

# Long-Term Water Supply Evaluation

April 2021

Lincoln Water Department  
Lincoln, Massachusetts

**Long-Term Water Supply Evaluation  
Lincoln, Massachusetts**

April 2021

Prepared by





April 25, 2021

Mr. Jim Hutchinson, Chair  
Lincoln Board of Water Commissioners  
16 Lincoln Road  
Lincoln, MA 01773

Subject: Long Term Water Supply Evaluation  
Lincoln, MA  
T&H No. 6493

Dear Mr. Hutchinson:

In accordance with our agreement, Tata & Howard is pleased to present this Long-Term Water Supply Evaluation for the Lincoln Water Department (LWD). The purpose of this evaluation was to review the current water supply and treatment practices and compare the long-term sustainability of these sources with two potential future water supply and/or treatment alternatives. The evaluation includes an assessment of the viability of each of the source and treatment alternatives for meeting regulatory water quality requirements and the estimated capital and operations and maintenance (O&M) costs associated with each alternative over a 20-year planning period.

During the course of this project, the undersigned served as Project Officer, Mr. Yogesh Jitoo, P.E. served as Project Manager, Ms. Katie Carreira and Ms. Jenna O'Connell served as Assistant Project Engineers, and Ms. Karen Gracey, P.E. provided technical reviews.

At this time, we wish to express our continued appreciation to the LWD and the Board of Water Commissioners for their participation in this study and for their help in collecting information and data. We appreciate the opportunity to assist the LWD on this important project.

Sincerely,

TATA & HOWARD, INC.

Ryan P. Neyland, P.E.  
Vice President

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# Section 1

## SECTION 1 – GENERAL

### 1.1 Background

The Lincoln Water Department (LWD) pumps and treats water from two sources to provide potable water to its customers throughout the water distribution system. The Tower Road Well is a groundwater source that is treated with chemical addition for pH adjustment, corrosion control, and fluoride treatment and discharged directly into the distribution system. Flint's Pond (also referred to as Sandy Pond) is a surface water supply that is drawn through an intake in the pond and pumped from the Raw Water Pump Station (RWPS) at 77 Sandy Pond Road up to the Flint's Pond Water Treatment Plant (WTP) at 80 Sandy Pond Road where the water is treated prior to being discharged into the distribution system for customer use. The Flint's Pond WTP treats the surface water using membrane filtration followed by chemical feed addition for disinfection and fluoride, a below grade clearwell for contact time with the chlorine to meet regulatory disinfection requirements, and chemical addition for pH adjustment and corrosion control as the water is pumped into the distribution system.

The two sources are located in the Charles River Basin and have an annual average registered withdrawal volume of 0.35 million gallons per day (mgd) and permitted withdrawal volume of 0.18 mgd for a combined registered and permitted volume of 0.53 mgd through the LWD's existing Water Management Act (WMA) Permit. Under normal operations, the Flint's Pond WTP supplies approximately 70-percent of the total system demand and the remaining 30-percent of the total demand is provided by the Tower Road Well.

### 1.2 Flint's Pond Raw Water Pump Station and Water Treatment Plant

A locus map showing the Flint's Pond RWPS and Flint's Pond WTP is included in Figure No. 1-1. The RWPS is located approximately 1,100 feet in a southeasterly direction from the WTP. The RWPS is connected to the WTP by a 12-inch diameter raw water transmission main that runs along Sandy Pond Road. The original membrane filtration WTP was constructed in 2003, and upgrades were completed in 2010 to convert the existing membranes to Memcor low pressure membranes. The design capacity of the WTP is 1.6 mgd, but the WTP typically operates at a flow rate of 600 gallons per minute (gpm) for 8-16 hours per day depending on the season with typical production ranging from 0.3 to 0.6 mgd.

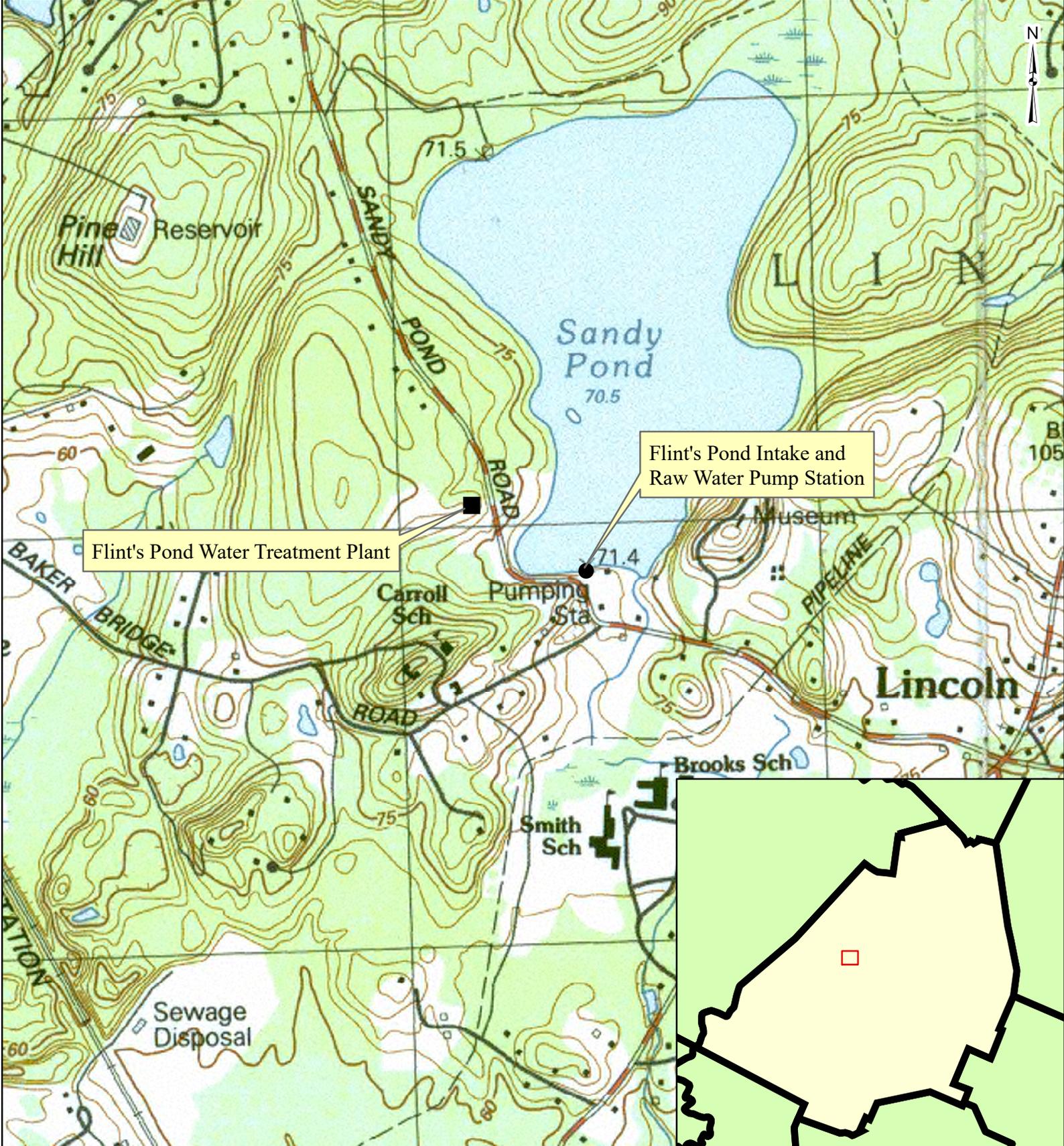
Historically, raw surface water from Flint's Pond has elevated levels of total organic carbon (TOC) and dissolved organic carbon (DOC), especially during the warmer months of the year. The elevated levels of TOC and DOC indicate the increased presence of natural organic matter (NOM), which is a precursor to the formation of disinfection byproducts (DBPs) in the distribution system when free chlorine is added. DBPs are grouped into two sets of contaminants referred to as Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s). Based on sampling data collected by the LWD, the HAA5 levels observed in

the distribution system have been low and are not a significant water quality concern. However, TTHM formation has presented a much greater challenge to the LWD with elevated levels of TTHMs in the distribution system observed on a regular basis.

The maximum contaminant level (MCL) for TTHM is based on the locational running annual average (LRAA), which is determined by averaging the quarterly results for all samples collected at a particular sampling location for the previous four calendar quarters. The LRAA MCL for TTHM is 80 micrograms per liter ( $\mu\text{g/L}$ ), also referred to as parts per billion (ppb). The LWD collects DBP samples from two sites in the distribution system including the Lincoln North site (55 Old Bedford Road) and the Sam Brooks site (1175 Lexington Road). After the 3<sup>rd</sup> Quarter sample results were collected on August 1, 2017 from the Sam Brooks site, the LRAA result was 81.5 ppb, which exceeded the TTHM MCL.

As a result of the water quality history and TTHM MCL violation, the Massachusetts Department of Environmental Protection (MassDEP) issued an Administrative Consent Order with Penalty (ACOP Enforcement No. 00003940), which was executed by the LWD on May 22, 2018. The ACOP summarized a plan of action and the associated deadlines for compliance with the TTHM MCL. The LWD was required to collect samples from the Bedford Road Water Storage Tank, Lincoln North, and Sam Brooks locations in the distribution system for TTHM compliance. Due to the elevated levels of TTHMs in the water system, the MassDEP required the LWD to collect monthly samples from these three locations to better monitor the TTHM trends throughout the year. In addition to TTHM levels at the three sites in the distribution system, raw water quality samples at the Tower Road Well and the Flint's Pond WTP were required on a monthly basis by the MassDEP. TOC and DOC samples were required from the Flint's Pond raw water intake, and TOC samples were required at the Tower Road Well.

Based on information and data collected and submitted by the LWD to the MassDEP between May 2018 and October 2018, the MassDEP issued a Technical Deficiency Letter dated November 26, 2018. The letter required the LWD to collect additional water quality samples from Flint's Pond, Tower Road Well, Bedford Road Tank, and the Lincoln North and Sam Brooks DBP sampling sites between December 2018 and November 2019. Sampling continued to include, but was not limited to, TOC and DOC in the raw water at Flint's Pond, TOC in the water at the Tower Road Well, and TTHMs at the Bedford Road Tank, Sam Brooks, and Lincoln North sampling locations. The intent of the sampling program was to extend the previous sampling program required by the MassDEP to evaluate if recent operational changes implemented by the LWD were reducing the TTHM levels in the distribution system.



Date: April 2021  
 Approximate Scale: 1" = 1,000'

Locus Map  
 Flint's Pond Water Treatment Plant  
 and Raw Water Pump Station  
 Lincoln, MA

Figure No.  
 1-1

TOC and DOC levels increased significantly in April 2019, and the levels remained elevated even into the winter of 2019. The LWD exceeded the TTHM MCL at its Lincoln North sampling location in the 3<sup>rd</sup> Quarter when the LRAA was 81.3 ppb. After the 4<sup>th</sup> Quarter samples were collected, the LWD exceeded the TTHM MCL at its Lincoln North and Sam Brooks sampling locations when the LRAA was 81.8 ppb at Lincoln North and 82.1 ppb at Sam Brooks. There were unexpected events that occurred in 2019 at the Tower Road Well that forced the well to be out of service and prevented the LWD from implementing certain operational changes and contributed to the elevated levels of TTHMs in the distribution system.

On February 4, 2020, the MassDEP issued the LWD a new ACOP and Notice of Noncompliance (NON), Enforcement No. 00008871, for the additional violations of the MCL for TTHMs at the Lincoln North and Sam Brooks sampling sites in the distribution system. Based on conceptual improvements that were mutually agreed upon by the MassDEP and the LWD, the ACOP and NON required the LWD to take a series of steps to implement a coagulant chemical feed system prior to the membrane filtration at the Flint's Pond WTP to enhance TOC removal through the WTP and reduce TTHM formation in the distribution system. A pilot test was completed, and the summary report was submitted to the MassDEP on August 5, 2020 in compliance with the ACOP and NON, Item No. III.8.E. The pilot study report detailed the conclusions of the pilot study and recommended specific coagulant addition parameters to achieve TOC removal to reliably maintain compliance with the MCL for TTHMs in accordance with 310 CMR 22.07E(1). An aluminum chlorohydrate (ACH) coagulant chemical feed system design and BRP WS 29 permit application were submitted to the MassDEP on January 28, 2021 for review and approval to construct the new chemical feed system at the RWPS. Upon approval of the permit application, the LWD plans to proceed with the construction and implementation of the new ACH chemical feed system.

### 1.3 Tower Road Well

A locus map showing the Tower Road Well is included in Figure No. 1-2. The existing Tower Road Well was constructed in the mid-1960s and is a 48-foot deep gravel packed well with a 24-inch casing and ten feet of shutter style screen at the bottom of the well. The existing well pump station is equipped with a Goulds 10RJLO 8-stage vertical turbine pump with a 50 horsepower motor and variable frequency drive (VFD) with a typical pumping rate of 400 gpm. The maximum authorized daily withdrawal from the Tower Road Well is 0.48 mgd based on the existing WMA Permit.

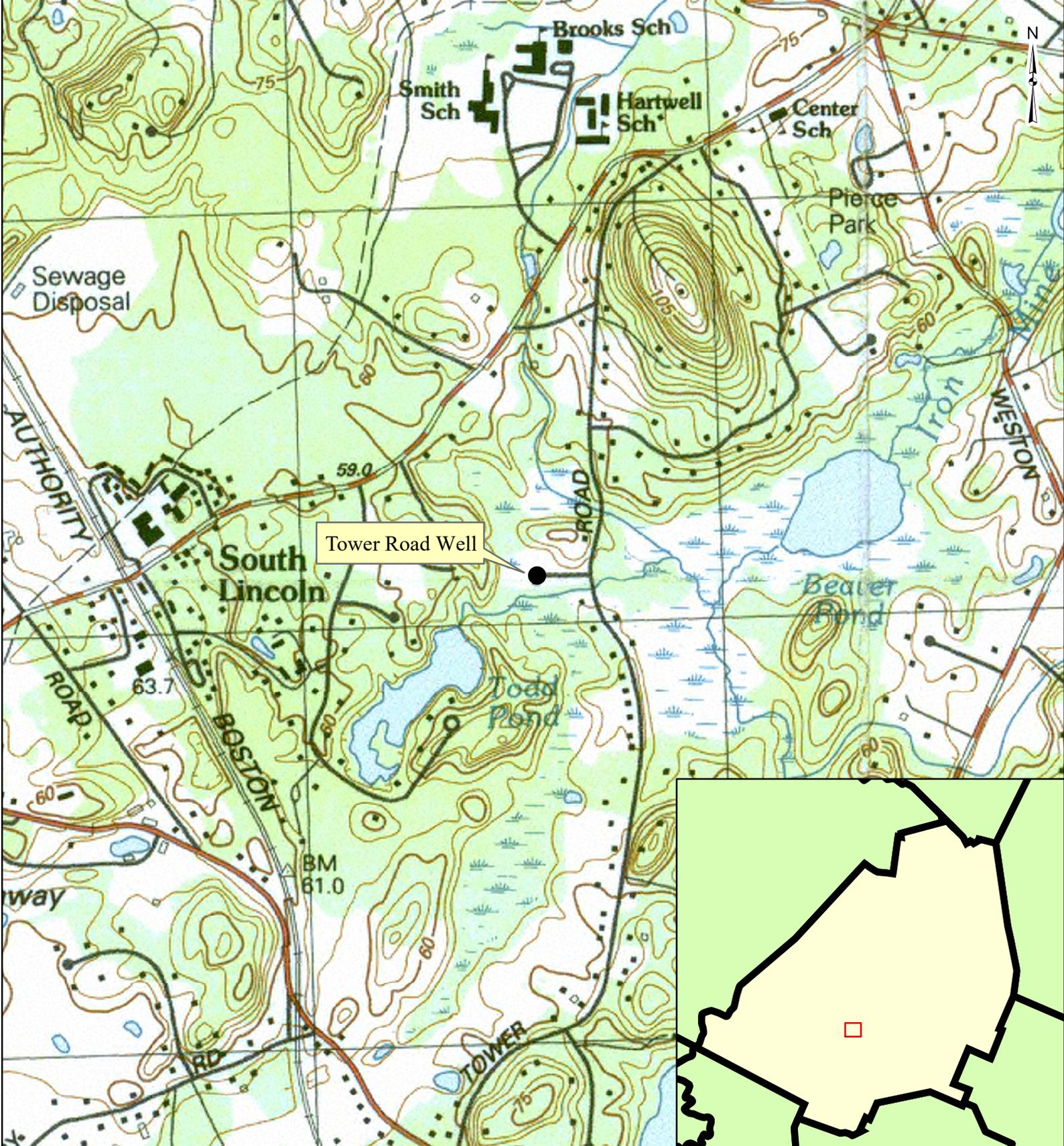
During the summer months when precipitation is low, the pumping rate at the Tower Road Well is limited due to a declining specific capacity, which is defined as the gpm per foot of water drawdown in the well (gpm/ft). Due to the age, style, and condition of the existing well screen, raw water iron and manganese collect on and around the screen and restrict the yield of the Tower Road Well. The recent specific capacity of the well was measured at approximately 17 gpm/ft, which represents a decline by greater than 50-percent of the specific capacity when the well was originally constructed of 37 gpm/ft. Due to the decline in specific capacity, the drawdown of the water in the well required to produce the desired

pumping rate is significantly greater. For example, if the specific capacity declined by 50-percent of the original specific capacity, this means that greater than double the drawdown would be required in the well to produce the original pumping rate. If a drawdown of nearly 11 feet was required to produce 400 gpm when the well was originally constructed, a drawdown of approximately 23.5 feet would be required based on the recent specific capacity measured for the well.

When static groundwater levels are low during dry summer month, the low well level alarm is triggered and shuts down the well pump to prevent damaging the pump. The pumping rate has to be reduced so the water level is not drawn down to the low well level alarm setpoint in order to keep the well pump running. Without these restrictions on the pumping rate due to the declining yield of the well, the annual percentage of water supplied from the Tower Road Well could be greater than the 30-percent previously mentioned.

The LWD plans to construct a replacement well near the existing Tower Road Well to restore the specific capacity and consistent water production from the Tower Road site. Small diameter test wells were previously drilled in December 2003 and showed preliminary yields sufficient for a replacement well with a production rate of 400 to 450 gpm at a specific capacity of 32 gpm/ft. The LWD plans to verify the yield and specific capacity from the previously drilled test well. If the data is consistent with that collected in 2003, the LWD plans to prepare and submit the necessary design documents and permit applications for MassDEP approval to construct the replacement well. The LWD can construct a replacement well at the Tower Road site by June 30, 2023, which is the end of Fiscal Year 2023 (FY23).

In addition to the replacement well at the Tower Road Well site, the LWD has been planning and will construct chemical feed system improvements at the Tower Road Well Pump Station. Construction of the Tower Road Well chemical feed improvements will be completed in FY22, and include new chemical feed equipment for the existing sodium hydroxide, zinc orthophosphate, and sodium fluoride chemical feed systems, new chemical containment lining system in the sodium hydroxide bulk storage area to prevent any future release of sodium hydroxide if a chemical spill or leak occurs in the building, new exhaust fan, and new emergency showers and associated water heater in compliance with the Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI) Z358.1 standard for tempered water requirements.



Date: April 2021  
 Approximate Scale: 1" = 1,000'

Locus Map  
 Tower Road Well  
 Lincoln, MA

Figure No.  
 1-2

## 1.4 Evaluation Purpose

The purpose of this Long-Term Water Supply Evaluation is to review the LWD's current water supply and treatment practices and compare the long-term sustainability of these sources with two potential future water supply and/or treatment alternatives. The three source and treatment alternatives reviewed in this Long-Term Water Supply Evaluation are summarized in this section. The improvements planned at the Flint's Pond WTP, including the addition of a coagulant chemical feed system to improve TOC removal, and at the Tower Road Well site, including the construction of a replacement well to restore the water production from the well, will be implemented by the end of FY23 regardless of the long-term water supply and treatment approach taken by the LWD.

Since the planned improvements at the existing facilities will be completed by the end of FY23, all capital and operations and maintenance (O&M) cost comparisons associated with this evaluation began in FY24. The planning period under review as part of this evaluation included a 20-year period extending from FY24 through FY43. The necessary improvements required to operate and maintain existing sources in Alternative No. 1 during the planning period were reviewed and summarized in this evaluation as well as the new infrastructure construction and operations and maintenance requirements associated with the implementation of the new source and/or treatment alternatives included in Alternative No. 2 and Alternative No. 3.

### Alternative No. 1

The continued use of the two existing sources with an improved finished water quality produced at the Flint's Pond WTP following the implementation of the new coagulant chemical feed system and an increase in annual production from the Tower Road Well following the construction of a replacement well.

### Alternative No. 2

The continued use of the two existing sources similar to Alternative No. 1, but with the design and construction of a new WTP with a more conventional treatment process that is better suited for TOC removal from the Flint's Pond water supply. The same construction of a replacement well for the Tower Road Well is included in this Alternative No. 2.

### Alternative No. 3

The construction and implementation of a connection to the Massachusetts Water Resources Authority (MWRA) to fully supply and meet the water demands of the Town, while eliminating the two existing local sources of water supply completely.



## Section 2

## SECTION 2 – SOURCE AND TREATMENT ALTERNATIVES

### 2.1 Alternative No. 1 - Utilizing Existing Sources

Alternative No. 1 includes the continued use of the existing Flint’s Pond WTP and Tower Road Well Pump Station after the implementation of the improvements planned through FY23. The planned improvements for the Flint’s Pond WTP include the construction of a new ACH coagulant chemical feed system at the Flint’s Pond RWPS. The coagulant will be added to the raw water to enhance TOC removal through the membrane filtration process at the WTP and reduce TTHM formation in the distribution system. The construction of the ACH chemical feed system at the Raw Water Pump Station will be completed by the end of FY21. Based on the results of the pilot study, the design parameters for the new ACH chemical feed system and modified membrane cleaning operations are shown in Table No. 2-1.

**Table No. 2-1  
ACH Coagulant Addition and Resultant Membrane Operations Design Criteria**

Parameter	Design Recommendation
Coagulant	ACH
Dose	2.0 mg/L – 4.0 mg/L
pH adjustment	N/A
WTP Flow Rate	550 gpm – 1,100 gpm
Backwash Interval	30 Minutes
Acid Wash Interval	96 Hours (4 Days)
Chlorine Wash Interval	192 Hours (8 Days)
Clean-In-Place (CIP) Interval	30 Days
Backwash Recycle Rate	5.0% of Raw Water

The pilot study results showed a reduction in TTHM formation in the finished water ranging from 20-percent to 60-percent when adding ACH prior to the membrane filtration when compared to the TTHM formation in the finished water produced by the existing full scale WTP with no coagulant addition. The reduction in TTHM formation observed during the pilot study will be beneficial to the LWD in its efforts to maintain compliance with the MCL for TTHMs. However, the coagulant addition and subsequent TOC removal and reduction in TTHM formation is only one component of the overall strategy to optimize operations to maintain compliance with the MCL for TTHMs in the distribution system if Alternative No. 1 is selected. Clearwell water level should remain low to minimize water stored in the clearwell, the Bedford Road Storage Tank operational band should be set to allow the tank to drop to 16 feet before being refilled to maximize turnover and minimize water age in the tank and system, free chlorine residuals in the system should be monitored to avoid adding excess chlorine that can contribute to greater TTHM formation, and production from the Tower Road Well which contains low levels of TOC, and therefore

lower TTHM formation, should be maximized to help offset any water produced at the WTP with higher levels of TTHMs.

Concurrent to the design of the new coagulant chemical feed system, the LWD is reviewing the temporary and permanent residuals handling upgrades that will be necessary to manage the additional residuals produced as a result of adding an aluminum-based coagulant. The design and construction of residuals handling upgrades at the Flint's Pond WTP site will be completed before the end of FY23 as part of the planned improvements already scheduled for the Flint's Pond WTP as part of the LWD's existing source improvements.

In August 2020, the LWD replaced the 240 existing Memcor® L10V microfiltration membrane modules and isolation valves with new Memcor® L10N microfiltration membrane modules and isolation valves on the five filter skids at the Flint's Pond WTP. Due to the age and condition of the existing membrane modules, integrity testing and sonic testing results indicated that routine pinning of the membranes was no longer a viable solution to maintain the existing modules. The L10V membrane modules were replaced with Memcor® L10N membranes, which were newer technology membranes but the direct replacements for the filter skids since Memcor no longer manufactured the older L10V membranes.

Temporary modifications were made to the clean-in-place (CIP) chemical feed systems at the Flint's Pond WTP in 2020. The modifications were short-term upgrades that were implemented so that the cleaning chemical feed systems were all operational to conduct routine acid and chlorine maintenance washes (MW) and monthly CIP cleanings of the membranes, and specifically to ensure the proper cleanings could be completed after the new membranes were installed. The LWD has designed and permitted through the MassDEP permanent upgrades to the CIP chemical feed systems. The construction of the CIP chemical feed system upgrades is scheduled to be completed in the spring 2021. New containment pallets for the drum storage and transfer pumps will be provided in the Filter Room, and new day tanks, containment pallets, level monitoring systems, and pneumatic chemical feed pumps will be installed in the new CIP chemical Room between the administration area of the WTP and the High Lift Pump Room. In addition to the CIP upgrades, bulk liquid sodium hydroxide chemical feed system upgrades including a new bulk tank, day tank, transfer pump, exterior fill station, and containment area lining system will be constructed, as well as improvements to the sodium fluoride and zinc orthophosphate chemical feed systems.

The planned improvements at the Tower Road Well include the construction of a replacement well with a new submersible well pump and abandonment of the existing well and vertical turbine pump. The specific capacity at the existing Tower Road Well has declined by more than 50-percent from its original specific capacity when it was constructed over 50 years ago in the mid-1960s. Due to the age, style, and condition of the existing shutter style well screen, the Tower Road Well can no longer be restored through cleaning and redevelopment for periods any greater than one month without reverting back to the declined specific capacity.

With the decline in the specific capacity and lower static water levels during the warmer months when water supply from the well is most important, water production has to be limited from the well at certain times to prevent shutdown on low water levels. Water supplied from the Tower Road Well has lower TOC concentrations and lower TTHM formation compared to the water from Flint's Pond, which helps to maintain the overall TTHM levels below regulatory limits in the distribution system. When the Tower Road Well production declines, there is a greater reliance on the Flint's Pond WTP to meet the water demands of the system. The increase in production from the existing Flint's Pond WTP with little TOC removal has historically resulted in a rise in TTHM levels in the distribution system, and violations of the MCL for TTHMs have occurred as detailed in Section 1 of this report.

The LWD plans to replace the existing Tower Road Well with a new gravel packed well on the same property including a new submersible well pump, motor, and VFD, a pitless adapter, new site piping to connect the new well to the pump discharge piping in the existing pump station, electrical and instrumentation upgrades, and supervisory control and data acquisition (SCADA) integration. The existing well will be abandoned following construction of the replacement well.

Prior to the construction of the replacement well, the LWD has been planning and will construct chemical feed system improvements at the Tower Road Well Pump Station in FY22. Improvements include new chemical feed equipment, new chemical containment lining system in the sodium hydroxide bulk storage area, new exhaust fan, and new emergency showers and associated water heater in compliance with the Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI) Z358.1 standard for tempered water requirements.

The planned improvements at the Flint's Pond WTP and Tower Road Well Pump Station will be completed by the end of FY23. These scheduled improvements have to be constructed in the immediate future to either maintain compliance with drinking water regulations and guidelines or satisfy requirements of MassDEP ACOs or Sanitary Survey Deficiencies. Each identified improvement is directly or indirectly connected to regulatory compliance or MassDEP orders. Although the replacement well at the Tower Road Pump Station is not under a MassDEP ACO or a deficiency listed in the last Sanitary Survey, the loss of production from the Tower Road Well requires an increase in production from the existing Flint's Pond WTP. The increase in production from the Flint's Pond WTP has historically resulted in a rise in TTHM levels and violations of the MCL in the distribution system due to the lack of TOC removal. A replacement well will restore the consistent and reliable production from the Tower Road Well that is necessary to optimize production from both existing water sources to prevent any future TTHM MCL violations.

Beyond FY23, additional major process equipment will require replacement at the existing Flint's Pond RWPS and WTP during the 20-year planning period. The two 100 horsepower (hp) raw water pumps and VFDs at the RWPS that draw water from the pond and pump to the WTP and the two 60 hp finished water pumps and VFDs that draw water from the clearwell and pump finished water from the WTP into the distribution system will likely

need to be replaced. Based on a life expectancy of seven years, the filter membrane modules will require replacement in FY28, FY35, and FY42, a total of three full membrane module changeouts. Additional process equipment, smaller pumps, air compressors, valves, instruments, electrical equipment, and SCADA equipment and programming will require upgrades and/or replacements during the planning period as the existing equipment reaches the end of its useful life. Basic chemical feed equipment maintenance, repairs, and replacements should be covered by the annual O&M budget provided routine maintenance and necessary repairs and replacements are done annually. After the planned replacement well and chemical feed system upgrades at the Tower Road Well Pump Station are constructed, additional work at the pump station during the planning period will be limited and should be covered by the annual O&M budget if routine maintenance and repairs are done annually. The capital and O&M costs associated with these upgrades and the continued use of the existing sources during the 20-year planning period are summarized in Section 4 of this report.

## **2.2 Alternative No. 2 - New Flint's Pond Water Treatment Plant**

Alternative No. 2 includes the continued use of the two existing sources similar to Alternative No. 1, but with the design and construction of a new Flint's Pond WTP rated for 1.6 mgd with a more conventional treatment process, such as dissolved air flotation (DAF) clarification followed by dual media gravity filtration. A conventional surface water treatment facility is better suited for TOC removal from the source water drawn from Flint's Pond. In addition to the new Flint's Pond WTP, the continued use of the Tower Road Pump Station is included in Alternative No. 2 with the replacement well and chemical feed upgrades that are already planned for construction by the end of FY23.

The coagulant addition in Alternative No. 1 is not a fully resilient solution that will ensure TTHM MCL compliance unless other operations mentioned in Alternative No. 1 continue to be optimized and closely monitored by the LWD. A conventional WTP will provide more significant TOC removal and greater reductions in TTHM formation than the membrane filtration process with coagulant addition. With the construction of a new conventional WTP better suited for TOC removal, the optimization of treatment plant operations and the maximizing of production from the Tower Road Well will be less significant. The Flint's Pond WTP will be able to operate alone (without blending of water from the Tower Road Well) and produce finished water with low levels of TOC and TTHM formation that will not be at risk for violating the MCL for TTHMs.

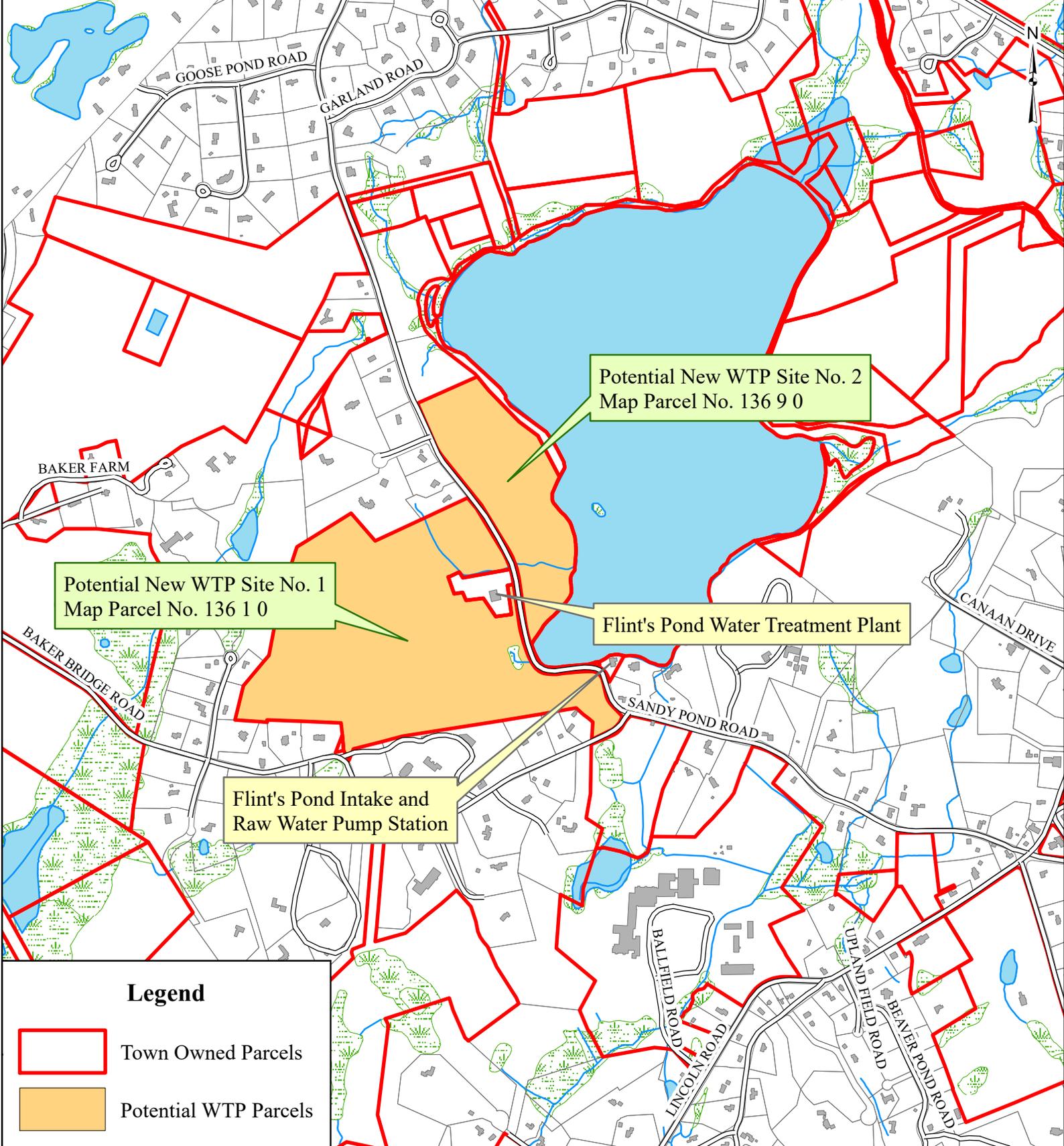
The construction of a conventional WTP to replace the existing Flint's Pond WTP is the more conservative treatment approach to ensure long-term compliance with the TTHM MCL. A new WTP will provide a multi-barrier approach where multiple treatment processes within the same treatment facility can provide treatment of the target particulates, organics, or other contaminants. A new WTP will provide redundancy in situations where certain equipment may be out of service so that the full capacity of the WTP is always available. The treatment processes included in a new conventional WTP will also provide treatment for some emerging contaminants that may not be of concern based on the existing source water quality.

### 2.2.1 New Water Treatment Plant Site

As part of Alternative No. 2, the potential locations where a new WTP could be constructed were reviewed. A new WTP would have to be constructed in a different location from the existing WTP since the existing WTP is the Town's primary drinking water source and would have to remain in service until a new WTP was constructed, tested, and activated. The existing Flint's Pond RWPS and WTP are located on Town-owned parcels along Sandy Pond Road as shown in Figure No. 2-1. The parcel on which the existing WTP is located does not have sufficient space for a new WTP to be constructed. A new DAF WTP would require a new site located on another Town-owned parcel around Flint's Pond.

The Town-owned parcels along Sandy Pond Road and around Flint's Pond are shown in Figure No. 2-1. Based on historical data for the size of a DAF WTP with a rated capacity of 1.6 mgd, the new building footprint could be approximately 100-feet by 80-feet. In addition to this, three below-grade tanks would be required including a clearwell for disinfection contact time, a filter backwash supply tank, and a spent backwash water tank. The three tanks can likely be constructed below the main floor of the WTP so that no additional footprint is required for the tanks. A series of three lined lagoons and one unlined infiltration basin will be required on the site to collect residuals, including DAF float and spent backwash water, and discharge supernatant water back to the ground. Additional space near the new WTP would be required for an emergency generator, access road around the facility, and driveway to Sandy Pond Road. A stormwater collection system with an infiltration basin and overflow channel constructed on the site would also be required. The final layout would be dependent on the needs of the LWD, but the new infrastructure would require a minimum footprint of three acres.

Two potential new WTP site locations are identified in Figure No. 2-1 along Sandy Pond Road, including Site No. 1 (Map Parcel No. 136 1 0) and Site No. 2 (Map Parcel No. 136 9 0). Site No. 1 is the parcel surrounding the existing Flint's Pond WTP parcel. The existing RWPS and associated raw water transmission line could be reused and extended if Site No. 1 was utilized. Site No. 2 is located further to the north and on the east side of Sandy Pond Road with the parcel directly abutting the pond. The existing RWPS and associated raw water transmission line could be reused and extended to feed a new WTP at Site No. 2. New raw water pumps will likely have to be installed to account for the extended raw water transmission main. Alternatively, a new intake in the pond and RWPS could be constructed at Site No. 2 to eliminate the need to extend the raw water transmission line and to withdraw water directly from Flint's Pond closer to the new WTP. A new intake and RWPS would eliminate the raw water transmission main in Sandy Pond Road and reduce the size of the raw water pumps.



**Legend**

- Town Owned Parcels
- Potential WTP Parcels

Potential Site Alternatives

Long-Term Water Supply Evaluation

Figure No.

2-1



Date: April 2021  
 Approximate Scale: 1" = 1,000'

Lincoln, MA

Extending the existing raw water transmission main to the new WTP and reusing the existing RWPS will require less permit approvals by federal, state, and local agencies. A new intake and RWPS will require work and the construction of permanent structures in Flint's Pond. When any work is done in a waterbody, several permit filings are triggered specifically to protect the surface water resource. The Town of Lincoln owns most of the parcels surrounding Flint's Pond as shown in Figure No. 2-1, but these parcels are all marked as conservation land. These parcels may be ideal in terms of available space and proximity to the RWPS, Flint's Pond, and to existing utilities along Sandy Pond Road, but conservation restrictions will need to be reviewed with the Conservation Commission to determine if constructing a new WTP on any of these parcels will be feasible. Additional information regarding the potential permitting associated with a new WTP is included in Section 3 of this report.

### **2.2.2 Pilot Testing**

Two seasons of pilot testing (summer and winter) will be required to review various treatment processes and the associated operating ranges, loading rates, and chemical feed doses for optimum treatment and finished water quality. Residuals production data and water quality will be collected during the pilot study for each season. The results of the two seasonal pilot studies will be presented in a pilot report to the MassDEP for review and approval of the pilot study and the recommended full scale treatment process prior to the design of the new WTP.

If the LWD pursues a new intake and RWPS if Site No. 2 is selected as the location for the new WTP, a comprehensive review of the raw water quality at the potential new intake location should be conducted to determine any significant variances in raw water quality from the current intake location. Different raw water quality can require modified operational parameters and setpoints to achieve the same finished water quality as the operational settings required for raw water drawn from the current intake. With pilot testing required to support the proposed full-scale WTP design, pilot testing of the raw water from the potential new intake location may be necessary to determine optimum operational conditions for the alternate raw water intake.

### **2.2.3 Treatment Process Description**

A new DAF WTP will include a series of treatment processes for a multi-barrier treatment approach. The actual treatment process and operational parameters will need to be determined through an extensive pilot study including a winter and summer pilot test. Based on historical surface water treatment in this area, the general treatment process may include the addition of an oxidizing agent prior to a pre-oxidation tank for oxidation of any iron and manganese in the raw water for eventual removal through the clarification and filtration processes, coagulant addition, rapid mixing, two stage flocculation (slow mixing), DAF clarification, multi-media filtration including sand and Granular Activated Carbon (GAC), and a clearwell for contact time with free chlorine for meeting regulatory disinfection requirements. Chemical addition into the finished water will match the

existing WTP and will include sodium hydroxide for pH adjustment, zinc orthophosphate for corrosion control, and fluoride to help prevent tooth decay.

A coagulant will be injected into the water and mixed in the rapid mix tanks. The rapid mix tanks will be sized to accommodate a flow of 1.6 mgd plus an additional flowrate from the recycling of decant water from the spent backwash water tank at a rate of up to five percent of the raw water flow. The purpose of the rapid mixers is to provide rapid and complete dispersion of the coagulant prior to the water entering the flocculation tanks. The rapid mix tanks will be designed to provide 30 seconds of contact time at the maximum flow rate through the new WTP. Each tank will be equipped with a variable speed mixer to allow for optimizing the mixing of the coagulant with the water to allow for the formation of pin-point floc particles.

Effluent water from the rapid mixers will enter the flocculation tanks and DAF units for further treatment. Each DAF unit will consist of a two-stage flocculation tank, air saturation system, and clarification tank. The design will include three DAF units to treat the maximum capacity of the WTP. Each flocculation tank will be designed to provide ten minutes of detention time. Each tank will be divided into two stages by an under-flow baffle wall, with each half equipped with two flocculation mixers. Water will enter the tank, flow down through the first chamber, pass under the baffle wall, and overflow the second chamber which discharges to the clarification tank. The flocculation mixers (flocculators) are slow rotating mixers equipped with variable speed drives that mix the water slowly so as to allow minute floc particles from the rapid mix tanks to come into contact with each other and agglomerate into slightly larger floc particles that are more easily removed in the clarifier that follows.

The clarifier utilizes water that is highly saturated with air to “float” the floc particles to the surface of the clarifier for removal. The water overflowing the second stage of the flocculation tank moves down a narrow channel and under a partition wall where it flows upwards within a partitioned zone of the clarifier containing dispersion headers that introduce the air saturated water. The saturated water discharged by the dispersion headers releases micro-bubbles yielding what resembles a milky froth (referred to as white water) that floats the floc to the top of the clarifier and suspends it there for a period of time. The “float” is then periodically removed by a mechanical device (slowly rotating brush or oscillating flights) by drawing it into a sludge channel at the outlet end of the clarifier. An automatic spray wash system installed along the sides on the DAF tank prevents the float from sticking to the tank walls. A series of perforated pipes along the bottom of the clarifier collects the clarified water which discharges into an upflow chamber with an overflow weir that maintains equal clarifier tank water level/flow through all operational DAF units.

The air saturation system recycle pumps draw suction from the DAF effluent piping. The DAF air saturation system consists of variable speed recycle pumps, air saturation tanks, diffusion headers, and motorized valves. Air compressors furnish the compressed air to the saturation system. The recycle pumps convey clarified water into the saturation tank at a rate of six to twelve percent of the clarifier flow rate. The water enters the top of the tank and trickles down through packing designed to allow a thin film of water to flow

around the packing media resulting in a large water surface area which maximizes the air-to-water transfer. A single pipeline carries the saturated water to the inlet end of each DAF unit where it divides into two headers in the inlet channel, each with a motorized valve. The distribution header valves allow the operator to modify the amount of saturated water being injected into the DAF tank based on the quality and/or volume of the water being treated, by adding or removing headers from service, in addition to modifying the recycle flow percentage.

DAF effluent water will discharge to the multi-media filters for additional treatment and polishing of the water. Filter effluent water will be dosed with chlorine and flow through a below grade clearwell to achieve the required contact time for disinfection purposes. High lift pumps will draw water from the clearwell and pump the water after chemical addition into the distribution system for customer use.

The float skimmed from the surface of each DAF tank will be pumped to the onsite residuals handling system. Filter backwash sludge after the filter backwash water settles in a spent backwash tank will be pumped and discharged to the same exterior residuals handling system. The exterior residuals management system can include three lined sludge lagoons that are operator selectable by manual operation of the inlet valves at each lagoon. Supernatant from each lined lagoon will be periodically discharged to an adjacent unlined lagoon to infiltrate the water back into the ground. A groundwater discharge permit is not required for this setup including the lined lagoons followed by an unlined infiltration basin.

### **2.3 Alternative No. 3 - Massachusetts Water Resources Authority Connection**

Alternative No. 3 includes the construction and implementation of a connection to the MWRA to fully supply and meet the water demands of the Town, while eliminating the two existing local sources of water supply completely. The MWRA is a Massachusetts public authority which was established in 1984 to provide wholesale water and sewer services to metropolitan Boston communities. The MWRA currently provides services to 3.1 million people and more than 5,500 large industrial users, including the supply of drinking water to local water departments in 53 communities. The MWRA obtains raw water from the Quabbin and Wachusett Reservoirs in the Chicopee and Nashua River basins, respectively. The Quabbin Reservoir is located about 65 miles west of Boston and has a maximum storage capacity of 412 billion gallons, which is equivalent to approximately five to six years of supply. The Wachusett Reservoir is about 35 miles to the west of Boston and has a maximum storage capacity of 65 billion gallons. The total safe yield, which is the volume of water that can be reliably provided even during an extended drought, of the MWRA's supplies is approximately 300 mgd. The water system's annual average day demand (ADD) is approximately 200 mgd.

Due to the well protected watersheds that feed the reservoirs and act as natural filters, MWRA is one of the few large water systems nationwide which is not required by the EPA's surface water filtration regulations to filter the water. Raw water from the reservoirs is treated at the John J. Carroll Water Treatment Plant (CWTP) in Marlborough, Massachusetts. At the CWTP, water is treated with ozone as a primary method of

disinfection and ultraviolet (UV) light as a second method of primary disinfection. UV light was added in April 2014 in compliance with the EPA's Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). A combination of sodium hypochlorite and aqueous ammonia is added to the finished water to form monochloramine for residual disinfection in the distribution system. The water is also treated with sodium carbonate for alkalinity adjustment and corrosion control, carbon dioxide to adjust the pH, and fluoride to promote dental health. MWRA considers a total chlorine residual of 0.2 mg/L a minimum target level at all points in the distribution system. According to MWRA's website, the pH of the finished water leaving the WTP ranges from 9.0 to 9.5. The MWRA conducts hundreds of thousands of tests per year for over 120 contaminants and continuously meets all EPA and MassDEP drinking water MCLs.

As previously mentioned, the combined safe yield of the Quabbin and Wachusett Reservoirs is approximately 300 mgd. Since incorporating conservation and system management goals into standard operating practices more than 20 years ago, demand on MWRA's water system has decreased substantially. According to information provided by the MWRA, the system had an ADD of approximately 195.76 mgd in 2020. The average withdrawal from the MWRA system from 2010 through 2020 held steady ranging from a low of 191.8 mgd in 2019 to a high of 208.01 mgd in 2016 when there was a significant drought period during the summer. Compared to the system's total safe yield of approximately 300 mgd, there is an estimated surplus of approximately 100 mgd. The MWRA is registered to withdraw 186.7 mgd from the Chicopee River Basin and 126.12 mgd from the Nashua River Basin under its WMA registration.

The MWRA has two different operating policies (OP) for a community to purchase MWRA finished water: OP.05 for Emergency Connections and OP.10 for formally joining the MWRA. To establish a permanent interconnection with MWRA or an MWRA served community and be fully supplied by MWRA, formal admission to the MWRA is required as governed by MWRA's Policy OP.10. Based on a review of Policy OP.10 and correspondences with the MWRA, MassDEP, and Department of Conservation and Recreation (DCR), permitting and regulatory approval for a permanent interconnection to be a fully supplied water community will be difficult since Lincoln has sustainable existing water sources with sufficient capacity and good water quality. Additional information on this process is included in Section 3 as the requirements will likely restrict the LWD from pursuing a permanent MWRA connection for a full water supply at this time.

There are benefits to joining the MWRA water system beyond its ability to supply high quality drinking water. MWRA runs several loan programs which are available to any MWRA member community (as designated by MWRA Policy OP.10), and some are prorated for partially supplied communities as follows:

1. Local Water System Assistance Program (LWSAP) – MWRA's LWSAP provides a total of \$724 million in 10-year, zero-interest loans to eligible member communities for local water system improvements projects.
2. Lead Service Line Replacement Loan Program (LLP) – MWRA's LLP provides 10-year, zero-interest loans to eligible communities to enable the communities to develop local programs to fully remove lead service lines from the community

water main to the homes or businesses. Through May 2020, MWRA has distributed a total of \$16.8 million in 10-year, interest-free loans to 11 communities to fully replace lead service lines.

In addition, MWRA provides several annual opportunities for community staff training at no cost and arranges for the receipt of Training Contact Hours (TCHs) for participants. Training includes emergency response, water quality, distribution system management, and current regulatory and public interest issues. MWRA will provide routine and emergency technical and field assistance to communities as needed, such as emergency advice, emergency disinfection equipment and operators, special water quality sampling, equipment loans, advice for storage tank/water age problems, use of leak detection crews, assistance working with MassDEP, and more.

If the LWD pursued a formal admission to the MWRA to become a fully served MWRA community, all of Lincoln's water demand will be supplied by MWRA. The LWD's existing water sources would no longer be required. The existing Flint's Pond RWPS, Flint's Pond WTP, and Tower Road Well could be either decommissioned or repurposed. In addition, if Lincoln became a fully served MWRA community, the LWD would no longer be responsible for water treatment. A different organizational structure of current LWD personnel would need to be considered based on the modified needs for operating and maintaining the Lincoln water distribution system.

### **2.3.1 Potential Interconnections**

The two options for Lincoln to obtain MWRA water include the construction of a direct connection to the MWRA distribution system or the construction of a connection with a neighboring MWRA community to indirectly receive MWRA water. In the latter case, Lincoln would be considered the receiving community and the neighboring MWRA community supplying Lincoln would be considered the donor community. A direct connection to the MWRA distribution system is the simplest option from an operational and administrative standpoint. However, based on correspondences with the MWRA and a review of the existing MWRA system, it is likely not feasible at this time for Lincoln to install a direct connection to the MWRA based on the locations of MWRA water main infrastructure.

Various public water systems surrounding Lincoln are currently a fully or partially served MWRA community. Weston, Waltham, and Lexington are all fully served MWRA water communities. Bedford is a partially served MWRA water community. If Lincoln wanted to be fully supplied by a neighboring MWRA served community, Lincoln would still need to apply to become an MWRA community. Options for constructing an interconnection with Weston, Lexington, or Waltham are evaluated in the following sections. Budgetary cost estimates are presented for potential interconnection infrastructure including booster pump stations, pressure reducing valve (PRV) vaults, and/or water main improvements in Section 4 of this report.

If Lincoln pursues the alternative to become a fully served MWRA community, a complete system-wide hydraulic evaluation, including the Lincoln system as well as the neighboring community systems, should be performed to determine which community may be better suited to supply Lincoln with the water necessary to meet its current and future demands. The study should evaluate the existing hydraulic gradeline in each system, the existing and projected demands of each system, and potential hydraulic limitations of surrounding communities based on their existing infrastructure. In addition, the LWD should coordinate with the surrounding MWRA communities to determine the feasibility of constructing interconnections and the willingness of each community to supply Lincoln with a sufficient volume of water. As part of the process of applying to become an MWRA community, Lincoln would need to obtain support from the transporting/donor community and execute an Intermunicipal Agreement (IMA) with that community.

### **Weston**

There is currently one existing interconnection and one potential future interconnection location between Lincoln and Weston. The existing piping interconnection is located on Weston Road just north of Lincoln Street. The other potential interconnection is located on Route 117, or South Great Road, but the existing water main in Weston ends approximately 1,800 linear feet short of the Lincoln/Weston town line.

The Weston water distribution system is comprised of two services areas, the Main Zone and the High Zone. The hydraulic gradeline in the Main Zone is approximately 369 feet above main sea level (MSL), and the hydraulic gradeline in the High Zone is approximately 400 feet above MSL. Both potential interconnection locations between Lincoln and Weston would be located within the Main Zone of the Weston distribution system. Compared to the hydraulic gradeline of 393 feet above MSL in the Lincoln system, the gradeline in Weston's Main Zone is approximately 24 feet lower. The difference in hydraulic gradeline between the two systems is equivalent to a pressure of approximately 10 psi. If an interconnection was constructed between the Lincoln distribution system and the Main Zone of the Weston distribution system without a booster pump station, the hydraulic gradeline of the Lincoln system would decrease by approximately 24 feet and static pressures throughout the system would drop by approximately 10 psi. The reduction in system pressure would also result in a reduction in the available fire flows throughout the system. Therefore, a booster pump station would be needed for Weston to supply water to the existing Lincoln system to sustain the current hydraulic gradeline.

A booster pump station can consist of either an above-ground building or a below-ground vault. The type of pump station will likely depend on the interconnection location and if any buried infrastructure exists at that location. The booster pump station would likely include a prefabricated building or vault, a flow meter, interior piping, valves and appurtenances, and a pumping system. Other work involved in constructing a booster pump station include site work, heating, ventilation, and air conditioning (HVAC), electrical work, and instrumentation. The booster pump station could be connected to the existing Lincoln SCADA system.

At the existing interconnection between Lincoln and Weston on Weston Road, there is existing 8-inch diameter unlined cast iron water main on the Lincoln side and an 8-inch diameter cement lined ductile iron water main on the Weston side. The *Weston Interconnection Evaluation*, prepared for the LWD by Wright Pierce in 2013, recommended that the existing 8-inch diameter water mains on Weston Road from the interconnection point at the town line to Moccasin Hill Road and from Conant Road to Silver Hill Road be replaced with 12-inch diameter water mains to reduce headloss and reduce the required total dynamic head on the new pumps at a booster pump station. The report also recommended connecting a small section of 8-inch diameter water main on Conant Road, near Laurel Drive, to improve hydraulics of the system. The *Weston Interconnection Evaluation* recommendations did not include replacing the 8-inch water main between Moccasin Hill Road and Conant Road with a new 12-inch water main, but if this 8-inch section of water main remains in place, then it may be a bottleneck (section of 8-inch water main between two 12-inch water mains) that could impact the hydraulics and restrict flows at the interconnection. The system-wide hydraulic study would need to confirm the necessary water main upgrades to meet the demands of the Lincoln system while maintaining system pressures in both systems.

At the potential interconnection location between Lincoln and Weston on Route 117, there is an existing 8-inch diameter asbestos cement water main on the Lincoln side and 10-inch diameter water main of unknown material on the Weston side. The water main on the Weston side does not extend to the town boundary. Approximately 1,800 linear feet of new water main would need to be installed from the end of the existing water main in Weston to connect to the Lincoln distribution system. A new 12-inch diameter water main would be recommended to connect the two systems. As previously mentioned, a hydraulic study would need to review and confirm if the existing 8-inch and 10-inch diameter water mains, and the new 12-inch diameter water main to connect the two systems, would have the hydraulic capacity to meet the necessary demands of the Lincoln system while maintaining system pressures in both systems.

### Lexington

There is one existing interconnection between Lincoln and Lexington, located at the Minuteman High School south of North Great Road. The specific water main size and materials at the interconnection location are unknown. Based on information provided by the MWRA, the hydraulic gradeline of the Lexington distribution system ranges from approximately 422 to 434 feet above MSL. Compared to the hydraulic gradeline of 393 feet above MSL in Lincoln, the gradeline in Lexington is approximately 29 to 41 feet higher. This difference in hydraulic gradeline between the two systems is equivalent to a pressure range of approximately 13 to 18 psi. If a permanent interconnection was constructed between the Lincoln distribution system and the Lexington distribution system without a PRV, the hydraulic gradeline of the Lincoln system would increase by approximately 29 to 41 feet and static pressures throughout the system would increase by approximately 13 to 18 psi. Therefore, a PRV would likely be needed for Lexington to supply water to Lincoln while sustaining the current hydraulic gradeline.

As previously mentioned, Lincoln should consider installing two interconnections with a donor community to develop redundancy and ensure a continued supply of water if one interconnection must be taken offline for maintenance or during an emergency event. Similar to Weston, potential water main installations or replacements may be required within the Lexington and Lincoln distribution systems to construct the necessary interconnections. As part of the recommended system-wide hydraulic evaluation if Lincoln pursues the alternative to become a fully served MWRA community, system mapping data and a hydraulic model of the Lexington distribution system should be acquired and evaluated to determine potential interconnection locations and required water main upgrades. State approvals were recently obtained for Lexington to supply MWRA water to its neighboring communities of Burlington and Bedford due to ongoing water supply and water quality concerns in those two systems. As part of the system-wide hydraulic evaluation, supplying water to meet the demands of Burlington and Bedford would also have to be factored into the analysis when determining if the Lexington distribution system has the hydraulic capacity to supply Lincoln's demands.

An interconnection to supply water from Lexington to Lincoln could consist of a below-ground vault with a PRV. The vault can include the PRV, a flow meter, interior piping, valves and appurtenances. The PRV controls and status signals should be connected to the existing Lincoln SCADA system so PRV activity can be monitored. Additional work for the PRV vault will include site work, HVAC, electrical work, and instrumentation. Any existing buried infrastructure or ledge at the proposed PRV locations may make installation of a below-ground vault more difficult. Water main installations or replacements may be required within the Lexington or Lincoln distribution systems based on the hydraulics within the system and at the interconnection locations, but the system-wide hydraulic evaluation would have to be conducted to fully understand the necessary water main upgrades.

### **Waltham**

There are no existing known interconnections between Lincoln and Waltham. Based on information provided by the MWRA, the hydraulic gradeline of the Waltham distribution system ranges from approximately 420 to 432 feet above MSL. Compared to the hydraulic gradeline of 393 feet above MSL in Lincoln, the gradeline in Waltham is approximately 27 to 39 feet higher. This difference in hydraulic gradeline between the two systems is equivalent to a pressure range of approximately 12 to 17 psi. If a permanent interconnection was constructed between the Lincoln distribution system and the Waltham distribution system without a PRV, the hydraulic gradeline of the Lincoln system would increase by approximately 27 to 39 feet and static pressures throughout the system would increase by approximately 12 to 17 psi. Therefore, a PRV would likely be needed for Waltham to supply water to Lincoln while sustaining the existing hydraulic gradeline.

The existing water main infrastructure in the Waltham water distribution system has not been reviewed. Similar to Weston and Lexington, potential water main installations or replacements will likely be required within the Waltham and Lincoln distribution systems to construct two necessary interconnections. As part of the recommended system-wide hydraulic evaluation if Lincoln pursues the alternative to become a fully served MWRA

community, system mapping data and a hydraulic model of the Waltham distribution system should be acquired and evaluated to determine potential interconnection locations and required water main upgrades.

Similar to the information provided regarding an interconnection between Lincoln and Lexington, an interconnection to supply water from Waltham to Lincoln would likely consist of a below-ground vault with a PRV. The PRV controls and status signals should be connected to the existing Lincoln SCADA system so PRV activity can be monitored. Additional work for the PRV vault will include site work, HVAC, electrical work, and instrumentation. Any existing buried infrastructure or ledge at the proposed PRV locations may make installation of a below-ground vault more difficult. Water main installations or replacements may be required within the Waltham or Lincoln distribution systems based on the hydraulics within the system and at the interconnection locations, but the system-wide hydraulic evaluation would have to be conducted to fully understand the necessary water main upgrades.



# Section 3

## SECTION 3 – PERMITTING

### 3.1 Alternative No. 1 – Utilizing Existing Sources

Certain permit approvals will be required to implement the planned improvements to continue to use the existing Flint’s Pond WTP and Tower Road Well. A BRP WS 29 Permit for Water Treatment Chemical Addition Retrofits of Water Systems Serving Greater than 3,300 People has already been issued by the MassDEP for the CIP and process chemical feed upgrades at the Flint’s Pond WTP. The new coagulant chemical feed system at the RWPS will require another BRP WS 29 Permit through the MassDEP. The design and construction of permanent residuals handling upgrades at the Flint’s Pond WTP to properly manage additional residuals produced as a result of the new coagulant addition will require the LWD to obtain a BRP WS 25 Treatment Facility Modification Permit through the MassDEP.

Replacing raw and finished water pumps at the Flint’s Pond WTP with similar size and capacity pumps will not require any permits through the MassDEP nor will the future replacement of membrane modules with direct replacement membranes as completed in August 2020. Routine chemical feed equipment maintenance and replacements will not require unique permits from the MassDEP as long as there are no significant changes to chemical feed equipment or pumping rates. Miscellaneous process equipment, electrical improvements, and instrumentation and SCADA upgrades will not require MassDEP permits if significant changes to the design or operations of the WTP are not part of the upgrades.

The Tower Road Replacement Well will require a series of permits through the MassDEP. Following successful completion of test well redevelopment and site survey, the replacement well process will include a BRP WS 17 Permit Application for Approval to Site a Source and Conduct a Pumping Test. The BRP WS 17 Application would include justification for the replacement well, summary of historical and recent test well drilling efforts including water quality, and discussion of Zone I ownership. As part of the proposal for a replacement well, a pumping test proposal would be submitted to the MassDEP to outline the proposed well design and operation scheme, proposed testing program scope and protocol, decommissioning of the original source, and characterization of land uses within the Zone I.

After the construction of the new replacement well and completion of an extended pump test, the results of the pump test and the engineering design drawings and specifications for new equipment needed for the replacement well will have to be submitted to the MassDEP in a BRP WS 20 Permit Application for Approval to Construct a Source. After the new replacement well is activated, a BRP WS 36 Permit Application to officially abandon the existing Tower Road Well will be required through the MassDEP.

In addition to the permits required through the MassDEP, the work to construct a replacement well and associated site improvements including the piping between the

replacement well and the new pump station will require a Notice of Intent (NOI) to be filed with the Lincoln Conservation Commission to obtain an Order of Conditions for conditions required during construction to preserve and protect the bordering vegetated wetlands at the Tower Road Well site.

Prior to the construction of the replacement well, the LWD is planning to construct chemical feed system improvements at the Tower Road Well Pump Station in FY22. The chemical feed improvements and plumbing and HVAC upgrades will require the approval of a BRP WS 29 Permit Application through the MassDEP.

### 3.2 Alternative No. 2 - New Flint’s Pond Water Treatment Plant

The local, state, and federal permitting required to construct a new DAF or conventional style WTP in Alternative No. 2 will be much more significant than continuing to utilize the LWD’s existing sources and treatment facilities. Table No. 3-1 summarizes the permits and filings that may be required to construct a new WTP. Depending on the final scope of work included in the design and construction of the new WTP, certain permit filings may not be needed. Additional information on the potential permit filings is included in this section.

**Table No. 3-1  
Summary of Required Permits for Proposed WTP**

Jurisdiction	Agency	Permit
Project Site	Executive Office of Energy and Environmental Affairs - MEPA	Environmental Notification Form
	NHESP - Regulatory Review	MESA Information Request Form
	Lincoln Conservation Commission	Notice of Intent and Order of Conditions
	MA Historical Commission - Secretary of the Commonwealth	Project Notification Form
	Planning Board/Zoning Board of Appeals	Site Plan Review
WTP Construction	Building Department	Building Permit and Certificate of Occupancy
	MassDEP	BRP WS 21D Pilot Test Proposal
		BRP WS 22D Pilot Test Report
		BRP WS 24 to Construct New WTP Facility > 1.0 mgd

A permitting process through the Executive Office of Energy and Environmental Affairs (EEA) Massachusetts Environmental Policy Act (MEPA) Program will likely be required for a new surface water WTP with a capacity of 1.6 mgd. If a project meets or exceeds one or more specific MEPA thresholds, a review is triggered in accordance with 301 CMR

11.03. The MEPA process will include the filing of an Environmental Notification Form (ENF) and public hearings, but a more extensive Environmental Impact Report (EIR) can likely be avoided with the proper documentation and information submitted as part of the ENF.

A Massachusetts Endangered Species Act (MESA) Information Request Form will have to be submitted to the Natural Heritage and Endangered Species Program (NHESP) to determine if there are any Estimated or Priority Habitat mapped on the site of the new WTP. If any endangered species exist on the site, a protection plan during construction will be required. Work within the 100-foot buffer zones surrounding wetlands or waterbodies will require the filing of a Notice of Intent (NOI) with the Lincoln Conservation Commission. If any Estimated or Priority Habitat exist on the project site, a joint NOI/MESA filing can be submitted through the Lincoln Conservation Commission and NHESP to streamline the review and approval process. An Order of Conditions will be issued by the Lincoln Conservation Commission with conditions that will have to be followed during construction to protect the wetlands or waterbodies. Although the Town of Lincoln owns most of the parcels surrounding Flint's Pond, these parcels are all marked as conservation land. Conservation restrictions will need to be reviewed with the Conservation Commission to determine if constructing a new WTP on one of the potential parcels will be permitted since both are marked as conservation land.

A Project Notification Form (PNF) will have to be submitted to the Massachusetts Historical Commission (MHC) to determine if any buildings or structures have been designated as historical. A site or parcel can also have potential historical significance which will be important to determine through the MHC review. If a site has any potential historical significance, an archaeological survey can be required on the entire project parcel during design and prior to any construction. A typical survey includes several small, shallow excavated pits to determine if any historical objects were buried on the project site. On undisturbed parcels located adjacent to a surface water, there is a greater chance that historical groups may have once occupied the site leaving objects of historical significance behind on the project site. If objects of significance were found, the site may not be authorized for use during construction or mitigation measures may be required to further explore and relocate historical objects from the project site prior to construction.

Filings with the Planning Board, Zoning Board of Appeals, and Building Department to review the proposed WTP may be required. Coordination with the Building Department will be required and will include a review of the design components included on the State Construction Control Forms as well as a review of fire protection requirements with the local Fire Department.

Various permit applications and approvals will be required through the MassDEP during the project planning and design stages. Permits will be required for approval to conduct the pilot study (BRP WS 21D), for approval of the final pilot study report (BRP WS 22D), and for approval of the project design drawings and specifications to construct the new WTP (BRP WS 24). Other approvals through the MassDEP may be necessary depending on the results of the pilot study and the proposed WTP design. For example, the MassDEP

Guidelines for Public Water Systems identify a typical DAF and filter loading rate. If the pilot shows effective treatment at loading rates greater than these typical rates in the MassDEP Guidelines, special approval through the MassDEP for use of the higher loading rates will be required.

If the LWD pursues the construction of a new WTP at Site No. 2 (Map Parcel No. 136 9 0) and elects to construct a new intake and RWPS, then additional permitting will be required. Table No. 3-2 lists the permits that would be required for a new intake and RWPS. In this scenario, the RWPS building will be located on the same parcel as the new WTP, but closer to Flint’s Pond to draw water from the intake in the pond and pump the raw water to the start of the treatment process in the WTP.

**Table No. 3-2  
Summary of Required Permits for New Raw Water Pump Station and Intake**

Jurisdiction	Agency	Permit
Intake and Raw Water Pump Station	MassDEP Division of Watershed Management/ USEPA	Temporary NPDES Discharge Permit
	U.S. Army Corps of Engineers - New England District	Department of the Army General Permit - Category 1 Notification Form
	MassDEP - 401 Water Quality Dredging and Fill Program	401 Water Quality Certificate: BRP WW 08 & BRP WW 11
	MassDEP Waterways Licensing Program	Chapter 91 Waterways License

If the RWPS is constructed in an area adjacent to the pond, the deep excavation to construct a wetwell for the raw water pumps will likely require extensive dewatering. With the high volume of water pumped during the dewatering process, discharge to an upland area for infiltration will be a challenge. A temporary National Pollutant Discharge Elimination Systems (NPDES) discharge permit to allow for the return of water pumped from the dewatering process directly back to the nearby surface waterbody during construction can be obtained through the United States Environmental Protection Agency (USEPA). Some minor sampling is typically required, but the NPDES Permit provides a means to properly discharge the water in a controlled manner without having to constantly monitor an upland infiltration area for flooding.

Permitting through the United States Army Corps of Engineers and MassDEP will be required. With any dredging or pond bottom disturbance in a waterbody, a Massachusetts General Permit Category 1 Notification Form will have to be filed with the Army Corps of Engineers. A 401 Water Quality Certificate for minor dredging (BRP WW 08) and minor fill (BRP WW11) will be required for the construction of the new intake in the pond. Additionally, Flint’s Pond (also referred to as Sandy Pond) is considered a Great Pond. A Great Pond is defined as any pond or lake that contained more than 10 acres in its natural

state. The construction of any structure within a Great Pond requires a Chapter 91 Waterways License to be obtained through the MassDEP.

### **3.3 Alternative No. 3 - Massachusetts Water Resources Authority Connection**

Various permits would have to be filed and regulatory requirements would have to be met if Lincoln pursues joining the MWRA as a fully served community for its water supply through the construction of interconnections with a donor community such as Weston, Lexington, or Waltham. Based on a review of the MWRA's Policy OP.10 and correspondences with the MWRA, MassDEP, and DCR, permitting and regulatory approval for a permanent interconnection to become a fully supplied water community will be difficult since Lincoln has sustainable existing water sources with sufficient capacity and good water quality. Potential permitting and regulatory requirements are summarized within this section for Alternative No. 3 for a MWRA connection.

#### **3.3.1 Massachusetts Interbasin Transfer Act (ITA) Review**

The Interbasin Transfer Act (ITA) gives the Massachusetts DCR Water Resources Commission (WRC) the authority to approve or deny transfers of water or wastewater outside of the river basin of origin. The ITA requires protection of the donor basin from any negative environmental or infrastructure impacts due to the withdrawal and interbasin transfer of additional water. The ITA also requires the receiving community to have sound water supply management practices in place prior to the transfer of water resources between river basins, including a history of compliance with water conservation performance standards for residential gallons per capita day (rgpcd) of 65 gpcd and unaccounted for water (UAW) less than 10-percent. The DCR's Office of Water Resources (OWR) provides technical review of the applications, advises the WRC on regulatory and technical issues concerning the ITA, and makes recommendations to the WRC concerning the applicant's compliance with the criteria of the ITA. The OWR maintains the administrative record for the WRC's ITA reviews and coordinates the EEA's review of ITA applications.

A WRC review under the ITA is triggered by a request to transfer water or wastewater from one basin of origin to a different watershed basin. For the ITA review to be triggered, a transfer must not only cross a basin line, but also cross a town line. Lincoln's existing sources are located within the Charles River watershed. The MWRA's Quabbin and Wachusett Reservoirs are located in the Chicopee and Nashua River watersheds, respectively. If an interconnection was constructed between Lincoln and any surrounding community that receives MWRA water, a transfer of water would cross both a town line and a basin line, and an ITA review would likely be triggered. Even if the surrounding community was in the same watershed basin as Lincoln, the donor basin is based on the locations of the Quabbin and Wachusett Reservoirs, not the basin in which the neighboring community is located.

If the transfer volume is 1.0 mgd or less, the WRC may issue a "Determination of Insignificance." If a transfer is determined to be "insignificant", no further review is

required under the ITA. However, the review is also based on the environmental impact of the transfer. A transfer of less than 1.0 mgd could potentially cause significant environmental impacts, and therefore, would not be granted a “Determination of Insignificance.” If the transfer is not issued a “Determination of Insignificance,” then it is considered a “significant” transfer and a full review is required under the ITA. The EEA’s MEPA requires the community to file an EIR for a significant interbasin transfer. To streamline the review process, the WRC uses the EIR as its application. The WRC has developed specific criteria that is reviewed as part of the ITA information required to be included in an EIR. Based on correspondences with DCR specifically, even though the annual average daily transfer volume to meet Lincoln’s water demands is approximately 0.50 mgd, any transfer between basins and across town lines is considered significant in the Commonwealth and receiving a “Determination of Insignificance” is not likely. Any requested transfer is deemed significant as it allows for the transfer request to go through the proper review and evaluation to determine if it meets the established criteria for an interbasin transfer to protect the donor community and to preserve and protect each local environment.

The WRC typically considers certain major criteria when approving an interbasin transfer:

1. An EIR must be submitted to EEA and approved through the MEPA process, as detailed in the MEPA Review section below.
2. The ITA requires “that all reasonable efforts have been made to identify and develop all viable sources in the receiving area of the proposed interbasin transfer (MGL Ch. 21 Section 8D(1)).” Receiving communities must demonstrate that all existing sources have been exhausted and are not viable to meet the water demands of the community now or in the future. Receiving communities will also have to demonstrate that a new source evaluation has been completed with no viable alternatives for a new source within its own basin that could provide a greater capacity or better water quality than the existing sources.
3. The receiving area must demonstrate that all practical measures to conserve water have been taken and the WRC water conservation performance standards are met for 65 gpcd and 10-percent or less UAW.
4. A reasonable instream flow in the river from which the water is transferred must be maintained. The WRC will evaluate the impacts of transferring the requested volume from the donor community’s watershed. The transfer of water from the MWRA’s sources would not impact their watersheds, and this factor is not a concern.
5. The WRC will evaluate the impacts of transferring the requested volume to the groundwater withdrawals of the donor community. Since the requested transfer of water would be from the MWRA’s reservoirs, this criterion is not applicable because MWRA’s sources are surface water sources.
6. The WRC must consider the “cumulative impacts of all past, currently authorized, or proposed transfers on streamflows, groundwater, lakes, ponds, reservoirs or other impoundments in the donor basin and relevant sub-basins.” The MWRA would provide much of this information based on past, current, and future transfers expected based on connections to the MWRA system.

### 3.3.2 MEPA Review

Per MEPA regulations, the MEPA review process requires state agencies to study the environmental impacts of projects requiring state permitting, financial assistance, or land disposition, and to use all feasible measures to avoid, minimize, and mitigate damage to the environment or, to the extent damage to the environment cannot be avoided, to minimize and mitigate damage to the environment to the maximum extent practicable. If a project meets or exceeds one or more specific MEPA thresholds, a review is triggered. According to 301 CMR 11.03, for water related projects, an Environmental Notification Form (ENF) and mandatory EIR are required under MEPA regulations if the project meets or exceeds one or more of the thresholds listed in the regulations. Two thresholds listed include (1) New interbasin transfer of water of 1.0 mgd or more or any amount determined significant by the WRC, and (2) New water service to a municipality or water district across a municipal boundary through new or existing pipelines, provided that the project is undertaken by an agency, unless a disruption of service emergency is declared in accordance with applicable statutes and regulation. Either of these thresholds will likely trigger the ENF and mandatory EIR preparation under the MEPA regulations.

For communities seeking admission to the MWRA, there is a specific EIR scope and outline that must be followed. The required information addresses donor basin and receiving area criteria derived from the ITA criteria. As previously mentioned, the EIR would act as the application to the WRC. The MEPA review must be completed before the WRC can approve or deny the interbasin transfer. After the MEPA review is completed, and the ITA application is submitted using the EIR as the application, the WRC will hold public hearings within 60 days of receipt of the application. The WRC will make a decision on the ITA application within 60 days of the final public hearing. Completion of the paperwork and preparation of the documents required for the joint ITA and MEPA review can be extensive, time consuming, and a major effort by the LWD and its consultant.

### 3.3.3 MassDEP BRP WS 32 – Distribution System Modifications

MassDEP requires any public water supplier, or their representative, to apply for a BRP WS 32 approval for Distribution Modifications for systems that serve more than 3,300 people. According to MassDEP's Drinking Water Program Policy No. 08-01, Substantial Modifications to a Public Water System That Require a Permit, any project that incorporates a physical interconnection with another community, or creates alternate pressure zones, is considered a substantial modification, and requires the submittal of a permit application for a BRP WS 32. The construction of an interconnection that does not currently exist for the permanent transfer of water between Lincoln and a surrounding community will require the submittal of a permit application to the MassDEP.

### 3.3.4 Intermunicipal Agreement (IMA)

If an interconnection is installed between Lincoln and a surrounding community, an Intermunicipal Agreement (IMA) will be required between Lincoln and the donor community. The IMA would need to specify the agreed upon billing terms for water purchased by either system. The IMA may also indicate an approved annual average water transfer between the communities involved, a maximum daily transfer volume or maximum transfer flow rate, the method of the water supply and transport, and which community is responsible for funding and maintaining the interconnection infrastructure, among other mutually agreed upon conditions. If the LWD further pursues an interconnection with a surrounding community, the LWD should begin discussions with the potential donor community regarding costs, terms of agreement, and language to be included in an IMA.

### 3.3.5 MWRA Application for Admission

Communities seeking admission to the MWRA must submit an application to the MWRA Advisory Board and MWRA Board of Directors. There is no formal application form to fill out, but the community must submit the following documentation:

- Information of water demand requested from MWRA (typical peak, emergency peak, and average use).
- Documentation that no water supply source has been abandoned without a MassDEP declaration.
- Documentation that no local supply source feasible for development has been identified by the community or MassDEP.
- Documentation that Effective Demand Management Measures have been established and detailed description of water conservation and water accountability programs undertaken.
- Water use survey of users consuming more than 20 million gallons per year.
- Description of municipal zoning and non-zoning measures designed to protect local sources of supply.
- Disaggregation of the community's total water consumption by customer class.
- Documentation on existing source safe yield, protection needs, and contamination threats.
- Local Water Supply Management Plan or Water Management Plan approved by WRC. Documentation of community's adoption of the approved Plan.
- Signed legislation documenting approval (the applicant community must receive approval from the MWRA Advisory Board, the General Court, and the Governor).
- WRC Approval of Interbasin Transfer.
- MEPA Sign-off (ENF Certificate of the Secretary of EEA).
- The applicant community must accept the admission to the MWRA program by a majority vote of City Council (if a city) or majority vote at Town Meeting (if a town), including documentation of the applicant community's acceptance.

Upon meeting the above requirements, as applicable, the admission of a community to the MWRA is ultimately subject to approval by the MWRA Advisory Board and MWRA Board of Directors.



# Section 4

## SECTION 4 – COST EVALUATION

### 4.1 Alternative No. 1 – Utilizing Existing Sources

Alternative No. 1 includes the continued use of the existing Flint’s Pond WTP and Tower Road Well Pump Station after the implementation of the improvements planned through FY23. The planned improvements at the Flint’s Pond WTP and Tower Road Well Pump Station will be constructed in the immediate future to help maintain compliance with drinking water regulations and guidelines or satisfy requirements of MassDEP ACOs or Sanitary Survey Deficiencies. These planned improvements were identified in Section 2 of this report. The capital costs associated with these improvements are not included in this evaluation comparing the future water supply alternatives since these upgrades are already planned and will be necessary regardless of which alternative is selected by the LWD for its long-term water supply and treatment approach.

#### 4.1.1 Future Capital Improvements

Beyond FY23, additional major process equipment will require replacement at the existing Flint’s Pond RWPS and WTP during the 20-year planning period between FY24 and FY43. The two 100 hp raw water pumps, motors, and VFDs at the RWPS and two 60 hp finished water pumps, motors, and VFDs will require replacements. Conditions of the pumps will need to be reviewed to determine the actual timing for replacement, but we have assumed the raw water split case centrifugal pumps and VFDs will be replaced in FY24 after approximately 20 years of service if these were last replaced around 2004, and the finished water vertical turbine pumps and VFDs will be replaced in FY31 after approximately 15 years of service since these were last replaced in 2016 and 2017. Based on a life expectancy of seven years, the filter membrane modules will require replacement in FY28, FY35, and FY42, a total of three full membrane module changeouts. The replacement of the seven programmable logic controllers (PLCs) at the WTP, including all installation and programming, as well as setup and programming of the SCADA Human Machine Interface (HMI) screens at the operator workstations (OWS) can be completed in FY25. Additional process equipment, smaller pumps, air compressors, valves, instruments, and electrical equipment will require upgrades and/or replacements during the planning period as the existing equipment reaches the end of its useful life. Process equipment replacements have been assumed to be constructed in FY32 with general electrical upgrades planned for FY38.

The larger capital improvements projects and their associated costs that will be planned for the Flint’s Pond WTP throughout the evaluation period are summarized in Table No. 4-1. The estimate of probable construction cost for each project listed in Table No. 4-1 includes the supply and installation costs, an annual escalation rate of 2.5-percent based on the fiscal year when the project will be completed, and 25-percent allowance for engineering and contingencies.

After the planned replacement well and chemical feed system upgrades at the Tower Road Well Pump Station are constructed, additional work at the pump station during the planning period between FY24 and FY43 will be limited and should be covered by the annual O&M budget if routine maintenance and repairs are completed annually. No additional major capital improvements have been included for the Tower Road Well Pump Station during the planning period.

**Table No. 4-1  
Capital Costs Utilizing Existing Sources - FY24 Through FY43**

<b>Capital Improvement</b>	<b>Replacement Year</b>	<b>Estimated Replacement Cost</b>
Raw Water Pumps (2), Motors, and VFDs	FY24	\$300,000
PLC Replacements and SCADA Upgrades	FY25	\$420,000
Membrane Module Replacement (240 Modules)	FY28	\$380,000
Finished Water Pumps (2), Motors, and VFDs	FY31	\$520,000
General Process Equipment and Instrument Upgrades	FY32	\$500,000
Membrane Module Replacement (240 Modules)	FY35	\$460,000
Electrical Equipment and System Upgrades	FY38	\$500,000
Membrane Module Replacement (240 Modules)	FY42	\$540,000
	<b>Total</b>	<b>\$3,620,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

#### 4.1.2 Annual Operations & Maintenance Costs

The LWD operates and maintains the water system including the two pump stations, WTP, storage tank, and the distribution system using funds appropriated under an annual O&M budget. The total O&M budget projected for FY22 based on information provided by the LWD is \$1,870,000. The annual O&M budget is used to fund operator salaries and benefits and costs associated with electric and gas usage; chemical supplies; fuel supplies; sludge and waste disposal; general supplies for the pump stations, WTP, and distribution system; engineering services; external vendor services; water quality sampling; administrative tasks; and equipment, building, and site maintenance. Debt services are also included in the annual water system O&M budget. The direct O&M costs, such as electric and chemical costs, associated with the operations and maintenance of the existing pump stations and WTP were the focus of this evaluation for comparison to the other two future water supply alternatives. Indirect costs such as operator salaries and benefits, debt services, and engineering services that would likely be relatively consistent between the water supply alternatives were less significant when comparing the alternatives.

The allocation of direct O&M costs between the two pump stations and the WTP is not listed in the O&M budget, but an estimate of the direct O&M costs associated with each facility has been prepared based on information such as historical electric bills and the volume of water pumped and treated at each of the facilities. The annual O&M costs

associated with the existing Flint’s Pond RWPS and WTP are summarized in Table No. 4-2 based on the FY22 budget. Although the costs may increase through the planning period due to general escalation of costs, the direct O&M costs summarized in Table No. 4-2 provide a basis for the expected costs associated with continuing to utilize the Flint’s Pond RWPS and WTP.

**Table No. 4-2  
Flint’s Pond RWPS and WTP Direct O&M Costs**

<b>Line Item</b>	<b>Annual O&amp;M Cost (FY22 Budget)</b>
Electric Utility	\$105,000
Gas Utility	\$10,000
Chemicals	\$25,000
Sludge/Waste Disposal	\$30,000
Materials & Supplies	\$20,000
Equipment Maintenance	\$65,000
Building Maintenance	\$8,000
Site Maintenance	\$2,000
<b>Total</b>	<b>\$265,000</b>

The direct O&M costs associated with the Tower Road Well Pump Station are summarized in Table No. 4-3 based on the LWD’s FY22 budget. Similar to the Flint’s Pond annual O&M costs, the costs listed in Table No. 4-3 provide a basis for the O&M costs expected for the continued use of the Tower Road Well Pump Station as part of Alternative No. 1. The total direct annual O&M costs associated with the continued use of the Flint’s Pond RWPS and WTP and the Tower Road Well Pump Station are estimated at \$348,000.

**Table No. 4-3  
Tower Road Well Pump Station Direct O&M Costs**

<b>Line Item</b>	<b>Annual O&amp;M Cost (FY22 Budget)</b>
Electric Utility	\$40,000
Gas Utility	\$3,000
Chemicals	\$13,000
Materials & Supplies	\$12,000
Equipment Maintenance	\$10,000
Building Maintenance	\$3,000
Site Maintenance	\$2,000
<b>Total</b>	<b>\$83,000</b>

## 4.2 Alternative No. 2 - New Flint's Pond Water Treatment Plant

Alternative No. 2 includes the continued use of the two existing sources similar to Alternative No. 1, but with the design and construction of a new Flint's Pond WTP rated for 1.6 mgd with a more conventional treatment process, such as DAF clarification followed by dual media gravity filtration, which is better suited for treatment of the water from Flint's Pond. In addition to the new Flint's Pond WTP, the continued use of the Tower Road Pump Station is included in Alternative No. 2 with the replacement well and chemical feed upgrades that are already planned for construction by the end of FY23. Similar to Alternative No. 1, the cost associated with the planned improvements at the Tower Road Well Pump Station are not included in this evaluation since these upgrades will be constructed in the immediate future to help maintain compliance with drinking water regulations and will be necessary regardless of which alternative is selected by the LWD for its long-term water supply and treatment approach.

### 4.2.1 New Water Treatment Plant Design and Construction Costs

If Alternative No. 2 to construct a new Flint's Pond WTP is the selected long-term water supply and treatment approach, the capital improvements that would be required under Alternative No. 1 at the existing Flint's Pond RWPS and WTP will not be required. In lieu of the capital costs included in Table No. 4-1 for Alternative No. 1, the costs associated with the planning, design, and construction of a new Flint's Pond WTP in Alternative No. 2 would have to be funded by the LWD.

Before the design of a new WTP can be started, a two-season pilot study will be needed to determine operating ranges, loading rates, and chemical feed doses for optimum treatment and finished water quality of the selected treatment process, likely DAF clarification followed dual media filtration. Water quality sampling and residuals production data will be collected during the pilot study for each season to determine if there are any seasonal challenges associated with the treatment process. If the LWD pursues a new intake and RWPS if Site No. 2 is selected as the location for the new WTP, a comprehensive review of the raw water quality at the potential new intake location should be conducted as part of the pilot study. With pilot testing required to support the proposed full-scale WTP design, pilot testing of the raw water from the potential new intake location may be necessary to determine optimum operational conditions for the alternate raw water intake. The estimated cost for a two-season pilot study, including the evaluation of water quality and operational settings associated with a new intake, is approximately \$300,000.

Based on recent costs for similarly sized water treatment facilities, the estimated cost for the design and construction of a new 1.6 mgd DAF WTP is \$16.0 million, including all construction and engineering costs for design, permitting, and construction services. The estimated costs assume the construction of the new WTP will be completed in FY26 and include an annual escalation rate of 2.5-percent on current construction costs and 25-percent allowance for engineering and contingencies.

If the existing RWPS is used to draw water from the pond and pump to the new WTP, a new raw water pipeline to extend the existing 12-inch raw water main in Sandy Pond Road from its location near the existing WTP to the new DAF WTP will be required. An extension of the 12-inch raw water main by 2,000 linear feet (LF) would be needed if the new WTP was located on Site No. 2 (Map Parcel No. 136 9 0). The estimate of probable construction cost for 2,000 LF of 12-inch ductile iron raw water main to be constructed in FY26 is \$700,000, including an annual escalation rate of 2.5-percent and 25-percent allowance for engineering and contingencies. The raw water pumps and VFDs would likely require replacement with larger pumps to provide the additional total dynamic head (TDH) that will be required to pump the raw water an additional 2,000 LF to a WTP located at a different elevation from the existing WTP. The estimate of probable construction cost to replace the raw water pumps in FY26 with larger pumps is \$350,000, including an annual escalation rate of 2.5-percent and 25-percent allowance for engineering and contingencies. A summary of the capital costs associated with the design and construction of a new DAF WTP for the Flint’s Pond water supply is included in Table No. 4-4.

**Table No. 4-4  
Capital Costs for New DAF WTP and Raw Water Main Extension**

<b>Capital Improvement</b>	<b>Estimated Cost</b>
Two Season Pilot Study	\$300,000
New DAF Water Treatment Plant	\$16,000,000
12-Inch DI Raw Water Main Extension (2,000 LF)	\$700,000
Raw Water Pumps (2), Motors, and VFDs	\$350,000
<b>Total</b>	<b>\$17,350,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

If the LWD pursues the construction of a new WTP at Site No. 2 (Map Parcel No. 136 9 0) and elects to construct a new intake and RWPS, then the estimated \$1,050,000 for the raw water main extension and new raw water pumps will not be required. Instead, there will be additional costs to design and construct the new intake, RWPS, and raw water pipeline between the new RWPS and the new WTP at Site No. 2. The estimate of probable construction cost for a new intake, RWPS, and raw water pipeline is approximately \$4,300,000 assuming the construction will be completed in FY26 and including an annual escalation rate of 2.5-percent on current construction costs and 30-percent allowance for engineering and contingencies. The allowance for engineering and contingencies is greater for the design and construction of the intake and RWPS than other capital improvements due to the significant permitting effort that will be required to construct a permanent structure in the pond. A summary of the capital costs associated with the design and construction of a new DAF WTP, intake, and RWPS for the Flint’s Pond water supply is included in Table No. 4-5.

After the new WTP is constructed, tested, and operational, the LWD can consider repurposing or demolishing the existing WTP. Repurposing or demolishing the existing RWPS and intake in the pond will also need to be considered if a new intake and RWPS are constructed. At a minimum, the existing intake line feeding the existing RWPS should be cut and capped to eliminate the physical connection between the original RWPS and the pond intake.

**Table No. 4-5  
Capital Costs for New DAF WTP, Intake, and RWPS**

<b>Capital Improvement</b>	<b>Estimated Cost</b>
Two Season Pilot Study	\$300,000
New DAF Water Treatment Plant	\$16,000,000
New Intake and RWPS	\$4,300,000
<b>Total</b>	<b>\$20,600,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

#### 4.2.2 New Water Treatment Plant Operations & Maintenance Costs

If the Town chooses to pursue the new DAF WTP in Alternative No. 2, the expected annual O&M costs will change from those required for the existing Flint’s Pond membrane filtration WTP. Table No. 4-6 provides a summary of the estimated annual direct O&M costs associated with a new DAF WTP compared to the direct O&M costs previously listed in Table No. 4-2 for the existing Flint’s Pond WTP based on the budgeted costs for FY22. The total annual direct O&M costs for Alternative No. 2 for the new DAF WTP and the continued use of the Tower Road Well Pump Station (as shown in Table No. 4-3) are estimated at \$478,000.

The increase in labor cost is based on the assumption that a new operator at a salary of \$80,000 per year would need to be hired to assist in the more advanced WTP operations. Electrical and gas utility costs will likely increase due to the additional pumps, compressors, and equipment required for daily operations and the larger overall size of the new DAF WTP for lighting and HVAC. With a new DAF WTP, the clean in place chemicals used for cleaning the membranes at the existing WTP will no longer be required. However, there will likely be greater coagulant chemical usage on a daily basis at a new DAF WTP which would offset the chemical cost savings from eliminating the membrane cleaning chemicals. The sludge/waste disposal costs are currently used for pumping and disposing of the clean in place chemical wash water. The new DAF WTP will require period removal and disposal of DAF floating sludge and filter backwash residuals, but with proper residuals management, these costs can be less than the annual costs incurred by the current membrane cleaning process. The annual O&M costs associated with materials, supplies, and maintenance are expected to increase with the more advanced treatment process and additional equipment to maintain. Finally, the filter media replacement costs

for the new DAF WTP are estimated based on the use of granular activated carbon (GAC) and the annual value the LWD should budget to prepare for future replacements of filter media when it is consumed. GAC filter media is expected to require replacement every five years.

**Table No. 4-6  
Flint’s Pond DAF WTP and Existing WTP Direct O&M Costs**

<b>Line Item</b>	<b>DAF WTP Estimated Annual O&amp;M Cost</b>	<b>Existing WTP Annual O&amp;M Cost (FY22 Budget)</b>
Labor	\$80,000	-
Electric Utility	\$130,000	\$105,000
Gas Utility	\$12,000	\$10,000
Chemicals	\$25,000	\$25,000
Sludge/Waste Disposal	\$20,000	\$30,000
Materials & Supplies	\$25,000	\$20,000
Equipment Maintenance	\$75,000	\$65,000
Building Maintenance	\$10,000	\$8,000
Site Maintenance	\$3,000	\$2,000
Filter Media Replacement	\$15,000	-
<b>Total</b>	<b>\$395,000</b>	<b>\$265,000</b>

### 4.3 Alternative No. 3 - Massachusetts Water Resources Authority Connection

Alternative No. 3 includes the construction and implementation of a connection to the MWRA to fully supply and meet the water demands of the Town. Based on a review of the MWRA’s Policy OP.10 and correspondences with the MWRA, MassDEP, and DCR, permitting and regulatory approval for a permanent interconnection to become a fully supplied water community will be difficult since Lincoln has sustainable existing water sources with sufficient capacity and good water quality. The LWD would need to apply to formally join the MWRA pursuant to OP.10 to purchase and receive MWRA water through a neighboring MWRA community. The challenges associated with this application process and obtaining regulatory approval to join the MWRA were reviewed in Section 3.3.

#### 4.3.1 MWRA Entrance Fee and Annual Assessment Fees

If Alternative No. 3 is pursued by the LWD and approved by the necessary regulatory agencies, the capital improvements and the associated costs that would be required under Alternative No. 1 at the existing Flint’s Pond RWPS and WTP during the planning period and the new DAF WTP construction under Alternative No. 2 will not be needed. However, there would be various infrastructure costs to facilitate an interconnection with a neighboring MWRA community and costs to formally join the MWRA consisting of an entrance fee and annual assessment fees (water rates). Upon being admitted as a new

MWRA community, the MWRA charges an entrance fee to cover the new community's fair share of the costs of the waterworks system in place at the time the user joins. The entrance fee may be paid in one lump sum or through a 25-year, interest-free payment plan with a grace period for the first three years. The total entrance fee is scaled for each community that enters based on the overall cost of the MWRA waterworks system at the time of entrance and the new community's annual average daily water supply needs approved for purchase from the MWRA.

If Lincoln becomes a fully served MWRA community, the volume of water required to be purchased would need to meet current and projected demands in Lincoln. According to Lincoln's 2019 Annual Statistical Report (ASR), the average daily demand (ADD) in 2019 was approximately 0.47 mgd (326 gpm pumped continuously over the course of a 24-hour day). According to DCR's Water Needs Forecast prepared for the Town of Lincoln, the projected 2033 ADD is estimated to be 0.53 mgd (368 gpm pumped continuously over the course of a 24-hour day) including a 5-percent water supply buffer. Lincoln's existing total WMA Permit authorized average daily withdrawal volume is 0.53 mgd, including a registered withdrawal of 0.35 mgd and a permitted withdrawal of 0.18 mgd. Based on the historical water usage and DCR projected water demands, the annual average daily volume of water required to fully supply the Town of Lincoln was estimated at 0.53 mgd throughout the planning period for the purposes of determining the approximate entrance fee and annual assessment fees.

The ADD for each year of the 20-year planning period between FY24 and FY43 was assumed to be 0.53 mgd. Cost estimates associated with formally joining the MWRA with a yearly ADD of 0.53 mgd were provided by the MWRA based on FY21 fees. Based on an annual escalation on the current FY21 entrance fees of 2.5-percent, the estimated entrance fee for the LWD to join the MWRA system in FY24 is approximately \$2,540,000. The estimated annual assessment fee in FY24 for purchasing an ADD of 0.53 mgd is approximately \$950,000 based on an annual increase in water rates by 3.9-percent. The MWRA indicated a standard increase in the annual assessment fee by 3.9-percent has been adopted through 2030 but using this same annual increase would provide a budgetary value for future years for the planning period included in this evaluation. Based on the estimated FY24 assessment fee of \$950,000 and the annual increase of 3.9-percent in the rates, the annual assessment fee is estimated to increase to approximately \$1,970,000 by FY43. The sum of the estimated annual assessment fees for the 20-year planning period from FY24 through FY43 is approximately \$28,000,000.

The entrance fee would be paid directly by the LWD to the MWRA. The annual assessment fees may be paid either directly to the MWRA or to the donor community. Based on information provided by the MWRA, in most cases the MWRA bills the receiving community (LWD) directly for their annual water usage. However, in some cases, the MWRA bills the donor community (Weston, Lexington, or Waltham) for the MWRA water usage, and the receiving community (LWD) would pay the donor community for the water delivered through the interconnection. Even if the annual assessment charges are paid directly to the MWRA by the LWD, the IMA between the donor community and the LWD for water supplied through the interconnection will likely include an additional charge to

be paid by the LWD to the donor community, above and beyond the MWRA annual assessment fees. If the LWD pursues an interconnection with a surrounding community, the LWD should begin discussions with the potential donor community regarding potential water delivery charges. An evaluation could be conducted to determine what the additional charges imposed on the LWD should be to fund required infrastructure improvements, if necessary, and additional operations and maintenance costs of the donor community.

#### 4.3.2 Initial Capital Cost and MWRA Entrance Fee Summary

The total capital costs associated with joining the MWRA for its full water supply consist of the costs to construct the interconnections and water main infrastructure with a neighboring MWRA donor community, the MWRA Entrance Fee previously summarized in Section 4.3.1, and engineering costs associated with the permitting and MWRA application for admission. The cost to construct a permanent interconnection(s) between Lincoln and a neighboring MWRA community will depend on which neighboring MWRA community that the LWD determines provides the most advantageous connection(s). As discussed in Section 2.3.1, the interconnections may consist of a booster pump station or PRV vault along with any required water main infrastructure improvements. The LWD would be responsible for all costs related to the design, permitting, and construction of the interconnection(s) with a neighboring MWRA community. For redundancy purposes, two interconnections should be considered between Lincoln and the donor community.

The budgetary construction cost for two potential booster pump stations near the Lincoln/Weston town line are summarized in Table No. 4-7. A booster pump station can consist of either an above-ground building or a below-ground vault. The type of pump station will likely depend on the interconnection location and if any buried infrastructure exists at that location. The booster pump station would likely include a prefabricated building or vault, a flow meter, interior piping, valves and appurtenances, and a pumping system. Other costs involved in constructing a booster pump station include site work, HVAC, electrical work, and SCADA and instrumentation. The estimate of probable construction cost for each booster pump station is \$975,000, including an annual escalation rate of 2.5-percent with expected construction being completed in FY24 and a 25-percent allowance for engineering and contingencies. The estimated costs are based on above ground booster pump stations and do not include any costs for legal fees, land acquisitions, or easements to site the booster pump stations.

Based on the *Weston Interconnection Evaluation* prepared in 2013, recommendations for one interconnection between Weston and Lincoln at Weston Road included the replacement of the existing 8-inch diameter water mains on Weston Road from the interconnection point at the town line to Moccasin Hill Road and from Conant Road to Silver Hill Road with 12-inch diameter water mains. The water main upgrades would reduce headloss and the required head on the new pumps at a booster pump station. A hydraulic evaluation would be needed to confirm the necessary water main upgrades, but to avoid a potential bottleneck, the 8-inch water main along Weston Road from Moccasin Hill Road to Conant Road should also be replaced with a 12-inch diameter water main. The *Weston Interconnection Evaluation* also recommended connecting a small section of

8-inch diameter water main on Conant Road, near Laurel Drive, to improve hydraulics of the system. The estimate of probable construction cost for approximately 5,800 linear feet of new 12-inch diameter ductile iron water main is \$1,950,000 and for approximately 700 linear feet of new 8-inch diameter ductile iron water main is \$200,000. The total estimated probable construction cost for the required water main improvements at this interconnection is \$2,200,000. The budgetary cost estimates for water main improvements are shown in Table No. 4-7 and include the costs associated with the water main, valves, fittings, hydrants, and other appurtenances, temporary and permanent trench pavement, an annual escalation rate of 2.5-percent with expected construction being completed in FY24, and a 25-percent allowance for engineering and contingencies.

**Table No. 4-7  
Weston Booster Pump Stations and Water Main Improvements Cost Estimate**

<b>Capital Improvement</b>	<b>Estimated Cost</b>
<b>Weston Road Interconnection</b>	
Booster Pump Station	\$975,000
New 12-inch DI water main (5,800 LF)	\$1,950,000
New 8-inch DI water main (700 LF)	\$200,000
<b>Route 117 Interconnection</b>	
Booster Pump Station	\$975,000
New 12-inch DI water main (1,800 LF)	\$610,000
<b>Total</b>	<b>\$4,710,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

For a second potential interconnection location between Lincoln and Weston on Route 117, recommendations in the *Weston Interconnection Evaluation* included the construction of approximately 1,800 linear feet of new 12-inch water main from the end of the existing water main in Weston to connect to the Lincoln distribution system at the town boundary. The estimated probable construction cost for approximately 1,800 linear feet of new 12-inch diameter ductile iron water main is \$610,000 as shown in Table No. 4-7, and includes the construction costs for the water main, valves, fittings, hydrants, and other appurtenances, temporary and permanent trench pavement, an annual escalation rate of 2.5-percent with expected construction being completed in FY24, and a 25-percent allowance for engineering and contingencies.

The total cost of the two booster pump stations and the water main improvements associated with the construction of two interconnections between Lincoln and Weston is approximately \$4,710,000 based on the work being completed in FY24. If Lincoln received its full water supply from Weston and only one interconnection was installed, the one point of entry would present a concern in terms of relying on one point of entry for its continuous water supply. The conservative approach would be to construct two points of entry with two interconnections to provide redundancy and ensure a continued supply of

water if one interconnection had to be taken offline for maintenance or during an emergency event.

The estimated total cost for the construction of two interconnections with Weston in FY24, including two booster pump stations and potential water main improvements, the Entrance Fee to join the MWRA network as a fully served MWRA community, and engineering costs associated with the permitting and MWRA application for admission is summarized in Table No. 4-8. The total estimated cost is \$8,000,000 based on connecting to the MWRA in FY24.

**Table No. 4-8  
Summary of Capital Costs for MWRA Connection with Weston**

Item	Cost Estimate
Weston Road Interconnection	\$3,125,000
Route 117 Interconnection	\$1,585,000
MWRA Entrance Fee	\$2,540,000
Engineering and Permitting for MWRA Admission	\$750,000
<b>Total</b>	<b>\$8,000,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

The entrance fee may be paid in one lump sum payment or through a 25-year, interest-free payment plan with a grace period for the first three years. If Lincoln paid the entrance fee over the 25-year payment plan, the initial capital costs associated with becoming a fully served MWRA community would just include the costs to construct interconnections with the donor community and the engineering and permitting costs associated with the MWRA application and admission process. If the \$2,540,000 entrance fee was paid over a 25-year, interest-free payment plan with a grace period for the first three years, the annual payment for the remaining 22 years would be approximately \$115,450.

Interconnections to supply water from Lexington or Waltham to Lincoln would consist of below-ground vaults with PRVs. Each vault construction can include site work, PRV, a flow meter, interior piping, valves and appurtenances, HVAC, electrical work, and SCADA and instrumentation. The estimate of probable construction cost for each PRV vault is \$825,000, or a total of \$1,650,000 for two vaults, including an annual escalation rate of 2.5-percent with expected construction being completed in FY24 and a 25-percent allowance for engineering and contingencies.

As a budgetary estimate for the water main improvements that may be necessary for interconnections with Lexington or Waltham, the estimated cost associated with the water main upgrades for the two Weston interconnections of \$2,760,000 has been incorporated into the summary of capital costs for an MWRA connection with Lexington or Waltham in Table No. 4-9. Water main installations or replacements may be required within the

Lexington, Waltham, or Lincoln distribution systems based on the hydraulics within the system and at the interconnection locations, but a system-wide hydraulic evaluation would have to be conducted to understand the necessary water main upgrades. The estimated total cost to construct two interconnections with Lexington or Waltham, the MWRA Entrance Fee to join the MWRA network as a fully served MWRA community in FY24, and the engineering and permitting costs associated with the MWRA application and admission process is \$7,700,000.

**Table No. 4-9**  
**Summary of Capital Costs for MWRA Connection with Lexington or Waltham**

Item	Cost Estimate
Two PRV Vault Interconnections	\$1,650,000
Water Main Upgrades	\$2,760,000
MWRA Entrance Fee	\$2,540,000
Engineering and Permitting for MWRA Admission	\$750,000
<b>Total</b>	<b>\$7,700,000</b>

<sup>1</sup>The baseline FY21 (non-escalated) estimated replacement costs are shown in Appendix A for future planning purposes.

### 4.3.3 Annual MWRA Assessment Fees and Operations & Maintenance Costs

The total annual costs associated with becoming a fully served MWRA community consist of the MWRA annual assessment fees and any operation and maintenance costs required for the interconnections and local infrastructure. As previously mentioned, the LWD will also likely be required to pay an annual surcharge to the donor community for use of the donor community’s water main infrastructure to transfer the MWRA water from the MWRA water main connection to the town line between the donor community and the Town of Lincoln, and that surcharge would be negotiated as part of an IMA. A 5- to 10-percent surcharge can be assumed for planning purposes for the donor community surcharge for the water supply

The estimated annual assessment fees in FY24 for purchasing an ADD of 0.53 mgd are approximately \$950,000 as shown in Table No. 4-10. The MWRA indicated a standard increase in the annual assessment fees of 3.9-percent has been adopted through FY30 and using this same annual increase beyond FY30 would provide a budgetary value for future years for the planning period included in this evaluation. Based on the estimated FY24 assessment fees of \$950,000 and the annual increase of 3.9-percent in the rates, the annual assessment fees are estimated to increase to approximately \$1,970,000 by FY43. The estimated annual assessment fees for the 20-year planning period from FY24 through FY43 total approximately \$28,000,000.

**Table No. 4-10**  
**Annual MWRA Assessment Fees and O&M Costs**

Item	FY24 Annual Costs
MWRA Annual Assessments <sup>1</sup>	\$950,000
Interconnections (2) O&M Costs	\$75,000
<b>Total</b>	<b>\$1,025,000</b>

<sup>1</sup>The MWRA assessment fees are scheduled to increase by 3.9-percent annually.

With the construction of two new interconnections, annual maintenance will be minimal for the interconnection infrastructure over the 20-year planning period. Annual direct O&M costs for the two interconnections may include electricity, building or vault repairs, improvements or replacements for the interior piping and appurtenances, pumping system repairs or replacements, flow meter calibrations or replacement, electrical and instrumentation repairs, and routine site maintenance. An annual O&M cost of \$75,000 was estimated for the two new interconnections as shown in Table No. 4-10. The current treatment operators on staff may be repositioned as distribution system operators, but the general number of operators will likely remain the same to properly operate and maintain the distribution system in accordance with MWRA requirements. The total annual costs associated with becoming a fully served MWRA community are estimated in FY24 at \$1,025,000, including the assessment fees and O&M costs. The annual costs associated with the MWRA connection may increase to greater than \$2,000,000 towards the end of the 20-year planning period based on the expected 3.9-percent annual increase in the assessment fees.

The annual costs presented do not include the potential surcharge the LWD may be required to pay to the donor community under an IMA. Based on other similar IMAs, a 5- to 10-percent surcharge can be assumed for planning purposes for the donor community surcharge for the water supply. The annual costs also do not include the annual MWRA entrance fee payments of approximately \$115,450 that would be required if the LWD elected to pay the MWRA entrance fee over a 25-year payment plan instead of the lump sum value of \$2,540,000 presented in Table No. 4-8 and Table No. 4-9.



# Section 5

## SECTION 5 – CONCLUSIONS

### 5.1 Alternative No. 1 – Utilizing Existing Sources with Improvements

Alternative No. 1 includes the continued use of the existing Flint’s Pond WTP and Tower Road Well Pump Station after the implementation of the improvements planned through FY23. Planned improvements include chemical feed upgrades at both the Flint’s Pond WTP and Tower Road Well Pump Station, new coagulant chemical feed system at the Flint’s Pond RWPS, and a replacement well and pump at the Tower Road Well site. The planned improvements at the Flint’s Pond WTP and Tower Road Well Pump Station will be constructed in the immediate future to help maintain compliance with drinking water regulations and guidelines or satisfy requirements of MassDEP ACOs or Sanitary Survey Deficiencies. These planned improvements were identified in Section 2 of this report. The capital costs associated with these improvements planned through FY23 are not included in this evaluation comparing the future water supply alternatives since these upgrades are already planned and will be necessary regardless of which alternative is selected by the LWD for its long-term water supply and treatment approach.

Continuing use of the existing sources with the scheduled improvements planned through FY23 may be the most cost-effective solution for the planning period as shown in Table No. 5-1 in Section 5.4, but it also comes with greater risk in terms of meeting treatment requirements and maintaining compliance with regulatory drinking water standards. The coagulant addition at the Flint’s Pond RWPS and subsequent TOC removal and reduction in TTHM formation is only one component of the overall strategy to optimize operations to maintain compliance with the MCL for TTHMs in the distribution system if Alternative No. 1 is selected. Clearwell water level at the WTP should remain low to minimize water stored in the clearwell after chlorine addition, the Bedford Road Storage Tank operational band should be set to allow the tank to maximize turnover and minimize water age in the tank and system, free chlorine residuals in the system should be monitored to avoid adding excess chlorine that can contribute to greater TTHM formation, and production from the Tower Road Well which contains low levels of TOC, and therefore lower TTHM formation, should be maximized to help offset any water produced at the WTP with higher levels of TTHMs.

The membrane filtration system requires a consistent level of maintenance to be most effective and maintain its integrity. If any maintenance is deferred, there is a potential for material and equipment failures that can result in water quality degradation and significant, additional maintenance costs not included in the costs presented in this report. If the LWD determines that Alternative No. 1 is the best long-term water supply and treatment approach, we recommend that a routine maintenance plan for both facilities is developed and diligently followed. Following a stringent maintenance plan will keep both sources and all facilities running efficiently and reduce the risk that either would suffer major, unexpected equipment failures. The LWD could choose to perform an above ground asset inventory to determine specific equipment or infrastructure most in need of maintenance

or replacement and develop a formal plan for capital costs and O&M costs to replace or improve the existing sources and infrastructure over the 20-year planning period.

## **5.2 Alternative No. 2 - New Flint's Pond Water Treatment Plant**

Alternative No. 2 includes the continued use of the two existing sources similar to Alternative No. 1, but with the design and construction of a new Flint's Pond WTP rated for 1.6 mgd with a more conventional treatment process, such as dissolved air flotation (DAF) clarification followed by dual media gravity filtration. A conventional surface water treatment facility is better suited for TOC removal from the source water drawn from Flint's Pond. In addition to the new Flint's Pond WTP, the continued use of the Tower Road Pump Station is included in Alternative No. 2 with the replacement well and chemical feed upgrades that are already planned for construction by the end of FY23.

The coagulant addition in Alternative No. 1 is not a fully resilient solution by itself that will ensure TTHM MCL compliance. The other operational settings and factors mentioned in Alternative No. 1 must continue to be optimized and closely monitored by the LWD to maintain compliance with drinking water regulations. A conventional WTP will provide more significant TOC removal and greater reductions in TTHM formation than the membrane filtration process with coagulant addition. With the construction of a new conventional WTP better suited for TOC removal, the optimization of treatment plant operations and the maximization of production from the Tower Road Well will be less important. The Flint's Pond WTP will be able to operate alone (without blending of water from the Tower Road Well) to produce finished water with low levels of TOC and TTHM formation that will not be at risk for violating the MCL for TTHMs.

The construction of a conventional WTP to replace the existing Flint's Pond WTP is a more conservative treatment approach to ensure long-term compliance with the TTHM MCL. A new WTP will provide a multi-barrier approach where multiple treatment processes within the same treatment facility can provide treatment of the target particulates, organics, or other contaminants. A new WTP will provide redundancy in situations where certain equipment may be out of service so that the full capacity of the WTP is always available. The treatment processes included in a new conventional WTP will also provide treatment for some emerging contaminants that may not be of concern based on the existing source water quality.

Prior to pursuing the design and construction of a new Flint's Pond WTP, we recommend some initial review with local and state agencies on the required permitting and filings that may be necessary. The permitting process can present a number of challenges with certain obstacles that may inhibit the project from progressing. A summary of the potential permitting requirements was presented in Section 3. The more critical and potentially restrictive permits can be reviewed with the appropriate agency to ensure the project is a viable alternative without constructability limitations before proceeding with any preliminary design or piloting work.

The construction of a new WTP would be a major capital cost for the LWD as shown in Table No. 5-1 in Section 5.4. There would be a considerable amount of lead time through the early design stages for the LWD to pursue and secure a long-term, low interest loan through the MassDEP's Drinking Water State Revolving Fund (DWSRF) process, but the investment is significant. After the new WTP is operational, the annual O&M costs are comparable to that of the existing WTP with the main increase in costs pertaining to the potential need for an additional operator at the new, more advanced WTP.

### **5.3 Alternative No. 3 - Massachusetts Water Resources Authority Connection**

Alternative No. 3 includes the construction and implementation of a connection to the MWRA to fully supply and meet the water demands of the Town, while eliminating the two existing local sources of water supply completely. To establish a permanent interconnection with MWRA or an MWRA served community and be fully supplied by MWRA, formal admission to the MWRA is required as governed by MWRA's Policy OP.10. Based on a review of Policy OP.10 and correspondences with the MWRA, MassDEP, and DCR, permitting and regulatory approval for a permanent interconnection to be a fully supplied water community is not likely since Lincoln has sustainable existing water sources with sufficient capacity and good water quality.

If the LWD pursued a formal admission to the MWRA to become a fully served MWRA community, all of Lincoln's water demand will be supplied by MWRA. The LWD's existing water sources would no longer be required. The existing Flint's Pond RWPS, Flint's Pond WTP, and Tower Road Well could be either decommissioned or repurposed. In addition, if Lincoln became a fully served MWRA community, the LWD would no longer be responsible for water treatment. A different organizational structure of current LWD personnel would need to be considered based on the modified needs for operating and maintaining the Lincoln water distribution system.

The formal MWRA admission process can take about two years to complete. Following admission into the MWRA community, the design and construction of the required infrastructure improvements will require additional time depending on the extent of the required improvements. The design of potential infrastructure improvements can be initiated during the formal admission process, but that presents a risk to the LWD in the event the Town's request to join the MWRA is not accepted.

A full system-wide hydraulic evaluation should be conducted if Lincoln pursues the option to become a fully served MWRA community. The study should evaluate the existing hydraulic gradelines in Lincoln and the potential donor community, the existing and projected demands of each system, and potential hydraulic limitations of surrounding communities based on their existing infrastructure. In addition, the LWD should coordinate with the surrounding MWRA communities to determine the feasibility of constructing interconnections and the willingness of each community to supply Lincoln with a sufficient volume of water. As part of the process of applying to become an MWRA community, Lincoln would need to obtain support from the transporting/donor community and execute an Intermunicipal Agreement with that community.

The Interbasin Transfer Act requires “that all reasonable efforts have been made to identify and develop all viable sources in the receiving area of the proposed interbasin transfer (MGL Ch. 21 Section 8D(1)).” Receiving communities must demonstrate that all existing sources have been exhausted and are not viable to meet the water demands of the community now or in the future. Receiving communities also have to demonstrate that a new source evaluation has been completed and showed that no viable alternatives for a new source within its own basin could provide a greater capacity or better water quality than the existing sources.

During its review of any proposed interbasin transfer, the DCR’s WRC considers the quality and quantity of the source when evaluating its viability. In Lincoln’s case, although the existing Flint’s Pond and Tower Road Well require upgraded infrastructure and treatment procedures, the sources are considered viable long-term sources. The existing sources do not experience significant contamination issues outside of the seasonal high levels of organic matter in Flint’s Pond which can be expected from any surface water supply. The authorized withdrawals from the sources under the MassDEP’s WMA Permit and the safe yields of the sources are sufficient for supplying Lincoln’s average day and maximum day demands.

The WRC also requires the receiving community to demonstrate that all practical measures to conserve water have been taken and the WRC water conservation performance standards are met. Lincoln’s residential gallons per capita day have been consistently below the 65 gpcd standard in recent years. In 2017 and 2018, Lincoln’s UAW was close to 25-percent based on the ASRs. In 2019, the UAW dropped to 10.2-percent. Lincoln would need to demonstrate a consistent value for UAW at or less than the standard 10-percent for three years in a row to support its need for an alternate water supply.

Based on correspondences with State agencies, it is unlikely that the LWD would be granted approval for an interbasin transfer of water. The LWD’s existing sources can meet and exceed the current and future water demands of the Town. A change in LWD’s existing circumstances would likely have to occur for the DCR’s WRC to consider approving an interbasin transfer of water. The DCR has previously considered major financial hardships as a factor when approving a community’s interbasin transfer request, especially if the cost of designing and constructing a new WTP is outside of the financial ability of the Town. However, the DCR has never granted approval for an interbasin transfer based solely on financial reasons.

In addition to the permitting and regulatory approval hurdle that the LWD would face in its attempt to join the MWRA, there would be major capital costs for two new interconnections with a surrounding donor community that is already served by the MWRA and water main improvements in Lincoln and the donor community. In addition, a significant Entrance Fee would be required for the LWD to formally join the MWRA based on its expected water usage. Annual costs will include the assessment fees for actual water purchased by Lincoln based on the MWRA water rates, potential additional charges the donor community may apply for use of its system to transport water to Lincoln, and the

O&M costs associated with the two new interconnections. The costs associated with the MWRA Alternative No. 3 are shown in Table No. 5-1.

#### 5.4 Cost Comparison of Alternatives

The necessary improvements required to operate and maintain existing sources in Alternative No. 1 during the planning period were reviewed and summarized in this evaluation as well as the new infrastructure construction and operations and maintenance requirements associated with the implementation of the new source and/or treatment alternatives included in Alternative No. 2 and Alternative No. 3. Each long-term water supply and treatment approach presents its own advantages and challenges for the LWD as reviewed in this report. A major consideration in the LWD’s decision moving forward will be the capital and O&M costs associated with each alternative. Table No. 5-1 summarizes the capital and annual O&M costs for each of the three alternatives.

**Table No. 5-1  
Summary of Planning Period Capital and Annual Costs**

Supply Alternative	Estimated Capital Costs	Estimated Annual Direct Costs
Alternative No. 1 – Utilize Existing Sources with Improvements	\$3,620,000	\$348,000
Alternative No. 2 – New Flint’s Pond WTP and Raw Water Main Extension	\$17,350,000	\$478,000
Alternative No. 2A – New Flint’s Pond WTP, Intake, and RWPS	\$20,600,000	\$478,000
Alternative No. 3 – MWRA Connection with Donor Community	\$8,000,000	\$1,025,000 <sup>1</sup>

<sup>1</sup>The annual direct costs for Alternative No. 3 are based on the projected MWRA assessment fee for water usage in FY24. The MWRA assessment fee is scheduled to increase at an annual rate of 3.9-percent which would increase the annual direct costs for Alternative No. 3 to greater than \$2,000,000 by FY43.

The capital costs presented for Alternative No. 1 include the major capital improvements that will be required during the 20-year planning period at the existing Flint’s Pond RWPS and WTP. The capital costs presented for Alternative No. 2 include the costs associated with the design and construction of a new DAF WTP and an extension of the raw water pipeline to the new WTP. In Alternative No. 2A, the capital costs include the construction of a new intake and RWPS to supply water to the new DAF WTP in lieu of extending the raw water pipeline. In Alternative No. 3 for the MWRA connection, the capital costs include the one-time Entrance Fee paid directly to the MWRA, the engineering and permitting costs associated with the MWRA application and admission process, and the construction costs associated with two booster pump station interconnections and water main improvements with the Town of Weston. The necessary water main improvements within Lincoln and Weston to support the transfer of water at each interconnection would have to be determined through a hydraulic evaluation, but estimates have been prepared

based on the previous *Weston Interconnection Evaluation* completed in 2013 for the LWD. If interconnections are constructed with the Town of Lexington or Town of Waltham instead of Weston, the necessary capital improvements will differ and costs may vary, but the capital costs presented in Table No. 5-1 represent a budgetary estimate for the initial costs associated with becoming a fully served MWRA community.

The annual direct costs for Alternative No. 1 represent the direct O&M costs associated with operating the existing Flint's Pond WTP and RWPS and the Tower Road Well Pump Station. Similarly, the annual direct costs for Alternative No. 2 represent the direct O&M costs associated with operating the new Flint's Pond WTP and RWPS and the existing Tower Road Well Pump Station. Alternative No. 3 includes the direct O&M costs associated with operating the two new interconnections and the annual assessment fee for the purchase of MWRA water based on an estimated water usage of 0.53 mgd and projected MWRA water rates. The annual assessment fee included in Alternative No. 3 is based on the projected FY24 water rates for the MWRA. Based on the 3.9-percent annual increase in assessment fees adopted by the MWRA, the annual costs associated with the MWRA connection may increase to greater than \$2,000,000 towards the end of the 20-year planning period.

The annual costs for all alternatives represent the direct costs associated with operating the supply and treatment facilities, and in the case of the MWRA alternative, the direct costs also include the annual assessment fee for purchasing the water. The annual costs presented in Table No. 5-1 do not include all other expenses included in the annual LWD operations budget that would continue to be funded regardless of the future supply and treatment alternative approach. The projected FY22 operations budget for the LWD is \$1,870,000 meaning approximately \$1,522,000 in annual indirect operating expenses would be required regardless of the alternative selected. The annual direct costs listed in Table No. 5-1 are presented only to show the difference in direct annual costs between the three alternatives, but do not represent the total annual operations budget that would need to be funded by the LWD. The indirect operating expenses would need to be added to the values shown in Table No. 5-1 to understand the total expected annual operating expenses of the LWD.



# Appendix A

## APPENDIX A

The capital construction costs included in the report are escalated costs based on the projected fiscal year (FY) in which each cost was estimated to be incurred. The fiscal year for each escalated cost is included in the report. Table No. 4-1 in the report shows the projected fiscal year for each of the capital improvements in Alternative No. 1. For the capital costs included in Table No. 4-4 and Table No. 4-5 for Alternative No. 2, the costs were projected to be incurred in FY26. For the capital costs associated with Alternative No. 3 in Table No. 4-7, Table No. 4-8, and Table No. 4-9, the costs were projected to be incurred in FY24.

The current FY21 baseline (non-escalated) cost estimates for the same tables from Section 4 of the report are included in this Appendix A for use by the LWD for future planning purposes. The tables included in Appendix A are numbered in conjunction with the same numbering system used in Section 4 of the report, including an “A” at the end of the table number. For example, Table No. 4-1A shows the baseline FY21 estimated replacement costs for the same capital improvements shown in Table No. 4-1 in the report. In addition to the baseline FY21 cost estimate, the projected useful life of the equipment included in each capital improvement is included for planning purposes.

### Alternative No. 1 (FY21 Costs)

**Table No. 4-1A  
Capital Costs Utilizing Existing Sources**

Capital Improvement	FY21 Estimated Replacement Cost	Useful Life (Years)
Raw Water Pumps (2), Motors, and VFDs	\$270,000	20
PLC Replacements and SCADA Upgrades	\$400,000*	15-20
Membrane Module Replacement (240 Modules)	\$320,000	7
Finished Water Pumps (2), Motors, and VFDs	\$400,000	15
General Process Equipment and Instrument Upgrades	\$380,000	15-20
Electrical Equipment and System Upgrades	\$325,000	30

\*The SCADA Upgrades cost in the report were escalated at 1.25% instead of 2.5% based on typical costs from T&H and R.E. Erickson.

### Alternative No. 2 (FY21 Costs)

**Table No. 4-4A  
Capital Costs for New DAF WTP and Raw Water Main Extension**

Capital Improvement	FY21 Estimated Replacement Cost	Useful Life (Years)
Two Season Pilot Study	\$275,000*	
New DAF Water Treatment Plant	\$14,140,000	Various (10-100)
12-Inch DI Raw Water Main Extension (2,000 LF)	\$620,000	100
Raw Water Pumps (2), Motors, and VFDs	\$310,000	20

\*Pilot study costs in report were escalated at 1.25% instead of 2.5% based on typical costs from T&H.

**Table No. 4-5A  
Capital Costs for New DAF WTP, Intake, and RWPS**

<b>Capital Improvement</b>	<b>FY21 Estimated Replacement Cost</b>	<b>Useful Life (Years)</b>
Two Season Pilot Study	\$275,000*	
New DAF Water Treatment Plant	\$14,140,000	Various (10-100)
New Intake and RWPS	\$3,850,000	Various (10-100)

\*Pilot study costs in report were escalated at 1.25% instead of 2.5% based on typical costs from T&H.

**Alternative No. 3 (FY21 Costs)**

**Table No. 4-7A  
Weston Booster Pump Stations and Water Main Improvements Cost Estimate**

<b>Capital Improvement</b>	<b>FY21 Estimated Replacement Cost</b>	<b>Useful Life (Years)</b>
Weston Road Interconnection		
Booster Pump Station	\$905,000	Various (20-100)
New 12-inch DI Water Main (5,800 LF)	\$1,810,000	100
New 8-inch DI Water Main (700 LF)	\$185,000	100
Route 117 Interconnection		
Booster Pump Station	\$905,000	Various (20-100)
New 12-inch DI Water Main (1,800 LF)	\$565,000	100

**Table No. 4-8A  
Summary of Capital Costs for MWRA Connection with Weston**

<b>Capital Improvement</b>	<b>FY21 Estimated Replacement Cost</b>	<b>Useful Life (Years)</b>
Weston Road Interconnection	\$2,900,000	Various (20-100)
Route 117 Interconnection	\$1,470,000	Various (20-100)
MWRA Entrance Fee	\$2,360,000	
Engineering and Permitting for MWRA Admission	\$725,000*	

\*Engineering and Permitting costs in report were escalated at 1.25% instead of 2.5% based on typical costs from T&H.

**Table No. 4-9A  
Summary of Capital Costs for MWRA Connection with Lexington or Waltham**

<b>Capital Improvement</b>	<b>FY21 Estimated Replacement Cost</b>	<b>Useful Life (Years)</b>
Two PRV Vault Interconnections	\$1,530,000	Various (20-100)
Water Main Upgrades	\$2,560,000	100
MWRA Entrance Fee	\$2,360,000	
Engineering and Permitting for MWRA Admission	\$725,000*	

\*Engineering and Permitting costs in report were escalated at 1.25% instead of 2.5% based on typical costs from T&H.



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