the manganese oxide coated media (GreensandPlus) layer. Pressure filtration is typically effective for iron levels up to 10 mg/L and manganese levels up to 2 mg/L. Beyond that, the filter run times decrease to unmanageable durations or the surface area/diameter of the filters needs to be increased to a point at which the square footage of the proposed facility is not as cost effective when compared with other technology.

7.2.3 Membrane Filtration

Membrane filtration can also be used to remove iron and manganese from water. Membranes work by pushing water through a thin layer of semi-permeable material. There are several types of membrane systems and membrane pore sizes available. The pore size of the membrane affects what contaminants can be removed by the membrane system. As the pore size decreases, more energy or force is needed to push the water through the membrane material. The largest pore size opening is called microfiltration which can be used to remove iron and manganese. Smaller pore sizes such as ultrafiltration, nanofiltration and reverse osmosis can be used to filter out smaller particles and contaminants including viruses. It is important to note that as the pore size decreases, the membrane system starts to remove alkalinity making the water more corrosive, increasing the chemical addition needs for corrosion control.

7.2.4 Ion Exchange

Ion exchange is a treatment process that operates through exchange of ions in water with ions from an insoluble, permanent, solid resin bed. Processes utilizing ion exchange operate by removing the contaminant of interest through charge attraction of the contaminant to the media. The resin media selected is dependent on the contaminant to be removed. Media beds are either positively or negatively charged to provide cation or anion exchange. One type of media may be used to remove both iron and manganese. However, the iron or manganese must be in its dissolved form for the resin media to work. Iron precipitates readily when pumped from wells and the iron precipitate can blind the top of the resin, increasing backwash frequency. Should iron be present, a pretreatment filter is required ahead of the ion exchange system. Over time, as water flows through the resin bed, the media becomes exhausted and must be regenerated on or off site or disposed of. Water softener systems utilize this technology and are regenerated using a brine solution

which adds sodium to the finished water. Typically, these types of systems are used for very small water supply systems since chemical pre-treatment is not required, making them easier to operate. The cost of the ion exchange resin and its future replacement are high when compared with manganese oxide coated media.

7.2.5 Biological Filtration

Biological filtration is a newer technology being used for iron and manganese removal in New England. There are currently three full-scale water treatment facilities utilizing this technology. This type of process is also a pressure filtration system but the media, such as sand, is used to support the growth of bacteria that remove the iron and manganese from the water. When both iron and manganese are present, often one set of filters is needed for iron removal and another set of filters for manganese removal. This can double the number of filters needed when compared with pressure filtration using manganese oxide coated media. However, biological filtration may be used to remove very high levels of iron and manganese with a much smaller filter bed area than would be needed using manganese oxide coated media. While more filter vessels are needed, the savings on the overall size of the filters make this a viable option when the water supply contains high levels of iron and/or manganese.

7.2.6 Treatment Summary

Prior to selection of a particular treatment process, the Town must conduct pilot testing of the preferred treatment removal process(es). Pilot testing involves operation of a small-scale treatment facility on the water supply to determine the adequacy of the treatment process to deliver water of good quality that meets the standards established by the MassDEP. Prior to conducting the pilot test, MassDEP approval to conduct the test must be obtained. Once conducted, the pilot report must be submitted to MassDEP for approval. After that, the Town may initiate design of the proposed water treatment facility. The process from pilot testing through design and construction of a new water treatment facility is a multi-year process of about three to four years assuming work proceeds expeditiously.

7.3 Installation of New Source Supply Well(s)

Siting of new source supply wells involves three primary factors (1) sufficient amount of contiguous open space to provide a 400-foot radius or 11.5 acres, (2) land use activities, since no land use activities except those directly related to the operation and maintenance of the public water supply are permitted in Zone I and (3) soil types, since gravel-packed wells (similar to the Town's PWS existing wells) can only be developed in areas with favorable sand and gravel deposits and limited wetlands. The new source process is extensive and begins with a desktop analysis to evaluate potential sites meeting the above three factors.

Once potential site(s) have been identified and provided accessibility, test well work typically begins with installing 2-1/2 inch diameter test wells using drive and wash method, conducting a short pump test to estimate yield and taking water quality samples, then, depending on results, may require installing 4-inch diameter test wells using sonic drilling method and conducting pump tests on those wells. Larger test wells provide more accurate data for estimating the yield of the permanent well.

Provided the test well work yields favorable results, the new source approval process may be initiated with the MassDEP. This is a multi-year process and takes at least five years, requiring extensive environmental permitting.

Additionally, the new source will likely require some form of treatment ranging from chemical treatment for corrosion control to physical treatment for iron and/or manganese removal.

The understanding is that there were provisions for additional wells at the Rosenfeld well field. The new source investigations should consider this as a starting point should the Town seek to pursue the new source process.

7.4 Interconnection with Neighboring Water System(s)

Interconnections are another potential source of supply. The Town's PWS has an existing interconnection with the Whitinsville Water Company (WWC). Purchase of water could be a viable alternative. The Town should conduct a supply source analysis to compare the life-cycle costs involved with the purchase of water in comparison with construction of a new water treatment facility for the Blackstone Wells or installation of a new well. As part of this analysis, the Town should consider the potential impact of long-term blending of water from the WWC with the Town's supplies. Blending water qualities can have unintended consequences that could have financial implications.

Section 8.0 –Conclusions and Next Steps

8.1 Overview

This project provides a valuable planning tool for the Town to enhance water supply resiliency with regards to resource vulnerabilities from both natural and manmade factors such as droughts and floods associated with climate change and contamination from land use practices. The analysis considered water supply sources for the Town public water supplier (PWS), other small PWSs and those with private wells. The project resulted in the identification of resource vulnerabilities and methods of enhancing resiliency going forward.

8.2 Summary of Findings

The following provides a summary of the findings identified in the previous Sections of this report.

1. Town PWS Supply Capacity

    a. For the current water demands, the Town's PWS is able to meet the MassDEP requirement that with any individual supply pump out of service, the remaining pump(s) be capable of providing the current maximum daily pumping demand of the system. However, there is very little buffer and without providing treatment for Wells 1, 2 and 3 or constructing a new well. Ultimately, the Town does not have the supply capacity to meet additional demands from new developments and/or expansion of the system to connect properties with contaminated wells.

    b. Manganese within the water from the Town's Blackstone Wells 1, 2 and 3 has been detected at levels exceeding 0.3 mg/L. Additionally, levels in Well 1 exceeded 1 mg/L and the average level continued to exceed 0.3 mg/L, therefore the well was taken off-line/out of service. More recent samples from Wells 2 and 3 have indicated levels are less than 0.3 mg/L. The levels above 0.05 mg/L result in discolored water and staining fixtures/laundry while levels equal to or greater than 0.3 mg/L trigger health concerns.

    c. Iron within the water from the Town's wells has been detected at levels exceeding the SMCL of 0.3 mg/L. Average levels of iron have been below 0.3 mg/L, however, Blackstone Well 2 shows a recent increase in iron. These levels may result in discolored water and staining fixtures/laundry but are not as problematic as the manganese levels.

2. Additional Water Supply

    a. Additional water supply for the Town's PWS can be obtained through treatment of Well 1, 2 and 3; construction of a new well; or interconnection with a neighboring water system. The Town should consider conducting a new source study to weigh the advantages and disadvantages of each option.

b. As noted above, Blackstone Well 1 is off-line due to elevated levels of manganese. A corrective action plan is needed to determine how this well will be managed into the future, ie. replace the well or implement manganese removal treatment. If manganese removal treatment is pursued, this treatment should be planned to accommodate all three of the Blackstone Wells.

c. An initial step in exploring for a new well involves conducting a desktop analysis of site suitability involving three primary factors (1) sufficient amount of contiguous open space to provide a 400-foot radius or 11.5 acres, (2) land use activities, since no land use activities except those directly related to the operation and maintenance of the public water supply are permitted in Zone I and (3) soil types, since gravel-packed wells (similar to the Town's PWS existing wells) can only be developed in areas with favorable sand and gravel deposits and limited wetlands. Since the new source process is extensive, this initial desktop study is a valuable tool in assessing the viability of installing a new source. The understanding is that there were provisions for additional wells at the Rosenfeld well field. The new source investigations should consider this as a starting point should the Town seek to pursue the new source process.

d. Interconnection with neighboring water suppliers is another potential option. The Town should conduct a supply source analysis to compare the life-cycle costs involved with the purchase of water in comparison with construction of a new water treatment facility for the Blackstone Wells or installation of a new well. As part of this analysis, the Town should consider the potential impact of long-term blending of water from the neighboring water system with the Town's supplies. Blending water qualities can have unintended consequences that could have financial implications.

3. Town PWS WMA Permit

a. The Town currently has a small buffer in the WMA permitted withdrawal of less than 0.1 mgd to accommodate additional demand without having to apply for a new WMA permit to request additional withdrawals. However, the WMA permitted withdrawal increases for the period March 1, 2019 through February 28, 2024 to allow an additional 0.04 mgd and increases again for the period March 1, 2024 to March 28, 2029 to allow an additional 0.05 mgd. There is also a 5% buffer factor of 0.04 mgd which can be applied to the permit provided the Town meets certain permit requirements.

b. The Town has pumped some of the wells at rates higher than the Approved Gallon per Minute (gpm) Pumping Rate. To maintain daily withdrawals within permitted limits, variable frequency drive (VFD) units coupled with modifications to the SCADA system to integrate a maximum flow rate for each supply will help to limit the possibility of the well pumps operating above the permitted rates.

4. Unaccounted for Water

    a. The Town's PWS has an unaccounted for water (UAW) which exceeds the MassDEP maximum threshold of 10 percent. The Town should consider completion of a water audit as a first step in addressing the high UAW. The purpose of a water audit is to evaluate water use in relation to water produced in order to reduce water losses and non-revenue water.

5. Town PWS Water Supply Infrastructure

    a. Blackstone Wells 1, 2 and 3: The three pump station buildings are generally in good condition; however, each requires roof replacement.

    b. Blackstone Well 1 is accessible via a bridge along the Home Brew Dam which is in deteriorating condition and creates a shallow pond adjacent to the wells.

    c. Blackstone Wells 1, 2 and 3: Each well is located proximate to surface water making it vulnerable to flooding especially since part of each pump station is below ground elevation. Note that the well casing should extend above the flood elevation level to mitigate the impacts of the 100-year flood.

    d. Main Office and Garage: The garage provides limited space for vehicle and equipment/material storage and maintenance. Some parts and equipment are kept outside due to space limitations. Access to the chemical feed equipment is challenging given the small space allotted for this equipment in the garage. A new facility is needed for Water Division offices and garage to provide a centralized location for this equipment.

    e. Bernat Wells 4, 5 and 6: The facilities are in good condition however, they are in close proximity to the Blackstone River and are subject to flood risks especially since part of each pump station is below ground elevation. Additionally, these wells are located within 100-year flood mapped areas. Note that the well casing should extend above the flood elevation level to mitigate the impacts of the 100-year flood.

    f. Bernat Wells 4, 5 and 6: Access to the well pump stations requires crossing a culvert that is in deteriorating condition. Failure of this culvert would compromise access to these facilities. The culvert is located between the water treatment facility and the well pump stations.

    g. East Street Booster Pump Station: Evaluate the need to improve the East Street Service Area to provide water storage which will allow the pumps to rest and provide enhanced system resiliency.

6. Methods to Enhance Water Supply Protection through Planning

    a. Develop a Source Water Protection Master Plan for a holistic approach to protecting public and private water supplies. The plan should be made available to the public to educate all water consumers on methods of protecting both the quantity and quality of the water supplies.

    b. Review the Groundwater Protection Overlay District Bylaw to verify conformance with current MassDEP recommendations. Consider enhancement of these bylaws to provide additional provisions to protect against groundwater contamination.

    c. Develop Water Conservation and Drought Management Plan protecting both public and private water supplies within the Town. The plan should be made available to the public to educate all water consumers on methods of protecting both the quantity and quality of the water supplies.

    d. Update the Water System Emergency Response Plan to account for potential flooding of the water supply wells/pump stations.

    e. Adopt a Private Well Bylaw that would require private well owners to comply with the same water conservation requirements as those on public water supply.

    f. Review proposed developments and consider their potential impact on public and private water quality and quantity.

7. Water Supply Contamination

    a. Continue to keep informed of the contamination sampling in the Kempton Road area and work with residents and the State to identify opportunities to connect these properties to the Town's PWS. Evaluate infrastructure needs to expand the Town's PWS to connect those properties with contaminated private wells.

    b. Encourage private well owners to test the water quality of their wells in accordance with MassDEP recommendations. MassDEP recommends sampling for a number of contaminants upon sale of the property or when initially installing the well, then testing for most contaminants every ten years, while sampling for coliform bacteria, nitrate and nitrite once every year.

    c. Keep informed of emerging contaminants such as Per- and Polyfluoroalkyl Substances (PFAS). Conduct testing in accordance with MassDEP recommendations.

8. Water Supply for Fire Protection

    a. Evaluate the hydraulics of the public water system to enhance fire protection capabilities at areas with low pressure and/or flow.

    b. Consider installation of fire supply cisterns in areas without access to the public water system as new developments are proposed.

8.3 Next Steps

The next steps for the Town include developing a plan and schedule to address the findings and recommendations identified. With regards to supply capacity, the Town should complete initial investigations into the alternative sources: (1) treatment of the Blackstone Wells, (2) new source siting study and (3) the viability of the purchase of water from a neighboring water system. These initial investigations would provide the Town with more details on the potential capital and operation and maintenance costs associated with each and the magnitude of the additional supply that would be available. Additionally, the Town should take measures to address the water supply infrastructure vulnerabilities identified to protect and maintain its existing resources. Finally, the report identified several planning methods to enhance water supply protection that should be considered by the Town for implementation.

There are several funding programs that the Town could consider in addressing the water supply vulnerabilities including:

1. Continued funding through additional Municipal Vulnerability Preparedness (MVP) program Action Grants.
    a. The results of this study indicate that climate change is a critical factor in the overall resiliency of the Town's drinking water supply, making follow on projects eligible for continued funding through the MVP program.
    b. Grants are reimbursed at 75% and require 25% match through in-kind services or cash.
    c. Grant applications are typically due in the Spring and Fall. The current round deadline for submitting a grant application is June 11, 2020.
    d. The Town could consider an Alternative Source Study through this grant program to evaluate the options identified above for additional water supply.

2. Water Management Act (WMA) grant program
    a. This grant program is available to WMA permit holders and the Town is eligible since it holds a WMA permit.
    b. Grants are reimbursed at 80% and require 20% match through in-kind services or cash.
    c. Grant proposals are typically due in October with the award of contracts the following January and all work must be completed by the following June 30th.
    d. Both planning and implementation projects are eligible and the Town could consider an Alternative Source Study through this grant program.

3. Drinking Water State Revolving Fund (DWSRF) program
    a. The DWSRF program funds planning and construction phase projects.
    b. This is primarily a low interest loan program which makes it more suitable for construction phase projects such as construction of a new water treatment facility.
    c. The request process begins with a Project Evaluation Form submitted in August followed by the release of the Intended Use Plan in January with eligible projects submitting SRF applications by the following October.

4. USDA Rural Development Loan and Grant program
    a. The Rural Development Loan and Grant program is another funding option typically utilized for larger cost projects such as a new water treatment facility.
    b. This program offers both loans and grants with amounts depending on the size of the community and certain demographics such as the median household income. Smaller communities with lower median household income typically receive larger portions of grant funds than other communities.
    c. The program involves an extensive application process and it is recommended that the Town meet with a USDA Rural Development Loan and Grant program representative prior to initiating the grant application process.

5. MassWorks Infrastructure Grants
    a. The MassWorks Infrastructure Grant is another funding program that would help pay for a construction project.
    b. This is a very competitive funding program and the Town would need to partner with businesses to demonstrate that the project would bring additional housing and mixed-use facilities along with the creation of new jobs. For example, the grant program has funded water system expansion projects, but the expansion would need to connect a new mixed-use facility or other job-creating development.
    c. Applications are typically due by early August.

APPENDIX A
Maps

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SUTTON

NORTHBRIDGE

SUTTON

MENDON

UXBRIDGE

DOUGLAS

MILLVILLE

BURRILLVILLE

NORTH SMITHFIELD

FIGURE A-1: UXBRIDGE WATER SUPPLY BY PARCEL

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

- Community Groundwater Source
- Non-Community Groundwater Source
- Water Line
- Public Water Supply
- Private Well
- Public Water Supply and Private Well
- Small Public Water Supply

0 0.25 0.5 1 Miles

N

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses

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SUTTON

NORTHBRIDGE

SUTTON

MENDON

UXBRIDGE

DOUGLAS

Irrigation well at HS

MILLVILLE

BURRILLVILLE

NORTH SMITHFIELD

FIGURE A-2: PARCELS WITH PRIVATE WELLS

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

Private Well

- In SearchWell Database
- Not in SearchWell Database

0 0.25 0.5 1 Miles

N

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses
3. SearchWell Database: Well Addresses

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SUTTON

NORTHBRIDGE

SUTTON

MENDON

UXBRIDGE

DOUGLAS

MILLVILLE

BURRILLVILLE

NORTH SMITHFIELD

0 0.25 0.5 1 Miles

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses
3. SearchWell Database: Well Addresses

N

FIGURE A-3: PWS WELLS ZONE I AND ZONE II AREAS AND 21E SITES

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

- Community Groundwater Source
- Non-Community Groundwater Source
- Wellhead Protection Zone I
- Wellhead Protection Zone II
- Water Line
- Public Water Supply
- Private Well
- Public Water Supply and Private Well
- Small Public Water Supply

21E Sites

- Other
- Hazardous Material
- Oil
- Oil and Hazardous Material
- Contaminated Soil

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SUTTON

NORTHBRIDGE

SUTTON

MENDON

UXBRIDGE

DOUGLAS

MILLVILLE

BURRILLVILLE

NORTH SMITHFIELD

FIGURE A-4: FEMA DESIGNATED FLOOD ZONES

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

- Community Groundwater Source
- Non-Community Groundwater Source
- Water Line
- Public Water Supply
- Private Well
- Public Water Supply and Private Well
- Small Public Water Supply

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- X: 0.2% Annual Chance of Flooding

0 0.25 0.5 1 Miles

N

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses
3. SearchWell Database: Well Addresses

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SUTTON

NORTHBRIDGE

SUTTON

MENDON

UXBRIDGE

DOUGLAS

MILLVILLE

BURRILLVILLE

NORTH SMITHFIELD

FIGURE A-5:
POTENTIAL PWS EXPANSION — IN-FILL PWS SERVICES

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

- Water Line
- Public Water Supply
- Private Well
- Public Water Supply and Private Well
- Small Public Water Supply
- In-Fill (Undeveloped/ Developable)

0 0.25 0.5 1 Miles

N

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses
3. SearchWell Database: Well Addresses

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MENDON

UXBRIDGE

MILLVILLE

NOTE: Potential Public Water Supply Expansion Area is outlined in red. Expansion includes connection of properties with private wells to existing water lines and proposed water line expansions. This possible expansion of the public water system is contingent on the results of hydraulic studies, further evaluation and testing of private wells and funding availability.

FIGURE A-6: KEMPTON ROAD CONTAMINATION AREA AND POTENTIAL PWS EXPANSION

FUSS & O'NEILL

ResilientCE
Resilient Civil Engineering, P.C.

Legend

- Potential Public Water Supply Expansion Area
- Existing Water Line
- Public Water Supply
- Private Well
- Small Public Water Supply
- In-Fill (Undeveloped/ Developable)
- Undevelopable
- Disposal Site
- Potential Water Line Expansion

Private Wells with VOC Sample

- <=1x DW Standard
- >1x DW Standard
- Not Detected
- Private Well, Sampling Declined

0 0.1 0.2 0.4 Miles

N

Data sources:
1. MassGIS: Infrastructure, Hydrology, and Administrative Data
2. Water Division: Service Addresses

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APPENDIX B

List of Contamination Sites

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RTN	City/Town	Release Address	Site Name Location Aid	Reporting Category	Notification Date	Compliance Status	Date	Phase	RAO Class	Chemical Type
2-0020501	UXBRIDGE	44 MENDON STREET	JOHN FARNUM HOUSE	120 DY	04/10/2018	PSNC	04/02/2019	PHASE II	PN	
2-0020486	UXBRIDGE	215 HARTFORD ROAD EAST	ROADWAY RELEASE	TWO HR	03/28/2018	PSNC	05/25/2018		PN	
2-0020339	UXBRIDGE	119 MAIN STREET	HYDRAULIC OIL RELEASE	TWO HR	10/17/2017	PSNC	11/15/2017		PN	
2-0019690	UXBRIDGE	RTE 146 S @ EXIT 2	TT ACCIDENT	TWO HR	11/10/2015	PSNC	12/29/2015		PN	
2-0019677	UXBRIDGE	2 WEST HARTFORD AVE	FORMER GETTY STATION	120 DY	10/20/2015	PSNC	06/28/2016			
2-0019549	UXBRIDGE	2 WEST HARTFORD AVE	GAS STATION	72 HR	06/25/2015	PSNC	06/28/2016		PN	
2-0019482	UXBRIDGE	775 MILLVILLE ROAD	HYDRAULIC OIL RELEASE	TWO HR	04/17/2015	PSNC	06/12/2015		PN	Oil
2-0019264	UXBRIDGE	30 VETERANS WAY	ROADWAY SPILL	TWO HR	07/23/2014	PSNC	09/16/2014		PN	Oil
2-0019180	UXBRIDGE	336 N MAIN ST	VILLAGE CLEANERS PROPERTY	TWO HR	04/28/2014	RTN CLOSED	04/27/2016			Hazardous Material
2-0019093	UXBRIDGE	298 SUTTON ST	RESIDENTIAL FUEL OIL RELEASE	TWO HR	01/12/2014	PSNC	11/20/2015		PN	Oil
2-0019042	UXBRIDGE	COMMERCE DRIVE	ROADWAY RELEASE	TWO HR	11/14/2013	RAO	01/13/2014		A1	Oil
2-0019037	UXBRIDGE	10 C ST	RESIDENCE	72 HR	11/07/2013	RAO	02/18/2014		A2	Oil
2-0018679	UXBRIDGE	58 N. MAIN ST	ROADWAY SPILL	TWO HR	08/31/2012	RAO	10/22/2012		A1	Oil
2-0018640	UXBRIDGE	RTE146 S BTWEN MILL AND CHOCK	DIESEL FUEL RELEASE	TWO HR	08/01/2012	RAO	10/05/2012		A2	Oil
2-0018636	UXBRIDGE	26 DOUGLAS RD	CUMBERLAND FARMS STATION	TWO HR	07/26/2012	RAO	09/18/2012		A2	Oil
2-0018158	UXBRIDGE	538 MENDON ST.	ROADWAY ACCIDENT	TWO HR	04/19/2011	RAO	06/22/2011		A2	Oil
2-0017689	UXBRIDGE	5 PATRICK HENRY ST	RESIDENTIAL	TWO HR	10/28/2009	RAO	12/10/2009		A2	Oil
2-0017210	UXBRIDGE	246 PROVIDENCE ST	POLE 25-2	TWO HR	08/15/2008	RAO	08/17/2009		A2	
2-0016998	UXBRIDGE	HOMEWARD AVE	PARCEL 3	TWO HR	03/07/2008	RAO	04/11/2008		A1	Oil
2-0016967	UXBRIDGE	RTE 146 NORTHBOUND	BETWEEN EXIT 3 + 4	TWO HR	02/12/2008	RAO	12/30/2008		A2	Oil
2-0016866	UXBRIDGE	2 WEST RIVER RD	FORMER MILL BUILDING	120 DY	10/25/2007	TIER 2	06/01/2015	PHASE II		Oil and Hazardous Material
2-0016767	UXBRIDGE	19 DEPOT ST	BERNAT MILL COMPLEX	TWO HR	07/21/2007	RAO	07/12/2010	PHASE II	A2	Hazardous Material
2-0016733	UXBRIDGE	146 MENDON ST	LTI UXBRIDGE STANLEY LTD PARTNERSHIP	72 HR	06/22/2007	RTN CLOSED	10/20/2008			Oil
2-0016356	UXBRIDGE	ROUTE 146 N LACKEY DAMN BRG	VONHEIN CONSTRUCTION ROADWAY REL	TWO HR	08/16/2006	RAO	06/04/2012		A1	Oil
2-0016269	UXBRIDGE	7 HIGHLAND PARK	ROTHROCK RESIDENCE	TWO HR	06/08/2006	RAO	02/16/2007		A2	

RTN	City/Town	Release Address	Site Name Location Aid	Reporting Category	Notification Date	Compliance Status	Date	Phase	RAO Class	Chemical Type
2-0016183	UXBRIDGE	EAST HARTFORD AVENUE AT OAK ST	PETROLEUM HEAT & POWER ROADWAY REL	TWO HR	04/04/2006	RAO	06/02/2006		A2	Oil
2-0016157	UXBRIDGE	145 HECLA ST	UXBRIDGE DPW YARD	TWO HR	03/16/2006	RAO	05/22/2006		A1	Oil
2-0016043	UXBRIDGE	136 NORTH MAIN ST	FORMER RAMELLI AUTO	72 HR	12/22/2005	RTN CLOSED	10/10/2006			Oil
2-0015964	UXBRIDGE	30 LACKEY DAM RD	MOTIVA STATION	TWO HR	10/25/2005	RAO	10/27/2008	PHASE II	A2	Oil
2-0015933	UXBRIDGE	492 QUAKER HWY	BERTS BREAKFAST & LUNCH	TWO HR	10/11/2005	RAO	02/08/2013		A2	
2-0015821	UXBRIDGE	72 IRONSTONE RD	BFI	TWO HR	07/14/2005	RAO	08/19/2005		A1	Oil
2-0015803	UXBRIDGE	869 QUAKER HWY	HOOD COMPANIES-HOOD SAND AND GRAVEL	120 DY	07/18/2005	RAO	07/18/2005			Hazardous Material
2-0015732	UXBRIDGE	674 QUAKER HWY	QUAKER DIAMOND	TWO HR	05/03/2005	RTN CLOSED	07/07/2005			
2-0015723	UXBRIDGE	869 QUAKER HWY	ESTATE OF WILLIAM H. HOOD	72 HR	04/29/2005	RAO	08/18/2005			Hazardous Material
2-0015577	UXBRIDGE	336 NORTH MAIN ST	MR ROBERT AND MS NANCY BAGLEY	TWO HR	01/25/2005	RTN CLOSED	03/26/2007			
2-0015561	UXBRIDGE	869 QUAKER HWY	ESTATE OF WILLIAM H. HOOD	72 HR	01/14/2005	RAO	08/18/2005			Oil and Hazardous Material
2-0015541	UXBRIDGE	336 NORTH MAIN ST	VILLAGE CLEANERS	72 HR	12/23/2004	RTN CLOSED	03/26/2007			Hazardous Material
2-0015509	UXBRIDGE	146 MENDON ST	FMR STANLEY WOOLEN	TWO HR	12/03/2004	RAO	04/10/2007		A1	Oil and Hazardous Material
2-0015334	UXBRIDGE	44 DEPOT ST	UTILITY POLE NO 9-1	TWO HR	07/16/2004	RAO	09/14/2004		A2	
2-0015327	UXBRIDGE	RTE 146 N	NEAR LACKEY DAM ROAD EXIT	TWO HR	07/11/2004	RAO	09/17/2004		A1	Oil
2-0015276	UXBRIDGE	869 QUAKER HWY	THE HOOD CAMPANIES	120 DY	06/03/2004	RAO	07/22/2004		A2	Oil
2-0015274	UXBRIDGE	WEST ST	WHP TRUCKING	TWO HR	06/04/2004	RAO	03/21/2005		A1	Oil
2-0015273	UXBRIDGE	145 HECLA ST	TOWN OF UXBRIDGE HWY DEPT GARAGE	120 DY	06/03/2004	RAO	04/06/2006	PHASE III	A2	Oil and Hazardous Material
2-0015100	UXBRIDGE	674 QUAKER HWY	XTRA MART	TWO HR	01/27/2004	RAO	03/30/2004		A1	
2-0015071	UXBRIDGE	589 MILLVILLE RD (SOUTH OF)	G LOPES CONSTRUCTION CO	TWO HR	01/08/2004	RAO	02/19/2004		A1	Oil
2-0014992	UXBRIDGE	DEPOT ST	NEWELL ROAD ASSOCIATION	120 DY	11/06/2003	RAO	11/12/2004		A2	Hazardous Material

RTN	City/Town	Release Address	Site Name Location Aid	Reporting Category	Notification Date	Compliance Status	Date	Phase	RAO Class	Chemical Type
2-0014966	UXBRIDGE	674 QUAKER HWY	46 IRON STONE RD (SMITH RESIDENCE)	TWO HR	10/20/2003	RTN CLOSED	07/09/2004			Hazardous Material
2-0014893	UXBRIDGE	325 MENDON ST	WAUCANTUCK MILLS	72 HR	08/28/2003	RTN CLOSED	02/11/2008			Oil
2-0014708	UXBRIDGE	30 LACKEY DAM RD	SHELL STATION	72 HR	03/20/2003	RAO	11/30/2005			Hazardous Material
2-0014704	UXBRIDGE	674 QUAKER HWY (RT 146A)	X-TRA MART STATION	72 HR	03/18/2003	RAO	12/29/2006	PHASE IV	A2	Oil
2-0014575	UXBRIDGE	30 LACKEY DAM RD	SHELL STATION 117459	72 HR	12/05/2002	RAO	11/30/2005	PHASE II	A2	Hazardous Material
2-0014486	UXBRIDGE	HARTFORD AVE W	MASS ELECTRIC CO TRANSFORMER RELEASE	TWO HR	09/25/2002	RAO	11/25/2002		A2	
2-0014250	UXBRIDGE	250 PROVIDENCE ST	FMR RONS TEXECO	72 HR	03/29/2002	RTN CLOSED	12/24/2002			Oil
2-0014137	UXBRIDGE	BLACKSTONE ST	INTERSECTION OF RT 122	TWO HR	12/22/2001	RAO	02/19/2002		A2	
2-0014134	UXBRIDGE	250 PROVIDENCE ST	QUAKER HIGHWAY REALTY TRUST PROPERTY	72 HR	12/17/2001	TIERI	12/24/2002	PHASE IV		Oil and Hazardous Material
2-0014132	UXBRIDGE	RTE 16 AT SEAGRAVE ST	BELLINGHAM LUMBER CO	TWO HR	12/19/2001	RAO	02/19/2002		A1	
2-0013997	UXBRIDGE	277 NORTH MAIN ST	HOLLISTON SERVICE STATION	72 HR	09/19/2001	RTN CLOSED	07/03/2002			Oil
2-0013858	UXBRIDGE	DOUGLAS ST AT RTE 146	LOVEYS GARAGE	TWO HR	06/15/2001	RAO	08/16/2001		A2	Oil
2-0013495	UXBRIDGE	QUAKER HWY	MA HWY DEPT	TWO HR	09/26/2000	RAO	02/01/2001		A2	Oil
2-0013414	UXBRIDGE	6 FOREST LN	BFI	TWO HR	08/07/2000	RAO	06/20/2001		A1	Oil
2-0013340	UXBRIDGE	140 MENDON ST	FMR STANLEY WOOLEN MILLS	120 DY	08/10/2000	RAO	06/19/2002	PHASE II	B1	Oil and Hazardous Material
2-0013284	UXBRIDGE	366 EAST HARTFORD ST	BLACKSTONE HERITAGE STATE PARK	120 DY	05/10/2000	RAO	05/31/2002	PHASE II	A2	Oil
2-0013215	UXBRIDGE	CASSIE LN	LOT 5	TWO HR	03/29/2000	RAO	07/18/2000		A2	
2-0013123	UXBRIDGE	19 DEPOT ST	DEPOT AND MENDON ST	120 DY	01/04/2000	RAO	01/03/2001		A2	Oil and Hazardous Material
2-0013096	UXBRIDGE	JOHNSON RD	CHOCKALOG RD	TWO HR	12/27/1999	RAO	05/03/2000		A2	Oil
2-0012952	UXBRIDGE	QUAKER HWY	JOSEPH COVE PROPERTY	120 DY	11/24/1999	DPS	06/01/2000			Oil and Hazardous Material

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2-0012631	UXBRIDGE	230 MENDON ST	ECK PROPERTY	72 HR	01/26/1999	RAO	03/24/1999		A2	Oil
2-0012493	UXBRIDGE	278 MAIN ST	POST OFFICE	72 HR	11/13/1998	RAO	04/30/2008	PHASE III	A2	
2-0012454	UXBRIDGE	79 RIVER RD	INDUSTRIAL DR CROSS STREET	120 DY	09/14/1998	DPS	11/06/1998			Oil and Hazardous Material
2-0012407	UXBRIDGE	535 QUAKER HWY RT 146A	RICKS AUTOBODY	72 HR	09/16/1998	REMOPS	10/05/2005	PHASE V		Hazardous Material
2-0012079	UXBRIDGE	111 POND ST	LOT 1	TWO HR	01/28/1998	RAO	03/30/1998		A2	Oil
2-0011855	UXBRIDGE	22 DOUGLAS ST	CUMBERLAND FARMS	72 HR	08/26/1997	RTN CLOSED	02/23/1998			Oil
2-0011834	UXBRIDGE	22 DOUGLAS ST	CUMBERLAND FARMS	TWO HR	08/14/1997	RTN CLOSED	02/23/1998			Oil
2-0011616	UXBRIDGE	22 DOUGLAS ST	CUMBERLAND FARMS	TWO HR	02/14/1997	RAO	02/28/2000	PHASE III	A2	Oil
2-0011283	UXBRIDGE	277 NORTH MAIN ST	HELLEN SERVICE CO INC	120 DY	06/18/1996	RTN CLOSED	07/31/1996			Hazardous Material
2-0011149	UXBRIDGE	596 DOUGLAS ST	MHD FACILITY 48	120 DY	03/01/1996	RAO	01/09/1997		B1	Hazardous Material
2-0010871	UXBRIDGE	277 NORTH MAIN ST	HELLEN SERVICE CO INC	72 HR	07/31/1995	RAO	10/10/2012	PHASE V	A3	Oil
2-0010784	UXBRIDGE	325 MENDON ST	FORMER WAUCONTUCK MILL	72 HR	05/22/1995	RTN CLOSED	03/04/1998			Oil
2-0010701	UXBRIDGE	WEST HARTFORD AVE	RIVER ST POND	TWO HR	03/13/1995	RAO	01/08/1997		A1	Oil
2-0010291	UXBRIDGE	WORCESTER PROVIDENCE TPKE	100 YDS N OF MI MARKER 40	TWO HR	04/29/1994	RAO	04/18/1995		A1	Oil
2-0010287	UXBRIDGE	130 DOUGLAS ST	RTE 116	72 HR	04/27/1994	RAO	08/29/1994		A1	Oil
2-0010203	UXBRIDGE	QUAKER HWY RTE 146A	SOUTH OF UXBRIDGE DISTRICT COURT HOUSE	TWO HR	02/22/1994	RAO	08/26/1994		A2	Oil
2-0010192	UXBRIDGE	582 QUAKER HWY	BY LOADING DOCK UNITED SUPPLY PARKNG LOT	TWO HR	02/14/1994	RAO	06/09/1994		A1	Oil
2-0001109	UXBRIDGE	2 HARTFORD AVE W	GETTY STATION	NONE	09/29/1993	RAO	03/04/1999		A2	
2-0001002	UXBRIDGE	REAR DEPOT ST	UXBRIDGE SUBSTA 321	NONE	07/15/1993	RAO	03/31/2000	PHASE IV	A2	Oil
2-0000901	UXBRIDGE	325 MENDON ST	WAUCANTUCK MILL FMR	NONE	10/15/1992	TIERI	03/03/1998	PHASE V		Oil
2-0000788	UXBRIDGE	124-136 NORTH MAIN ST	RAMELLI FORD	NONE	04/15/1991	REMOPS	01/29/2007	PHASE V		
2-0000522	UXBRIDGE	336 NORTH MAIN ST	PURITAN CLEANERS	NONE	04/13/2010	TIERI	03/26/2007	PHASE II		
2-0000374	UXBRIDGE	1 NORTH MAIN ST	ROYS MOBIL STATION 01 PG6	NONE	03/27/1989	RAO	06/22/1995	PHASE III	A2	

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2-0000139	UXBRIDGE	152 HARTFORD ST	STRATHMORE SHIRE REALTY	NONE	08/27/1985	DEPNFA	09/02/1993			Oil
2-0000138	UXBRIDGE	146 MENDON ST	STANLEY WOOLEN MILLS FMR	NONE	10/15/1988	REMOPS	07/01/2019	PHASE V		

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2-0020841	MILLVILLE	166 LINCOLN STREET	DIESEL FUEL RELEASE TO STORM DRAIN	TWO HR	04/01/2019	PSNC	05/22/2019		PN	
2-0020701	MILLVILLE	334 CHESTNUT HILL RD	OIL RELEASE AT RESIDENCE	TWO HR	11/04/2018	PSNC	05/07/2019		PN	
2-0020438	MILLVILLE	513 CHESTNUT HILL ROAD	#2 FUEL OIL RELEASE	TWO HR	01/23/2018	PSNC	11/20/2018		PN	
2-0020206	MILLVILLE	HICKORY ROAD AND CHESTNUT HILL	HICKORY ROAD AND CHESTNUT HILL ROAD	TWO HR	05/22/2017	PSNC	07/05/2017		PN	
2-0019818	MILLVILLE	60 CENTRAL STREET	RESIDENTIAL PROPERTY	TWO HR	03/22/2016	PSNC	05/19/2016		PN	
2-0019728	MILLVILLE	111-139 MAIN STREET	LUBE OIL RELEASE BEHIND 111-139 MAIN ST	TWO HR	12/14/2015	PSNC	02/12/2016		PN	
2-0019567	MILLVILLE	19 PROVIDENCE ST	19 PROVIDENCE ST CONDOS	TWO HR	07/08/2015	TIER1D	07/15/2016			
2-0019472	MILLVILLE	KILLINEY WOOD RD	HYDRAULIC OIL SPILL	TWO HR	04/13/2015	PSNC	05/28/2015		PN	Oil
2-0018932	MILLVILLE	32 CENTRAL STREET	MOTOR VEHICLE ACCIDENT	TWO HR	07/08/2013	RAO	09/06/2013		A2	
2-0018787	MILLVILLE	190 CENTRAL ST	PW - 465 CENTRAL ST, N. SMITHFIELD, RI	72 HR	01/10/2013	PSNC	12/31/2015	PHASE II	PN	Oil and Hazardous Material
2-0018661	MILLVILLE	122 BIRTHALET WAY	MILLVILLE ELEMENTARY SCHOOL	72 HR	08/09/2012	RAO	12/06/2012		B1	Oil
2-0018326	MILLVILLE	196 MAIN ST	MILLVILLE FIRE STATION	TWO HR	09/02/2011	RAO	10/26/2011		A2	Oil
2-0017164	MILLVILLE	31 HARKNESS RD	RESIDENCE	TWO HR	08/06/2008	RAO	05/24/2012	PHASE II	A2	Oil
2-0016535	MILLVILLE	56 MAIN ST	MILLVILLE DEVELOPMENT	TWO HR	01/08/2007	RAO	01/28/2008		A2	Oil
2-0015121	MILLVILLE	72 KILLINEY WOODS	SOCHIAS OIL & GAS INC	TWO HR	02/09/2004	RAO	03/29/2004		A1	Oil
2-0014685	MILLVILLE	5 HARKNESS ST	ORCHARD OAKS BUILDERS	TWO HR	02/26/2003	RAO	04/22/2003		A1	Oil
2-0014015	MILLVILLE	238 MAIN ST	PREFERRED AUTO SALES	TWO HR	09/30/2001	RAO	09/24/2002		A1	Oil and Hazardous Material

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2-0011666	MILLVILLE	LINCOLN ST	POLE 35	TWO HR	04/01/1997	RAO	06/03/1997		A1	Oil
2-0000852	MILLVILLE	117 KEMPTON RD	KEMPTON RD PROPERTIES	NONE	08/13/1991	TIERI	10/01/1993			Oil