



## MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities

Prepared For:

**Massachusetts Water  
Resources Authority**

September 2025



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**APPENDICES**

Appendix A	MWRA’s Steps for Admission of New Communities to the MWRA Water System
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## List of Acronyms and Abbreviations

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ACOE	Army Corps of Engineers
ACS	American Communicate Survey
ADD	Average Day Demand
ASR	Annual Statistical Report
Authority	Massachusetts Water Resources Authority
BCB	Boston City Base
BLSF	Bordering Land Subject to Flooding
BUAR	Board of Underwater Archeological Resources
BVW	Bordering Vegetated Wetlands
CCR	Consumer Confidence Report
CDS	Congressionally Directed Spending
CGP	Construction General Permit
CL DI	Cement Lined Ductile Iron
COM PWS	Community Public Water System
CMP	Conservation and Management Permit
CP	Control Panel
CPF	Community Project Funding
CVA	Chicopee Valley Aqueduct
DCR	Department of Conservation and Recreation
DRGP	Dewatering and Remediation General Permit
DS	Distribution System
DWSP	Drinking Water Supply Protection
DWSRF	Drinking Water State Revolving Fund
EEA	Executive Office of Energy and Environmental Affairs
EIR	Environmental Impact Report
ENF	Environmental Notification Form
EPA	Environmental Protection Agency
fps	Feet per Second
GP	General Permit
GPD	Gallons per Day
gpm	Gallons per Minute
HGL	Hydraulic Grade Line
hp	Horsepower
ISO	Insurance Service Organization
ITA	Interbasin Transfer Act
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MAWPA	Massachusetts Wetlands Protection Act
MHC	Massachusetts Historical Commission

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MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MDD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
MWRA	Massachusetts Water Resources Authority
NAVD88	North American Vertical Datum of 1988
NC	Non-community Water System
NFF	Needed Fire Flow
NFPA	National Fire Protection Association
NHESP	National Heritage and Endangered Species Program
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NTNC	Non-transient Non-Community Water System
OHW	Ordinary High Water
OOC	Order of Conditions
OPCC	Opinion of Probable Construction Cost
ORW	Outstanding Resource Water
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PNF	Project Notification Form
PPG	Pre-Development Planning Grant
PRV	Pressure Reducing Valve
PS	Pump Station
psi	Pounds per Square Inch
PWS	Public Water System
QA	Quabbin Aqueduct
QR	Quabbin Reservoir
RDA	Request for Determination of Applicability
SA	Service Area
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SEARCH	Special Evaluation Assistance for Rural Communities and Households
SWSC	Springfield Water & Sewer Commission
SWPPP	Stormwater Pollution Prevention Plan
SWTR	Surface Water Treatment Rule
TDH	Total Dynamic Head
THPO	Tribal Historic Preservation Officers
TM	Transmission Main
TNC	Transient Non-Community
USDA	United States Department of Agriculture

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USGS	United States Geological Survey
VFD	Variable Frequency Drive
WIFIA	Water Infrastructure Finance and Innovation Act
WMA	Water Management Act
WOTUS	Waters of the United States
WQC	Water Quality Certification
WRC	Water Resources Commission
WST	Water Storage Tank
WTF	Water Treatment Facility
WTP	Water Treatment Plant

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**Tighe&Bond**

**SECTION 1**

# Section 1

## Project Background

Tighe & Bond and Hazen and Sawyer (Hazen) prepared this MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities Report for the Massachusetts Water Resources Authority (MWRA, the Authority) as part of MWRA Contract No. 7973. The Authority requested the completion of this study to better understand the infrastructure needed to expand its system to include the Quabbin Reservoir Watershed communities. This study is one of four expansion studies recently undertaken by the Authority. The past studies looked at the expansion of the following areas:

- MetroWest Communities
- Ipswich River Basin Communities
- South Shore Communities

This expansion study quantifies the Authority's existing system capacity available to serve new customers, identify the critical infrastructure needed to add capacity and deliver that available capacity to new communities, and/or to provide new water supply alternatives such as surface water intake and treatment or groundwater supply. Planning level cost estimates are provided for the conceptual project alternatives.

The study provides potential options that could be explored further with any community interested in joining the MWRA water system or exploring alternative groundwater supplies for their community. Additional evaluations will be required if any community is interested in pursuing any of the options included in this report, or other options that involve developing new sources in the Quabbin watershed.

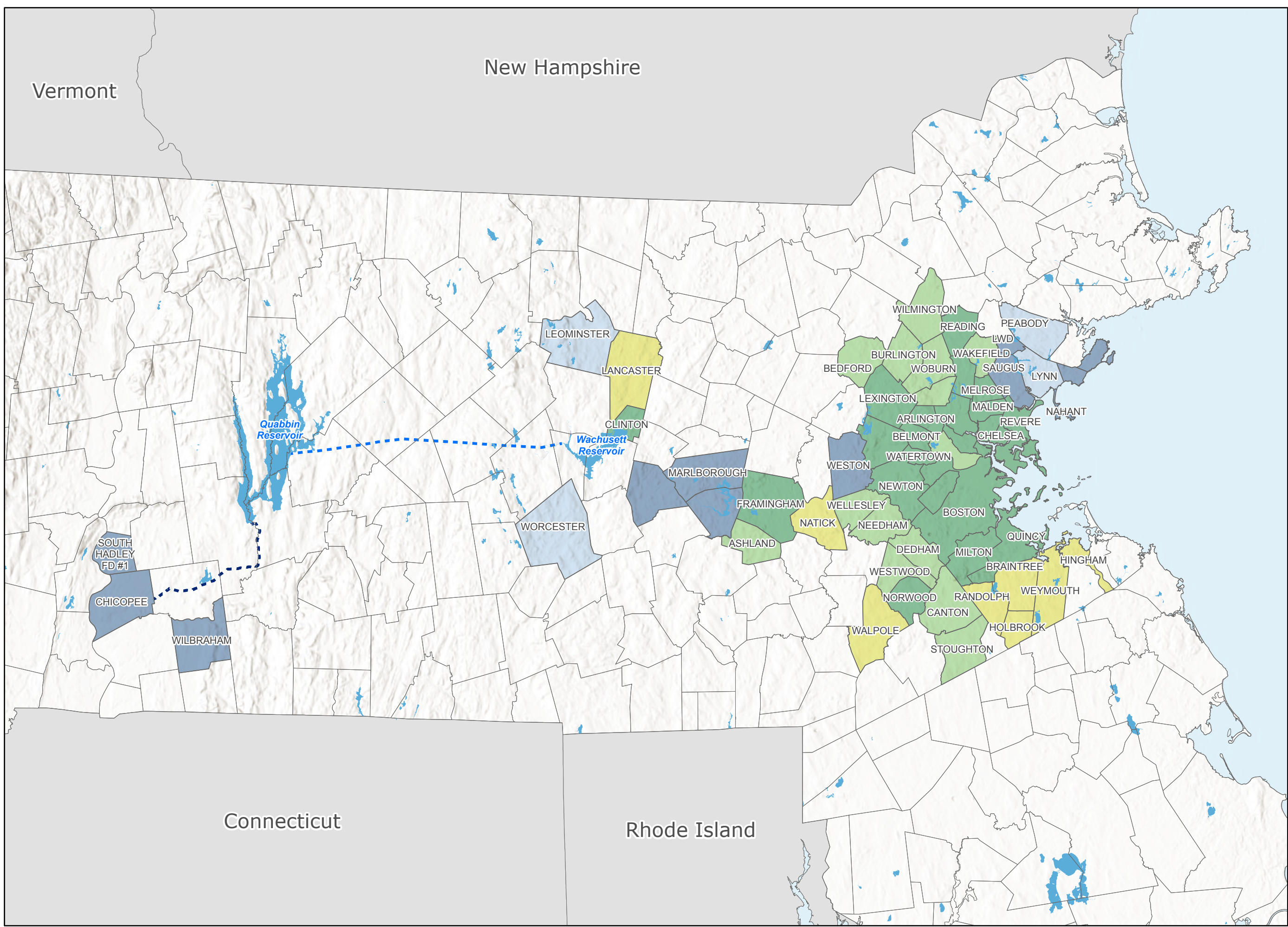
### 1.1 Purpose of Study and Project Objectives

The Authority supplies water to 53 communities throughout Massachusetts as shown on Figure 1-1. The purpose of this study was to evaluate the feasibility of expanding water supply to 12 communities within and near the Quabbin Reservoir Watershed. These communities surround the Quabbin Reservoir, which is one of the largest unfiltered water supplies in the United States. The Authority's water comes from the Quabbin Reservoir along with the Wachusett Reservoir and the Ware River Watershed.

The Quabbin Reservoir Watershed communities being evaluated consist of:

- Barre
- Belchertown
- Hardwick
- Ludlow
- New Salem
- Orange
- Pelham
- Petersham
- Phillipston
- Shutesbury
- Ware
- Wendell

Figure 1-2 shows the location of these communities as well as prior expansion study communities.



**Figure 1-1  
MWRA Service Area**

**LEGEND**

- - - Quabbin Aqueduct
- - - Chicopee Valley Aqueduct
- Public Water Supply Reservoir
- Town Boundary

**Existing MWRA Community**

Service Type

- Water & Sewer
- Full Sewer - Partial/Emergency Water Only
- Water Only
- Partial/Emergency Water Only
- Sewer Only

0 4 8  
Miles

1:506,880  
1 inch equals 8 miles

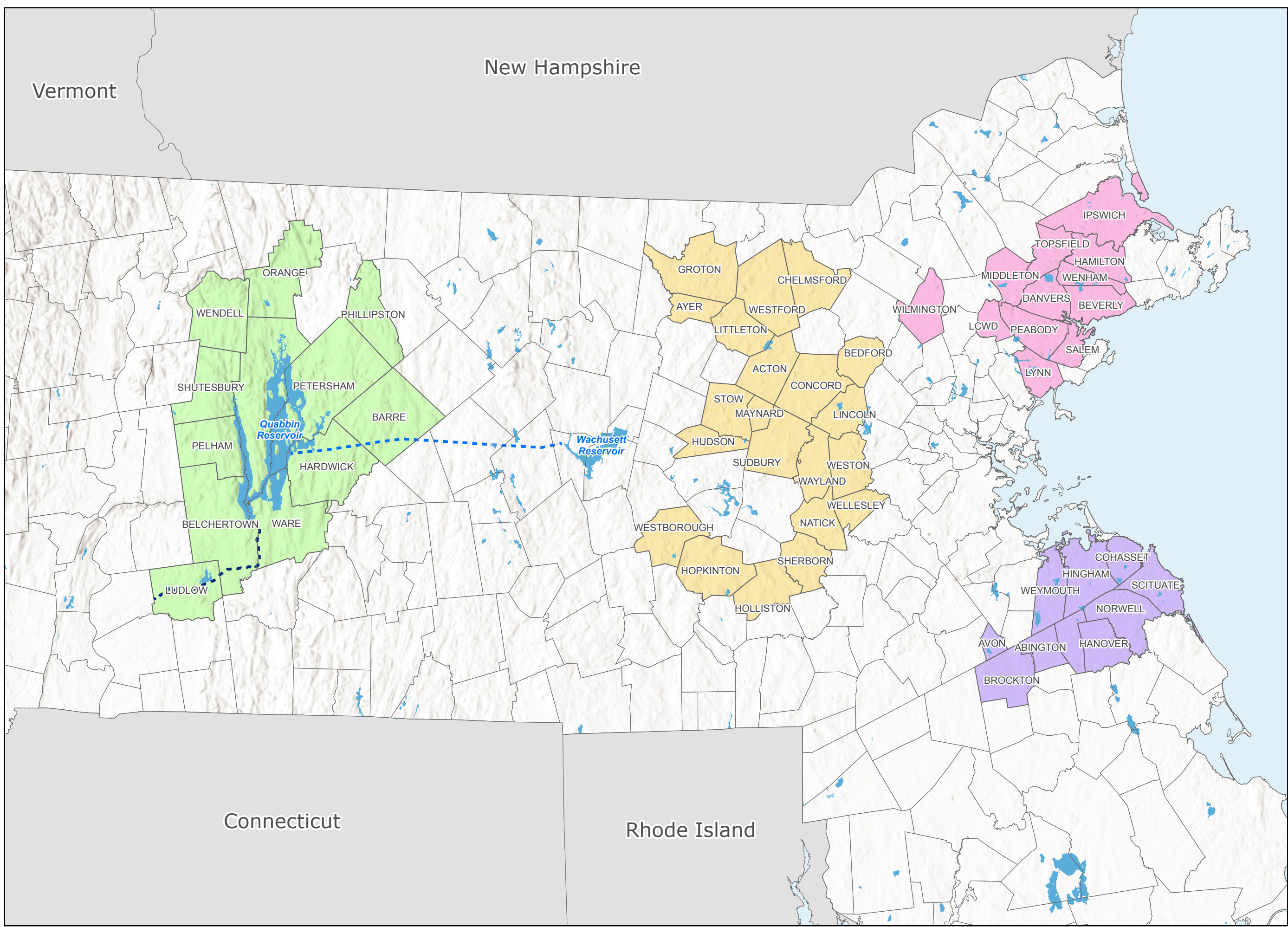
**NOTES**

1. Town Boundaries were downloaded from MassGIS
2. MWRA Communities were taken from MWRA Service Area Map (MWRA.com)

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

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**Figure 1-2  
MWRA Expansion  
Study Communities**

**LEGEND**

- - - Quabbin Aqueduct
- - - Chicopee Valley Aqueduct
- 2024 Quabbin Expansion Study Community
- Public Water Supply Reservoir
- Town Boundary

**Prior Expansion Study Community**

- Ipswich
- Metro West
- South Shore

0 4 8  
Miles

1:506,880  
1 inch equals 8 miles

**NOTES**  
Town Boundaries were provided by MassGIS

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**  
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There is a potential opportunity to provide a new water supply source to one or more Quabbin Reservoir Watershed communities through transmission mains, new intakes, and/or groundwater sources. One of the main drivers for some communities to join the Authority's system is the presence of Per- and polyfluoroalkyl substances (PFAS) as more communities must meet Massachusetts Department of Environmental Protection (MassDEP) maximum contaminant level (MCL) for PFAS, as well as the new, more stringent federal drinking water MCL for PFAS. Additional challenges include well capacity limitations, water demands, and other water quality issues. Furthermore, some of the communities within the Quabbin Reservoir Watershed do not have an existing community (COM) public water system (PWS). Extending the Authority's system would increase these communities' access to a clean and dependable water supply.

This study provides the communities within the Quabbin Reservoir Watershed with potential options to consider connecting to the Authority's water system or identifying a new groundwater supply in the Quabbin watershed. Specifically, the evaluation aims to:

- Quantify the Authority's existing system and reservoir capacity available to serve new customers within the Quabbin Reservoir Watershed.
- Identify the critical infrastructure needed to add capacity and deliver water to new communities and/or provide new water supply alternatives such as surface water intake and treatment or groundwater supply.
- Provide planning-level cost estimates for the alternatives.
- Identify additional items such as permitting that would need further study if any of the communities chose to proceed with any of the potential expansion projects.

The proposed critical infrastructure presented in this study is conceptual and is meant to serve as a starting point for interested communities to discuss the potential for future Authority connections or developing new groundwater sources in the Quabbin watershed. Further evaluations will be necessary if any community is interested in joining the Authority.

## 1.2 Methodology of Study Approach

The identification of infrastructure needs and associated costs to extend the Authority's service area to provide water to the Quabbin Reservoir Watershed communities included in this study proceeded in a stepwise manner as summarized below. Study area communities contributed to the gathering of information.

- **Step 1 – Review Information:** A data request was prepared to collect information from the study communities. The data received from the communities were reviewed along with the previous expansion studies recently undertaken by the Authority.
- **Step 2 – Analyze Water Demand and Asset Data Collected for Each of the Quabbin Reservoir Watershed Communities:** The water demand and system asset data were analyzed for each of the communities. The findings were summarized and included hydraulic gradient, local infrastructure, water quality, and concerns that needed to be addressed to supply these communities. Potential service areas were developed for communities without COM PWSs. This step evaluated how the communities could be physically supplied with public water.

- **Step 3 – Determine if there is Excess Capacity in Existing MWRA Quabbin Reservoir Facilities:** The capacity of the Brutsch Water Treatment Facility (WTF) and the Chicopee Valley Aqueduct (CVA) were identified based on MWRA records. Potential supply from the Quabbin Aqueduct was also evaluated. It was assumed that the existing service area for communities with a COM PWS and the potential service area for communities without a COM PWS would be fully supplied should they connect to the Authority’s system. The results of these analyses helped guide the identification and recommendation of infrastructure improvements to achieve the desired expansion objectives.
- **Step 4 – Identify and Evaluate Potential MWRA System Modifications:** Recognizing that water demands of the expansion area communities may be greater than the existing MWRA system can supply, or that the geographical extent of the study area is well outside the limits of existing infrastructure, potential MWRA system modifications, such as new transmission mains, new intake facilities, surface water treatment facilities and groundwater supply alternatives were identified and evaluated. Pipe sizing calculations for new infrastructure required to transport water and sizing of new intake(s), storage, pumping and treatment facilities were included as part of this analysis for five conceptual expansion projects selected from the potential surface water intake and groundwater supply alternatives.
- **Step 5 – Estimate Capital Costs and Grant Funding Sources:** For the five conceptual expansion projects, order of magnitude capital costs were developed. Potential sources of grant funds were identified.
- **Step 6 – Identify Implementation Considerations:** Implementation considerations were identified including potential required permits, new source approvals, the MWRA application process, and potential water quality concerns with changing water supply sources. This study assumed that the potential MWRA supply to each community would be the primary source for the study communities. As such, blending from different sources is not considered in this study. However, because a complete transition to MWRA water from the Quabbin Reservoir or to new groundwater wells is under consideration for the communities involved, any change in water sources and quality may introduce water quality challenges, which would need to be thoroughly assessed in future analyses.

Based on the development and execution of the approach methodology described above, key assumptions and study limitations are summarized as follows.

- For communities without existing COM PWSs within the study area, the extent of potential service areas typically consisted of the Town Centers. Potential demands were estimated using typical planning standards and a tally of service types within the potential service area based on available GIS data. Specific development projects identified by the communities or the Authority to be supplied by a new service area were included as applicable.
- For communities with COM PWSs, it was assumed there would be no expansion beyond the current service area unless a community or the Authority provided information on specific developments that would require public water supply.
- Analysis of population projections and future buildout to undeveloped parcels was not conducted.
- Capacity evaluations of the existing CVA and the Brutsch WTF were conducted by MWRA based on the use of hydraulic models and existing water supply for the three

CVA communities. Available information on the safe yield of the Quabbin Reservoir was used to help determine the additional water supply that can be withdrawn from the Quabbin Reservoir without adverse impacts on existing withdrawals.

- It was assumed that the service area for communities without COM PWSs would be developed based on a conceptual analysis using elevation contours and hydraulic grade. Appropriate hydraulic grade lines (HGLs) were based on potential service elevations for the new service areas that would connect to the Authority. For communities that have COM PWSs, HGLs at the connection points between the Authority's infrastructure and each community were compared.

**Tighe&Bond**

**SECTION 2**

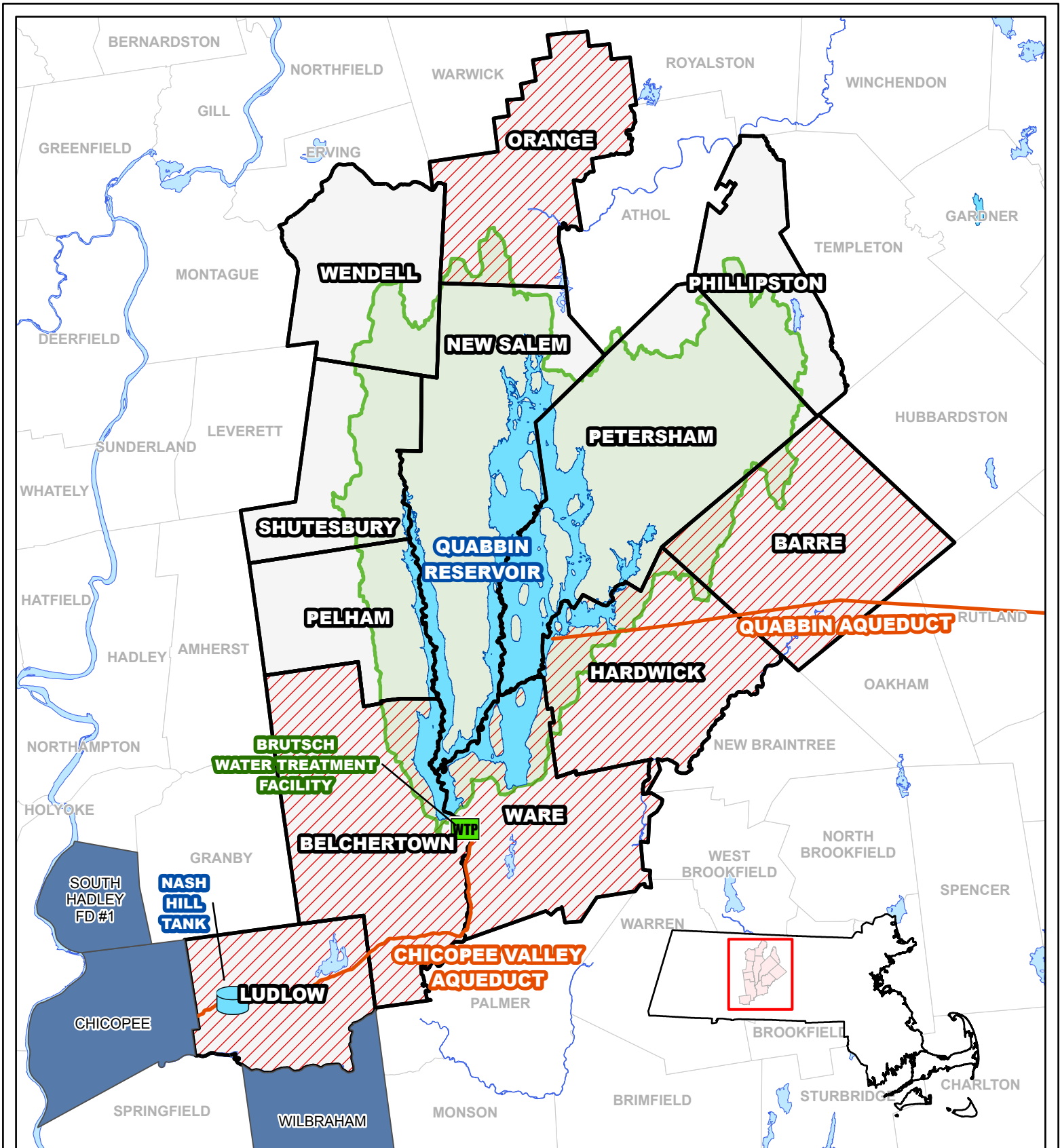
## Section 2 Overview of Quabbin Watershed Study Communities

This study is comprised of communities within and near the Quabbin Reservoir Watershed, which are shown on Figure 2-1. The status of the water supply for each community included in this study is summarized in Table 2-1. As shown, six communities have existing Community Public Water Systems (COM PWSs). The remaining six do not have existing COM PWSs, although some do have Non-Transient Non-Community Water Systems (NTNCs) and Transient Non-Community Water Systems (TNCs), which are public water systems. Community residents may also be served by private wells, which typically provide water to single family homes and are regulated by local boards of health or health departments.

**TABLE 2-1**  
Current Water Supply Status of Study Communities

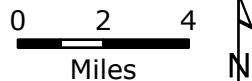
Community	Proximity to MWRA System <sup>1</sup>	System Status <sup>2</sup>	Supply Source <sup>2</sup>
Barre	Adjacent to QA	Existing COM PWS	COM PWS and NON-COM PWS wells
Belchertown	Adjacent to CVA, QR	Existing COM PWS	COM PWS and NON-COM PWS wells
Hardwick	Adjacent to QA, QR	Existing COM PWS	COM PWS and NON-COM PWS wells
Ludlow	Adjacent to CVA	Existing COM PWS <sup>3</sup>	SWSC, MWRA <sup>3</sup> and NON-COM PWS wells
New Salem	Adjacent to QR	No Existing COM PWS	NON-COM PWS wells
Orange	Not adjacent	Existing COM PWS	COM PWS and NON-COM PWS wells
Pelham	Adjacent to QR	No Existing COM PWS <sup>4</sup>	Amherst PWS <sup>4</sup> and NON-COM PWS wells
Petersham	Adjacent to QR	No Existing COM PWS	NON-COM PWS wells
Phillipston	Not adjacent	No Existing COM PWS	NON-COM PWS wells
Shutesbury	Adjacent to QR	No Existing COM PWS	NON-COM PWS wells
Ware	Adjacent to CVA, QR	Existing COM PWS	COM PWS and NON-COM PWS wells
Wendell	Not adjacent	No Existing COM PWS	NON-COM PWS wells

1. CVA: Chicopee Valley Aqueduct, QA: Quabbin Aqueduct, QR: Quabbin Reservoir  
A "Not Adjacent" community has no MWRA facilities nearby. An "Adjacent" community has existing MWRA facilities within the town, as noted.
2. COM PWS serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents; NON-COM public water system wells include NTNC wells and TNC wells.
3. SWSC supplies a significant portion of Ludlow, which is a COM PWS. A small number of customers in Ludlow are supplied by the Wilbraham Water System, which is an MWRA Member Community and COM PWS.
4. A small portion of Pelham is supplied by the Amherst Water System, which is a COM PWS.



**Legend**

- WTP Water Treatment Facility
- Water Storage Tank
- Aqueduct
- Quabbin Reservoir Watershed
- Municipality in Expansion Study
- Municipality in Expansion Study with Public Water System
- Existing MWRA Community
- Other Municipality



**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 2-1  
 Quabbin Reservoir Watershed Communities  
 September 2025

## **2.1 Review of Existing Information**

To determine potential expansion alternatives for the Quabbin Reservoir Watershed communities, information for MWRA's facilities in the area was reviewed as described in Section 2.1.1. Furthermore, information was requested from the Quabbin Reservoir Watershed communities and also obtained through publicly available documents. The data provided from the communities is summarized in Section 2.1.2.

### **2.1.1 MWRA Facilities Review**

To help quantify the available capacity of the MWRA's nearby resources for potential expansion projects, the MWRA provided the following data:

- Quabbin Reservoir bathymetry data
- Quabbin Reservoir water quality data
- Quabbin system GIS data including aqueduct and facility locations
- Brutsch Water Treatment Facility daily average flow data
- Chicopee Valley Aqueduct hydraulics
- Chicopee Valley Aqueduct and Nash Hill Tank summary data
- Quabbin Reservoir elevations for drought stages
- Quabbin Aqueduct cover depth along the alignment where it intersects with the communities of Hardwick and Barre

The approximate locations of the Chicopee Valley Aqueduct, Quabbin Aqueduct, Quabbin Reservoir, Brutsch Water Treatment facility and Nash Hill Tank are shown on Figure 2-1.

### **2.1.2 Community- and PWS-Specific Information**

To understand the existing facilities within the communities, the following data was requested by MWRA for communities with existing COM PWSs:

- Water distribution system studies or master plans
- Town-wide master planning documents
- Water system GIS data or permission to use water system GIS data
- Water Management Act Permit(s)
- Water distribution maps
- Typical hydraulic grade line elevations in the water distribution system
- Water quality data
- 2022 and 2023 Annual Statistical Reports (ASRs)
- Latest sanitary surveys
- Existing water sources and capacities
- Available withdrawal capacity from Springfield Water & Sewer (Ludlow only)
- Municipal Vulnerability Preparedness (MVP) Program report and/or Hazard Mitigation Plan
- Source Water Assessment and Protection (SWAP) Report
- Consumer Confidence Report (CCR)

For communities without existing COM PWSs, MWRA requested the following data:

- Town-wide master planning documents
- Buildings or facilities served by public groundwater wells
- Water quality data for wells including for Town-owned buildings and general information on water quality issues in private wells, if known.
- 2022 and 2023 ASRs for small public wells
- Latest sanitary surveys for small public wells
- MVP report and/or Hazard Mitigation Plan
- SWAP Report for small public wells

The data collected for the communities was used to summarize the hydraulic gradient, local infrastructure, water quality, and potential concerns that would need to be addressed to supply these communities. Table 2-2 summarizes the data obtained from the communities or through publicly available documents for the existing PWSs (COMs, TNCs, and NTNCs).

In addition to data requests from the MWRA, a virtual meeting was held on April 12, 2024 with the communities, MWRA, Tighe & Bond and Hazen to provide an overview of the project and discuss the data request.

**TABLE 2-2**  
Summary of Data Obtained for Quabbin Reservoir Watershed Public Water Systems

<b>Quabbin Reservoir Watershed Communities</b>	<b>Town Master Planning Documents</b>	<b>Water System GIS Data<sup>1</sup></b>	<b>Hydraulic Grade Line Elevations</b>	<b>Water Quality Data<sup>2</sup></b>	<b>Annual Statistical Reports</b>	<b>Sanitary Surveys<sup>4</sup></b>	<b>Consumer Confidence Report (for COM PWSs)</b>
Barre	Yes	Yes	No	Yes	Yes	Yes	Yes
Belchertown	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hardwick	Yes	Yes	No	Yes	Yes	Yes	Yes
Ludlow	Yes	Yes	No	Yes	Yes	Yes	Yes
New Salem	Yes	Yes	Not Available	Yes	Yes	Yes	Not Applicable
Orange	Yes	Yes	No	Yes	Yes	Yes	Yes
Pelham	Yes	Yes	Not Available	Yes	Yes	Yes	Yes <sup>3</sup>
Petersham	Yes	Yes	Not Available	Yes	Yes	Yes	Not Applicable
Phillipston	Yes	Yes	Not Available	Yes	Yes	Not Available	Not Applicable
Shutesbury	Yes	Yes	Not Available	Yes	Yes	Yes	Not Applicable

**TABLE 2-2**  
Summary of Data Obtained for Quabbin Reservoir Watershed Public Water Systems

<b>Quabbin Reservoir Watershed Communities</b>	<b>Town Master Planning Documents</b>	<b>Water System GIS Data<sup>1</sup></b>	<b>Hydraulic Grade Line Elevations</b>	<b>Water Quality Data<sup>2</sup></b>	<b>Annual Statistical Reports</b>	<b>Sanitary Surveys<sup>4</sup></b>	<b>Consumer Confidence Report (for COM PWSs)</b>
Ware	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wendell	Yes	Yes	Not Available	Yes	Yes	Yes	Not Applicable

1. Limited water system GIS data is available for some communities including community and non-community public water supply sources.
2. Water quality data reviewed from MassDEP Water Quality Reports, and/or Energy and Environmental Affairs (EEA) Data Portal, and/or Consumer Confidence Reports (see Table 2-4).
3. The Consumer Confidence Report for Pelham is for the Amherst Water System (a small portion of Pelham is supplied by the Amherst Water System).
4. Sanitary Surveys were collected for all PWSs within a community.

## 2.2 Local Infrastructure

Local infrastructure for each of the communities with an existing COM PWS are further described in this section including information on available water sources, Water Storage Tanks (WSTs), and booster pump stations (if any). For additional information on population and customers served by each COM PWS, refer to Table 3-4 under Section 3.1.

### 2.2.1 Barre

The Barre Water Department is a COM PWS located in the Town of Barre, Massachusetts. The Barre Water Department obtains its water from three gravel packed wells: Well 2021000-01G (Well 01G) located on South Barre Road, Well 2021000-02G (Well 02G) also located on South Barre Road, and Well 2021000-03G (Well 03G) located off of Vernon Avenue. Both Wells 01G and 02G, with the 0.5 million-gallon (MG) Sanderson Road WST, provide water to the high-pressure zone, which is primarily in the northern section of Town. Well 03G and the 0.3 MG Root Road WST provide water to the low-pressure service zone which comprises the southern section of Town. Barre has two booster pumps used to pump water to the Insight Meditation Society and the high-pressure zone. Barre has one pressure reducing valve (PRV). The Allen Hill (Barre Town) Reservoir (01S) is a small, man-made reservoir available as an emergency source only and is currently deemed inactive.

#### *Sources*

- Well 01G
  - 24-inch diameter gravel packed well that was drilled in 1960 with an approved pumping volume of 0.38 MGD (which is a combined rate with Well 02G).
- Well 02G
  - 24-inch diameter gravel packed well that was drilled in 1973 with an approved pumping rate of 0.38 MGD (which is a combined rate with Well 01G).
- Well 03G
  - 24-inch diameter gravel packed well installed in 1962 with an approved pumping rate of 0.3 MGD.

#### *WSTs*

- 0.5 MG Sanderson Road WST (High Zone)
  - 58-foot diameter and 25-foot high concrete WST installed in 2005 and filled by Wells 01G and 02G.
- 0.3 MG Root Road WST (Low Zone)
  - 42-foot diameter and 33-foot high concrete WST installed in 2006 filled by Well 03.

*Booster Pump Stations*

- Sanderson Road Booster Station
  - Provides water from the Sanderson Road WST to the Insight Meditation Society.
- Root Road Booster Station
  - Pumps water from the Root Road WST to the high-pressure system to supplement the water supplied from Wells 01G and 02G when necessary.

**2.2.2 Belchertown**

The Belchertown Water District is a COM PWS located in the Town of Belchertown, Massachusetts. The Belchertown Water District is supplied by five groundwater sources with an additional emergency source. The Jabish Brook Wells #1, #2, #3, and #4 (1024000-01G, -02G, -03G, and -04G) are located off Johnson Road, just east of the center of town. The Daigle Well (1024000-05G) is located approximately ¼ mile west of Federal Street in the northwest area of town. The Jabish Brook Wellfield system (1024000-06G) is located in the same area and aquifer as the Jabish wells. Belchertown Water District retains the Jabish Wellfield system as an emergency source.

There are two WSTs in the distribution system known as the New Park Street WST and the Allen Road WST. The New Park Street WST is a 250,000-gallon elevated steel WST installed in 2022 located in the center of town on Park Street. The Allen Road WST is a 500,000-gallon welded steel WST installed in 1981 located on Allen Road between Route 9 and Route 202.

*Sources*

- Jabish Brook Wells 1024000-01G, -02G, -03G, -04G
  - Installed in 1990 with a total approved pumping capacity of 324,000 gallons per day (gpd).
- Jabish Brook Wellfield System 1024000-06G
  - Retained as an emergency source, with a maximum capacity of 288,000 gpd.
- Daigle Well
  - Installed in 1993 with an approved yield of 1,296,000 gpd.

*WSTs*

- New Park Street WST
  - 250,000-gallon elevated steel WST installed in 2022
- Allen Road WST
  - 500,000-gallon welded steel WST installed in 1981

*Booster Pump Stations*

- Bay Road Underground Booster Pump Station
  - Boosts pressure in the Metacomet area and the Daigle well into the center of town and fills the Allen Road WST. This station also contains a PRV.

**2.2.3 Orange**

The Town of Orange is a small industrial community along the Millers River. The Orange Water Department was founded in 1892. The Orange Water Department maintains four active water supply wells and three active emergency surface water supplies. Well #1 is an active source, but rarely used due to the detection of elevated iron and manganese. Well #1 requires some preparation to be placed online. Well #2 (02G) and Well #3 (04G) are available for service and routinely used. Replacement Well #2A (05G) was approved for use in July 2011 and was placed in service shortly thereafter.

*Sources*

- Well #1 (01G)
  - 10-inch gravel well installed in 1943
- Well #2 (02G) and Well #2A (05G)
  - Well #2 is an 18-inch gravel packed well installed in 1954 and historically produces approximately 30% of the Orange Water Department demand.
  - Well #2A was installed as a replacement for Well #2.
  - These wells are not operated simultaneously and are alternated daily. Well #2 and Well #2A have an approved yield of 520,000 gpd.
- Well #3 (04G)
  - 24-inch diameter gravel packed well installed in 1983 and supplies the remaining approximately 70% of the Orange Water Department demand.
- Emergency surface water sources
  - Lake Mattawa (01S)
  - Coolidge Brook Reservoir (02S)
  - Crystal Spring (03S)
- Athol Purchase (01P)
  - Orange Water Department purchases water from nearby Athol to supply 48 homes in the "Tully" section of Orange

*WSTs*

- North WST
  - 1-million-gallon partially buried, pre-stressed WST

- South WST
  - 1-million-gallon partially buried, pre-stressed WST

*Booster Pump Stations*

- None

**2.2.4 Ware**

The Ware Water Department is a COM PWS located in the Town of Ware, Massachusetts. The Ware Water Department is currently served by six sources of water, two WSTs and one booster pump station.

*Sources*

- Well 01G (Well Nos. 1, 2, and 3)
  - Well 01G is a collection of 3 gravel packed wells located off Barnes Street adjacent to Muddy Brook (Well Nos. 1, 2, and 3). The combined approved daily production rate for Well Nos. 1, 2 and 3 is 0.95 MGD. Replacement wells for Well No. 2 (2R) and No. 3 (3R) have been drilled and tested but not yet developed.
- Well 02G ("Well 4")
  - 18-inch by 24-inch gravel packed well with a maximum daily production rate of 0.72 MGD.
- Well 03G ("Well 5")
  - 12-inch by 18-inch gravel packed well with a maximum daily production rate of 0.58 MGD.
- Well 04G
  - 42-foot wide by 23-foot deep caisson well with an maximum daily production rate of 0.475 MGD. Note that Well 01G (Well Nos. 1, 2, and 3) and Well 04G have a combined permitted capacity of 1.08 MGD due to their proximity.

*WSTs*

- Church Street WST
  - 1.5-million-gallon welded steel WST constructed in 1978
- Anderson Road WST
  - 1-million-gallon welded steel WST constructed in 1978

*Booster Pump Stations*

- Gilbertville Road Booster Pump Station
  - Supplies four houses that are above the hydraulic grade line of the Church Street WST and is equipped with a 4-hp pump and two 100-gallon hydropneumatic storage tanks.

### **2.2.5 Hardwick**

The Hardwick Center Water District is a small COM PWS located off Route 32A in Hardwick. The system consists of a combination of private residences and Town-owned buildings. The current water system's supply, storage, and treatment components were reconfigured and upgraded in 2008 and 2009. The Hardwick Center Water District is presently served by a single source of water located approximately 100 feet southeast of Ruggles Hill Road. There is one pressure zone in the system.

#### *Sources*

- Well 01G Ruggles Hill Road Well:
  - 8-inch diameter bedrock well installed in 1970
  - Assigned an allowable yield of 3,500 gpd

#### *Storage*

- 10,000-gallon underground, concrete atmospheric WST installed in 2008 with a usable capacity of 9,000 gallons.

#### *Booster Pump Stations*

- None

There are two additional COM PWSs in Hardwick including the Gilbertville Water District and the Wheelwright Water District. The Gilbertville Water District is located approximately 2.2 miles from the Hardwick Center Service Area. The Gilbertville Water District is supplied by two groundwater sources including Well 01G and Well 02G with a combined yield of 100,000 gpd. There is one rectangular 100,000 gallon underground concrete WST.

The Wheelwright Water District is also located approximately 2.2 miles from the Hardwick Center Service Area. The Wheelwright Water District is supplied by Well 02G and Well 03G both with approved pumping rates of 67 gpm. There is one concrete WST with a usable capacity of 225,000 gallons.

### **2.2.6 Ludlow**

The Springfield Water and Sewer Commission (SWSC) is a COM PWS serving a significant portion of Ludlow. SWSC supply sources include the Cobble Mountain Reservoir and Borden Brook Reservoir, which are filtered and treated at the West Parish Filters Water Treatment Plant in Westfield. SWSC provides retail service to customers in Springfield and Ludlow. Agawam, East Longmeadow and Longmeadow are regional water treatment customers.

Some customers in Ludlow are supplied by the Wilbraham Water System, which is an MWRA Member Community and COM PWS.

## **2.3 Water Quality of Quabbin Reservoir Watershed Public Water Systems**

A preliminary review of available drinking water quality was conducted by examining the following available information for public water systems within the Quabbin Reservoir Watershed:

- Consumer Confidence Reports (CCRs) for Community PWSs available as of November 2024
- Drinking Water Quality Reports, where available, as prepared by MassDEP for non-community systems as of November 2024
- Water quality data available on the Energy & Environmental Affairs (EEA) Data Portal of the Commonwealth of Massachusetts website (<https://eeaonline.eea.state.ma.us/portal#!/home>)

This review aimed to gain insight into the specific water quality concerns of the existing public water systems within the proposed service areas discussed in this study and identify where a new water source, such as a connection to the MWRA system or new groundwater wells, could provide potential benefits.

State and federal drinking water standards are summarized in Table 2-3. Water quality summaries are provided in Table 2-4, including a description of any existing treatment.

The list of systems in Table 2-4 is not an exhaustive list of the public water systems within the Quabbin Reservoir Watershed. The systems listed include the community public water systems as well as transient non-community (TNC) and non-transient non-community (NTNC) systems that are within proposed service areas that could be served by expansion of the MWRA system such as schools and municipal customers.

Additionally, not all monitored and reported water quality parameters are included in Table 2-4. Listed parameters focus on those nearing regulatory standards, along with lead, copper, and PFAS (per- and polyfluoroalkyl substances), due to the recent regulatory attention on these contaminants.

The contaminants listed in Table 2-4 are compared to the standards listed in Table 2-3. To varying degrees, the main concerns of the systems listed in Table 2-4 include iron, manganese, disinfection by-products, and PFAS. Lead and copper data were not available for all systems but where available, these contaminants were below their respective Action Levels.

**TABLE 2-3**

Summary of State and Federal Drinking Water MCLs, Health Advisories, and Action Levels

Parameter	Level	Type of Level
Iron	0.3 mg/L	Secondary Maximum Contaminant Level (SMCL)
Manganese	0.05 mg/L	SMCL
	0.3 mg/L	Lifetime Health Advisory (HA)
Lead	10 ug/L	Action Level (AL)
Copper	1.3 mg/L	AL
Total Trihalomethanes (TTHMs)	80 ug/L	Maximum Contaminant Level (MCL)
Haloacetic Acids (HAA5s)	60 ug/L	MCL
PFAS-6 <sup>1</sup>	20 ng/L	MCL
PFOS	4 ng/L	MCL
PFOA	4 ng/L	MCL
PFHxS	10 ng/L	MCL
PFNA	10 ng/L	MCL
HFPO-DA (Hexafluoropropylene oxide dimer acid)	10 ng/L	MCL
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS <sup>2</sup>	1 (unitless)	Hazard Index

<sup>1</sup> PFAS-6 (combined concentration of **PFOS** - Perfluorooctane sulfonic acid, **PFOA** - Perfluorooctanoic acid, **PFHxS** - Perfluorohexane sulfonic acid, **PFNA** - Perfluorononanoic acid, **PFHpA** - Perfluoroheptanoic acid, and **PFDA** - Perfluorodecanoic acid).

<sup>2</sup> Hazard Indices were not calculated.

**TABLE 2-4**  
Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Barre Water Department (COM)  2023 CCR, EEA Data Portal	• pH Adjustment	Iron (mg/L)	2.83 (average) 0.106 – 8.37 (range)	Elevated iron, above the SMCL of 0.3 mg/L
		Manganese (mg/L)	0.06 (average) 0.06 – 0.12 (range)	Elevated manganese, above the SMCL of 0.05 mg/L (below the HA of 0.3 mg/L)
	• Iron/Manganese Sequestration	Lead (ug/L)	1.1 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
	• Disinfection	Copper (mg/L)	0.3 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	Non-detect	--
Belchertown Water District (COM)  2023 CCR, EEA Data Portal	• pH Adjustment	Iron (mg/L)	0.58 (average) 0.08 – 1.0 (range)	Moderate iron, above the SMCL of 0.3 mg/L
		Manganese (mg/L)	0.055 (average) 0.014 – 0.076 (range)	Moderate manganese, above the SMCL of 0.05 mg/L (below the LHA of 0.3 mg/L)
	• Corrosion Control	Lead (ug/L)	2.8 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.52 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
	• Disinfection	PFAS-6 (ng/L)	2.12 (average) ND – 2.12 (range)	Below MCL of 20 ng/L
		Individual PFAS (ng/L)	PFOA = 3.36 (max) PFOS = 2.62 (max) PFHxS = 1.46 (max) HFPO-DA and PFNA non-detect	PFOA below MCL of 4 ng/L PFOS below MCL of 4 ng/L PFHxS below MCL of 10 ng/L

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

TABLE 2-4 (continued)

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Hardwick Center Water District (COM)	<ul style="list-style-type: none"> <li>pH Adjustment</li> <li>Corrosion Control</li> </ul>	Lead (ug/L)	0.003	Below AL of 10 ug/L
		Copper (mg/L)	0.183	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	3.5 (average) 2.16 – 5.29 (range)	Below MCL of 20 ng/L
2023 CCR, EEA Data Portal	<ul style="list-style-type: none"> <li>Disinfection</li> </ul>	Individual PFAS (ng/L)	PFOA = 2.5 (max) PFOS = 2.8 (max) PFNA, HFPO-DA, and PFHxS non-detect	PFOA below MCL of 4 ng/L PFOS below MCL of 4 ng/L
Hardwick, Gilbertville Water District (COM)	<ul style="list-style-type: none"> <li>pH Adjustment</li> </ul>	Lead (ug/L)	1.5 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.073 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	Non-detect	--
		Individual PFAS (ng/L)	Non-detect	--

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

**TABLE 2-4 (continued)**

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Hardwick, Wheelwright Water District (COM)  2023 CCR, EEA Data Portal	<ul style="list-style-type: none"> <li>• pH Adjustment</li> <li>• Disinfection</li> </ul>	Iron (mg/L)	0.25 (average) 0.186 – 0.303 (range)	Finished water, moderate iron, near or occasionally above the SMCL of 0.3 mg/L
		Manganese (mg/L)	0.028 (average) 0.014 – 0.042 (range)	Finished water, below the SMCL of 0.05 mg/L (below the HA of 0.3 mg/L)
		Lead (ug/L)	6.4	Below AL of 10 ug/L
		Copper (mg/L)	0.59	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	Non-detect	--
		Individual PFAS (ng/L)	PFOA = 0.78 (max) PFOS, PFNA, HFPO-DA, and PFHxS non-detect	PFOA below MCL of 4 ng/L
Hardwick, Eagle Hill School (COM)  EEA Data Portal	<ul style="list-style-type: none"> <li>• Softening</li> <li>• pH Adjustment</li> <li>• Corrosion Control</li> </ul>	Lead (ug/L)	--	Not available
		Copper (mg/L)	--	Not available
		PFAS-6 (ng/L)	2.54 (average) 2.16 – 2.97 (range)	Below MCL of 20 ng/L
		Individual PFAS (ng/L)	PFOA = 2.97 (max) PFOS = 1.56 (max) PFNA, HFPO-DA, and PFHxS non-detect	PFOA below MCL of 4 ng/L PFOS below MCL of 4 ng/L

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

**TABLE 2-4 (continued)**

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Ludlow (COM)	<ul style="list-style-type: none"> <li>Conventional filtration</li> </ul>	HAA5 (ug/L)	74 (highest LRAA), 39 – 87 (range)	Results for all sites, including Ludlow; Elevated HAA5, compared to MCL of 60 ug/L
		TTHM (ug/L)	78 (highest LRAA), 35 – 78 (range)	Results for all sites, including Ludlow; Elevated TTHM, compared to MCL of 80 ug/L
2023 CCR (Springfield Water & Sewer Commission)	<ul style="list-style-type: none"> <li>pH Adjustment</li> <li>Corrosion Control</li> <li>Disinfection</li> </ul>	Lead (ug/L)	0 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.09 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS (ng/L)	Non-detect	No detections for any of the 29 PFAS substances tested
New Salem, Swift River Elementary School (NTNC)	<ul style="list-style-type: none"> <li>Ion Exchange (PFAS Treatment) and GAC</li> <li>pH Adjustment</li> </ul>	Lead (ug/L)	--	Not available
		Copper (mg/L)	--	Not available
		PFAS-6 (ng/L)	Non-detect	Reported as non-detect beginning in July 2024, following installation of treatment system
EEA Data Portal	<ul style="list-style-type: none"> <li>Corrosion Control</li> <li>Disinfection</li> </ul>	Individual PFAS (ng/L)	Non-detect	Reported as non-detect beginning in July 2024, following installation of treatment system

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

TABLE 2-4 (continued)

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Orange (COM) 2023 CCR	<ul style="list-style-type: none"> <li>pH Adjustment</li> <li>Corrosion Control</li> <li>Disinfection</li> </ul>	Iron (mg/L)	Daily Use Wells: 0.13 (average), Non-detect – 0.19 (range) Backup Well: 3.6 (average), 3.3 – 3.8 (range)	Occasional iron at daily use wells, near the SMCL of 0.3 mg/L; elevated iron at backup well
		Manganese (mg/L)	Daily Use Wells: 0.096 (average), 0.014 – 0.17 (range) Backup Well: 0.21 (average), 0.20 – 0.22 (range)	Occasional manganese at daily use wells, at times above the SMCL of 0.05 mg/L (below the LHA of 0.3 mg/L); elevated manganese at backup well
		Lead (ug/L)	1.2 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.13 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS (ng/L)	Non-detect	
		Pelham (COM) 2023 CCR (Town of Amherst), EEA Data Portal	<ul style="list-style-type: none"> <li>Filtration</li> <li>pH Adjustment</li> <li>Corrosion Control</li> <li>Disinfection</li> </ul>	Lead (ug/L)
		Copper (mg/L)	0.11 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS (ng/L)	PFOA = 1.7 (max) PFOS = 0.78 (max) PFNA, HFPO-DA, and PFHxS non-detect	PFOA below MCL of 4 ng/L PFOS below MCL of 4 ng/L

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

**TABLE 2-4 (continued)**

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Petersham Town Hall (TNC)  2023 MassDEP Water Quality Report	• None	Iron (mg/L)	6.3 (max)	Elevated iron, above the SMCL of 0.3 mg/L
		Manganese (mg/L)	0.75 (max)	Elevated manganese, above the SMCL of 0.05 mg/L and the LHA of 0.3 mg/L
		Lead (ug/L)	--	Not reported
		Copper (mg/L)	--	Not reported
		PFAS-6 (ng/L)	77 (max)	Above the MCL of 20 ng/L
		Individual PFAS (ng/L)	PFOA = 33 (max) PFOS = 29 (max) PFNA = 2.4 (max) PFHxS = 3.3 (max) HFPO-DA non-detect	PFOA above MCL of 4 ng/L PFOS above MCL of 4 ng/L PFNA below MCL of 10 ng/L PFHxS below MCL of 10 ng/L
Petersham Center School (NTNC)  2023 MassDEP Water Quality Report	• Softening	Lead (ug/L)	1.9 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.009 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	7.7 (max)	Below the MCL of 20 ng/L
		Individual PFAS (ng/L)	PFOA = 4.4 (max) PFOS = 3.4 (max) PFHxS = 1.3 (max) HFPO-DA non-detect PFNA not reported separately	PFOA at MCL of 4 ng/L PFOS below MCL of 4 ng/L PFHxS below MCL of 10 ng/L

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

TABLE 2-4 (continued)

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Phillipston Memorial Building (NTNC)	<ul style="list-style-type: none"> <li>Filtration</li> <li>pH Adjustment</li> <li>Corrosion Control</li> </ul>	Lead (ug/L)	--	Not available
		Copper (mg/L)	--	Not available
		PFAS-6 (ng/L)	60 (average)	Above the MCL of 20 ng/L
EEA Data Portal	PFAS treatment planned	Individual PFAS (ng/L)	PFOA = 25 (max) PFOS = 16 (max) PFNA = 2.48 (max) PFHxS = 1.14 (max) HFPO-DA non-detect	PFOA above MCL of 4 ng/L PFOS above MCL of 4 ng/L PFNA below MCL of 10 ng/L PFHxS below MCL of 10 ng/L
Shutesbury Elementary School (NTNC)	<ul style="list-style-type: none"> <li>None</li> </ul>	Lead (ug/L)	--	Not available
		Copper (mg/L)	--	Not available
EEA Data Portal		PFAS (ng/L)	Non-detect	

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

TABLE 2-4 (continued)

Water Quality of Public Water Systems in the Quabbin Reservoir Watershed

Public Water System and Data Source	Treatment	Water Quality Parameter (units)	Result	Comments
Ware Water Department (COM) 2023 CCR, EEA Data Portal	<ul style="list-style-type: none"> <li>pH Adjustment</li> <li>Corrosion Control</li> <li>Disinfection</li> </ul>	Iron (mg/L)	0.97 (max)	Elevated iron, above the SMCL of 0.3 mg/L
		Manganese (mg/L)	0.26 (max)	Elevated manganese, above the SMCL of 0.05 mg/L (below the HA of 0.3 mg/L)
		Lead (ug/L)	4.1 (90 <sup>th</sup> perc)	Below AL of 10 ug/L
		Copper (mg/L)	0.18 (90 <sup>th</sup> perc)	Below AL of 1.3 mg/L
		PFAS-6 (ng/L)	9.3 (max)	Below the MCL of 20 ng/L
		Individual PFAS (ng/L)	PFOA = 3.6 (max) PFOS = 5.8 (max) PFHxS = 4.3 (max) PFNA and HFPO-DA non-detect	PFOA at MCL of 4 ng/L PFOS above MCL of 4 ng/L PFHxS below MCL of 10 ng/L
Wendell Town Buildings (TNC) EEA Data Portal	<ul style="list-style-type: none"> <li>None</li> </ul>	Lead (ug/L)	--	Not available
		Copper (mg/L)	--	Not available
		PFAS (ng/L)	Non-detect	

EEA = Executive Office of Energy & Environmental Affairs; AL = Action Level; SMCL = Secondary Maximum Contaminant Level; HA = lifetime Health Advisory; PFAS-6 = PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA; LRAA = locational running annual average; HAA5 = haloacetic acids; TTHM = total trihalomethanes; perc = percentile.

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**SECTION 3**

## Section 3

# System Capacity Evaluation

### 3.1 Existing and Potential Service Areas

Service areas were developed for Towns without existing COM PWSs, which are summarized in Section 3.1.1. Towns with COM PWSs have defined existing service areas, which are described in Section 3.1.2.

Should a community decide to pursue a new water supply, further analysis is needed to confirm and refine the extents of the service areas developed for study communities. Water supply to potential users not within the existing service areas for towns with COM PWSs within the study area would also require further analysis.

#### 3.1.1 Communities without Existing Water Systems

Maps of the service areas developed for study communities without existing COM PWSs are provided as Figures 3-1 through 3-7. Since the existing Hardwick Center COM PWS does not serve the entire town center, a potential service area for Hardwick was developed, as further discussed below.

For towns without a COM PWS, the extent of the potential service area in each community was generally limited to the town centers. Service areas do not include the entire town for the following reasons:

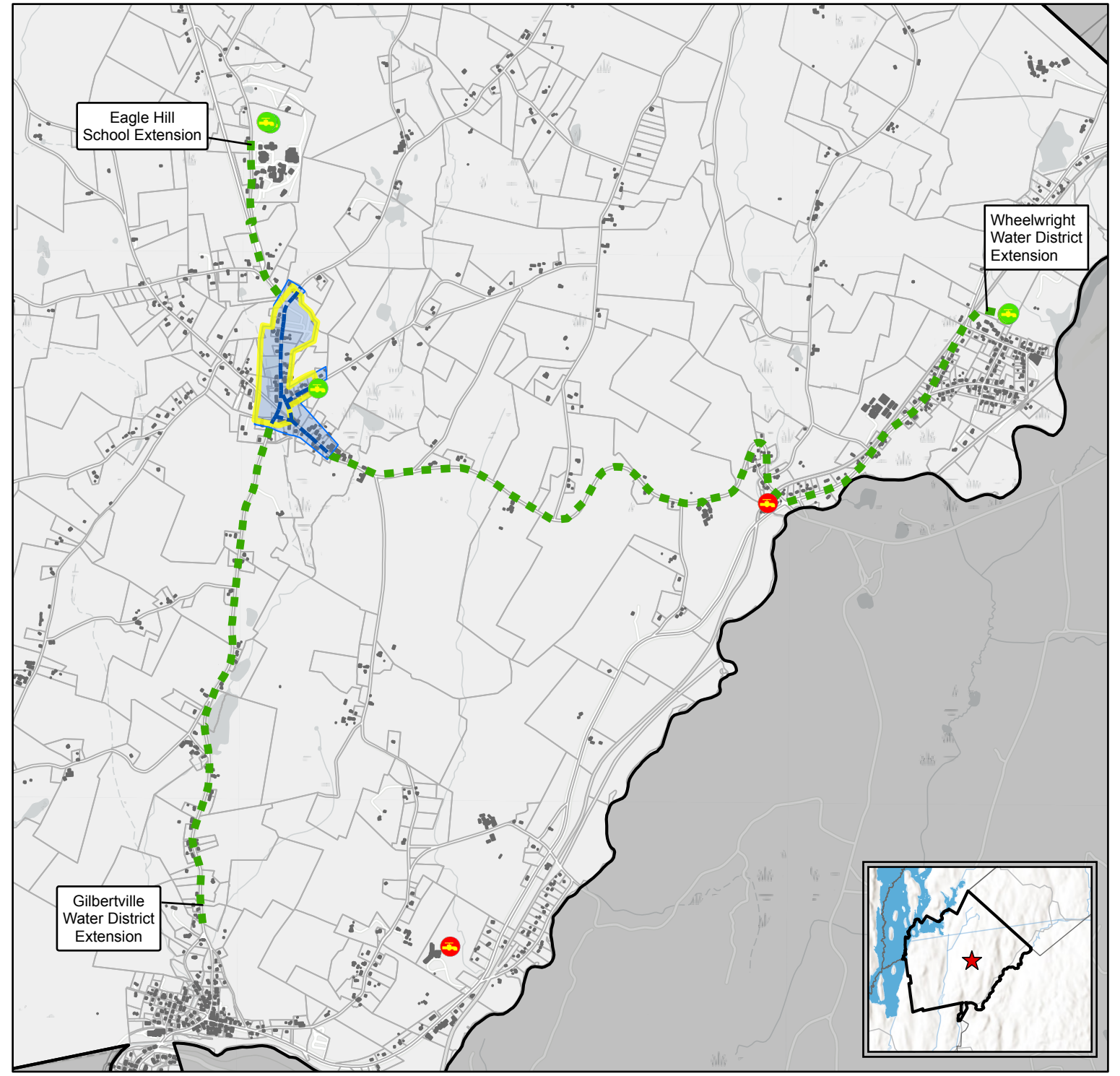
- Low population density outside of the town centers.
- Excessive lengths of water main required to serve a limited number of customers would be cost prohibitive.
- High water age in the distribution system due to lack of turnover and storage within water mains serving a low number of customers.

The town centers were determined from available planning documents. Minor expansions beyond the town centers were considered to include the potential service connections described below. Non-Community (NC) Water Systems and NTNC Water Systems included in the potential service areas are summarized in Table 3-1.











- Existing nearby residences and Non-Community Water Systems meeting approximate proximity and demand criteria.
- Specific developments that would need public water supply as identified by the Town or the MWRA.
- Known water quality issues, such as PFAS.

Service area extensions to existing entities beyond the above potential service connections for communities with and without COM PWSs were considered. Table 3-2 summarizes potential extensions for residential entities and schools. Table 3-3 summarizes potential extensions for recreational sites such as country clubs and miscellaneous entities. Residential entities and schools would be prioritized over recreational entities. PWSs other than MWRA could potentially supply these entities if they have excess supply to do so.

Note that the estimated service area demands for communities in this study did not include the potential service area extensions included in Tables 3-2 and 3-3. Potential challenges with connecting these potential service area extensions include costs associated with extending water main to these services, constructability challenges as applicable, pressure reduction or pumping if needed, and transitioning to a new water source.

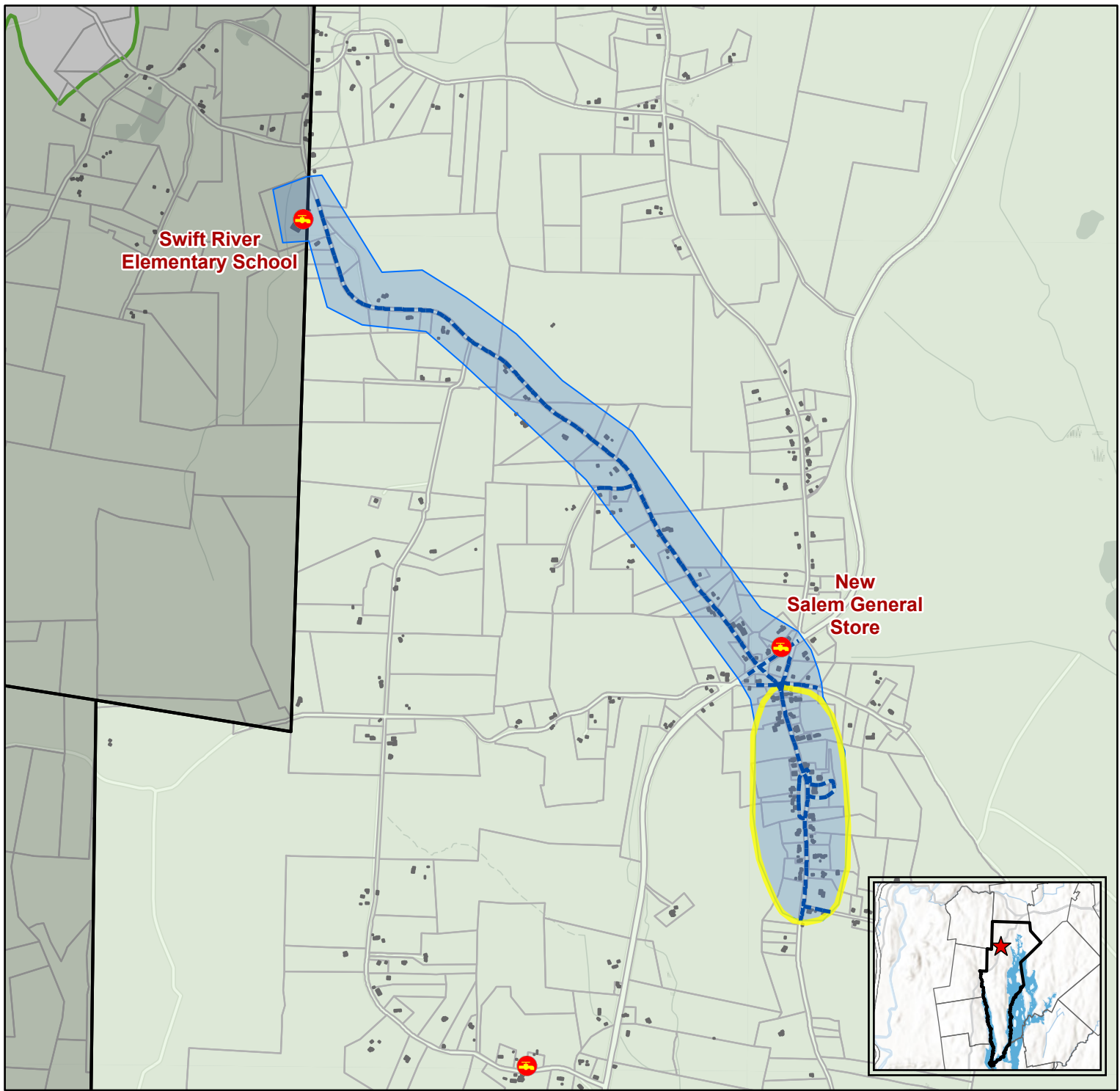


**Legend**









-  Community Groundwater Well
-  Non-Community Groundwater Well
-  Potential Water Main
-  Hardwick Extension
-  Potential Service Area
-  Building
-  Town Center from Planning Documents
-  Town Boundary
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-1  
Potential Service Area  
Hardwick, Massachusetts



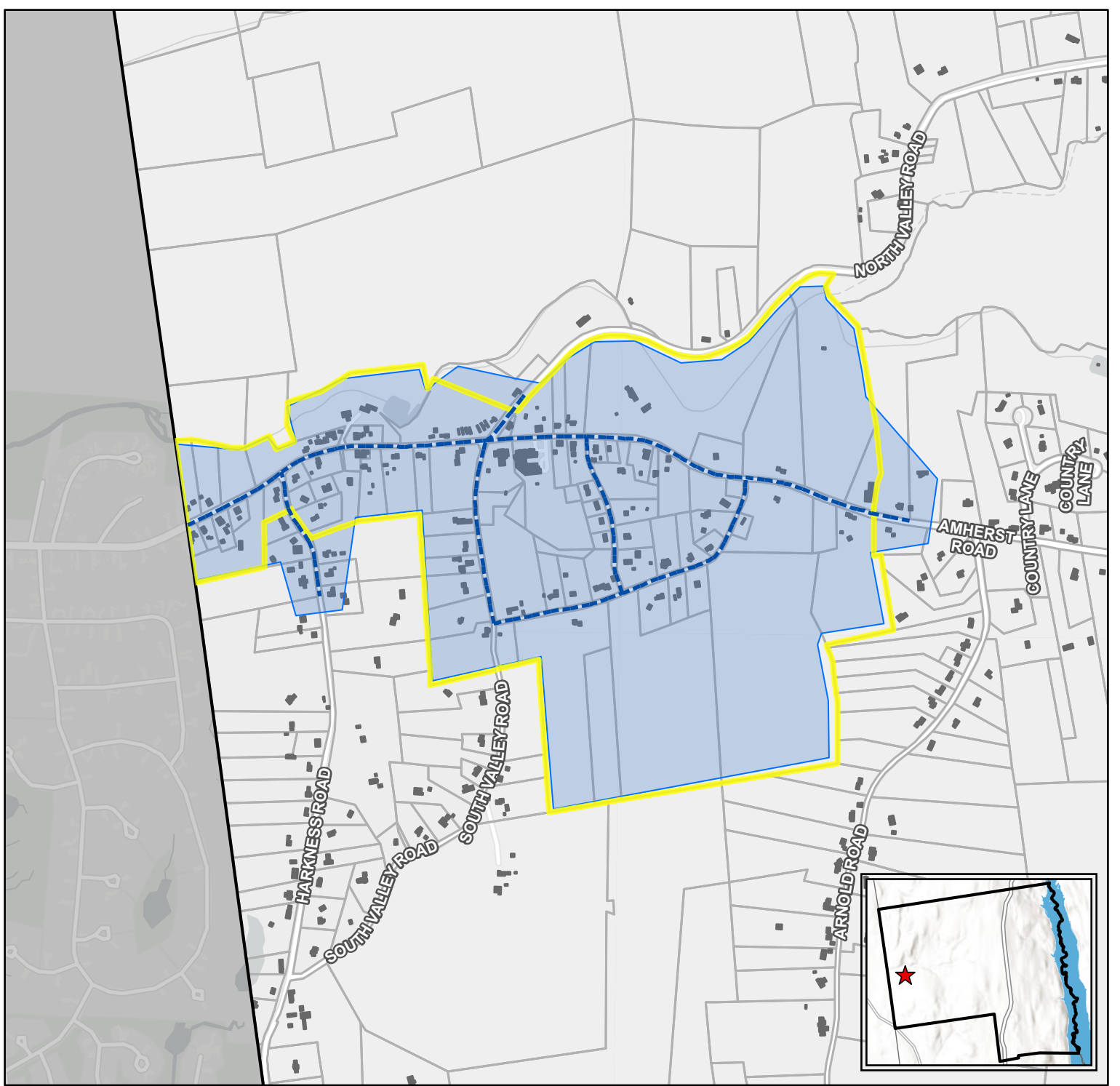
**Legend**

-  Non-Community Groundwater Well
-  Potential Water Main
-  Potential Service Area
-  Building
-  Town Center from Planning Documents
-  Town Boundary
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-2  
Potential Service Area  
New Salem, Massachusetts

1:24,000 0 1,000 2,000 Feet  
1 inch = 2,000 feet



**Legend**

- - - Potential Water Main
- Potential Service Area
- Building
- Town Center from Planning Documents
- Town Boundary
- Approximate Parcel Boundary
- Quabbin Reservoir Watershed









**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-3  
Potential Service Area  
Pelham, Massachusetts





**Legend**

-  Non-Community Groundwater Well
-  Potential Water Main
-  Potential Service Area
-  Building
-  Town Center from Planning Documents
-  Town Boundary
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed









**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-4  
Potential Service Area  
Petersham, Massachusetts

1:12,000 0 1,000  
1 inch = 1,000 feet Feet



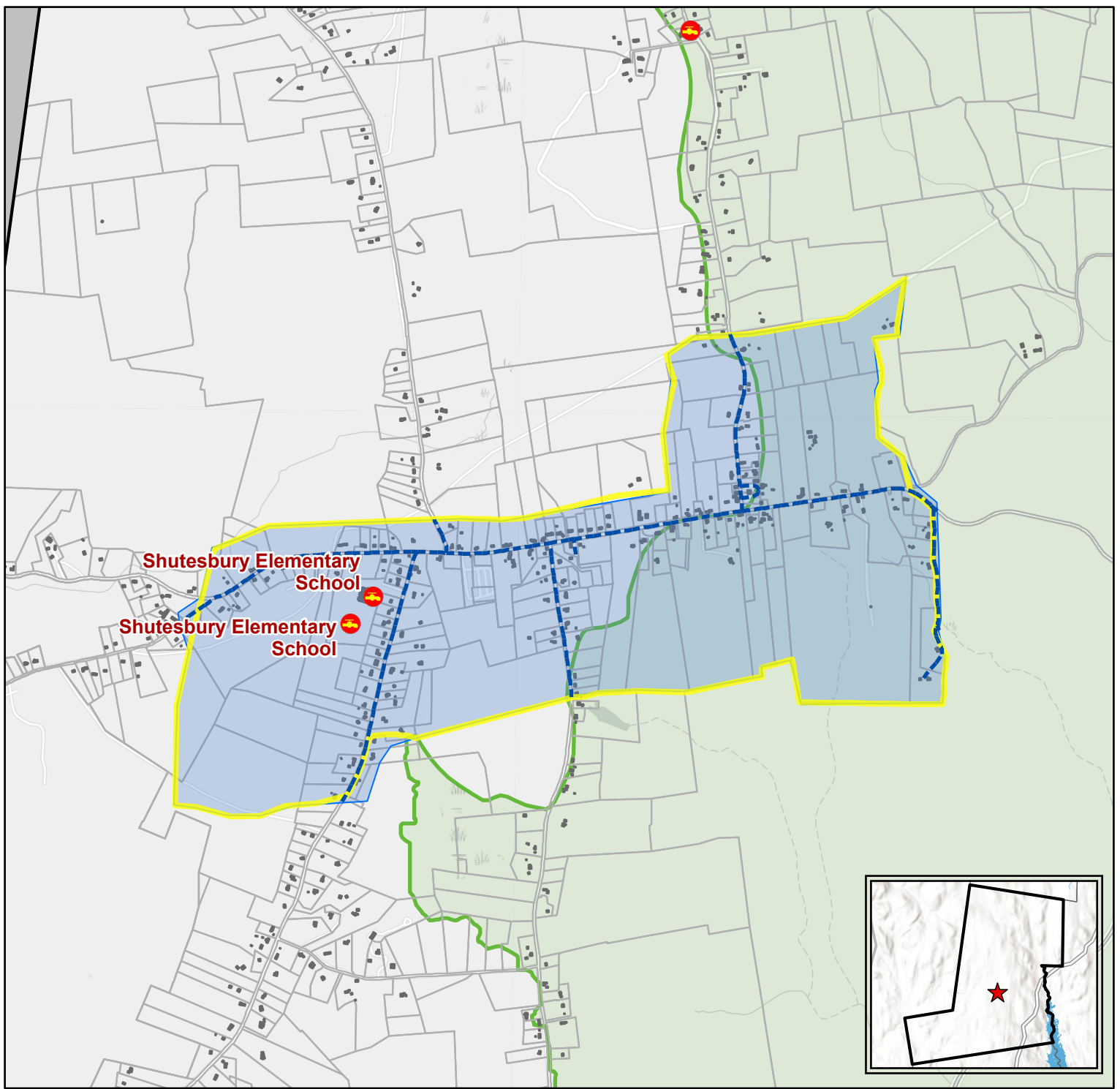
**Legend**

-  Non-Community Groundwater Well
-  Potential Water Main
-  Potential Service Area
-  Building
-  Town Center from Planning Documents
-  Town Boundary
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed









**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-5  
Potential Service Area  
Phillipston, Massachusetts

1:12,000 0 1,000 Feet  
1 inch = 1,000 feet



**Legend**

-  Non-Community Groundwater Well
-  Town Center from Planning Documents
-  Potential Water Main
-  Potential Service Area
-  Town Boundary
-  Building
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed









**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-6  
Potential Service Area  
Shutesbury, Massachusetts

1:24,000 0 1,000 2,000  
1 inch = 2,000 feet Feet

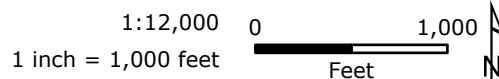


**Legend**

-  Non-Community Groundwater Well
-  Potential Water Main
-  Potential Service Area
-  Building
-  Town Center from Planning Documents
-  Town Boundary
-  Approximate Parcel Boundary
-  Quabbin Reservoir Watershed

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 3-7  
Potential Service Area  
Wendell, Massachusetts



**TABLE 3-1**  
Non-Community Water Systems Included in the Potential Service Areas

Site Name	System Class	ADD, gpd <sup>2</sup>	MDD, gpd <sup>2</sup>	Well ID
<b>New Salem</b>				
Swift River Elementary School <sup>1</sup>	NTNC	2,350	550	1204001-01G
New Salem General Store	NC	208	150	1204003-01G
<b>Petersham</b>				
Petersham Country Store	NC	335	230	1234012-01G
Petersham Town Hall	NC	100	35	1234004-01G
Petersham Center School	NTNC	600	370	1234006-02G
Petersham Montessori School	NC	88	45	1234011-01G
<b>Phillipston</b>				
Phillipston Memorial Building	NTNC	384	210	2235002-01G
<b>Shutesbury</b>				
Shutesbury Elementary School	NTNC	600	410	1272002-01,02G
<b>Wendell</b>				
Wendell Country Store	NC	208	160	1319006-01G

1. Swift River Elementary School has high PFAS in raw water and was specifically requested to be included in service area. A water treatment system was recently installed. Potential issues such as high water age due to the long water main from the New Salem Town Center to the Swift River Elementary School should be considered if supply is advanced.
2. Average day demand (ADD) and maximum day demand (MDD) based on 2022 and 2023 ASRs.

**TABLE 3-2**  
Potential Extensions for Residential Entities and Schools

Site Name <sup>1</sup>	System Class	ADD, gpd <sup>2</sup>	MDD, gpd <sup>2</sup>	Services <sup>2</sup>	Pop. Served <sup>2</sup>	Approx. Distance from Service Area (miles)	Well Type
<b>Barre</b>							
Barre MHP / Waterwheel Village	COM	5,700	7,300	72	114	2.9	COM Groundwater Well
<b>Belchertown</b>							
Cedarwood Apartments	COM	900	1,600	2	25	0.3	COM Groundwater Well
Washington Acres	COM	1,100	1,600	12	30	0.9	COM Groundwater Well
Sports Haven Mobile Home Park	COM	25,400	41,900	51	107	1.1	COM Groundwater Well
Pine Valley Plantation	COM	74,400	125,900	391	600	1.7	COM Groundwater Well
<b>Hardwick</b>							
Hardwick Elementary School	NTNC	700	1,400	1	194	2.5	Non-COM Groundwater Well
<b>Orange</b>							
The Farm School	TNC	1,800	2,900	1	100	1.6	Non-COM Groundwater Well
<b>Ware</b>							
Oakwood Park Mobile Homes	COM	NA	NA	65	211	2.9	COM Groundwater Well

1. Estimated service area demands for communities in this study did not include the potential extensions listed in this table.
2. Average day demand (ADD), maximum day demand (MDD), number of services and populations served based on 2022 and 2023 ASRs.

**TABLE 3-3**  
Potential Extensions for Recreational and Miscellaneous Entities

Site Name <sup>1</sup>	System Class	ADD, gpd <sup>2</sup>	MDD, gpd <sup>2</sup>	Services <sup>2</sup>	Pop. Served <sup>2</sup>	Approx. Distance from Service Area (miles)	Well Type
<b>Barre</b>							
Carter Stevens Farm/Brewery	TNC	1,600	2,630	4	50	0.4	Non-COM Groundwater Well
<b>Belchertown</b>							
Cold Spring Country Club	NTNC	1,100	3,800	1	75	1.5	Non-COM Groundwater Well
DCR Quabbin Admin Bldg	NTNC	500	2,100	1	80	3.1	Non-COM Groundwater Well
Mill Valley Golf Links Inc.	TNC	200	1,300	1	100	1.2	Non-COM Groundwater Well
<b>Hardwick</b>							
Hardwick Crossing Country Club	TNC	1,700	3,400	1	50	3.1	Non-COM Groundwater Well
<b>Ludlow</b>							
Church of Jesus Christ of LDS	TNC	80	160	1	100	0.8	Non-COM Groundwater Well
Villa Rose Restaurant	TNC	830	1,000	1	75	1.3	Non-COM Groundwater Well
Westover Golf Course	TNC	400	1,000	2	350	1.4	Non-COM Groundwater Well
<b>Petersham</b>							
The Quabbin Retreat	NTNC	3,300	4,000	1	40	1.4	Non-COM Groundwater Well
Quabbin Woods Restaurant	TNC	250	400	1	25	0.2	Non-COM Groundwater Well
<b>Phillipston</b>							
Lamb City Campground	TNC	2,900	NA	1	200	1.8	Non-COM Groundwater Well
Red Apple Farm, LLC	TNC	1,000	NA	2	125	2.5	Non-COM Groundwater Well

1. Estimated service area demands for communities in this study did not include the potential extensions listed in this table.
2. Average day demand (ADD), maximum day demand (MDD), number of services and populations served based on 2022 and 2023 ASRs.

The Town of Hardwick has three separate COM PWSs that serve different portions of the town in addition to the town center:

- Hardwick Center Water District
- Gilbertville Water District
- Wheelwright Water District

Therefore, the proposed service area for Hardwick includes the town center as well as extensions to the other existing community systems and to the nearby Eagle Hill School.

For communities without COM PWSs and for the Town of Ludlow, the parcels within proposed service areas were assigned customer usage categories based on Town parcel information. The estimated population served was based on the number of residential units and average household size for each town from the American Communicate Survey (ACS) 5-year estimates for 2022. Service connections and population served for each of the service areas are outlined in Table 3-4. For Hardwick, the data in Table 3-4 is based on a combination of Annual Statistical Report (ASR) data (i.e., for Gilbertville and Wheelwright Water Districts and for the Eagle Hill School) and the estimates as described (i.e., for the proposed service area for Hardwick Center, which also includes the Hardwick Center Water District).

**TABLE 3-4**

Summary of Existing and Potential Service Connections and Population Served

<b>Community</b>	<b>Service Connections</b>	<b>Population Served</b>
Barre <sup>2</sup>	1,132	4,098
Belchertown <sup>2</sup>	1,286	3,331
Hardwick (with extensions) <sup>1,2</sup>	434	1,952
Ludlow	6,437	14,580
New Salem	63	126
Orange <sup>2</sup>	1,874	6,492
Pelham	89	195
Petersham	123	266
Phillipston	23	50
Shutesbury	154	345
Ware <sup>2</sup>	2,482	7,376
Wendell	38	70

1. Hardwick (with extensions) includes Hardwick Center Water District, Gilbertville Water District, Wheelwright Water District and the Eagle Hill School.
2. Data as reported in 2023 ASRs. Data for Hardwick (with extensions) is based on a combination of ASR data and estimates from this study.

### 3.1.2 Communities with Existing Public Water Systems

For towns with a COM PWS, including Ludlow, no expansion beyond the current service area was generally assumed unless a community provided information on specific users that would need public water supply. The Eagle Hill School in Hardwick was included due to the proximity to the existing Hardwick Center COM PWS and high water consumption.

Service connections and population served for each of the service areas are outlined in Table 3-4. For these communities, as well as for the existing Gilbertville, Wheelwright Water Districts and the Eagle Hill School in Hardwick, the data in Table 3-4 was gathered from 2023 ASRs. For the Town of Ludlow, which has no individual ASR, the number of service connections and population served data were estimated as described above.

As previously noted, Ludlow is primarily supplied by the SWSC, which is constructing a new Water Treatment Plant (WTP). Ludlow is a retail customer of SWSC and Ludlow does not own its water distribution system mains. Ludlow would need to purchase its water system which creates an additional constraint for Ludlow to connect to the MWRA. Note that some customers in Ludlow are supplied by the Wilbraham Water System, which is an MWRA Member Community.

### 3.1.3 Service Area Hydraulic Grade Lines

Appropriate HGLs for proposed service areas within communities without COM PWSs and Hardwick were developed based on potential service elevations. These HGLs were estimated to target pressures ranging from 35 to 80 psi to customers and would need to include PRVs to individual / groups of customers at certain locations where pressures would be greater than 80 psi. Due to the wide range of elevations within some of the proposed service areas, some service locations would have static pressures greater than 80 psi at the proposed HGLs unless multiple pressure zones were created. For this study, one pressure zone for each proposed service area was assumed, but this can be refined if any of the projects are advanced. Table 3-5 summarizes the estimated HGLs for the proposed service areas. Static pressures for the proposed service areas in Pelham and Shutesbury exceed 100 psi for the HGLs summarized in Table 3-5.

The existing HGLs for communities with COM PWSs are summarized in Table 3-5. For these communities, the hydraulic gradients at the connection points between the source HGL and each community were compared. Refer to Table 4-9 and Figures 4-4 through 4-11 for a summary of HGLs at the connection points and infrastructure needed to match the existing HGLs of the COM PWSs. Further study (including modeling) is needed to confirm and refine estimated HGLs for proposed service areas and at connection points for communities with COM PWSs.

**TABLE 3-5**  
Summary of Hydraulic Grade Lines (HGLs)

<b>Proposed Service Areas<sup>1</sup></b>		
<b>Community</b>	<b>HGL (NAVD88 ft.)<sup>2</sup></b>	<b>Approx. Ground Elevation Range (NAVD88 ft.)<sup>2</sup></b>
Hardwick Center	1,052	863 - 971
New Salem	1,201	999 - 1,120
Pelham	641	277 - 560
Petersham	1,173	978 - 1,092
Phillipston	1,253	1,127 - 1,166
Shutesbury	1,315	967 - 1,234
Wendell	1,253	1,108 - 1,168
<b>Existing COM PWSs<sup>3</sup></b>		
<b>Community</b>	<b>HGL (NAVD88 ft.)<sup>2</sup></b>	
Belchertown	711 (Main Pressure Zone) 500 (Reduced Pressure Zone)	
Ware	659	
Orange (estimated)	800	
Barre (estimated)	866 feet (Low Pressure Zone) 1,058 (High Pressure Zone)	

1. HGLs estimated based on ground elevations of potential services within service areas. This section includes Hardwick Center since its existing COM PWSs are small, the Hardwick Center COM PWS doesn't include the entire Town Center and, as such, a proposed service area was developed.

2. Referenced to NAVD88 datum (Boston City Base (BCB) Datum = 6.46 feet + NAVD88 Datum). Based on max ground elevation plus approximately 35 psi (81 feet) and then refined as needed considering hydraulics analysis of transmission mains providing supply (refer to Section 4.3.2).

3. Information on the existing HGL of the water system in Ludlow was not available. Assumed similar to the Nash Hill Tanks overflow elevation in Ludlow.

## 3.2 Water Demands

The average and maximum daily water demands vary by community due to size and service population. Table 3-6 summarizes each community's average day demand (ADD) and maximum day demand (MDD) in gallons per day (gpd).

### 3.2.1 Water Demands for Existing Water Systems

Water demands for communities with existing COM PWSs are based on 2022-2023 ADD over the year and highest daily demand in the year for MDD, respectively. These demands were gathered from the ASRs filed with MassDEP for each community.

ADD and MDD for existing non-community systems within towns were also based on information from ASRs.

### 3.2.2 Water Demands for Communities without Public Water Systems

ADD for communities without COM PWSs and for Ludlow were estimated using customer usage categories and population served. This approach was utilized for the Town of Ludlow, which is served by the SWSC, because demand data for the Ludlow service area was not available for this study. The parcels within proposed service areas were assigned customer usage categories based on Town parcel information. The estimated population

served was based on the number of residential units and average household size for each town from the ACS 5-year estimates for 2022. The residential demands were based on 65 gal/person/day, which is a Massachusetts State Standard.

Municipal, Commercial, and Industrial Demands were based on building footprint and wastewater design flows from 310 CMR 15.00 (Title V). Water demand calculations are based on peak wastewater flow projections as shown below:

$$\text{Average Water Demand} = \text{Total Peak Wastewater Flow Rate} * 0.6$$

The wastewater flow rate factor of 0.6 is calculated as follows:

$$0.5 * (1/85\%)$$

This methodology is based on dividing peak wastewater flow projections in half as the wastewater flow projection is a peak flow number, and then dividing by 0.85 because the water discharged into the wastewater system excludes consumption, which is typically 15%. By dividing by 0.85, this 15% component is added back in to provide the average water demand. This equation and values are based on Tighe & Bond's experience developing demand projections for numerous public water systems throughout Connecticut and Massachusetts.

MDD for towns without existing COM PWSs were based on an assumed peaking factor of 2.0 to average day demands. Based on Tighe & Bond's experience, maximum day peaking factors can range from 1.3 to 2.5. The previous MetroWest expansion study used a maximum day peaking factor of 2.0.

Demands for Hardwick (with extensions) are based on a combination of ASR data (i.e., for Gilbertville and Wheelwright Water Districts, the Eagle Hill School, and other existing non-community systems within the proposed service area) and demand estimates as described (i.e., for the proposed service for Hardwick Center which also includes the Hardwick Center Water District).

The estimated demands for potential service areas in communities with and without COM PWSs would need to be confirmed and refined if discussions with interested communities are advanced.

**TABLE 3-6**  
Average and Maximum Day Demands for Study Communities

<b>Community</b>	<b>Average Day Demand (gpd)</b>	<b>Maximum Day Demand (gpd)</b>
Barre <sup>1</sup>	366,000	626,200
Belchertown <sup>1</sup>	243,000	482,600
Hardwick (with extensions) <sup>1,4</sup>	112,800	260,900
Ludlow <sup>2,3</sup>	1,393,100	2,786,200
New Salem <sup>2</sup>	12,500	26,300
Orange <sup>1</sup>	383,000	954,200
Pelham <sup>2</sup>	16,600	33,200
Petersham <sup>2</sup>	21,100	42,000
Phillipston <sup>2</sup>	5,000	10,000
Shutesbury <sup>2</sup>	26,400	52,400
Ware <sup>1</sup>	566,000	800,000
Wendell <sup>2</sup>	6,900	13,600
<b>Total</b>	<b>3,152,400</b>	<b>6,087,600</b>

1. Demands obtained from 2022 ASR filed with MassDEP for communities with existing COM PWSs.
2. Demands estimated based on customer usage categories and population served for communities without existing COM PWSs, and for Ludlow which is served by the SWSC (individual ASR data was not available for Ludlow).
3. Updated demand data for 2023 were received from Ludlow following completion of the analysis presented in this study. The reported average day demand for 2023 was 1.04 MGD, which closely aligns with the estimated average day demand listed in this table. Discrepancies between the reported and estimated values may be attributed to several factors, including: 1) the use of conservative wastewater design flows from 310 CMR 15.00 in estimating non-residential demands; 2) variations in actual household size compared to the ACS 5-year estimates, especially within multi-family residential units; and, 3) differences between actual customer classifications and the assumed parcel-based land use categories.
4. Hardwick (with extensions) includes Hardwick Center Water District, Gilbertville Water District, Wheelwright Water District and the Eagle Hill School.

### 3.3 MWRA Water System Capacity

The MWRA is a Massachusetts public authority providing wholesale water to 53 customer communities throughout Massachusetts. The Quabbin Reservoir supplies water to three Central Massachusetts Communities including Chicopee, Wilbraham and South Hadley Fire District No. 1 which is treated at the Brutsch WTF located in Ware. Treated water from the Brutsch WTF is transported to Chicopee, Wilbraham and South Hadley Fire District No. 1 through Chicopee Valley Aqueduct (CVA).

A screening analysis was conducted to identify how much additional water could be treated at the Brutsch WTF and transported to the study communities through MWRA's existing water transmission system (i.e. CVA). The Authority provided information on the current capacity of the Brutsch WTF and CVA. Potential supply from the Quabbin Aqueduct was also considered. This information helped guide the identification and recommendation of infrastructure improvements to achieve the desired expansion objectives. The results of the screening analysis are detailed below.

### 3.3.1 Existing MWRA Supply Capacity

The safe yield of MWRA's three water sources including the Quabbin Reservoir as well as the Wachusett Reservoir and the Ware River Watershed is 300 MGD. The 2019-2023 average 5-year reservoir withdrawals is 199 MGD. The total projected demand in 2040 is 245 MGD based on MWRA 2018 Water System Master Plan. The projected demand includes potential growth in population and employment and additional demand for partial and emergency users.

Some raw water from the Quabbin Reservoir is treated at the Brutsch WTF for the three Central Massachusetts Communities. The Brutsch WTF was designed for a maximum flow rate of 16 MGD. Water at the Brutsch WTF is treated with sodium hypochlorite and ultraviolet light for primary disinfection. For residual disinfection, sodium hypochlorite is applied. Each of the three CVA communities provides further corrosion control treatment to protect the water against leaching lead from home plumbing.

As noted above, treated water from the Quabbin Reservoir currently supplies Chicopee, Wilbraham and South Hadley Fire District No. 1 which is transported to each community via the CVA. Ware, Belchertown and Ludlow are adjacent to the CVA. The three CVA communities use an average of approximately 7.7 MGD based on data provided on MWRA's website. Capacity of the CVA is allocated to the three existing communities of Chicopee, Wilbraham, and South Hadley Fire District No. 1. Each community has a water supply agreement (contract) with MWRA that defines their maximum withdrawals on an annual and daily basis. Chicopee's allocation is a maximum of 2,150 million gallons per year and 10 MGD, Wilbraham's allocation is 503 million gallons per year and 3.5 MGD, and the South Hadley Fire District No. 1 has 600 million gallons per year and 3 MGD allocated. The total maximum daily allocation for all three communities is 16.5 MGD. A review of ASRs for 2016-2023 show that the communities are using approximately 70%-85% of their allocation depending on rainfall in a given year. Past hydraulic analysis performed by MWRA and their consultants have demonstrated that increasing the capacity of the CVA is not feasible while still maintaining required system pressure. Water is stored along the CVA in the Nash Hill Tank in Ludlow.

The Quabbin Aqueduct is a deep rock tunnel that flows by gravity conveying water from the Quabbin Reservoir to the Wachusett Reservoir. The Quabbin Aqueduct passes through the study communities of Hardwick and Barre. The depth of the Quabbin Aqueduct ranges from approximately 300 feet to 700 feet of cover along the alignment where it intersects with Hardwick and Barre. From the Wachusett Reservoir, water is then conveyed to the John J. Carroll WTP in Marlborough, Massachusetts, which treats water for the metropolitan Boston area.

The capacity of the MWRA supply sources in the study area for potential expansion are dependent on the capacity of the CVA, Brutsch WTF, and the Quabbin Aqueduct. Potential expansion alternatives that would provide supply from the CVA and Brutsch WTF were considered for this study. However, MWRA analyses indicated that the CVA and Brutsch WTF have no excess capacity. Tighe & Bond and MWRA engineering staff concluded that expansion alternatives utilizing supply from the Brutsch WTF and CVA are infeasible. The Quabbin Aqueduct flows by gravity and the hydraulic gradeline is at roughly the water elevation of the Quabbin Reservoir. The elevation of the Quabbin Reservoir under normal conditions is approximately 519-530 feet BCB (512.5-523.5 feet NAVD88). Engineering evaluations by Tighe & Bond and MWRA engineering staff determined the feasibility of connecting to the Quabbin Aqueduct to be low due to the size and complexity of designing and constructing a safe withdrawal connection.

**Tighe&Bond**

**SECTION 4**

## Section 4

# System Expansion Alternatives

The system expansion alternatives evaluated in this study included groundwater exploration and new surface water intake options for raw water sources. While numerous alternatives and variations could have been explored, the study required setting clear boundaries to focus the analysis. The alternatives presented here are conceptual in nature and intended to support preliminary discussions regarding potential future connections to the MWRA system or new groundwater supplies. If any projects advance, a more detailed evaluation—potentially including additional alternatives or modifications of those considered in this study—will be necessary.

Figure 4-1 provides an overview of the potential groundwater and new intake alternatives considered in this study. Five conceptual projects were selected for further study from the potential groundwater and new intake alternatives, which are shown on Figure 4-2. The Towns served by each of the conceptual projects are shown on Figure 4-3. This Section includes a discussion of the potential expansion alternatives and five conceptual projects. Water treatment and infrastructure components including water transmission mains, booster pump stations and storage tanks needed for the conceptual projects were evaluated. Opinions of probable construction cost (OPCCs) were developed for the five conceptual projects and are discussed in Section 5.

Assumed water treatment and infrastructure components used for the development of OPCCs are presented. It is recognized that other potential treatment and infrastructure component alternatives could be identified for conceptual projects as additional details are determined if the projects move forward to address community specific needs and preferences. Potential additional measures may be required that are not included in this study that can only be identified during future phases of conceptual project development. Further detailed analysis of raw water source development, water treatment and infrastructure components are needed if any of the conceptual projects move forward.

### 4.1 Review of Community Demands

The needed capacity of potential expansion alternatives was determined based on the potential service area demands of the study communities. A 20% contingency factor was added to the water demand estimates previously outlined in Section 3 for evaluating needed capacity.

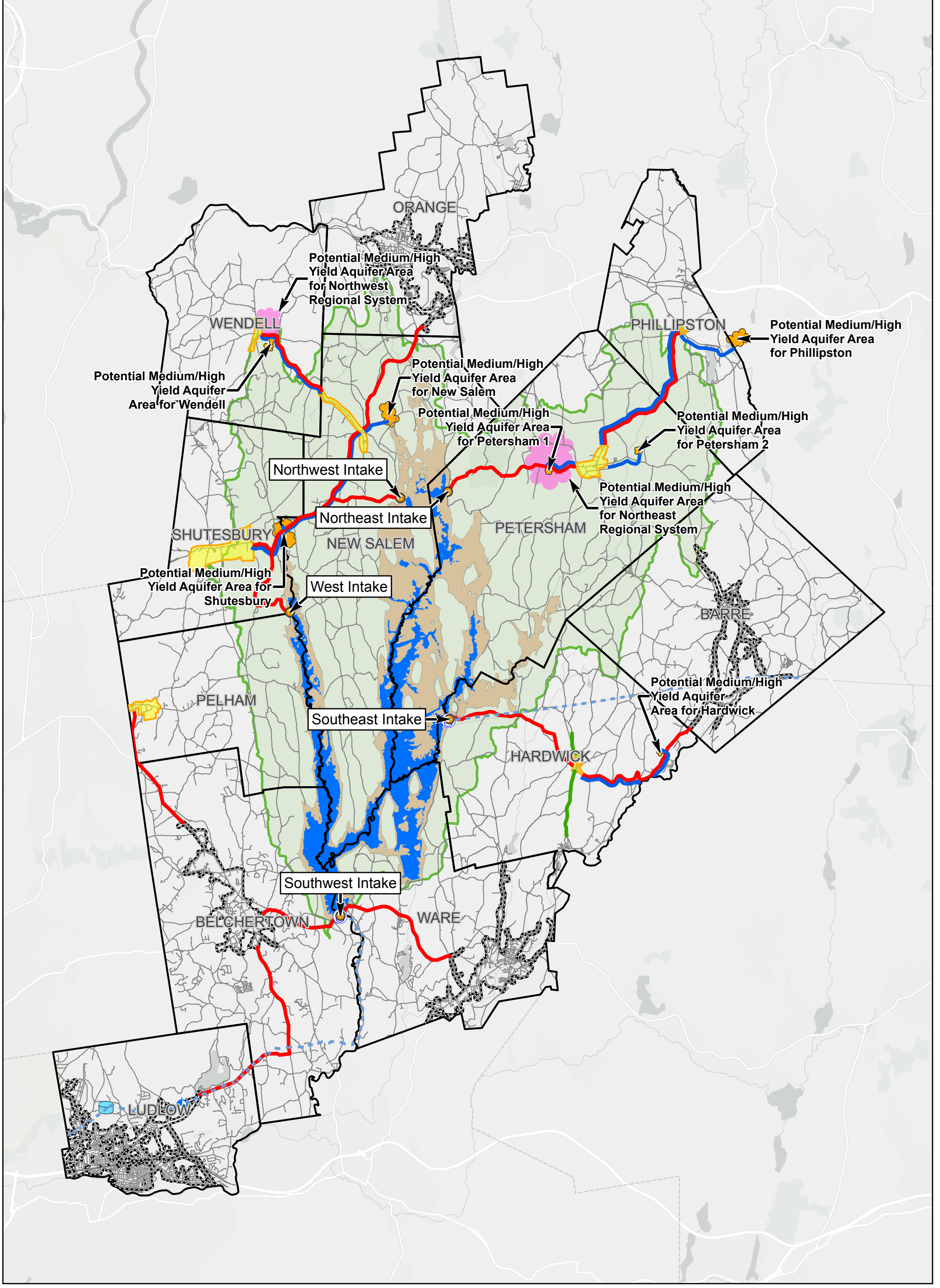
The 20% contingency factor was included in the water demand estimates to account for:

- The potential for expanding the system to existing developments that are not included in the proposed service areas.
- Uncertainty in estimating demands for towns without an existing COM PWS (i.e., without historical consumption data).
- Unaccounted-for water (UAW).

This contingency factor was also intended to account for other potential existing users that could be added to the service area. The 20% contingency factor is not intended to account for potential growth in any existing water system or town. Estimated demands for service

areas in each study community with the 20% contingency factor are summarized in Table 4-1.

As projects progress, the estimated demands in Table 4-1 could be updated to reflect the authorized withdrawals under the Water Management Act (WMA) for the COM PWSs in Barre, Belchertown, Orange, and Ware.



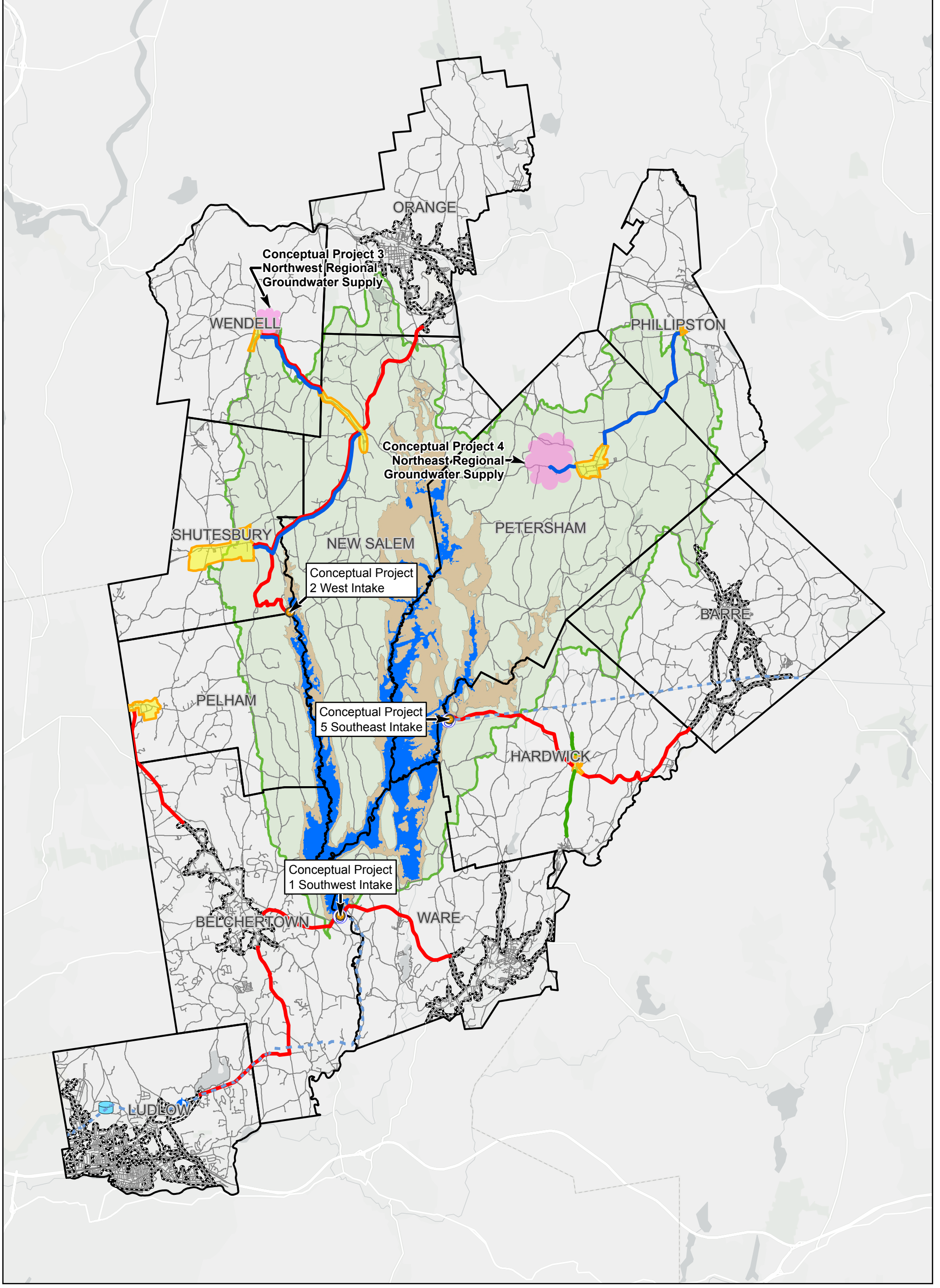
**Figure 4-1**  
**Potential Groundwater and Surface Water Intake Expansion Alternatives**  
 MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities  
 September 2025

**LEGEND**

CVA Pressure Reducing Valve	Conceptual Transmission Main Route - Groundwater	Existing Aqueduct	Proposed Service Area for Towns Without PWS	Quabbin Reservoir Drought Water Surface Elevation Below S3 Drought Emergency
Quabbin Intake	Conceptual Transmission Main Route - Surface Water	Road	Existing Water Service Area	Quabbin Reservoir Drought Water Surface Elevation Above S3 Drought Emergency
Nash Hill Water Tank	Hardwick Extension	Potential Medium/High Yield Aquifer Area (Decentralized)	Town Boundary	
Proposed Intake Location		Potential Medium/High Yield Aquifer Area (Regional)	Quabbin Reservoir Watershed	

1:240,000  
 1 inch = 20,000 feet

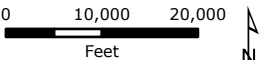
0 10,000 20,000  
 Feet



**LEGEND**

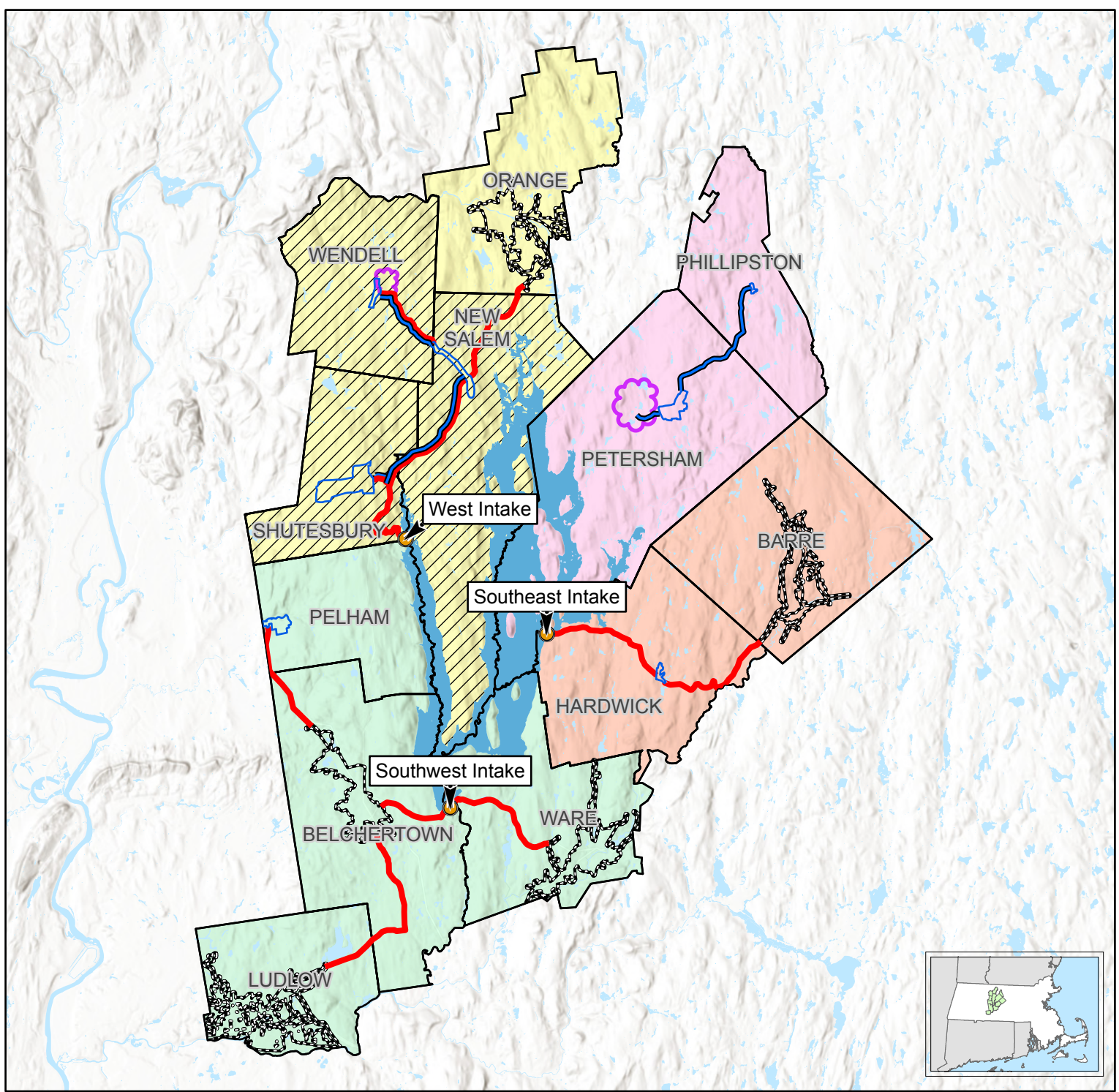
- CVA Pressure Reducing Valve
- Existing Quabbin Intake
- Nash Hill Water Tank
- Proposed Intake Location
- Conceptual Transmission Main Route - Groundwater
- Conceptual Transmission Main Route - Surface Water
- Conceptual Transmission Main - Raw Water Intake
- Hardwick Extension
- Existing Aqueduct
- Road
- Potential Medium/High Yield Aquifer Area (Regional)
- Proposed Service Area for Towns Without PWS
- Existing Water Service Area
- Town Boundary
- Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation
- Below S3 Drought Emergency
- Above S3 Drought Emergency

1:240,000  
1 inch = 20,000 feet



**Figure 4-2  
Conceptual Projects  
Overview**  
MWRA Water System Expansion  
Evaluation to Quabbin Reservoir  
Watershed Communities

September 2025



**Legend**

- Proposed Intake Location
- Conceptual Transmission Main Route - Groundwater
- Conceptual Transmission Main Route - Surface Water
- Proposed Service Area
- Potential Medium/High Yield Aquifer Area (Regional)
- Existing Water Service Area
- Quabbin Reservoir

**Towns Served by Conceptual Projects**

- 1: Southwest Intake
- 2: West Intake
- 3: Northwest Regional Groundwater Supply
- 4: Northeast Regional Groundwater Supply
- 5: Southeast Intake

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 4-3  
Towns Served By Conceptual Projects

September 2025



1:432,000  
0 18,000 36,000  
1 inch = 36,000 feet Feet



**TABLE 4-1**  
Study Community Demands Used for System Expansion Alternatives<sup>1</sup>

<b>Community</b>	<b>Average Day Demand (gpd)</b>	<b>Maximum Day Demand (gpd)</b>
Barre	440,000	752,000
Belchertown	292,000	580,000
Hardwick (with Extensions) <sup>2</sup>	136,000	314,000
Ludlow <sup>3</sup>	1,672,000	3,344,000
New Salem	15,000	32,000
Orange	460,000	1,145,000
Pelham	20,000	40,000
Petersham	26,000	51,000
Phillipston	6,000	12,000
Shutesbury	32,000	63,000
Ware	680,000	960,000
Wendell	9,000	17,000
<b>Total</b>	<b>3,788,000</b>	<b>7,310,000</b>

1. Demands from Table 3-6 plus a 20% contingency factor. This 20% contingency factor is not intended to account for potential growth in any existing water system or town (see Section 4.1 discussion).
2. Hardwick (with extensions) includes Hardwick Center Water District, Gilbertville Water District, Wheelwright Water District and the Eagle Hill School.
3. Demands for Ludlow are estimated since actual demand data are not available. See Table 3-6 for additional information on Ludlow demands.

## 4.2 Overview of Potential System Expansion Alternatives

Supply sources for the Quabbin Watershed Communities consist of new groundwater wells and the Quabbin Reservoir. This section describes the potential supply sources considered for this evaluation.

### 4.2.1 Groundwater Supply Alternatives

One option for serving the Quabbin Watershed communities is with new groundwater wells. While MWRA assumes that the community or communities would own and operate these systems, MWRA could facilitate permanent water supply easements (with the support of the Department of Conservation and Recreation (DCR), the Executive Office of Energy and Environmental Affairs (EEA), and other agencies) on protected watershed lands that would allow for a highly protected water supply. MWRA would work with the community or communities to determine appropriate well locations relative to natural water resources such as streams and surface waters.

Potential groundwater alternatives were considered for Towns without existing COM PWSs (Phillipston, Petersham, New Salem, Shutesbury, and Wendell) with the following exceptions:

- A groundwater alternative is presented for the Town of Hardwick due to the small size of the existing COM PWSs which serve individual areas of town. The new

groundwater alternative would supply all the service areas included in the Hardwick alternative (Hardwick Center, Gilbertville, Wheelwright, and Eagle Hill School).

- A groundwater alternative was not included for Pelham since the proposed service area in Pelham is mostly supplied by the existing Amherst PWS.

#### 4.2.1.1 Potential Groundwater Alternatives

The groundwater alternatives considered in this evaluation consist of regional systems supplying more than one community and decentralized systems supplying an individual community. Potential groundwater supply alternatives are listed below. Service areas within study communities that could be supplied by each potential groundwater source are noted. Figure 4-3 shows which communities are grouped into the Northwest and Northeast regional areas.

- Northwest Region
  - Decentralized Groundwater Systems to serve New Salem, Wendell, and Shutesbury independently.
  - A Regional Groundwater System to supply New Salem, Wendell and Shutesbury.
- Northeast Region
  - Decentralized Groundwater Systems to serve Petersham and Phillipston independently.
  - A Regional Groundwater System supplying Petersham and Phillipston.
- Hardwick
  - Decentralized Groundwater System to supply Hardwick including Hardwick Center Water District, Gilbertville Water District, Wheelwright Water District and the Eagle Hill School.

New groundwater supplies must adhere to Massachusetts Drinking Water Regulations and the Water Management Act. Additionally, any proposed well within the Quabbin Watershed would require jurisdictional review and approval by the MWRA and other regulatory agencies. As mentioned, the MWRA, in coordination with these agencies, could facilitate permanent water supply easements on protected watershed lands, ensuring a highly safeguarded water source. However, the discussion in this plan is conceptual and does not aim to identify all possible well locations, nor does it propose specific sites. Comprehensive groundwater siting studies would be necessary to guarantee adequate protection of new sources and to ensure that any related infrastructure does not negatively affect nearby natural resources.

For all groundwater supply alternatives, the following would need to be constructed:

- Treatment
- Water transmission mains
- Pump stations
- Storage

Additional information on these infrastructure components is provided in Section 4.3. Further preliminary evaluations, test drilling and water quality testing would need to be

conducted if any of the potential groundwater exploration alternatives are pursued. Once a well site location is selected, adequate space for the required Zone I protective radius would be needed, which is typically 400 feet (per 310 CMR 22.02).

Additional considerations for a groundwater alternative include:

- Preliminary new source permitting
- Land procurement or easement (if necessary)
- Construction of production well(s)
- Pump test(s)
- Final New Source Permitting
- Design and construction of well facility
- Wellhead protection compliance process
- Site inspection of permanent works and final source approval

Treatment of groundwater sources would be specific to the needs of the well water quality and to the needs and preferences of the individual community, which would therefore require further study. Any projects that move forward will need to perform a thorough analysis to determine if any water quality issues are present and consider what is required for treatment. Groundwater treatment assumptions for the purposes of this evaluation are discussed further in Section 4.3.5.

#### **4.2.1.2 Potential Groundwater Exploration Locations**

As a first step, approximate locations for potential groundwater explorations were determined based on areas with high groundwater availability and favorability according to United States Geological Survey (USGS) panels (*Groundwater Favorability of the Connecticut River Basin, New England States, Atlas HA-249, dated 1967* and *Groundwater Availability in the North Part of the Connecticut Valley Urban Area, Central New England, Map I-1074-I, dated 1980*).

Potential exploration areas were limited to mapped locations shown as capable of yielding moderate to large amounts of water that were near the service areas of study communities. Additional evaluation of the potential groundwater exploration areas is needed if alternatives advance to determine actual aquifer yields. The possibility of finding high yield areas outside of the USGS mapped areas should also be considered and evaluated if alternatives are advanced, as there are several existing non-community and community system wells in each of the study communities that are outside the USGS mapped areas.

After initially selecting potential exploration areas based on regions with high groundwater availability and suitability as identified by USGS mapping, the locations were further refined with a preference for undeveloped and publicly accessible land. However, as noted, the potential locations presented in this plan are conceptual. They do not represent an exhaustive list of possible well sites, nor do they imply a preference for specific locations. Detailed groundwater siting studies would be required to ensure adequate protection of new sources and to prevent any negative impact from related infrastructure on nearby natural resources.

The potential groundwater exploration locations for the regional and decentralized options are shown in Figure 4-1.

**4.2.1.3 Evaluation of Groundwater Alternatives**

For the Decentralized Groundwater System alternatives, potential exploration areas could generally be sited in publicly available undeveloped land. Most of the potential high yielding areas near the proposed service areas are in protected and recreational open spaces. Developing a well in protected watershed land would ensure a highly safeguarded water source but would require approval from regulatory agencies, including MWRA and the Massachusetts Legislature under Article 97.

The Decentralized Groundwater System alternatives were considered less favorable for further evaluation than the Regional Groundwater System alternatives early in the review process for the following reasons:

- A greater number of decentralized projects would need to be evaluated to include the same number of communities that could be served by two regional projects.
- More groundwater sources would be required for decentralized projects, meaning more sources to potentially site, develop, test, operate, treat, and maintain.
- From a managerial and operational perspective, a regional system is more efficient than several decentralized systems.

Therefore, the Decentralized Groundwater System alternatives were not evaluated further.

The Regional Groundwater System alternatives were further evaluated, but few locations met the necessary criteria for potential groundwater exploration. A regional system would require higher-yield wells compared to decentralized systems, necessitating larger exploration areas and likely 400-foot protective radii, whereas smaller-yield wells might allow for smaller protective zones. As a result, parts of the proposed exploration areas fall within protected and recreational open spaces. While these areas would provide a highly safeguarded water source, they would also require approval from regulatory agencies, including the MWRA and the Massachusetts Legislature under Article 97.

Additionally, although it would be preferable to limit exploration areas to publicly owned land, portions of the proposed explorations areas for the Regional Groundwater System alternatives fall within privately owned land. The purchase of private property adds an additional risk to the project if the property owner is unwilling to sell.

Figure 4-2 shows the potential groundwater exploration locations for the Northwest and Northeast Regional Groundwater System alternatives. For the Northwest Regional Groundwater System alternative, the location in Wendell was selected because it has the advantage of being at a higher elevation compared to areas in New Salem and Shutesbury, which minimizes pumping requirements. For the Northeast Regional Groundwater System alternative, the location in Petersham was selected because the potential area closest to the Phillipston service area is in Templeton.

#### 4.2.1.4 Summary of Groundwater Alternatives

Table 4-2 summarizes the needed capacity, length of transmission main needed for each alternative, and area of potential groundwater exploration within locations mapped as medium to high yield aquifers. The needed capacity was calculated using the MDD of the service areas supplied. Figure 4-1 shows the locations of the potential medium/high yield aquifer areas for each alternative, proposed transmission mains and potential service areas. As noted, the Decentralized Groundwater System alternatives were not retained for further evaluation. If a community was interested in pursuing a decentralized groundwater system, it would generally consist of separate wells for each community (at least one primary and one backup well) as well as WTPs for each community to address water quality issues, if any. A decentralized system would still require elevated WSTs for equalization and fire flow storage and distribution system piping sized for fire protection. However, transmission mains between communities would not be required. As previously discussed, comprehensive groundwater siting studies would be necessary to guarantee adequate protection of new sources and to ensure that any related infrastructure does not negatively affect nearby natural resources.

**TABLE 4-2**  
Summary of Groundwater Exploration Alternatives <sup>5</sup>

<b>Alternative</b>	<b>Water Demand Capacity Needed (Max Day Demand, gpd)<sup>3</sup></b>	<b>Length of Proposed Transmission Mains (Miles)<sup>4</sup></b>
<b><i>Decentralized Groundwater Systems</i></b>		
Shutesbury	63,000	1.6
Wendell	17,000	0.6
New Salem	32,000	0.9
Petersham <sup>1</sup>	51,000	1.2
Phillipston	12,000	3.0
Hardwick	314,000	3.7
<b><i>Regional Groundwater Systems<sup>2</sup></i></b>		
Northwest Regional – Supplies Shutesbury, Wendell, and New Salem	112,000	9.2
Northeast Regional – Supplies Petersham and Phillipston	63,000	6.0

1. There are two potential groundwater exploration areas in Petersham, as shown in Figure 4-1. Both are approximately the same distance from the proposed service area.
2. Potential exploration areas for regional groundwater systems were expanded to account for higher required yields and available (e.g., undeveloped and publicly available) land. Northwest Regional area located in Wendell. Northeast Regional area located in Petersham.
3. Water demands are rounded up to the nearest hundred.
4. Approximate lengths are from each groundwater exploration area to the center of each proposed service area.
5. Further analysis is required to determine actual aquifer yield and permitting constraints including a well development study. Areas noted in this table were determined from USGS aquifer favorability mapping.

### 4.2.2 Surface Water System Alternatives

Another option for serving the Quabbin Watershed communities is from new surface water intakes from the Quabbin Reservoir. These alternatives would require surface water intakes and WTPs.

For these alternatives, locations with suitable access and proximity were identified. Potential surface water intake alternatives were considered for all the study communities.

#### 4.2.2.1 Potential Surface Water Alternatives

The surface water alternatives considered in this evaluation consist only of systems capable of supplying more than one community from a new surface water intake at the Quabbin Reservoir. The following potential surface water system alternatives were identified, which are shown on Figure 4-1. Service areas within study communities that could be supplied by each system are noted.

- Southwest Region
  - Supplies Belchertown, Ware, Ludlow, and Pelham
- West or Northwest Region
  - This alternative considered a new intake at two different locations
  - Supplies New Salem, Wendell, Shutesbury, and Orange
- Northeast Region
  - Supplies Petersham and Phillipston
- Southeast Region
  - Supplies Hardwick and Barre

New surface water sources would need to comply with the Massachusetts Guidelines for Public Water Systems Chapter 3: Surface Water Supply Development. For all new Surface Water System alternatives, the following would need to be provided:

- Treatment
- Water transmission mains
- Pump stations
- Storage

Additional information on these infrastructure components is provided in Section 4.3. Further study will be required to identify other needs if any of these projects move forward such as a review of maintenance of chlorine residual, water age, and an updated bathymetric survey. Surface water treatment assumptions for the purposes of this evaluation are discussed further in Section 4.3.5.

#### 4.2.2.2 Potential Surface Water Intakes

Locations for new surface water intakes to supply the Surface Water System Regions listed above were primarily based on the intake being able to function under all drought conditions (i.e., able to draw water even under low reservoir levels). MWRA provided its Drought Trigger Plan, which is outlined in Table 4-3. The Drought Trigger Plan indicates Quabbin water elevations at each drought stage. MWRA also provided bathymetric data of the Quabbin Reservoir from the Department of Conservation and Recreation (DCR).

DCR indicated that the datum of the bathymetric data is not known with certainty. It was assumed that the bathymetric data is in NAVD88 feet since that is more conservative. DCR also indicated that due to the age of the bathymetric data, an updated bathymetric survey would be needed if a new intake project was advanced.

**TABLE 4-3**

Elevation of Quabbin Reservoir in MWRA Drought Trigger Plan

Drought Stages	Trigger (%)	Quabbin Elevation (ft)			
		Lower Bound		Upper Bound	
		BCB <sup>1</sup>	NAVD88	BCB <sup>1</sup>	NAVD88
Normal	80-100%	519	512.5	530	523.5
Below Normal	65-90%	510	503.5	525	518.5
Drought Warning	50-75%	500	493.5	516	509.5
S1 Drought Emergency	38-50%	490	483.5	500	493.5
S2 Drought Emergency	25-38%	477	470.5	490	483.5
S3 Drought Emergency	Below 25%			477	470.5

1. Boston City Base (BCB) Datum = 6.46 feet + NAVD88 Datum

The most severe drought stage S3 was used so that a new intake would be functional under all drought conditions. Potential intake locations were identified at or below an elevation of 477 feet BCB (470.5 feet NAVD88). Figure 4-1 shows the Quabbin Reservoir ground elevation based on if it is below the S3 drought emergency (blue) or above the S3 drought emergency (beige). Intakes should be in blue areas to be functional under all drought conditions. The northern regions of Quabbin Reservoir have limited areas at appropriate depth but there are more suitable locations in the southern region of the Quabbin Reservoir.

As shown in Figure 4-1, the Northwest intake would draw from a small noncontiguous impoundment during drought conditions. As such, the West intake was advanced over the Northwest Intake since it could supply the same communities as the Northwest Intake.

### 4.2.2.3 Summary of Surface Water Alternatives

Table 4-4 summarizes the needed capacity and length of transmission main needed for each Surface Water System alternative. The needed capacity was calculated using the MDD of the service areas supplied. Figure 4-1 shows the locations of the new intake alternatives, proposed transmission mains and potential service areas. As noted, the Northwest Intake alternative was not retained for further evaluation as it would draw from a small noncontiguous impoundment during drought conditions. In addition, the Northeast Intake alternative was not retained for further evaluation as the Northeast Regional Groundwater Supply project would supply the same communities.

**TABLE 4-4**  
Summary of New Surface Water Intake Alternatives

<b>Alternatives</b>	<b>Communities Supplied</b>	<b>Water Demand Capacity Needed Max Day Demand (MGD)</b>	<b>Length of Proposed Transmission Mains (Miles)<sup>1</sup></b>
Southwest Intake	Ware, Belchertown, Ludlow, Pelham	5.0	19
West Intake	Shutesbury, New Salem, Wendell, and Orange	1.3	17
Northwest Intake	Shutesbury, New Salem, Wendell, and Orange	1.3	16
Northeast Intake	Petersham and Phillipston	0.06	10
Southeast Intake	Hardwick and Barre	1.1	13

1. Includes raw water and finished water transmission mains from the proposed WTP to the center of each proposed service area or to the nearest existing distribution main, where connecting to an existing system (e.g., Barre, Belchertown, Ludlow, and Orange).

### 4.2.3 Selected Conceptual Project Alternatives

Five conceptual expansion projects to serve the Quabbin Reservoir Watershed communities were selected from the potential groundwater and surface water alternatives for further evaluation. The five conceptual projects are generally described as follows:

- Conceptual Project 1 – Southwest Intake
  - Supplies Belchertown, Ware, Ludlow and Pelham
- Conceptual Project 2 – West Intake
  - Supplies New Salem, Wendell, Shutesbury and Orange
- Conceptual Project 3 – Northwest Regional Groundwater Supply
  - Supplies New Salem, Wendell, and Shutesbury
- Conceptual Project 4 – Northeast Regional Groundwater Supply
  - Supplies Phillipston and Petersham
- Conceptual Project 5 – Southeast Intake
  - Supplies Hardwick and Barre

The five conceptual projects are shown in Figure 4-2 and summarized in Table 4-5. Infrastructure components, development of raw water sources and drinking WTPs for the conceptual projects are discussed in Section 4.3. Further details for each conceptual project are provided in Section 4.4. Section 4.2.1 provides information on reasons why the regional groundwater supply alternatives were advanced over the decentralized alternatives.

**TABLE 4-5**  
Summary of Conceptual Projects Evaluated

Conceptual Project		Capacity Provided (MGD)		Towns Served
No.	Name	ADD <sup>1</sup>	MDD <sup>1</sup>	
1	Southwest Intake	2.7	5.0	Belchertown, Ware, Ludlow, and Pelham
2	West Intake	0.5	1.3	New Salem, Wendell, Shutesbury, and Orange
3	Northwest Regional Groundwater Supply	0.06	0.1	New Salem, Wendell, and Shutesbury
4	Northeast Regional Groundwater Supply	0.03	0.06	Phillipston and Petersham
5	Southeast Intake	0.6	1.1	Hardwick and Barre

1. Average day demand (ADD), maximum day demand (MDD). Demands include 20% contingency factor. This 20% contingency factor is not intended to account for potential growth in any existing water system or town (see Section 4.1 discussion).

## 4.3 Infrastructure Components

### 4.3.1 Water Transmission Mains

Water transmission main routes were identified to connect proposed intakes and groundwater sources to each community. Routing generally followed major streets and roadways. Figure 4-2 shows the proposed locations of the transmission mains for the conceptual projects. The routing may change as further studies are conducted if any of the conceptual projects are advanced. Wetland crossings were avoided where possible. However, if wetlands crossings are needed, that can be addressed in future permitting tasks. Bridges and culverts were identified along the water main routes based on aerial imagery but should be confirmed if any of the conceptual projects are advanced.

Water main sizing was based on MassDEP Guidelines. Water mains were sized to provide maximum velocities of 2.5 to 3.0 fps. MassDEP Guidelines indicate water main diameters shall be at least 8-inch if providing fire protection or at least 3-inch if not providing fire protection.

It is assumed fire protection will be provided within proposed service areas and the minimum diameter of new mains in these locations would be 8-inch.

Transmission mains connecting service areas (e.g., between Shutesbury and New Salem) were assumed not to provide fire protection, as this would be provided by atmospheric storage for each service area. The minimum diameter of new transmission mains connecting service areas would be 3-inch but still required to meet the maximum pipe velocity criteria of 2.5 fps to 3.0 fps. It is important to consider water age for these potential projects. Many transmission main lengths are extensive and some communities have low demands. This would result in high storage volumes in the distribution system if the water main diameters are sized too large. There could be issues with water quality deterioration due to high water age such as formation of disinfection byproducts. It is also important to consider minimum velocities for low flow transmission mains. Frequent flushing may be needed if there are sections with lower flows. Cement lined ductile iron (CL DI) was assumed for the water main material.

Note that there may be multiple transitions between small diameter transmission mains (e.g. 3-inch) to larger diameter transmission mains ( $\geq 8$ -inch) back down to small diameter transmission mains, such as between service areas and the mains connecting the service areas. If any of the conceptual projects are advanced, the designer should consider potential issues with these diameter changes, such as increasing the potential for water main breaks as the mains age. Also note that transmission mains are typically larger in diameter, but in this study, 3-inch diameter transmission mains are appropriate based on the low demands of the service areas and potential high water age issues.

This project does not take into account replacement of existing water mains within the distribution systems of existing COM PWSs. This evaluation is based on fire flow requirements for existing conditions and did not consider potential for future development not specifically requested to be included. Additional information on fire protection is provided in Section 4.3.3.

Infrastructure components for water transmission mains are summarized in Table 4-6; several assumptions are based on MWRA's standard pipeline design guidance. Table 4-7 provides a breakdown of pipes for the conceptual expansion projects by diameter. While diameters were selected based on the criteria described above, it is understood that some

ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.

**TABLE 4-6**

Infrastructure Components - Water Transmission Mains  
(with Associated Appurtenances and Paving)

Infrastructure Component	Assumptions
Transmission Mains	<ul style="list-style-type: none"> <li>• For pipes <math>\leq</math> 24 inches: zinc-coated, cement-lined ductile iron (CL DI), Class 52 <sup>1</sup></li> <li>• Utility bridges or directional drilling for all major crossings (bridge, highway, railroad, river, stream)</li> </ul>
Gate Valves and Butterfly Valves	<ul style="list-style-type: none"> <li>• For pipes <math>\leq</math> 24 inches: gate valves <sup>1</sup></li> <li>• Spacing every 2,500 ft along all new mains and at community connection points</li> <li>• Includes valve boxes</li> </ul>
Air Release Valves and Blow Off Valves	<ul style="list-style-type: none"> <li>• Spacing every 2,500 ft</li> </ul>
Meter Vaults	<ul style="list-style-type: none"> <li>• At each community connection point</li> <li>• Vaults are equipped with the necessary mechanical, electrical, instrumentation and controls to collect flow and pressure measurements that can be communicated with MWRA and the community connected</li> <li>• Cabinets are above ground and includes equipment for power and communications</li> <li>• Includes venturi meter</li> </ul>
Paving	<ul style="list-style-type: none"> <li>• For transmission mains <math>\leq</math> 48 inches:               <ul style="list-style-type: none"> <li>○ MassDOT roads: 1 lane, includes final milling and paving (12 ft width lane)</li> <li>○ Local roads: 1 lane, includes final milling and paving (10 ft width lane)</li> </ul> </li> <li>• Bike trails: 10 ft width, complete replacement</li> </ul>
Hydrants	<ul style="list-style-type: none"> <li>• Spaced every 500 ft for water mains within proposed service area distribution systems.</li> </ul>

1. MWRA Standard.

**TABLE 4-7**  
Conceptual Project Pipe Lengths by Diameter

Pipe Diameter (inches) <sup>1,2</sup>	Southwest Intake	West Intake	Northwest Regional GW Supply	Northeast Regional GW Supply	Southeast Intake
	Project 1 (Miles)	Project 2 (Miles)	Project 3 (Miles)	Project 4 (Miles)	Project 5 (Miles)
≤4	4.2	3.0	9.2	6.1	-
6	-	-	-	-	3.7
8	2.2	9.8	9.8	4.9	6.0
10	4.7	8.6	-	-	4.9
12	--	5.0			
18	7.1	-	-	-	-
20	2.9	-	-	-	-
24	0.04	-	-	-	-
<b>Total</b>	<b>21.1</b>	<b>26.4</b>	<b>19.0</b>	<b>11.0</b>	<b>14.6</b>

1. All distribution system (DS) pipes are 8" diameter sized for fire protection; all transmission main (TM) pipes are sized for maximum pipe velocities of 2.5-3.0 fps. A breakdown of TM vs DS piping is provided in Tables 4-15 through 4-19 at the end of this Section. 24" provides 2.5 fps at 5 mgd, and 20" provides 2.8 fps at 4 mgd.
2. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.

### 4.3.2 Booster Pump Stations and Pressure Reducing Valves

Booster pump stations and PRVs are needed along most transmission mains to provide acceptable pressures along the transmission mains and to the service areas supplied. Assumed infrastructure components and criteria for booster pump stations and PRVs are summarized in Table 4-8.

**TABLE 4-8**

Infrastructure Components - Booster Pump Stations and PRVs

Infrastructure Component	Assumptions
Booster Pump Stations	<ul style="list-style-type: none"> <li>• Capacity: for each conceptual project, sized to provide maximum day demand for service area(s) supplied</li> <li>• Type: Split Case Centrifugal in Packaged Skids               <ul style="list-style-type: none"> <li>◦ Assumed efficiency of 80%</li> </ul> </li> <li>• Configuration: 2 duty, 1 standby</li> <li>• Packaged booster pumps with VFDs and Control Panel</li> <li>• Pump Station Building:               <ul style="list-style-type: none"> <li>◦ Floor area based on design capacity</li> <li>◦ Architecture: brick on block, cavity walls, pitched roof, single story, no basement</li> <li>◦ Outside standby generator in enclosure</li> </ul> </li> <li>• SCADA and instrumentation including flow meter</li> <li>• Site security, landscaping, and access road</li> </ul>
Pressure Reducing Valves (PRVs)	<ul style="list-style-type: none"> <li>• Configuration: one PRV at each station, with bypass</li> <li>• Vault: precast 6 ft x 10 ft, 6 feet high</li> </ul>

#### 4.3.2.1 Hydraulic Analysis

Distribution system hydraulics were evaluated to identify pump stations and pressure reducing valves needed along the proposed transmission mains to maintain acceptable pressures. Static hydraulic profiles were developed in Excel showing ground elevations and proposed HGLs. Hydraulic modeling software was used to confirm the transmission main HGLs and static pressures based on ground elevations. The hydraulic profiles are shown on Figures 4-4 through 4-11; these are referenced to NAVD88 datum (BCB Datum = 6.46 feet + NAVD88). Existing HGLs for Towns with COM PWSs or the approximate HGLs estimated for towns without existing COM PWSs (See Section 3.1.3) were used. These HGLs provide pressures ranging from 35 to 80 psi to customers and include PRVs as needed to individual / groups of customers for locations where pressures are greater than 80 psi. If any of the conceptual projects are advanced, some of the pump stations or PRVs could be eliminated with less stringent criteria determined during design.

Booster pump stations and PRVs would be needed along the transmission mains to maintain pressures within 35-200 psi in transmission mains. Pressures in the transmission mains were allowed to get significantly higher than would be acceptable in the service area distribution systems. Since ground elevations vary significantly along portions of the transmission main routes (alternating hills and valleys), PRVs were only used to keep pressures less than 200 psi. If the maximum pressure was lowered, then additional intermediate pump stations would be needed to maintain 35 psi along the high elevation points.

If water services are provided for properties located along transmission main routes, these water services would require individual PRVs. Potential risks associated with services along high pressure transmission mains should be considered if any of the projects are advanced. It was assumed that services along transmission main routes outside of the service areas would not be provided at this conceptual level of study.

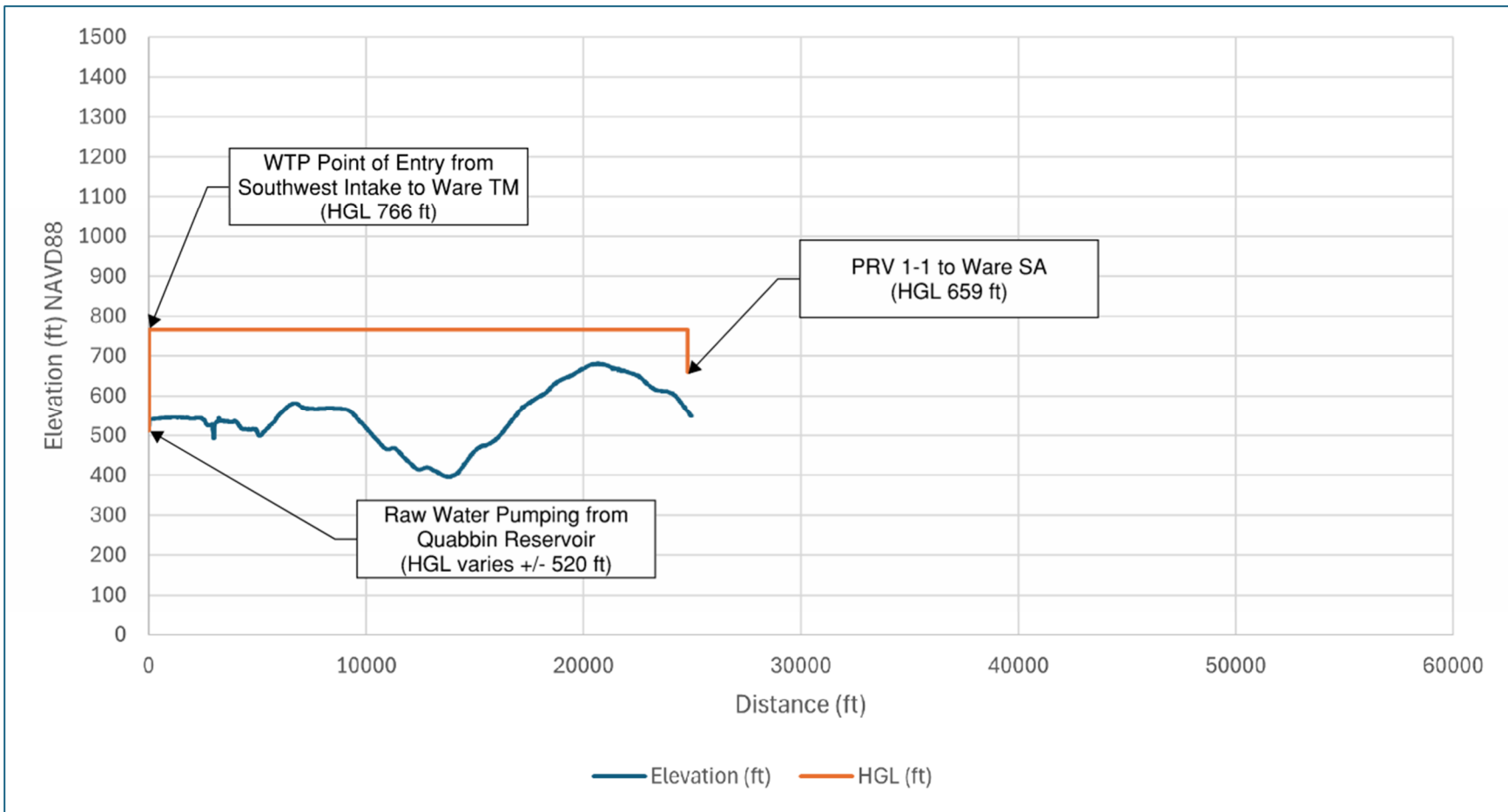
Some intermediate pump stations and PRVs are needed due to the wide range of elevations along the transmission main routes and service areas. The hydraulic profiles show the approximate locations of booster pump stations and PRVs needed along the transmission mains for each conceptual project. If any of the conceptual projects are advanced, a siting study to determine suitable locations for pump stations and PRVs should be conducted. The locations on the hydraulic profiles are approximate and should be refined as further project details are determined. Note that the hydraulic profiles present one option for layout of the transmission system for each conceptual project. There are other potential options for designing the transmission system layout and HGLs. Further hydraulic analysis is recommended if projects are advanced to refine HGLs, confirm suitable pressures in the mains, and refine alignments.

Table 4-9 provides a summary of the booster pump stations and PRVs. As illustrated, the Conceptual Projects involve multiple stages of pumping and pressure reduction through valves, to varying degrees, which is necessary to accommodate elevation changes in the area. This increases energy consumption due to repeated pressurization and throttling losses, causing inefficiencies as energy is diverted toward managing excess pressure.

**TABLE 4-9**  
Booster Pump Station and PRV Sizing Requirements

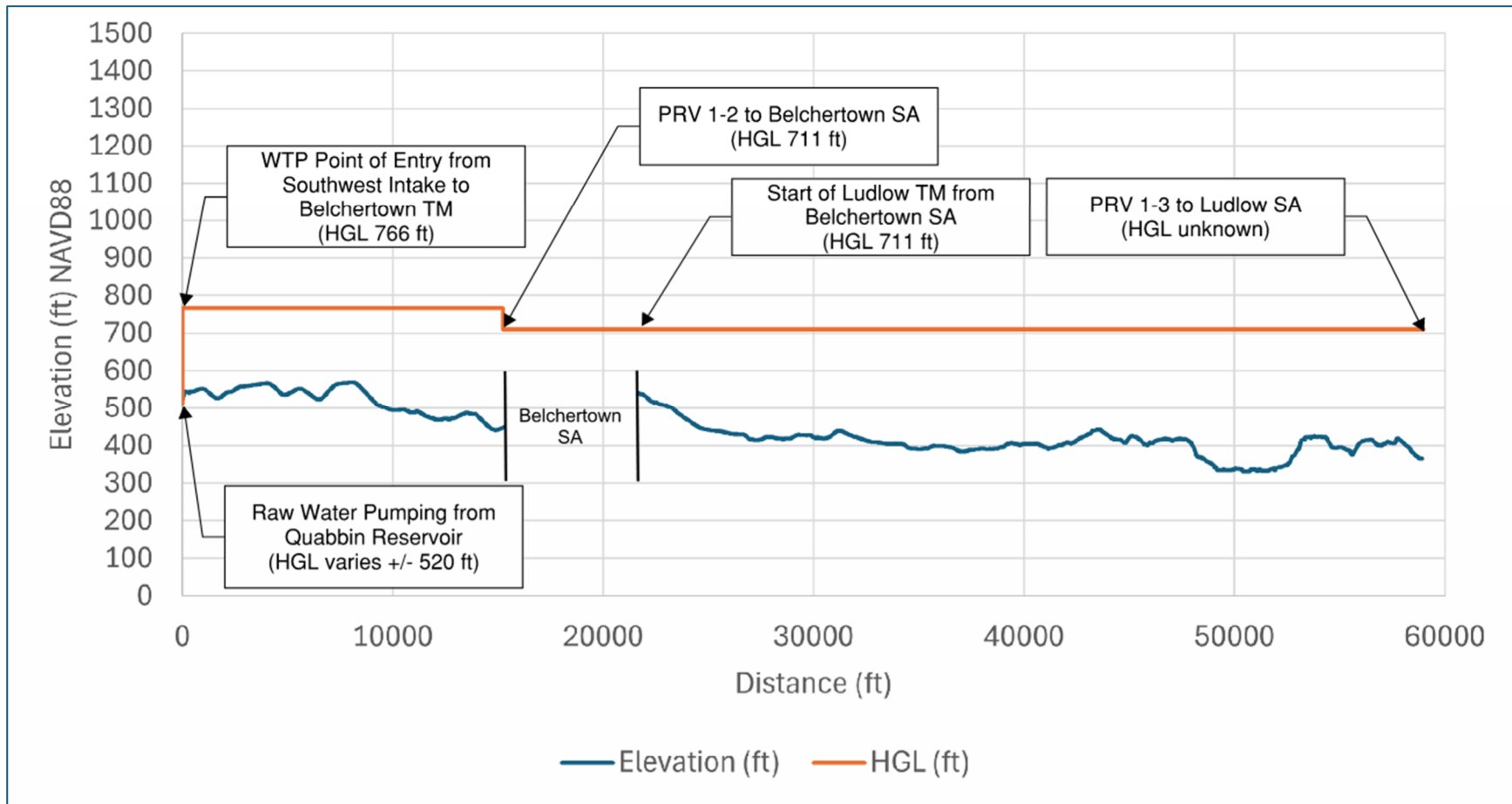
Booster Pump Station <sup>1</sup> / PRV	Flow Rate (MGD)	Upstream HGL <sup>2</sup>	Downstream HGL <sup>2</sup>	Total Dynamic Head (ft) (for PS)
<b>1. Southwest Intake</b>				
WTP Finished Water Pump	5.0	±520 <sup>1</sup>	766	±246
PRV 1-1 to Ware SA	0.96	766	659	--
PRV 1-2 to Belchertown SA	3.9	766	711	--
PRV 1-3 to Ludlow SA	3.3	711	See Footnote 4	--
PS-1 to Pelham TM	0.04	500 <sup>4</sup>	641	141
<b>2. West Intake</b>				
WTP Finished Water Pump	1.3	±520 <sup>1</sup>	987	±467
PS 2-1 to Shutesbury TM	1.3	987	1,108	121
PS 2-2 to Shutesbury SA	0.063	1,108	1,315	207
PRV 2-1 to New Salem TM	1.2	1,108	1,013	--
PS 2-3 to New Salem TM	1.2	1,013	1,110	97
PS 2-4 to New Salem SA	0.032	1,110	1,201	91
PS 2-5 to Wendell SA	0.016	1,201	1,253	52
PRV 2-2 to Orange TM	1.2	1,110	800 <sup>4</sup>	--
<b>3. Northwest Regional Groundwater Supply</b>				
PRV 3-1 to New Salem SA	0.094	1,253	1,201	--
PRV 3-2 to Shutesbury TM	0.063	1,201	1,013	--
PS 3-1 to Shutesbury SA	0.063	1,013	1,315	302
<b>4. Northeast Regional Groundwater Supply</b>				
PS 4-1 to Petersham SA	0.062	1,058	1,173	115
PS 4-2 to Phillipston TM	0.012	1,173	1,253	80
<b>5. Southeast Intake</b>				
WTP Finished Water Pump	1.1	±520 <sup>1</sup>	1,010	±490 <sup>1</sup>
PS 5-1 to Hardwick Center TM	1.1	1,010	1,060	50
PRV 5-1 to Barre TM	0.75	1,060	746	--
PS 5-2 to Barre SA	0.75	746	See Footnote 4	--
PRV 5-2 to Gilbertville SA	0.12	1,060	1,009	--
PS 5-3 to Eagle Hill School SA	0.03	1,060	See Footnote 4	--

1. Groundwater wells and raw water pump stations are not listed in this table. Refer to Section 4.4 for further information. Upstream hydraulic grade line of surface water WTP finished pump varies. Downstream pressure of Southeast Intake WTP finished water pump exceeds ±200 psi maximum pressure criteria.
2. Hydraulic Grade Line (HGL) in NAVD88 feet. BCB Datum = 6.46 feet + NAVD88
3. SA: Service Area; TM: Transmission Main; PS: Pump Station; PRV: Pressure Reducing Valve
4. Connection point to Pelham TM is from Belchertown SA's reduced zone (HGL is approximate); HGL of Ludlow SA at connection point is not known but is assumed similar to the Nash Hill Tanks overflow elevation; HGL of Orange estimated; Barre HGL is approx. 866 feet (low zone) or 1058 feet (high zone) at connection point; the HGL of the Eagle Hill School is not known but a pump station is assumed to be needed due to the higher ground elevation of the school. Assumed no PS or PRV needed to supply Wheelwright SA.



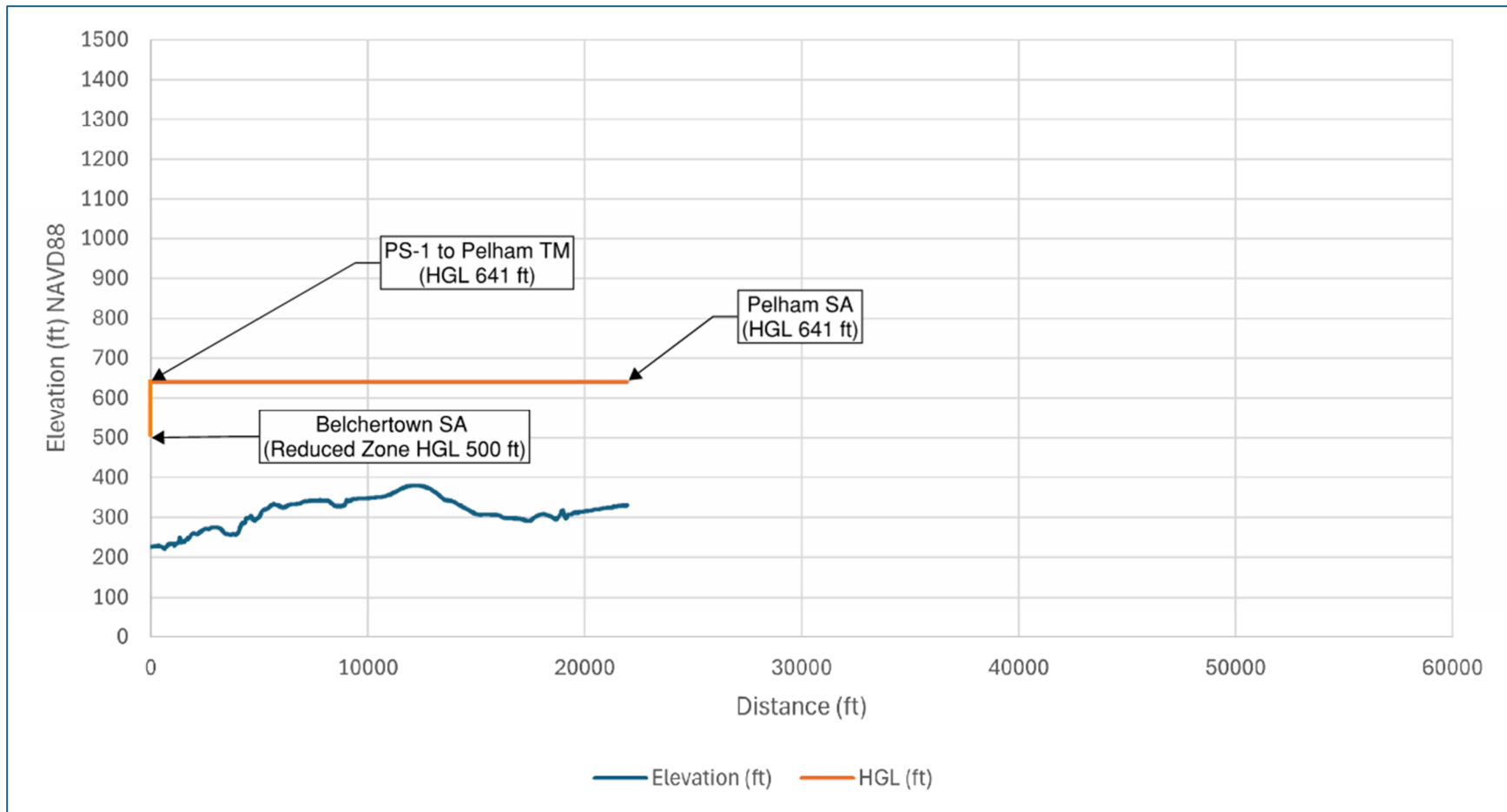
1. TM: Transmission Main, SA: Service Area

**FIGURE 4-4: Conceptual Project 1  
Southwest Intake Hydraulic Profile – Ware**



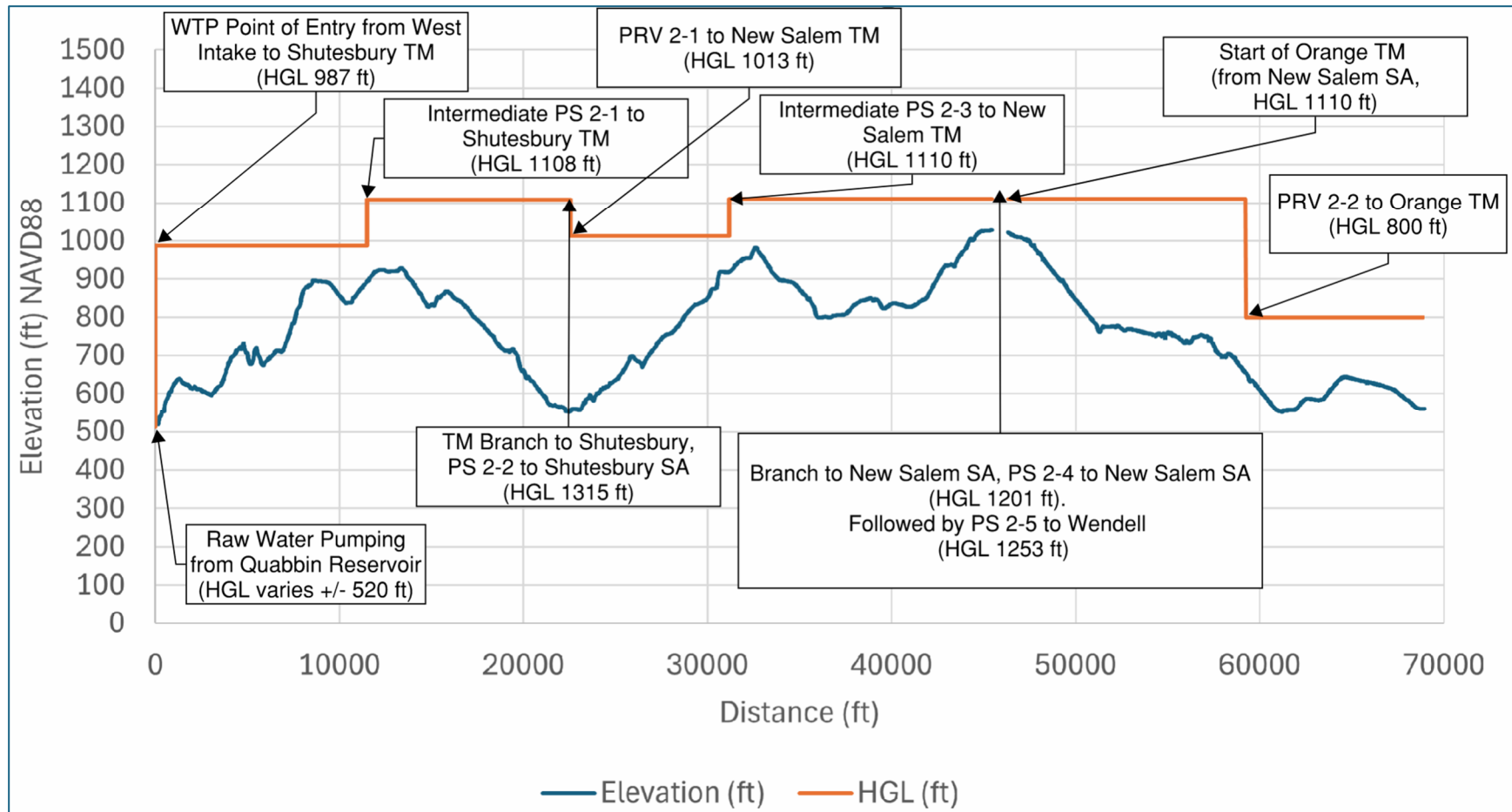
1. TM: Transmission Main, SA: Service Area

**FIGURE 4-5: Conceptual Project 1**  
**Southwest Intake Hydraulic Profile – Belchertown and Ludlow**



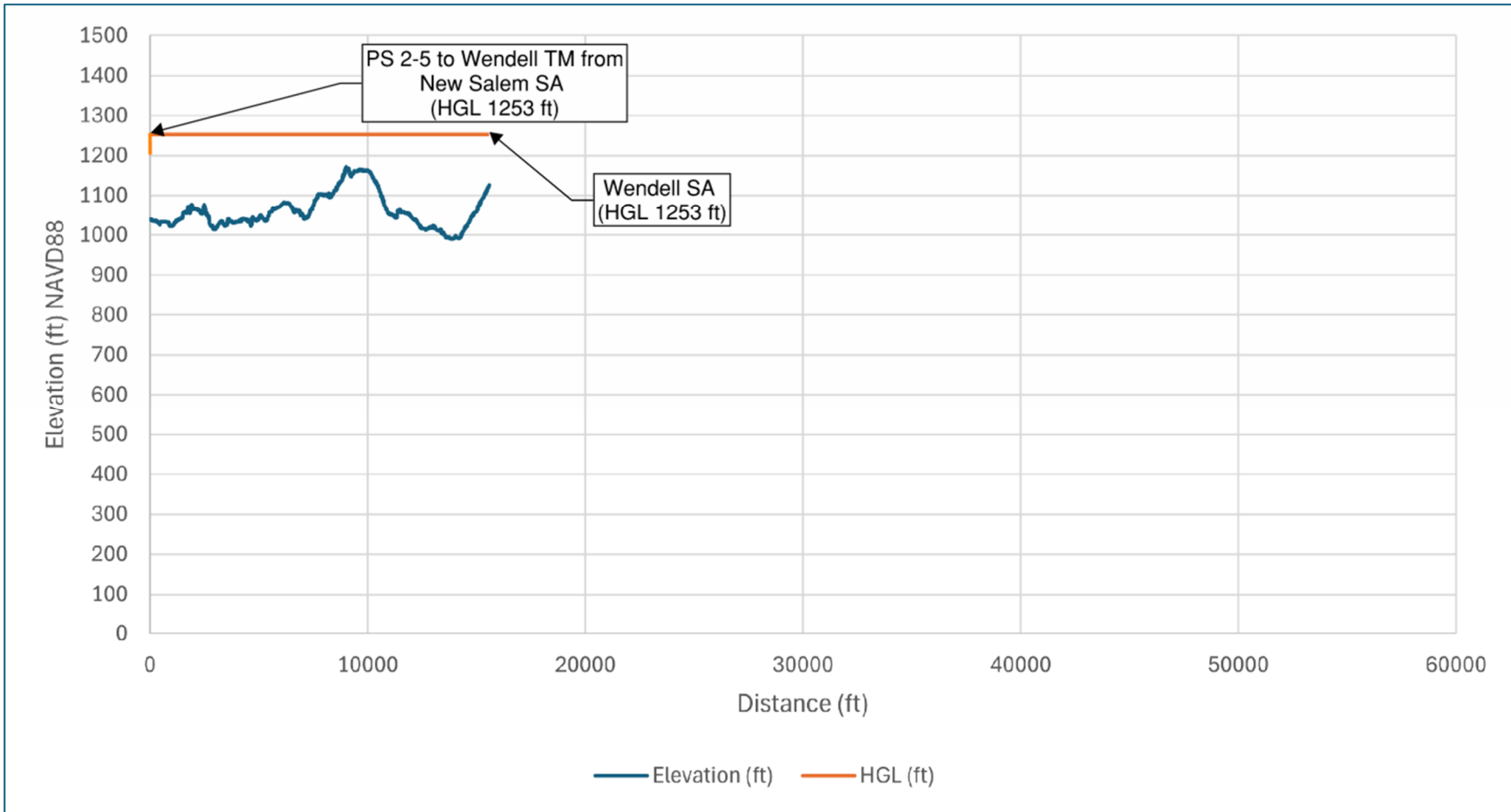
1. TM: Transmission Main, SA: Service Area

**FIGURE 4-6: Conceptual Project 1  
Southwest Intake Hydraulic Profile – Pelham**



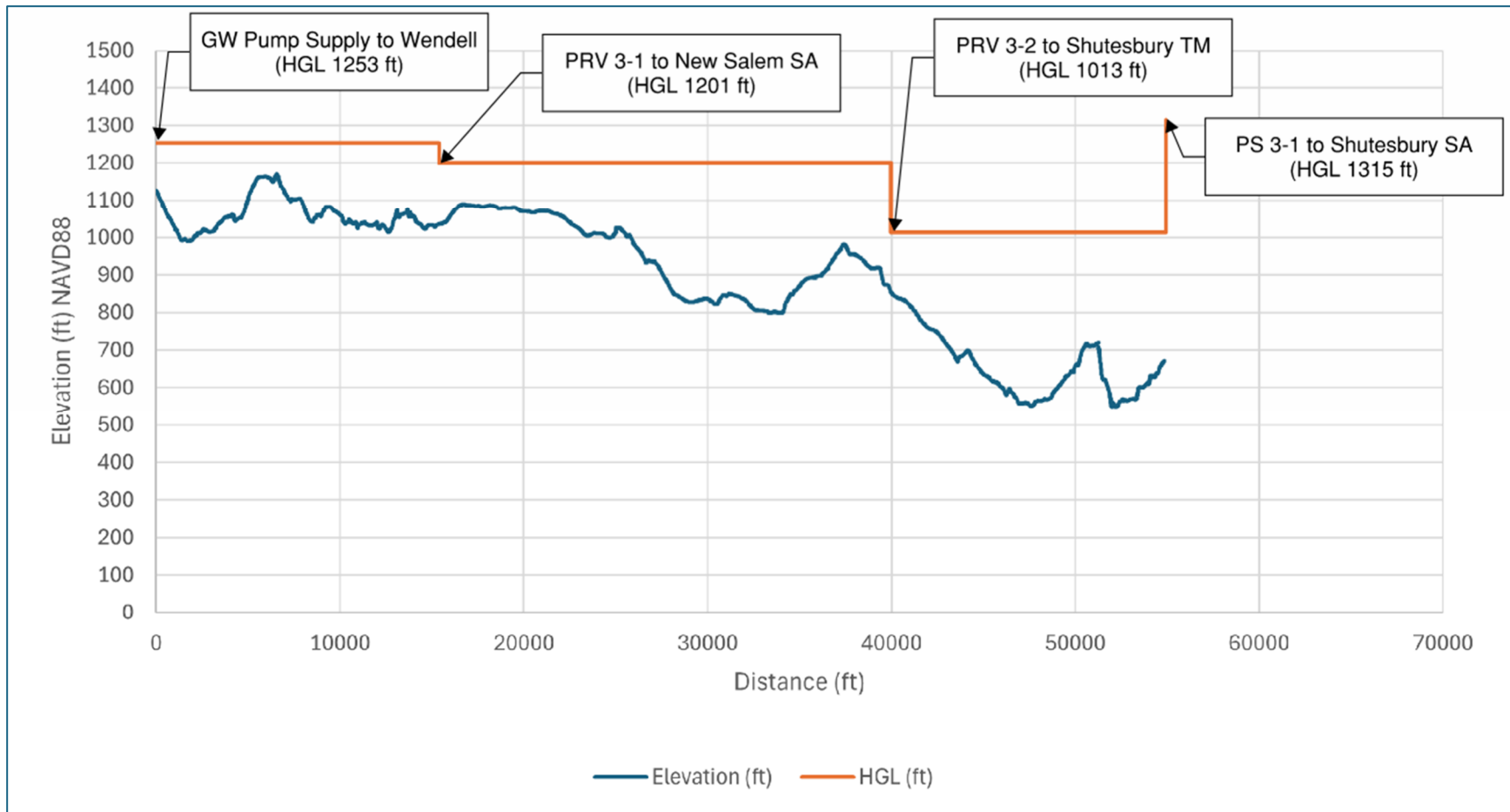
1. TM: Transmission Main, SA: Service Area

**FIGURE 4-7: Conceptual Project 2**  
**West Intake Hydraulic Profile - Shutesbury, New Salem, and Orange**



1. TM: Transmission Main, SA: Service Area

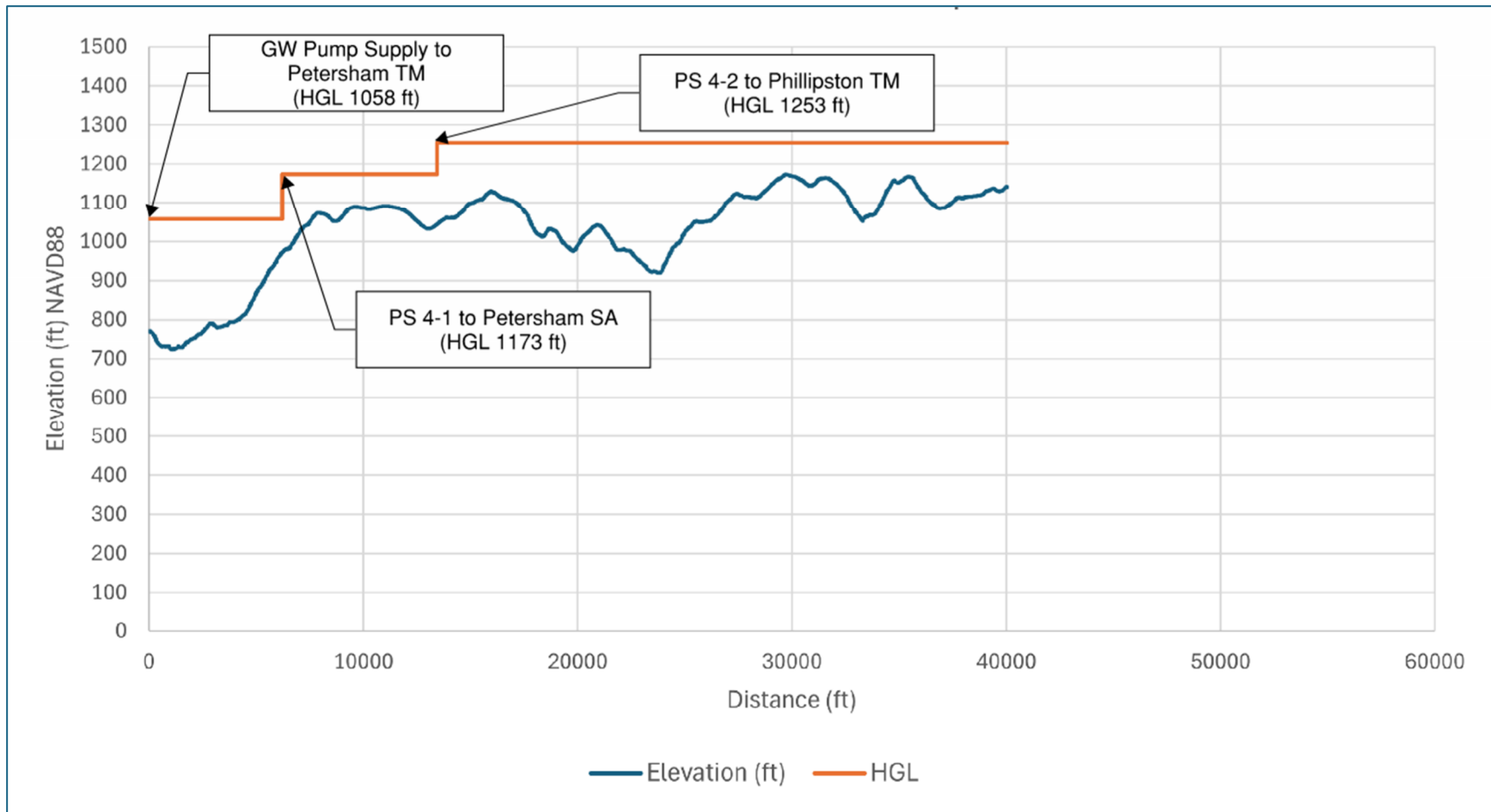
**FIGURE 4-8: Conceptual Project 2  
West Intake Hydraulic Profile - Wendell**



1. TM: Transmission Main, SA: Service Area

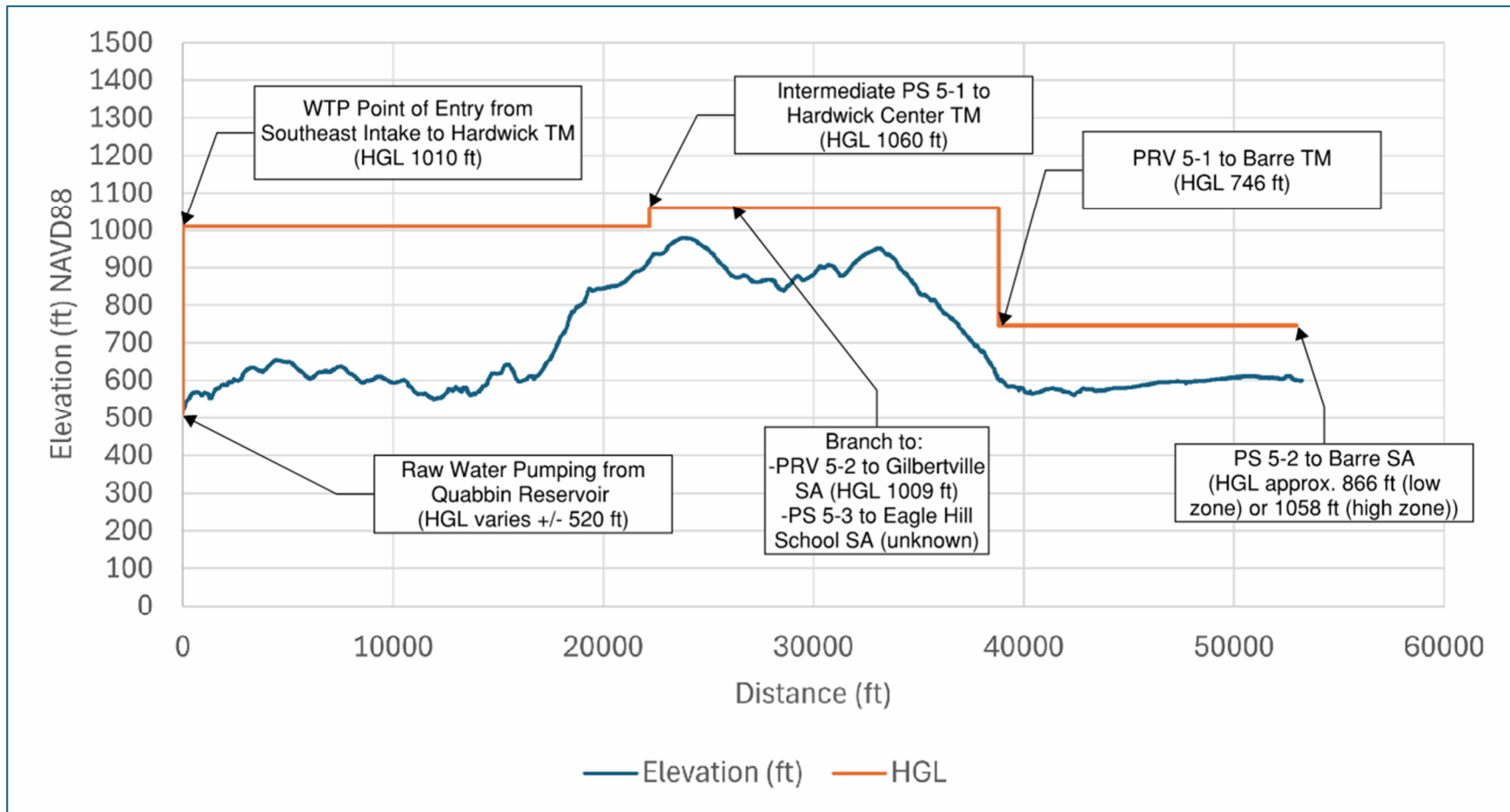
**FIGURE 4-9: Conceptual Project 3**

**Northwest Regional Groundwater Supply Hydraulic Profile – Shutesbury, New Salem and Wendell**



1. TM: Transmission Main, SA: Service Area

**FIGURE 4-10: Conceptual Project 4  
Northeast Regional Groundwater Supply Hydraulic Profile – Petersham and Phillipston**



1. TM: Transmission Main, SA: Service Area

**FIGURE 4-11: Conceptual Project 5  
Southeast Intake Hydraulic Profile – Hardwick and Barre**

### 4.3.3 Water Storage Tanks

WSTs are needed to provide equalization storage, emergency storage and fire protection storage, where applicable. Storage can also be provided to avoid pumping to and from closed systems, which do not have storage. For this Study, storage was included to avoid pumping to and from closed systems and for fire protection where applicable, as further discussed below. It is assumed that additional storage for Towns with existing COM PWSs that currently have storage will not be provided. However, storage is proposed for Hardwick since the proposed service area extends beyond the limits of the existing Hardwick Center COM PWS to include the entire town center as well as extensions to Eagle Hill School, Wheelwright Water District and Gilbertville Water District. New WSTs for Towns without existing COM PWSs are proposed. Additional intermediate storage is needed for transmission mains with intermediate pumping or with PRVs to pressure reduced zones, to avoid pumping to and from closed systems.

Preliminary needed storage volumes were calculated for the proposed WSTs. The storage volume depends on if fire protection is provided. This evaluation is based on fire flow requirements for existing conditions and did not consider potential for future development not specifically requested to be included. MassDEP Guidelines indicate the following:

- Storage should meet domestic demands plus fire flow where fire protection is provided.
- Minimum storage, if not providing fire protection such as with intermediate pumping systems, shall be equal to the average day consumption.
- 3-5 day complete water turnover (or more frequent turnover) is recommended as a starting point to avoid excessive water age.
- Fire flow requirements established by the National Fire Protection Association (NFPA) should be satisfied where fire protection is provided.

The NFPA minimum required fire flow and flow duration for Type 5 Construction (e.g., most residential construction) buildings is 1,500 gpm for 2 hours for fire flow area up to 3,600 square feet. Insurance Service Organization (ISO) Needed Fire Flow (NFF) were also considered. The ISO guidelines indicate that for 1 and 2 family dwellings not exceeding 2 stories in height, the needed fire flow is a maximum of 1,500 gpm for 1 hour.

Where communities may have high fire flow requirements other than for residential customers, it is assumed that fire flow protection would be provided separately (e.g., individual storage and booster pump systems, fire protection ponds, etc.), as is customary. Providing fire protection for residential buildings is included in the sizing of infrastructure components as an option for conceptual projects if any advance forwards and the project designer selects fire protection. If a conceptual project is advanced, the owner and designer may elect to not provide fire protection based on further analysis. Sizing of components to provide fire protection for buildings with high fire flow requirements is outside the scope of this study. Fire flow sizing, including for residential buildings, would need further evaluation if the conceptual projects move forward.

The WST assumptions are summarized in Table 4-10 and tank sizing criteria are summarized in Table 4-11. The minimum recommended storage for the proposed tanks is the smaller of the following:

- Average daily consumption + Fire Flow, or
- 5-Day Turnover Volume (per MassDEP Guidelines).

Note that the needed fire flow storage volume was based on the ISO guidelines to minimize excessive storage volumes. Nominal tank capacities were rounded to the nearest 1,000 gallons. It is noted that the type of tank (e.g. elevated or ground) should be evaluated in conjunction with a siting study and the need for split tanks should be considered. For this study, it is assumed that tanks within proposed service areas are elevated tanks approximately 100 feet in height with an overflow elevation at the hydraulic grade of the service area.

Intermediate WSTs were assumed to be pumped storage ground level tanks located on the upstream side of the associated intermediate pump stations approximately 20 feet in height. Two exceptions are the intermediate WSTs for the transmission main to Belchertown in Conceptual Project No. 1 and for the transmission main to Orange in Conceptual Project No. 2. Because these transmission mains supply PRVs that serve pressure reduced zones, it is assumed that these intermediate WSTs would consist of elevated tanks at the service area hydraulic grade. A siting analysis should be conducted if these projects move forward to determine if a suitable location at a higher elevation is available for a ground level tank.

Fire storage is based on existing conditions for residential services without consideration for potential future development and with the goal of minimizing storage requirements to avoid excessive water age per MassDEP Guidelines. The need for high storage volumes to provide fire protection should be considered against increasing water age with increasing storage volume. There could be issues with water quality deterioration due to high water age such as formation of disinfection byproducts. A detailed water quality and water age analysis should be conducted prior to sizing and siting water storage tanks for the conceptual projects if they are advanced.

**TABLE 4-10**  
Infrastructure Components – Water Storage Tanks

Infrastructure Component	Assumptions <sup>1</sup>
Water Storage Tanks	<ul style="list-style-type: none"> <li>• Assumed that additional storage for Towns with existing COM PWSs that currently have storage will generally not be provided unless noted.</li> <li>• Proposed tanks within service areas               <ul style="list-style-type: none"> <li>○ Sized to provide one day of ADD plus needed fire storage.</li> <li>○ Elevated style, 100 feet in height, composite tanks on concrete pedestals.</li> <li>○ Overflow elevation at HGL of service area.</li> </ul> </li> <li>• Proposed intermediate WSTs along transmission mains               <ul style="list-style-type: none"> <li>○ Sized to provide one day of ADD (fire protection not provided along these mains).</li> <li>○ Ground storage tank, circular style, 20 feet in height, precast concrete.</li> <li>○ Pumped storage (pump stations listed in Table 4-9).</li> <li>○ For tanks to reduced pressure zones<sup>1</sup>: elevated tank, 100 feet in height, composite steel tanks on concrete pedestals.</li> </ul> </li> <li>• Installed as a single tank; consider need to install as pairs.</li> <li>• No tank mixing system<sup>2</sup></li> <li>• Allowances for mechanical, electrical, automation, site/civil facilities, and landscape architecture.</li> </ul>

1. Applicable to Conceptual Project Nos. 1 and 2.

2. Previous MWRA Expansion Studies assumed no tank mixing system. Note that mixing systems are a MassDEP requirement. Further study should be conducted if any projects move forward to determine if mixing systems should be included.

**TABLE 4-11**  
Summary of Water Storage Tanks Sizing

Tank	Average Daily Consumption (gal) <sup>1</sup>	NFPA Fire Flow (gal) <sup>2</sup>	ISO Fire Flow <sup>3</sup>	5-Day Turnover Volume (gal) <sup>4</sup>	Minimum Recommended Usable Storage (gal) <sup>5</sup>	Nominal WST Capacity (gal) <sup>6</sup>
<b>1. Southwest Intake</b>						
Pelham Service Area WST	20,000	180,000	90,000	100,000	100,000	100,000
Belchertown TM Intermediate WST <sup>7</sup>	1,984,000	--	--	9,917,000	1,984,000	2,000,000
<b>2. West Intake</b>						
New Salem Service Area WST	15,000	180,000	90,000	75,000	75,000	75,000
Shutesbury Service Area WST	32,000	180,000	90,000	159,000	122,000	130,000
Wendell Service Area WST	9,000	180,000	90,000	42,000	42,000	42,000
Shutesbury TM Intermediate WST No. 1	515,000	--	--	2,573,000	515,000	520,000
Shutesbury TM Intermediate WST No. 2	32,000	--	--	159,000	32,000	32,000
New Salem TM Intermediate WST	483,000	--	--	2,415,000	483,000	490,000
Orange TM Intermediate WST <sup>7</sup>	460,000	--	--	2,298,000	460,000	460,000

1. Includes 20% contingency (rounded up to the nearest 1,000 gallons). This 20% contingency factor is not intended to account for potential growth in any existing water system or town (see Section 4.1 for discussion).

2. Based on NFPA recommendation of 1,500 gpm for 2 hours for Type V construction up to 3,600 sq.ft. of Fire Flow Area (e.g., residential).

3. Based on ISO recommendation of 1,500 gpm for 1 hour for 1- and 2- family dwellings not exceeding 2 stories in height (most conservative distance between buildings 0-10 ft). It's assumed that fire protection needs for larger residential buildings, commercial and industrial buildings would not be provided due to higher fire flow needs.

4. 3-5 day turnover recommended by MassDEP as a starting point (rounded up to the nearest 1,000 gallons).

5. Smaller of Average Daily Consumption + Fire Flow or 5-Day Turnover Volume (per MassDEP Guidelines), as applicable (rounded up to the nearest 1,000 gallons).

6. Usable storage rounded up to two significant figures. Type of WST (e.g. elevated or ground) should be evaluated in conjunction with a siting study.

7. WST serves reduced pressure zone.

8. It is assumed that additional storage for Towns with existing water systems that currently have storage will generally not be provided unless otherwise noted.

**TABLE 4-11**  
Summary of Water Storage Tanks Sizing (continued)

Tank	Average Daily Consumption (gal) <sup>1</sup>	NFPA Fire Flow (gal) <sup>2</sup>	ISO Fire Flow <sup>3</sup>	5-Day Turnover Volume (gal) <sup>4</sup>	Minimum Recommended Usable Storage (gal) <sup>5</sup>	Nominal WST Capacity (gal) <sup>6</sup>
<b>3. Northwest Regional Groundwater Supply</b>						
New Salem Service Area WST	15,000	180,000	90,000	75,000	75,000	75,000
Shutesbury Service Area WST	32,000	180,000	90,000	159,000	122,000	130,000
Wendell Service Area WST	9,000	180,000	90,000	42,000	42,000	42,000
<b>4. Northeast Regional Groundwater Supply</b>						
Petersham Service Area WST	26,000	180,000	90,000	127,000	116,000	120,000
Phillipston Service Area WST	6,000	180,000	90,000	30,000	30,000	30,000
Petersham TM Intermediate WST	32,000			157,000	32,000	32,000
<b>5. Southeast Intake</b>						
Hardwick (w/ Extensions) Service Area WST	136,000	180,000	90,000	677,000	226,000	230,000
Hardwick Center TM Intermediate WST	575,000	--	--	2,873,000	575,000	580,000

1. Includes 20% contingency (rounded up to the nearest 1,000 gallons). This 20% contingency factor is not intended to account for potential growth in any existing water system or town (see Section 4.1 for discussion).

2. Based on NFPA recommendation of 1,500 gpm for 2 hours for Type V construction up to 3,600 sq. ft. of Fire Flow Area (e.g., residential).

3. Based on ISO recommendation of 1,500 gpm for 1 hour for 1- and 2- family dwellings not exceeding 2 stories in height (most conservative distance between buildings 0-10 ft). It's assumed that fire protection needs for larger residential buildings, commercial and industrial buildings would not be provided due to higher fire flow needs.

4. 3-5 day turnover recommended by MassDEP as a starting point (rounded up to the nearest 1,000 gallons).

5. Smaller of Average Daily Consumption + Fire Flow or 5-Day Turnover Volume (per MassDEP Guidelines), as applicable (rounded up to the nearest 1,000 gallons).

6. Usable storage rounded up to two significant figures. Type of WST (e.g. elevated or ground) should be evaluated in conjunction with a siting study.

7. It is assumed that additional storage for Towns with existing water systems that currently have storage will generally not be provided unless otherwise noted.

### 4.3.4 Development of Raw Water Sources

Raw water sources to be developed consist of groundwater wells and new surface water intakes to draw raw water from the Quabbin Reservoir.

#### 4.3.4.1 Groundwater

As described in Section 4.2, approximate locations for potential groundwater explorations were primarily based on areas with high groundwater availability and favorability according to USGS mapping. Parts of the proposed exploration areas fall within protected and recreational open spaces and other portions fall within privately owned land. As noted, the potential locations presented in this plan are conceptual. The possibility of finding suitable high-yielding groundwater areas outside of the areas presented should be considered and evaluated if alternatives are advanced.

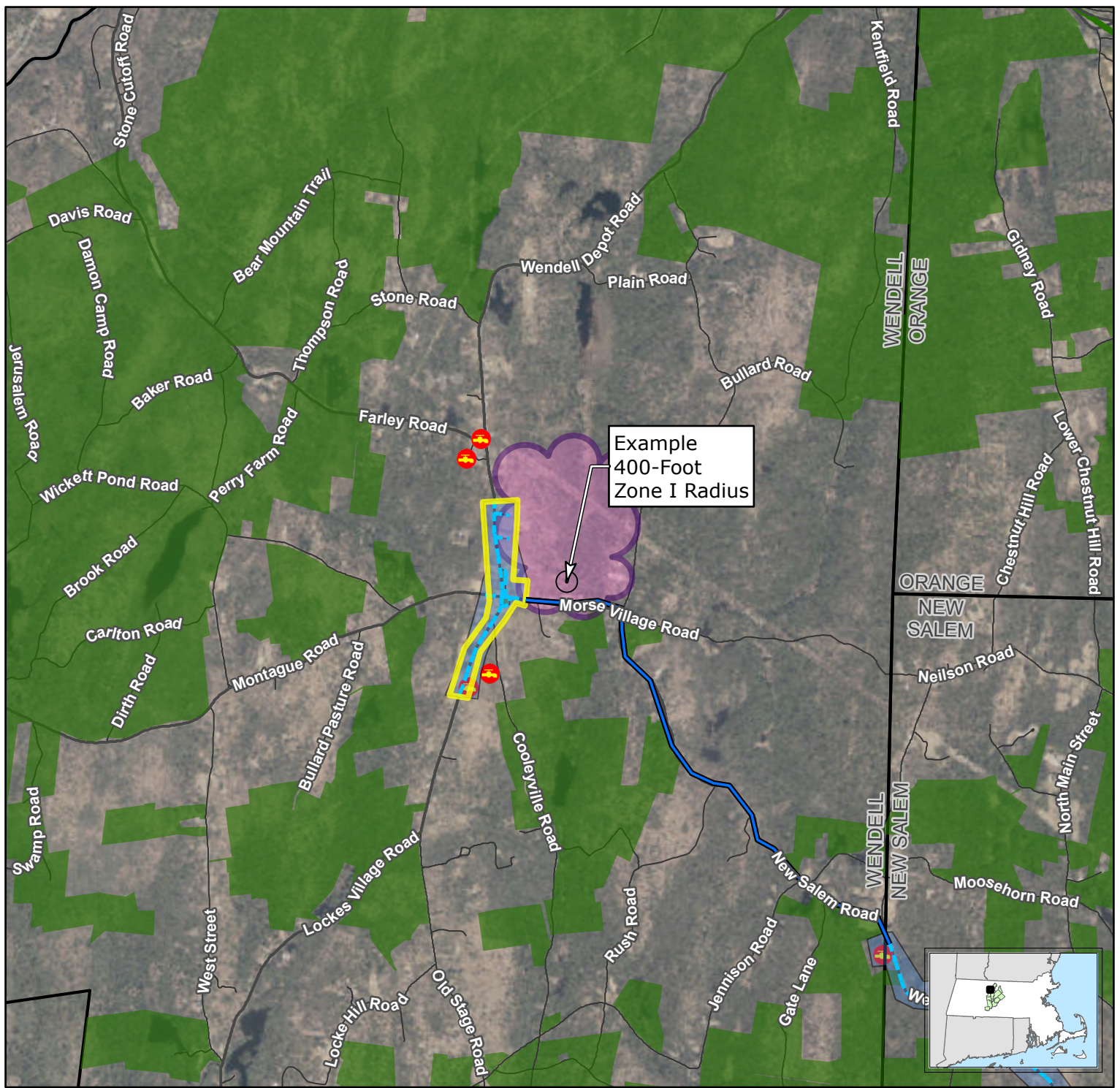
Potential groundwater exploration locations are shown on Figure 4-1 for all alternatives considered. For the Northwest and Northeast Regional Groundwater Supply Alternatives (Conceptual Projects No. 3 and 4) that were advanced for further evaluations, the exploration locations are shown on Figures 4-12 and 4-13, respectively. An example 400-foot protected radius is shown on the figures illustrating that the potential areas are large enough for the protective radius (the actual protected radius would be based on the well yield). Further study would be required to confirm the suitability and feasibility of locating groundwater sources at these proposed locations or to find suitable alternate locations.

Table 4-12 summarizes the infrastructure components related to the development of new groundwater wells. This assumes that a suitable well location is available at the yields indicated.



**TABLE 4-12**

Infrastructure Components – Groundwater Wells

Infrastructure Component	Assumptions
Groundwater Wells	<ul style="list-style-type: none"> <li>• Minimum of two wells, one primary and one backup well.</li> <li>• Wells consist of pitless adapters with submersible pumps and well casings extending above grade.</li> <li>• Each well individually piped and metered to a treatment and pumping facility.</li> <li>• SCADA and instrumentation to trend well flow, pressure, and water level.</li> </ul>

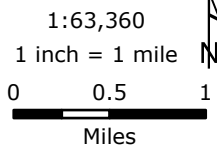


**Legend**

-  Non-Community Groundwater Well
-  Conceptual Transmission Main Route - Groundwater
-  Proposed Water Main
-  Example 400-Foot Zone I Radius
-  Potential Medium/High Yield Aquifer Area (Regional)
-  Article 97 Open Space
-  Town Center from Planning Documents
-  Proposed Service Area

Proposed groundwater well exploration locations are based on areas with high groundwater availability and favorability according to USGS panels (1967 and 1980).

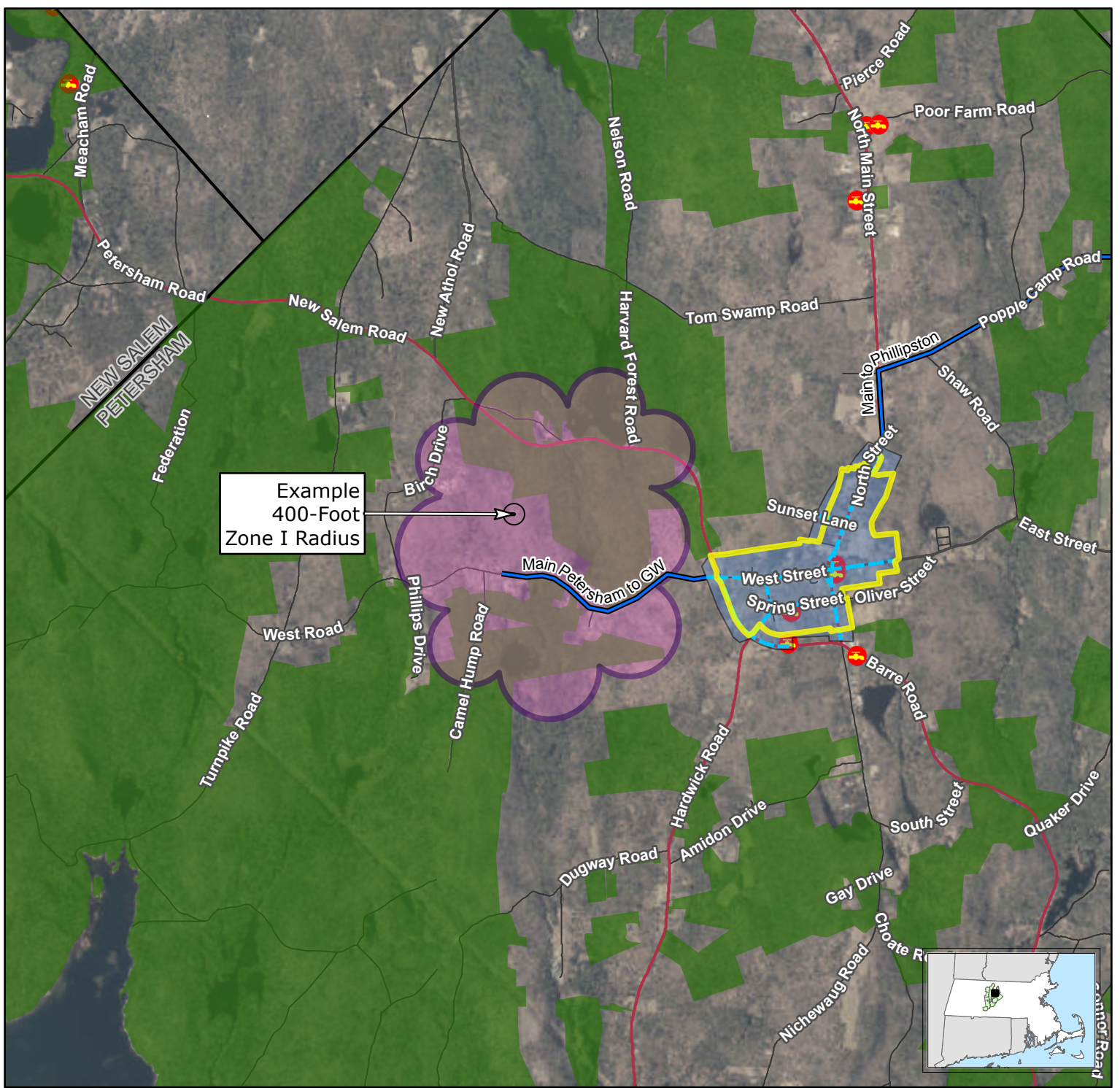
Color Orthophotography (2023) was provided by MassGIS.







**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 4-12  
Northwest Regional Groundwater Supply Exploration Area - Wendell, New Salem, and Shutesbury, MA

September 2025

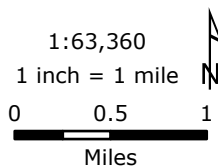


**Legend**

-  Non-Community Groundwater Well
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-  Example 400-Foot Zone I Radius
-  Potential Medium/High Yield Aquifer Area (Regional)
-  Article 97 Open Space
-  Town Center from Planning Documents
-  Proposed Service Area

Proposed groundwater well exploration locations are based on areas with high groundwater availability and favorability according to USGS panels (1967 and 1980).

Color Orthophotography (2023) was provided by MassGIS.



**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 4-13  
 Northeast Regional Groundwater Supply Exploration Area - Petersham and Phillipston, MA

September 2025

#### 4.3.4.2 Surface Water

As described in Section 4.2, surface intake locations were selected such that intakes would be functional under all drought conditions (i.e., where appropriate reservoir depths are available). Intake locations are shown on Figure 4-1. Further study would be required to confirm the suitability and feasibility of locating a new surface water intake at these proposed locations or to find suitable alternate locations.

Table 4-13 summarizes the infrastructure components related to the development of new surface water intakes. For the purposes of developing costs, it was assumed construction would consist of cofferdams and dewatering. Additional measures to protect the water quality of the surrounding reservoir would potentially be required during construction and should be considered and evaluated as projects move forward.

**TABLE 4-13**

Infrastructure Components – Surface Water Intakes

Infrastructure Component	Assumptions
Surface Water Intakes	<ul style="list-style-type: none"> <li>• Raw water intake structures including:               <ul style="list-style-type: none"> <li>○ Intake screens</li> <li>○ Compressed air systems</li> <li>○ Raw water pumps with VFDs, 2 duty and 1 standby configuration</li> </ul> </li> <li>• Above grade raw water pump house:               <ul style="list-style-type: none"> <li>○ Floor area based on design capacity:</li> <li>○ Architecture: brick on block, cavity walls, pitched roof, single story, no basement</li> </ul> </li> <li>• SCADA and instrumentation including flow meter</li> <li>• Site security, landscaping, and access road</li> </ul>

### 4.3.5 Water Treatment Plants

New WTPs are required for each conceptual project to treat raw surface water from the Quabbin Reservoir and raw groundwater. Table 4-14 summarizes the infrastructure components related to new drinking water plants. Treatment plants for each conceptual project are sized to provide the average day and maximum day demands summarized in Table 4-5.

For this evaluation, the goal is to provide budgetary cost information for a potential treatment building footprint and equipment costs for treatment, including chemical feed capability. As such, a baseline treatment for surface water and for groundwater has been assumed as discussed below as a starting point to focus the discussion and for the purposes of preparing the OPCCs. That said, there are other potential treatment alternatives, and the baseline is not intended to be representative of the sole option. Further evaluation will be required as projects advance to address community-specific needs and preferences (for example, with respect to chloramines, corrosion control, blending considerations, etc.). Where needed or desired, these potential additional measures may require additional treatment equipment at additional costs.

#### 4.3.5.1 Groundwater Treatment

Treatment for groundwater sources will be highly dependent on the water quality of the new wells. Common water quality considerations, which will require further study, include disinfection, corrosion control, hardness, PFAS, pH adjustment, iron and manganese, volatile organic compounds, arsenic, and other constituents.

For purposes of this evaluation, groundwater treatment plants for Conceptual Projects 3 and 4 were assumed to consist of chemical feed systems for disinfection and pH adjustment for corrosion control at minimum. It is assumed that wellhead protection would preclude the existence of contaminants such as PFAS, but this should be evaluated as projects move forward. Raw water would be pumped to a new treatment building by high head pumps, which would supply the distribution system following treatment.

As with the groundwater exploration areas, potential treatment facilities may fall within protected and recreational open spaces and would therefore require approval from regulatory agencies, including the MWRA and the Massachusetts Legislature under Article 97.

#### 4.3.5.2 Surface Water Treatment

Surface WTPs for Conceptual Projects 1, 2, and 5 were assumed to have a similar treatment process as the existing Brutsch WTF located in Belchertown, which treats drinking water for MWRA's three CVA Water System communities: Wilbraham, Chicopee and South Hadley Fire District No. 1. The existing treatment consists of sodium hypochlorite and UV for primary disinfection, and sodium hypochlorite for residual disinfection. Water from the Quabbin Reservoir is not filtered. It is assumed that the filtration waiver for the existing Quabbin surface WTP will extend to new intakes and treatment plants, but future evaluation will be required if projects with new surface WTPs proceed. Filtration could be required where intakes cannot be constructed in deep water, as could be the case for the West and North Intakes, or if localized water quality conditions do not meet the filtration avoidance.

For the purposes of this plan, it is assumed that raw water from the surface water intake would be pumped to a new treatment building and treated with UV and sodium hypochlorite as is the current practice at the Brutsch WTF. Finished water would be stored

in below-grade clearwells from which high lift finished water pumps would supply the distribution system.

In prior MWRA expansion evaluations, it was assumed that corrosion control and fluoride treatment would be undertaken by the individual communities, with treatment specific to the requirements and decisions of the individual community. However, at this level of conceptual study where specificity is limited, the evaluation must be based on generalized treatment requirements, such as pH adjustment for corrosion control, with the understanding that further evaluation will be needed as projects advance. The treatment facilities and the associated OPCCs are based on assuming pH adjustment for corrosion control, but the addition of fluoride is highly specific to individual communities and is therefore not included.

Treatment with chloramines in lieu of chlorine is a potential option that would be beneficial where there is potential for high water age. The OPCCs developed for this plan are based on residual disinfection using chlorine but alternate disinfectants should be evaluated if projects advance, particularly if future regulations mandate higher disinfection system residuals.

**TABLE 4-14**  
Infrastructure Components – Water Treatment Plants

Infrastructure Component	Assumptions
Surface WTPs	<ul style="list-style-type: none"> <li>• Treatment consisting of:                             <ul style="list-style-type: none"> <li>○ UV disinfection</li> <li>○ Chemical feed systems for pre and post chlorine (disinfection) and pH adjustment</li> </ul> </li> <li>• Below grade clearwell</li> <li>• Finished water pumps with VFDs, 2 duty and 1 standby configuration, size based on design capacity</li> <li>• Treatment building                             <ul style="list-style-type: none"> <li>○ Floor area based on design capacity and treatment requirements</li> <li>○ Architecture: brick on block, cavity walls, pitched roof, single story, no basement</li> </ul> </li> <li>• SCADA and instrumentation, including online analyzers</li> <li>• Site security, landscaping, and access road</li> </ul>
Groundwater WTPs	<ul style="list-style-type: none"> <li>• Treatment consisting of:                             <ul style="list-style-type: none"> <li>○ Chemical feed systems for disinfection and pH adjustment</li> </ul> </li> <li>• High head well pumps to pump raw water through treatment to the distribution system</li> <li>• Treatment building                             <ul style="list-style-type: none"> <li>○ Floor area based on design capacity and treatment requirements</li> <li>○ Architecture: brick on block, cavity walls, pitched roof, single story, no basement</li> </ul> </li> <li>• SCADA and instrumentation, including online analyzers</li> <li>• Site security, landscaping, and access road</li> </ul>

## 4.4 Description of Conceptual Projects

Section 4.2 provided an overview of potential expansion alternatives and the five conceptual expansion projects that were advanced. This section provides a more detailed description of the five conceptual expansion projects. Further evaluation of the future operation and infrastructure changes would need to be considered if any of the conceptual expansion projects are implemented.

### 4.4.1 Conceptual Project 1 - Southwest Intake

Conceptual Project 1 demonstrates how water could be supplied to Belchertown, Ware, Ludlow, and Pelham from a new Quabbin Reservoir intake located in the southwest portion of the reservoir near the existing CVA intake. The goal would be to meet the existing MDD of the towns with COM PWSs (Belchertown, Ware, and Ludlow) and the proposed service area for Pelham. Note that portions of the proposed service area for Pelham is currently supplied by the existing Amherst PWS. Table 4-15 provides a summary of Conceptual Project 1 which is illustrated in Figure 4-14.

### 4.4.2 Conceptual Project 2 - West Intake

Conceptual Project 2 demonstrates how water could be supplied to New Salem, Wendell, Shutesbury, and Orange from a new Quabbin Reservoir intake located in the western portion of the reservoir. The goal would be to meet the existing maximum day demands of Orange which has a COM PWS and the proposed service areas for New Salem, Wendell, and Shutesbury. Table 4-16 provides a summary of conceptual Project 2 which is illustrated in Figure 4-15.

### 4.4.3 Conceptual Project 3 - Northwest Regional GW Supply

Conceptual Project 3 demonstrates how water could be supplied to New Salem, Wendell, and Shutesbury from a new regional groundwater supply located in Wendell. The goal would be to meet the existing MDD of the proposed service areas for New Salem, Wendell, and Shutesbury. Table 4-17 provides a summary of Conceptual Project 3 which is illustrated in Figure 4-16.

### 4.4.4 Conceptual Project 4 - Northeast Regional GW Supply

Conceptual Project 4 demonstrates how water could be supplied to Phillipston and Petersham from a new regional groundwater supply located in Petersham. The goal would be to meet the existing maximum day demands of the proposed service area for Phillipston and Petersham. Table 4-18 provides a summary of conceptual Project 4 which is illustrated in Figure 4-17.

### 4.4.5 Conceptual Project 5 - Southeast Intake

Conceptual Project 5 demonstrates how water could be supplied to Hardwick and Barre from a new Quabbin Reservoir intake located in the southeast portion of the reservoir. The goal would be to meet the existing maximum day demands of Hardwick and Barre, which have COM PWSs. Table 4-19 provides a summary of conceptual Project 5 which is illustrated in Figure 4-18.

**TABLE 4-15**  
Conceptual Project No. 1 Summary – Southwest Intake

Communities Served	Service Connections and Population Served	Demands	Components			
			Development of Raw Water Source <sup>1</sup>	Water Treatment Plant <sup>1</sup>	Storage and Pumping <sup>1</sup>	Transmission Mains and Appurtenances <sup>2, 3, 4</sup>
Belchertown	Services ≈ 10,300	Average Day = 2.7 MGD	<ul style="list-style-type: none"> <li>- Raw Water Intake Structure</li> </ul>	<ul style="list-style-type: none"> <li>- Treatment Building</li> </ul>	<ul style="list-style-type: none"> <li>- Elevated WST for Gravity Service</li> </ul>	<ul style="list-style-type: none"> <li>- 2.9 miles of 20-inch (TM)</li> </ul>
Ware	Population ≈ 25,500	Maximum Day = 5.0 MGD	<ul style="list-style-type: none"> <li>- Screens and Airburst System</li> </ul>	<ul style="list-style-type: none"> <li>- UV System - 5.0 MGD design flow, 1 duty + 1 standby reactor</li> </ul>	<ul style="list-style-type: none"> <li>o Pelham SA = 0.10 MG</li> </ul>	<ul style="list-style-type: none"> <li>- 7.1 miles of 18-inch (TM)</li> </ul>
Ludlow			<ul style="list-style-type: none"> <li>- Raw Water Pumps (2+1 pumps, 1.7 MGD ea.)</li> </ul>	<ul style="list-style-type: none"> <li>- Pre and Post Chlorine and pH Adjustment Chemical Systems</li> </ul>	<ul style="list-style-type: none"> <li>o To Belchertown TM to Reduced PZ = 2.0 MG</li> </ul>	<ul style="list-style-type: none"> <li>- 4.7 miles of 10-inch (TM)</li> </ul>
Pelham			<ul style="list-style-type: none"> <li>- Raw Water Pump House</li> </ul>	<ul style="list-style-type: none"> <li>- Clearwell</li> </ul>	<ul style="list-style-type: none"> <li>- Booster Pump Station</li> </ul>	<ul style="list-style-type: none"> <li>- 4.2 miles of &lt;4-inch (TM)</li> </ul>
			<ul style="list-style-type: none"> <li>- Raw Water Piping (200-ft of 24-inch)</li> </ul>	<ul style="list-style-type: none"> <li>- Finished Water Pumps (2+1 pumps, 1.7 MGD ea.)</li> </ul>	<ul style="list-style-type: none"> <li>o Belchertown Reduced PZ to Pelham TM = 40,000 gpd</li> </ul>	<ul style="list-style-type: none"> <li>- 2.2 miles of 8-inch (DS)</li> </ul>
				<ul style="list-style-type: none"> <li>- Process Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Pressure Reducing Valves (3, to Ware, Ludlow, and Belchertown)</li> </ul>

1. Also includes cofferdams and dewatering, site work, electrical, SCADA, instrumentation, and access road.
















2. Also includes system valves, air release / blow-off valves, fire hydrants, and meter vaults. OPCCs include distribution system water mains within proposed service areas for Towns without COM PWSs.

3. Number of culverts: 25; number of bridges: 2

4. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.

**Figure 4-14  
Conceptual Project No. 1  
Southwest Intake**

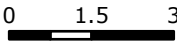
**Legend**

-  Community Groundwater Well
  -  Non-Community Groundwater Well
  -  CVA Pressure Reducing Valve
  -  Existing Quabbin Intake
  -  Nash Hill Water Tank
  -  Proposed Intake Location
  -  Conceptual Transmission Main Route
  -  Existing Aqueduct
  -  Road
  -  Proposed Service Area for Towns Without PWS
  -  Existing Water Service Area
  -  Town Boundary
  -  Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation**
-  Below S3 Drought Emergency
  -  Above S3 Drought Emergency


**LOCUS MAP**



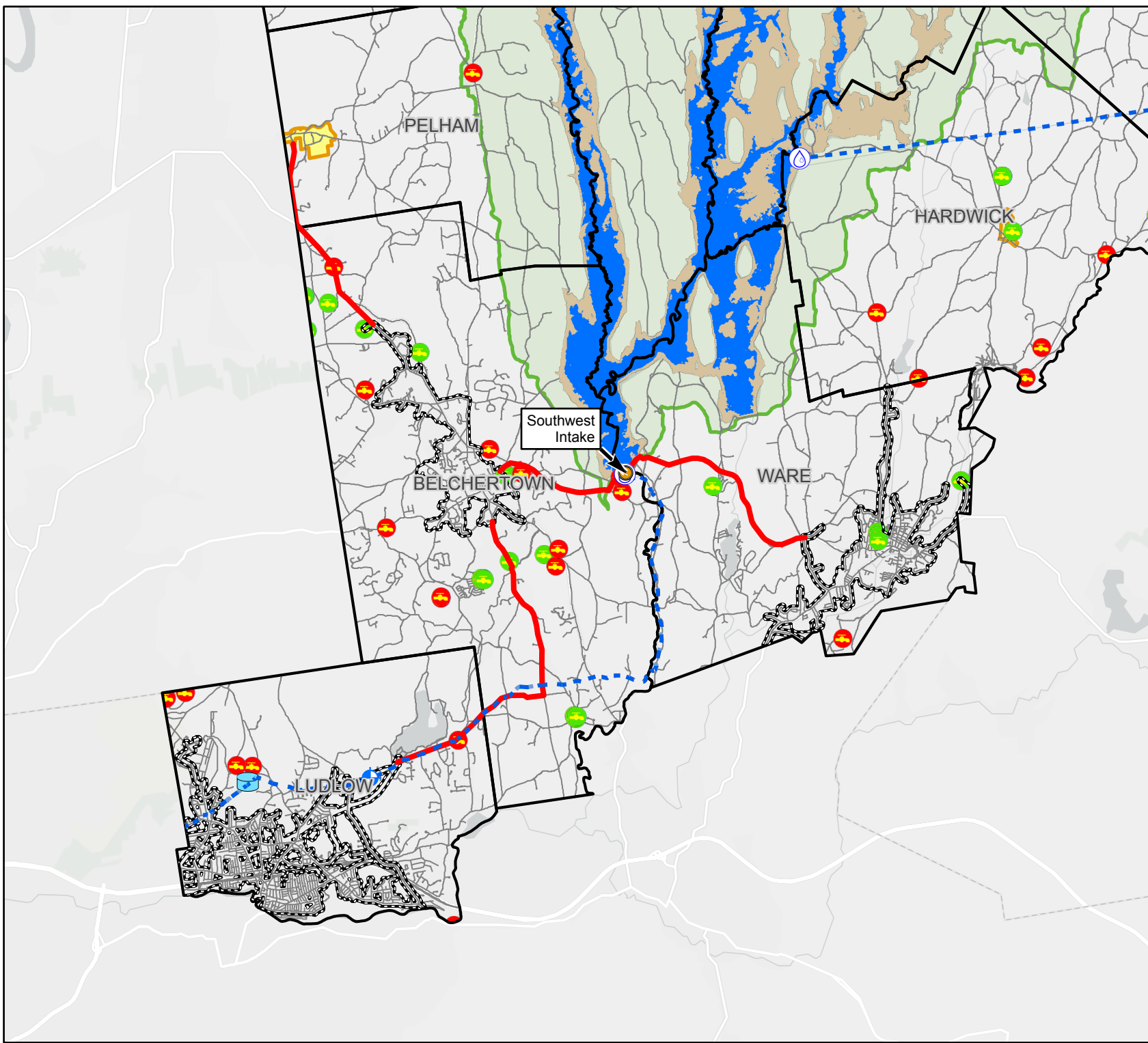
1:221,760  
1 inch = 3.5 miles



Miles



MWRA Water System Expansion  
Evaluation to Quabbin Reservoir  
Watershed Communities  
September 2025



**TABLE 4-16**  
Conceptual Project No. 2 Summary – West Intake

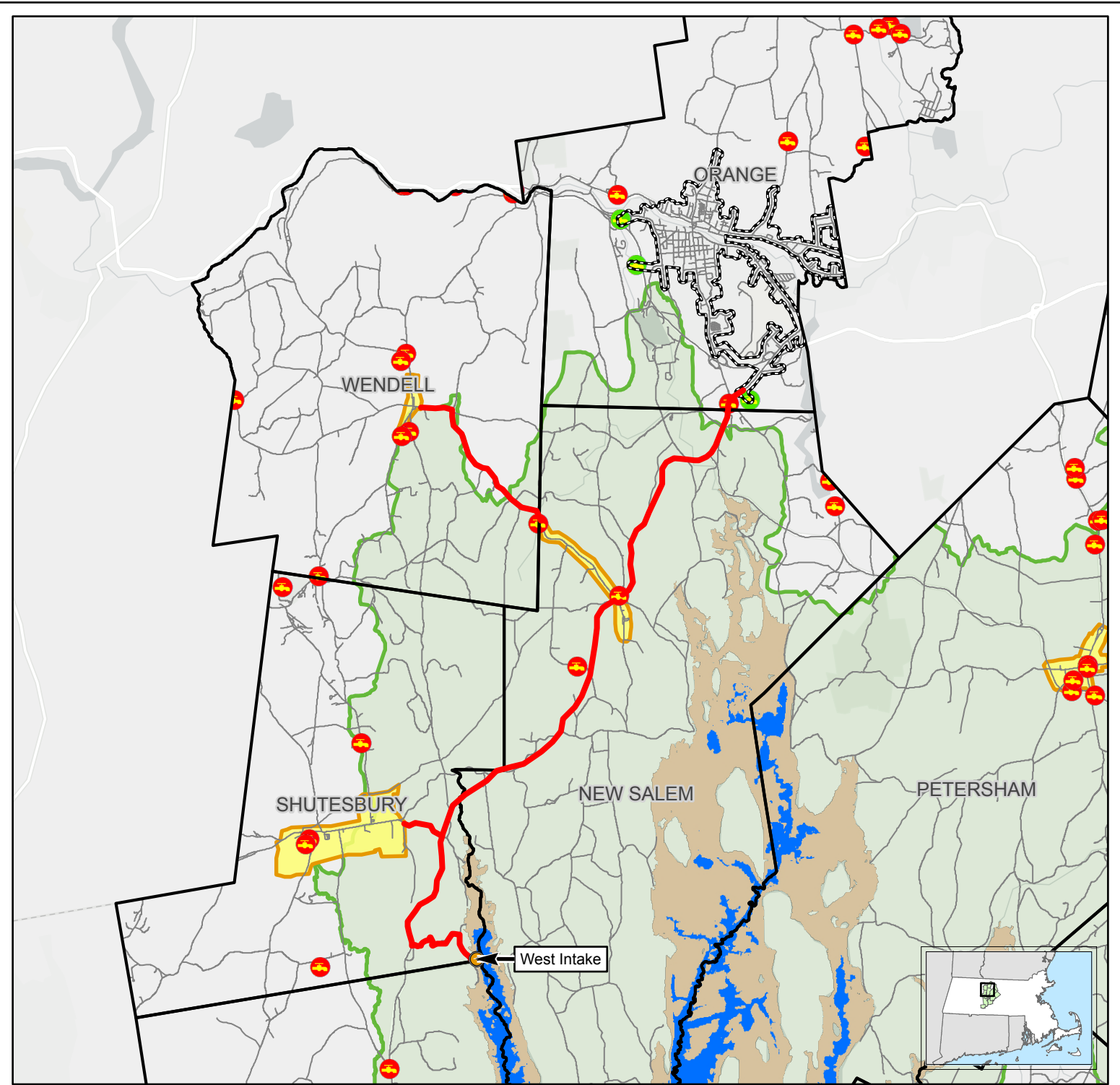
Communities Served	Service Connections and Population Served	Demands	Components			
			Development of Raw Water Source <sup>1</sup>	Water Treatment Plant <sup>1</sup>	Storage and Pumping <sup>1</sup>	Transmission Mains and Appurtenances <sup>2, 3, 4</sup>
New Salem  Wendell  Shutesbury  Orange	Services ≈ 2,200  Population ≈ 7,100	Average Day = 0.5 MGD  Maximum Day = 1.3 MGD	<ul style="list-style-type: none"> <li>- Raw Water Intake Structure</li> <li>- Screens and Airburst System</li> <li>- Raw Water Pumps (2+1 pumps, 0.4 MGD ea.)</li> <li>- Raw Water Pump House</li> <li>- Raw Water Piping (200-ft of 12-inch)</li> </ul>	<ul style="list-style-type: none"> <li>- Treatment Building</li> <li>- UV System - 1.3 MGD design flow, 1 duty + 1 standby reactor</li> <li>- Pre and Post Chlorine and pH Adjustment Chemical Systems</li> <li>- Clearwell</li> <li>- Finished Water Pumps (2+1 pumps, 0.40 MGD ea.)</li> <li>- Process Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Elevated WST for Gravity Service                             <ul style="list-style-type: none"> <li>o New Salem = 75,000 gpd</li> <li>o Shutesbury = 130,000 gpd</li> <li>o Wendell = 42,000 gpd</li> </ul> </li> <li>- Ground Level WST for Intermediate Pumping                             <ul style="list-style-type: none"> <li>o To Shutesbury TM = 0.52 MG Tank and 1.3 MGD PS</li> <li>o To New Salem TM = 0.49 MG Tank and 1.2 MGD PS</li> <li>o To Shutesbury SA = 32,000-gal Tank and 63,000 gpd PS</li> </ul> </li> <li>- Elevated WST for Intermediate PRV                             <ul style="list-style-type: none"> <li>o To Orange TM to Reduced PZ = 0.46 MG</li> </ul> </li> <li>- Booster Pump Stations                             <ul style="list-style-type: none"> <li>o To New Salem SA = 32,000 gpd</li> <li>o To Wendell SA = 16,000 gpd</li> </ul> </li> <li>- Piping</li> </ul>	<ul style="list-style-type: none"> <li>- 5.0 miles of 12-inch (TM)</li> <li>- 8.6 miles of 10-inch (TM)</li> <li>- 3.0 miles of &lt;4-inch (TM)</li> <li>- 9.8 miles of 8-inch (DS)</li> <li>- Pressure Reducing Valves (2, to Orange and New Salem)</li> </ul>

1. Also includes cofferdams and dewatering, site work, electrical, SCADA, instrumentation, and access road.

2. Also includes system valves, air release / blow-off valves, fire hydrants, and meter vaults. OPCCs include distribution system water mains within proposed service areas for Towns without COM PWSs.

3. Number of culverts: 39; number of bridges: 0

4. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.



**Legend**

- Community Groundwater Well
- Non-Community Groundwater Well
- Proposed Intake Location
- Conceptual Transmission Main Route
- Road
- Proposed Service Area for Towns Without PWS
- Existing Water Service Area
- Town Boundary
- Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation**
- Below S3 Drought Emergency
- Above S3 Drought Emergency

**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 4-15  
Conceptual Project No. 2  
West Intake



**TABLE 4-17**  
Conceptual Project No. 3 Summary – Northwest Regional Groundwater Supply

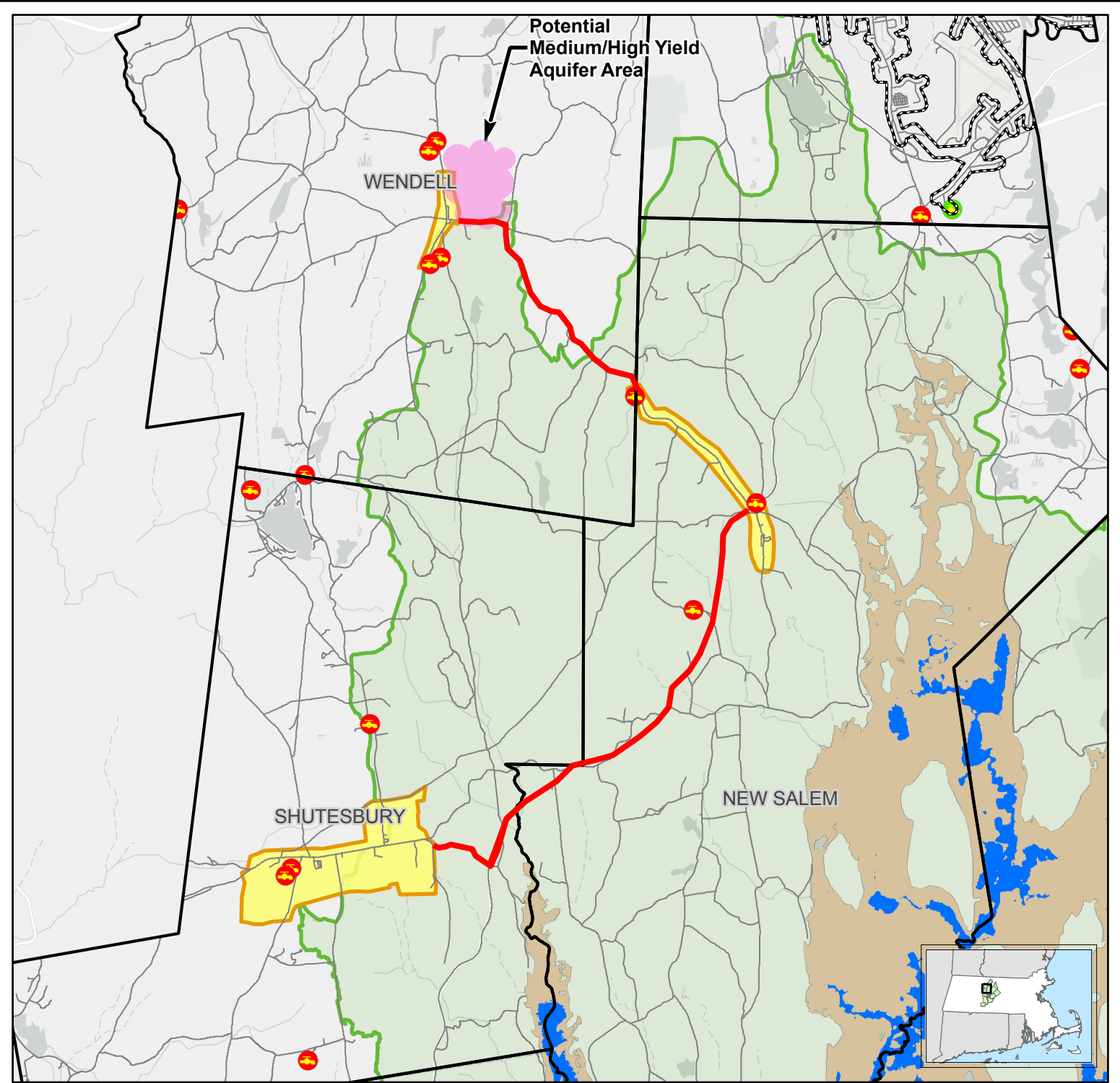
Communities Served	Service Connections and Population Served	Demands	Components			
			Development of Raw Water Source <sup>1</sup>	Water Treatment Plant <sup>1</sup>	Storage and Pumping <sup>1</sup>	Transmission Mains and Appurtenances <sup>2, 3, 4</sup>
New Salem  Wendell  Shutesbury	Services ≈ 260  Population ≈ 550	Average Day = 60,000 gpd  Maximum Day = 100,000 gpd	<ul style="list-style-type: none"> <li>- Groundwater Wells (1 well and backup), &gt;77 gpm each</li> <li>- Raw Water Piping (200-ft of &lt;4-inch)</li> </ul>	<ul style="list-style-type: none"> <li>- Treatment Building</li> <li>- Disinfection and pH Adjustment Chemical Systems</li> <li>- Process Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Elevated WST for Gravity Service                             <ul style="list-style-type: none"> <li>o New Salem = 75,000 gpd</li> <li>o Shutesbury = 130,000 gpd</li> <li>o Wendell = 42,000 gpd</li> </ul> </li> <li>- Booster Pump Stations                             <ul style="list-style-type: none"> <li>o To Shutesbury SA = 63,000 gpd</li> </ul> </li> <li>- Piping</li> </ul>	<ul style="list-style-type: none"> <li>- 9.2 miles of &lt;4-inch (TM)</li> <li>- 9.8 miles of 8-inch (DS)</li> <li>- Pressure Reducing Valves (2, to New Salem and Shutesbury)</li> </ul>

1. Also includes site work, electrical, SCADA, instrumentation, and access road.












2. Also includes system valves, air release / blow-off valves, fire hydrants, and meter vaults. OPCCs include distribution system water mains within proposed service areas for Towns without COM PWSs.

3. Number of culverts: 39; number of bridges: 0

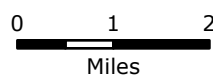
4. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.



**Legend**

-  Community Groundwater Well
-  Non-Community Groundwater Well
-  Conceptual Transmission Main Route
-  Road
-  Potential Medium/High Yield Aquifer Area (Regional)
-  Proposed Service Area for Towns Without PWS
-  Existing Water Service Area
-  Town Boundary
-  Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation**
-  Below S3 Drought Emergency
-  Above S3 Drought Emergency

1:126,720  
1 inch = 2 miles



**MWRA Water System Expansion Evaluation to Quabbin Reservoir Watershed Communities**

Figure 4-16  
Conceptual Project No. 3  
Northwest Regional Groundwater Supply  
September 2025

**TABLE 4-18**  
Conceptual Project No. 4 Summary – Northeast Regional Groundwater Supply

Communities Served	Service Connections and Population Served	Demands	Components			
			Development of Raw Water Source <sup>1</sup>	Water Treatment Plant <sup>1</sup>	Storage and Pumping <sup>1</sup>	Transmission Mains and Appurtenances <sup>2, 3, 4</sup>
Phillipston  Petersham	Services ≈ 150  Population ≈ 350	Average Day = 30,000 gpd  Maximum Day = 60,000 gpd	<ul style="list-style-type: none"> <li>- Groundwater Wells (1 well and backup), &gt;43 gpm each</li> <li>- Raw Water Piping (200-ft of &lt;4-inch)</li> </ul>	<ul style="list-style-type: none"> <li>- Treatment Building</li> <li>- Disinfection and pH Adjustment Chemical Systems</li> <li>- Process Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Elevated WST for Gravity Service                             <ul style="list-style-type: none"> <li>o Petersham = 120,000-gal</li> <li>o Phillipston = 30,000-gal</li> </ul> </li> <li>- Ground Level WST for Intermediate Pumping                             <ul style="list-style-type: none"> <li>o To Petersham SA = 32,000-gal Tank and 62,000 gpd PS</li> </ul> </li> <li>- Booster Pump Stations                             <ul style="list-style-type: none"> <li>o To Phillipston TM = 12,000 gpd</li> </ul> </li> <li>- Piping</li> </ul>	<ul style="list-style-type: none"> <li>- 6.1 miles of &lt;4-inch (TM)</li> <li>- 4.9 miles of 8-inch (DS)</li> </ul>











1. Also includes site work, electrical, SCADA, instrumentation, and access road.

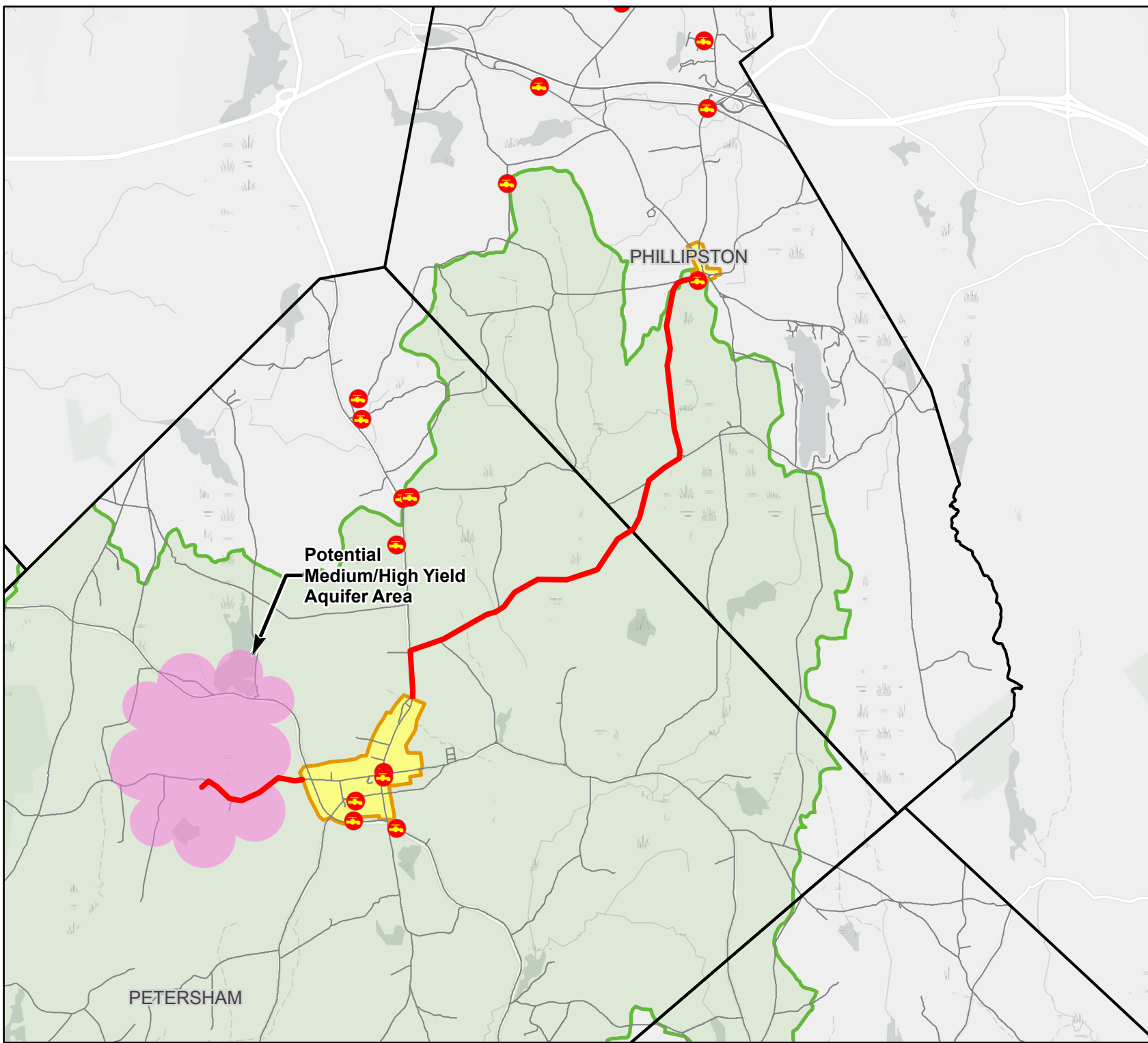
2. Also includes system valves, air release / blow-off valves, fire hydrants, and meter vaults. OPCCs include distribution system water mains within proposed service areas for Towns without COM PWSs.

3. Number of culverts: 23; number of bridges: 2

4. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.

**Figure 4-17  
Conceptual Project No. 4  
Northeast Regional  
Groundwater Supply**

- Legend**
-  Non-Community Groundwater Well
  -  Conceptual Transmission Main Route
  -  Road
  -  Potential Medium/High Yield Aquifer Area (Regional)
  -  Proposed Service Area for Towns Without PWS
  -  Existing Water Service Area
  -  Town Boundary
  -  Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation**
-  Below S3 Drought Emergency
  -  Above S3 Drought Emergency



Potential  
Medium/High Yield  
Aquifer Area

PHILLIPSTON

PETERSHAM

**LOCUS MAP**



1:95,040  
1 inch = 1.5 miles  
0 0.75 1.5  
Miles

MWRA Water System Expansion  
Evaluation to Quabbin Reservoir  
Watershed Communities  
September 2025



**TABLE 4-19**  
Conceptual Project No. 5 Summary – Southeast Intake

Communities Served	Service Connections and Population Served	Demands	Components			
			Development of Raw Water Source <sup>1</sup>	Water Treatment Plant <sup>1</sup>	Storage and Pumping <sup>1</sup>	Transmission Mains and Appurtenances <sup>2, 3, 4</sup>
Hardwick  Barre	Services ≈ 1,600  Population ≈ 6,100	Average Day = 0.6 MGD  Maximum Day = 1.1 MGD	<ul style="list-style-type: none"> <li>- Raw Water Intake Structure</li> <li>- Screens and Airburst System</li> <li>- Raw Water Pumps (2+1 pumps, 0.40 MGD ea.)</li> <li>- Raw Water Pump House</li> <li>- Raw Water Piping (475-ft of 10-inch)</li> </ul>	<ul style="list-style-type: none"> <li>- Treatment Building</li> <li>- UV System - 1.1 MGD design flow, 1 duty + 1 standby reactor</li> <li>- Pre and Post Chlorine and pH Adjustment Chemical Systems</li> <li>- Clearwell</li> <li>- Finished Water Pumps (2+1 pumps, 0.40 MGD ea.)</li> <li>- Process Piping</li> </ul>	<ul style="list-style-type: none"> <li>- Elevated WST for Gravity Service                             <ul style="list-style-type: none"> <li>o Hardwick 0.23 MG</li> </ul> </li> <li>- Ground Level WST for Intermediate Pumping                             <ul style="list-style-type: none"> <li>o To Hardwick Center TM = 0.58 MG Tank and 1.1 MGD PS</li> </ul> </li> <li>- Booster Pump Stations                             <ul style="list-style-type: none"> <li>o To Eagle Hill School SA = 29,000 gpd</li> <li>o To Barre SA = 75,000 gpd</li> </ul> </li> <li>- Piping</li> </ul>	<ul style="list-style-type: none"> <li>- 4.9 miles of 10-inch (TM)</li> <li>- 4.8 miles of 8-inch (TM)</li> <li>- 3.7 miles of 6-inch (TM)</li> <li>- 1.2 miles of 8-inch (DS)</li> <li>- Pressure Reducing Valves (2, to Barre SA and Gilbertville SA)</li> </ul>















1 Also includes cofferdams and dewatering, site work, electrical, SCADA, instrumentation, and access road.

2. Also includes system valves, air release / blow-off valves, fire hydrants, and meter vaults. OPCCs include distribution system water mains within proposed service areas for Towns without COM PWSs. It is assumed that distribution mains would be needed within the entire Hardwick Center service area since the extent of the existing COM PWS is not known.

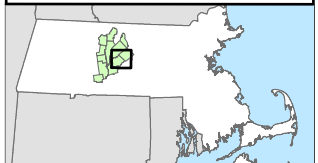
3. Number of culverts: 14; number of bridges: 2

4. While diameters were selected based on the criteria described in Section 4.3, it is understood that some ductile iron pipe diameters are more readily available than others. As projects move forward, consideration should be given to adjusting pipe sizing based on availability, if desired.

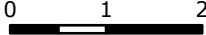
**Figure 4-18  
Conceptual Project No. 5  
Southeast Intake**

- Legend**
-  Community Groundwater Well
  -  Non-Community Groundwater Well
  -  Existing Quabbin Intake
  -  Proposed Intake Location
  -  Conceptual Transmission Main Route
  -  Hardwick Extension
  -  Existing Aqueduct
  -  Road
  -  Proposed Service Area for Towns Without PWS
  -  Existing Water Service Area
  -  Town Boundary
  -  Quabbin Reservoir Watershed
- Quabbin Reservoir Drought Water Surface Elevation**
-  Below S3 Drought Emergency
  -  Above S3 Drought Emergency


**LOCUS MAP**



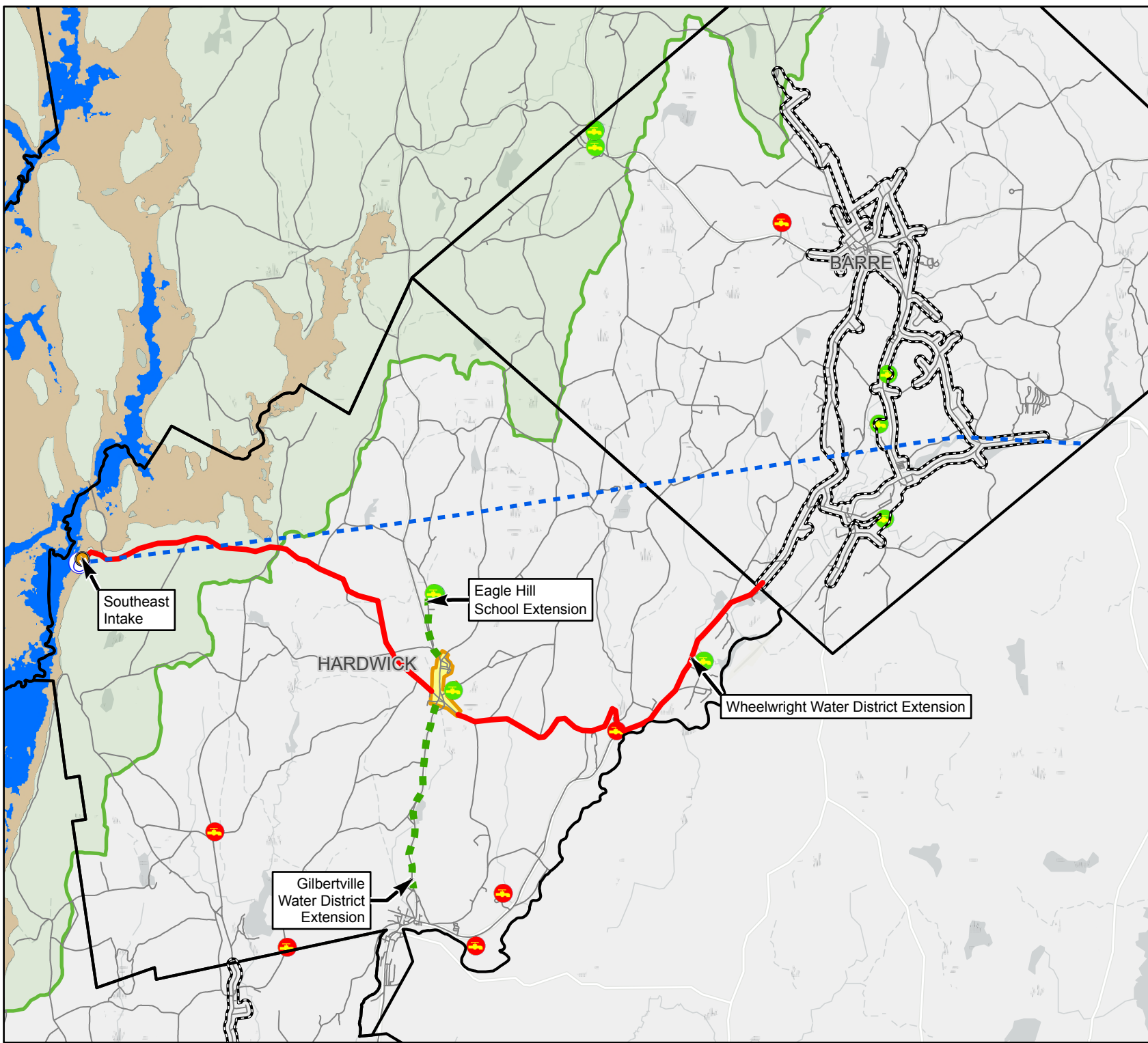
1:126,720  
1 inch = 2 miles



Miles



MWRA Water System Expansion  
Evaluation to Quabbin Reservoir  
Watershed Communities  
September 2025



**Tighe&Bond**

**SECTION 5**

## Section 5

# Conceptual Expansion Project Cost Estimates

Planning level opinion of probable construction costs (OPCCs) were developed for the five conceptual expansion projects discussed in Section 4. The OPCCs have several assumptions and limitations due to the conceptual nature of this study. In addition, there are many project costs that cannot be quantified at this conceptual stage of project development (e.g., permitting, planning and pre-design, etc.). These OPCCs should be used as an estimate of the relative magnitude of investment required for the projects. If the communities and MWRA advance any of the conceptual expansion projects, a more detailed analysis of the OPCCs should be developed as the projects are refined and designed.

### 5.1 Key Cost Estimating Assumptions and Limitations

The following assumptions were used in development of the OPCCs:

- Costs are in November 2024 dollars
  - 20-City Average Construction Cost Index, November 2024 = 13,632.39
- Construction costs include direct costs (materials and labor/installation), indirect costs (sales tax, insurance, and bonding costs), general contractor conditions at 20%, contractor overhead and profit at 20%, and materials and bidding contingency at 10% (to account for fluctuations in material costs, which can be influenced by changes in supply chain conditions, market demand, and inflation, and to accommodate a reasonable variance in bids due to factors like labor costs, workload, or interpretation of project requirements).
- An allowance for Design and Construction Phase Engineering costs are included in the OPCCs at 25% of the construction costs.
- A Project Contingency is included in the OPCC estimates to account for project unknowns at the current planning stage. In accordance with MWRA cost estimating policies, a Project Contingency allowance of 25% has been used.
- OPCC estimates incorporate the assumptions described in Section 4 regarding the development of the raw water sources (surface water intakes and groundwater wells), sizing of water transmission and distribution mains within service areas, associated piping appurtenances, paving, transmission and booster pumping stations, terminal and intermediate water storage tanks, and surface water and groundwater treatment facilities.
- An annual escalation of 3.5% has been included for a five-year period, based on the Authority's standard inflation rate for capital improvement plans (CIPs). As projects move forward and become better defined, project escalation costs should be revised based on the anticipated construction schedule.

Exclusions and limitations include:

- The following costs are excluded:
  - Community costs to join the MWRA system such as permit, application, and MWRA admission fees.
  - For communities with existing infrastructure (e.g., mains, tanks, pump stations), community costs related to improvements to the existing infrastructure, if required.
  - Costs for land acquisitions or temporary/permanent easements, legal fees, and permitting fees.
  - Costs for planning and preliminary design services.
  - Costs for rock excavation, handling/disposal of contaminated soils or groundwater, or utility-related costs.
  - This study has assumed an analysis of population projections and future buildout to undeveloped parcels would not be conducted. As such, costs for expansion due to future growth were excluded.
- Detailed evaluations of water quality considerations, hydraulic requirements, and siting locations (for siting and construction of transmission and distribution mains, tanks, pump stations, surface water intakes, and treatment buildings and for siting and development of groundwater wells) were not conducted and will require further evaluation as projects move forward.

## 5.2 Summary of Conceptual Expansion Project Cost Estimates

OPCCs for the conceptual expansion projects are summarized in Table 5-1.

These OPCCs should be used as an estimate of the relative magnitude of investment required for the projects. If the communities and MWRA advance any of the conceptual expansion projects, a more detailed analysis of the OPCCs should be developed as the projects are refined and designed.

**TABLE 5-1**

Summary of Opinion of Probable Construction Costs (in \$ Million)

Conceptual Project No.	1	2	3	4	5
	Southwest Intake	West Intake	Northwest Regional GW Supply	Northeast Regional GW Supply	Southeast Intake
<b>Description</b>	Supplies Belchertown, Ware, Ludlow and Pelham	Supplies New Salem, Wendell, Shutesbury and Orange	Supplies New Salem, Wendell, and Shutesbury	Supplies Phillipston and Petersham	Supplies Hardwick and Barre
<b>Components</b>					
Development of Raw Water Source	\$5.47	\$4.27	\$0.50	\$0.50	\$4.31
Water Treatment Plant	\$6.01	\$5.03	\$1.60	\$1.65	\$5.03
Storage and Pumping	\$12.12	\$20.87	\$5.90	\$4.59	\$11.90
Transmission Mains and Appurtenances	\$49.04	\$61.73	\$39.94	\$23.20	\$27.01
<b>SUB-TOTAL</b>	\$72.64	\$91.90	\$47.94	\$29.93	\$48.25
General Conditions - 20%	\$14.53	\$18.38	\$9.59	\$5.99	\$9.65
Contractor OH&P - 20%	\$14.53	\$18.38	\$9.59	\$5.99	\$9.65
Materials & Bidding Contingency - 10%	\$7.26	\$9.19	\$4.79	\$2.99	\$4.83
<b>CONSTRUCTION SUB-TOTAL</b>	\$108.96	\$137.85	\$71.91	\$44.90	\$72.37
Design and Construction Phase Engineering - 25%	\$27.24	\$34.46	\$17.98	\$11.22	\$18.09
<b>CONSTRUCTION AND ENGINEERING SUB-TOTAL</b>	\$136.20	\$172.31	\$89.89	\$56.12	\$90.47
Project Contingency Allowance - 25%	\$34.05	\$43.08	\$22.47	\$14.03	\$22.62
<b>CONCEPTUAL PROJECT COST - 2024 DOLLARS</b>	\$170.25	\$215.39	\$112.36	\$70.15	\$113.08
<b>CONCEPTUAL PROJECT COST - 2029 DOLLARS</b>	\$202.20	\$255.81	\$133.45	\$83.32	\$134.31

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**SECTION 6**

## **Section 6**

# **Funding Sources**

This section discusses potential federal and state funding sources that may be available for water systems. The eligibility for funding is dependent on the agency and type of loan or grant supplied. For example, most of the financing administered by the USDA is applicable only to small and rural towns and would require the eligible individual towns in this study to apply for the loan. Funding geared towards larger communities or populations is also available. Other funding alternatives such as betterment assessments, management districts, and considering a tax base are also included. Funding programs are tabulated and described in greater detail below:

### **Drinking Water Funding Opportunities**

- **Massachusetts Department of Environmental Protection**
  - Drinking Water State Revolving Fund (DWSRF) Loan
- **Massachusetts Division of Conservation Services**
  - Drinking Water Supply Protection Grant Program (DWSP)
- **Massachusetts Community One Stop for Growth Program**
  - MassWorks Infrastructure Program Grant
  - HousingWorks Infrastructure Program Grant
  - Rural Development Fund
- **United States Department of Agriculture Rural Development Loans and Grants**
  - Water and Waste Disposal Loan and Grant Program
  - Special Evaluation Assistance for Rural Communities and Households (SEARCH Grants)
  - Pre-Development Planning Grants (PPG Grants)
  - Emergency Community Water Assistance Grants
- **United States Environmental Protection Agency**
  - Water Infrastructure Finance and Innovation Act (WIFIA)
  - Community Grant Program
- **Other**
  - Betterment Assessments
  - Management Districts
  - Tax Base

- Drinking Water State Revolving Fund (SRF) Projects - These funds are used for public drinking water projects. The Massachusetts Clean Water Trust (the Trust), in partnership with the MassDEP provides cities and towns of the Commonwealth with low-interest rate loans for water infrastructure projects. These programs provide state-administered below market rate financing for the construction of publicly owned drinking water system projects. Projects to be financed are selected using a priority ranking system based upon the public health and environmental protection benefits of the proposed projects. Projects receiving financial assistance from the DWSRF will be eligible for loans at 2% interest, with possible partial loan forgiveness.
- Drinking Water Supply Protection (DWSP) Grant Projects – The Massachusetts Division of Conservation Services provides financial assistance through a reimbursement program for PWSs and municipal water departments. Funds can be used to purchase land or interests in land for purposes such as the protection of existing MassDEP-approved drinking water supplies, protection of planned future public drinking water supplies, or groundwater recharge. The reimbursement rate is 60% with a maximum award of \$350,000.
- Massachusetts Community One Stop for Growth Program – Designed to simplify access to 12 of the most popular integrated grant programs across several state entities with one online location, allowing applicants to be considered for multiple grant programs simultaneously. Application to the following funding opportunities can be accessed through the Community One Stop for Growth Program:
  - MassWorks Infrastructure Program Grant – This program provides the largest and most flexible source of capital funds to municipalities and other eligible public entities primarily for public infrastructure projects that support and accelerate housing production, spur private development, and create jobs throughout the Commonwealth. Grants typically range from around \$1 million to \$5 million for infrastructure projects.
  - HousingWorks Infrastructure Program Grant – This program provides capital funds to municipalities to support and unlock housing opportunities. This grant program awards funds based on the project’s nexus with housing, transportation, infrastructure, and community development needs. There is no set minimum or maximum amount that an eligible applicant may request. Historically, awards have ranged from \$300,000 to \$5 million, with an average award of \$2.5 million.
  - Rural Development Fund – This program was established for community and infrastructure development needs in small towns and rural municipalities. Projects score higher if the project creates or supports housing. Eligible populations include those <7,000 or population density <500/sq mi. Grants in this category will likely be \$50,000 to \$500,000.
- USDA Rural Development Loans and Grants - USDA’s Office of Rural Development has several programs that assist very small, financially distressed rural communities to extend and improve water and waste treatment facilities that serve local households and businesses.
  - Water and Waste Disposal Loan and Grant Program provides funding through long-term, low-interest loans for clean and reliable drinking water

systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas (populations of 10,000 or less).

- Special Evaluation Assistance for Rural Communities and Households (SEARCH Grants) may be used for predevelopment planning costs associated with construction or improvement of rural water or sanitary sewage facilities for communities with populations under 2,500 and median household income below poverty line or less than 80% of the statewide non-metropolitan median household income.
- Pre-Development Planning Grants (PPG) assists low-income communities having populations of 10,000 or less and median household income below poverty line or less than 80% of the statewide non-metropolitan median household income with initial planning and development of applications for USDA Rural Development Water and Waste Disposal direct loan/grant and loan guarantee programs. The maximum amount is \$60,000 or 75% of the pre-development planning costs.
- Emergency Community Water Assistance Grants help eligible communities prepare for or recover from emergencies that threaten access and availability to safe and reliable drinking water. Eligible communities include rural areas (populations of 10,000 or less) and median household income below the statewide non-metropolitan median household.
- Water Infrastructure Finance and Innovation Act (WIFIA) - The Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) established the WIFIA program, a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. Minimum project size for small communities (population of 25,000 or less) is \$5 million while the minimum project size for large communities is \$20 million. WIFIA funds a maximum of 49% of eligible project costs. Projects under the DWSRF program are eligible.
- Community Grant Program, USEPA – Administered by the EPA, eligible projects fall under Congressionally Directed Spending (CDS) and Community Project Funding (CPF) items in the Appropriations Acts. These are direct appropriations and communities work with their congressional delegation. Funding can be used for the planning, design, and construction of drinking water, wastewater, and stormwater infrastructure projects. The EPA uses the DWSRF framework as a guideline for implementation of these grants.
- Betterment Assessments - If the Town constructs a public water or sewer system, it could be partially funded by creating a Water or Sewer District, which would collect a special assessment tax based on the “betterment” of the site since it will have access to public water or sewer. Betterment assessments are a form of taxation, and, until paid, constitute a lien upon the land assessed. Service by a PWS is an improvement over on-site private wells. The betterment assessment is a one-time special tax that can be paid in one lump sum or apportioned up to a maximum of twenty years. Those property owners who did not pay in full at the time the betterment is assessed have the remainder of their assessments amortized over twenty years at a rate of 2% interest added annually to the unpaid balance.

- Management districts are legal, geographic areas that are established to carry out environmental work, such as funding and building infrastructure improvements, managing infrastructure or programs, or providing other environmental protection services.
- Tax Base – Town could consider a town-wide increase in property taxes to help support the project.

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**SECTION 7**

## Section 7

# Implementation Considerations

### 7.1 Permitting Considerations

Tighe & Bond completed a desktop review of the five alternatives to determine existing environmental constraints to establish an understanding of which environmental regulatory programs may be applicable. The following sections describe the type of jurisdictional constraints identified and tables are provided which present the required permit/approvals, the permitting authority and code, and the applicability for each alternative.

### 7.2 Drinking Water and Public Health

#### 7.2.1 Drinking Water Permits

MassDEP regulates drinking water for Massachusetts for public health under M.G.L Chapter 111, §§ 2C, 5E-G, 17, 143, 159-160A/B, 162, and 165, (for others see 310 CMR 22.01(2)) and its implementing regulations under 310 CMR 22.00. MassDEP sets standards for minimum drinking water requirements including for modifications of drinking water distribution systems: such as WSTs, distribution pump stations, and transmission main installations; the use of chemical treatment for blending supplies; the construction or modification of treatment facilities and chemical treatment; land acquisition for new supply facilities; and, for the abandonment of existing community supplies. MassDEP requires the submittal of a permit application for a myriad of purposes, not limited to but including for new sources, modifications to existing sources, and expansion of systems. A Filtration Avoidance Determination would be required for the new surface water source alternatives.

#### 7.2.2 Water Management Act

MassDEP, under M.G.L. c. 21G, § 3 / M.G.L. c. 30A, §§ 2 and its implementing regulations under 310 CMR 36.00 (which should be read together with the Massachusetts Water Management Act (WMA), M.G.L. c. 21G/310 CMR 36.00), also regulates the management of Massachusetts' water resources by regulating withdrawals of ground and surface waters over 100,000 gallons per day (gpd). These standards would be applicable to municipal water suppliers with existing WMA permits if local sources continue to be used in conjunction with one of the proposed alternatives in that municipality. However, this study has assumed that the existing and proposed service areas would be entirely supplied by the proposed new source alternative. For the proposed alternatives, new WMA permitted withdrawals would be needed for groundwater withdrawals in excess of 100,000 gpd. New intakes managed by MWRA would likely be covered under MWRA's current permitted withdrawal, but the WMA permitted withdrawal would need to be amended to list any new intakes. The WMA indicates that withdrawers with a Water Management Registration do not need a permit if they do not increase withdrawals over their permitted withdrawals or add any new withdrawal points to their system. If any of the proposed surface water intake alternatives move forward, additional analysis would be needed to determine if the increase, at the time the projects move forward, remains below MWRA's permitted withdrawal and if a new intake at the Quabbin Reservoir would be considered a new withdrawal point. If either the surface water or groundwater supply alternatives advance, it should be confirmed that the supply is sufficient for any new increase.

## 7.3 Environmental Permitting

### 7.3.1 MA Wetlands Protection Act and Local Wetland Protection Bylaws

The Massachusetts Wetlands Protection Act (MAWPA), under M.G.L. c. 131, § 40 and its implementing regulations at 310 CMR 10.00, is administered by each municipality's Conservation Commission. The MAWPA establishes jurisdiction over work in and near wetland resource areas, including inland Bank, Land Under Water Bodies and Waterways, Bordering Vegetated Wetlands (BVW), Bordering Land Subject to Flooding (BLSF; i.e., the limits of 100-year flooding), and the 200-foot Riverfront Area of perennial streams. Each municipality (12 study communities) also may or may not have a local wetlands protection bylaw (see Table 7-1 below for new sources). The MAWPA does not exempt new projects, but does exempt the maintenance, repair, and replacement (but not substantial change or enlargement) of existing and lawfully located facilities used in the service of the public and used to provide water. For the purposes of this evaluation, it is assumed that none of the concepts would qualify for this statutory exemption.

New projects with direct impacts, both temporary and permanent, are required to file a Notice of Intent (NOI) with the Conservation Commission. An NOI typically includes detailed information about existing conditions and proposed activities, as well as demonstration of compliance with the applicable performance standards and an alternatives analysis relative to direct impacts to wetland resource areas. The NOI process also entails public notice in the local newspaper and notification of abutters to the subject parcel(s).

Approval of the NOI results in the issuance of a permit (Order of Conditions; OOC) that is subsequently recorded at the Registry of Deeds and is valid for a period of three years. Activities that occur within the 100-foot Buffer Zone are also subject to Conservation Commission review. The typical timeframe for submission of an NOI is roughly one month for preparation of application from receipt of [minimum] 75% design drawings, and six to eight weeks from the date of submission.

#### 7.3.1.1 Limited Project Status

The MAWPA regulations establish Limited Project provisions for certain types of projects that generally have an overarching public benefit. Subject to each Conservation Commission's discretion, a project may be permitted even if all applicable Performance Standards are not met. The following are a list of possible Limited Project categories which may be used to permit the alternatives under the MAWPA (310 CMR 10.53(3)(d) and 310 CMR 10.53(3)(o)):

- 310 CMR 10.53(3)(d)
  - "The construction, reconstruction, operation and maintenance of underground and overhead public utilities, limited to electrical distribution or transmission lines, or communication, sewer, water and natural gas lines, may be permitted as a limited project pursuant to 310 CMR 10.24(7) provided that the project complies with all applicable provisions of 310 CMR 10.24(1) through (6), (9) and (10), and (7)(b)1. through 9."
- 310 CMR 10.53(3)(o)
  - "The exploration, development, construction, expansion, maintenance, operation, and replacement of public water supply wells or wellfields

(including necessary associated roads, ways, structures, and underground and overhead utility lines) derived from groundwater...”

### **7.3.2 Section 401 Water Quality Certification**

Section 401 of the Clean Water Act (33 U.S.C. 1251, 314 CMR 9.00) is administered by MassDEP. Typically, an Individual Water Quality Certification (WQC) is required if direct impacts to wetlands and waterways are greater than 5,000 square feet (sf); will result in the cumulative dredge of 100 or more cubic yards (cy) of sediment below the high water line; will result in any discharge of dredged and/or fill material to an Outstanding Resource Water (ORW) – the Quabbin Reservoir and much of its surrounding environs are located within ORW; or, if an Individual Permit is required under Section 404 of the Clean Water Act by the US Army Corps of Engineers under 33 CFR 325.1).

The Quabbin Reservoir is identified as a Class A Surface Water (public water supply) in the Massachusetts Surface Water Quality Standards (314 CMR 4.00). All public water supplies, including wetlands and tributaries thereto, are considered ORWs. The ORW designation is separate and distinct from surface water protection zones (Zones A, B, and C) associated with active surface water supplies. As such, an Individual WQC will be required. One application will likely be required for each alternative, unless MassDEP gives authorization for the alternatives to be coupled together. MassDEP does issue variances, although in the case of the proposed alternatives, a variance is likely not permissible.

The following provisions (314 CMR 9.06(3)) govern the discharge to ORWs and for work within DCR land designated within the Quabbin watershed, which may be used as an avenue for project approval:

- 314 CMR 9.06(3)(a)
  - “Projects conducted or approved by public or private water suppliers in the performance of their responsibilities and duties to protect the quality of the water in the watersheds, or to maintain, operate and improve the waterworks system, provided that such projects are implemented in accordance with applicable federal and state laws, regulations, and requirements;”
- 314 CMR 9.06(3)(c)
  - “Maintenance, repair, replacement or reconstruction but not substantial enlargement of existing and lawfully located structures or facilities including buildings, roads, railways, utilities, dams, and coastal engineering structures;”
- 314 CMR 9.06(3)(d)
  - “Where the designation was for public water supply purposes, activities subject to the comprehensive public water supply protection program enacted by the legislature for the Ware, Quabbin, and Wachusett watersheds in the Watershed Protection Act, St. 1992 c. 36 and M.G.L. c. 92. Any activity for which an applicant has been granted a variance by the Department of Conservation and Recreation pursuant to 350 CMR 11.06(3): Variances or for a discharge of dredged or fill material into a tributary that the Department of Conservation and Recreation has exempted pursuant to

350 CMR 11.06(4): Exemption of a Tributary. A span or other bridging technique shall be presumed to be a practicable alternative. This presumption may be overcome by credible evidence from a competent source. The Department will consult with the Department of Conservation and Recreation in reviewing the alternatives.”

The regulatory review timeline can range from 120 to 600 days depending on the complexity of the project and MassDEP staff availability to complete the review.

### **7.3.4 Section 404 Permitting Approval**

Section 404 of the Clean Water Act (33 CFR Parts 320-332) is administered by the United States Army Corps of Engineers (USACE). The USACE administers approval procedures for projects within Waters of the United States (WOTUS) under the General Permits for the Commonwealth of Massachusetts (MA GPs) as well as Individual Permits on a case-by-case basis. The most recent MA GPs were issued on June 2, 2023 and will expire on June 1, 2028. Authorization under the Clean Water Act of 1972 gives USACE jurisdiction over WOTUS, including areas below the Ordinary High Water (OHW) line of streams/rivers, lakes and ponds and vegetated wetlands. Under MA GP 24 temporary work is allowed for “Temporary Construction, Access, and Dewatering” activities for access to upland siting locations, specifically:

- “Temporary structures, work, and discharges, including cofferdams, necessary for construction activities or access fills or dewatering of construction sites that are not authorized under another GP activity.”

This is presuming that neither of the groundwater wells nor the landside components of the intakes are within WOTUS as in adjacent vegetated wetlands; if they are, an Individual Permit may be required. Neither GP 24 nor any other GP approves new structures within WOTUS outright.

With similar thresholds to Section 401, the MA GPs establish time of year restrictions relative to work resulting in tree removal that may impact Northern Long-Eared Bats or other federally protected species. USACE has three levels of permit approvals, Self-Verification, Pre-Construction, and Individual. Depending upon individual site conditions for each of the alternatives, the limiting factor for each approval is aerial extent and temporal duration of the work within WOTUS.

### 7.3.5 Massachusetts Environmental Policy Act

Review under the Massachusetts Environmental Policy Act (MEPA), under M.G.L. c. 30, §§ 61 through 62L its implementing regulations at 301 CMR 11.00), is required when:

- There is a state agency action (i.e., project undertaken by a state agency, requires a permit<sup>1</sup> from a state agency, involves financial assistance from a state agency, or a land transfer) and,
- The project exceeds one or more MEPA review thresholds set forth at 301 CMR 11.03.

Communities wishing to interconnect with the MWRA must obtain approval from the Executive Office of Energy and Environmental Affairs via the MEPA review Process.

The Projects will require state permitting approvals and possibly land transfer (i.e., Article 97 lands). The review levels vary depending on the exceedances of various thresholds, which range from impacts to wetlands, rare and endangered species, traffic, among others, see 301 CMR 11.03 for those thresholds. The following is a short list of possible thresholds which may also trigger MEPA review.

- 301 CMR 11.03(1) Land
- 301 CMR 11.03(2) State-Listed Species
- 301 CMR 11.03(3) Wetlands, Waterways and Tidelands
- 301 CMR 11.03(4) Water

The thresholds for 301 CMR 11.03(4) (a) and (b) are of particular interest to these Projects and are as follows.

#### 301 CMR 11.03(4) Water

##### (a) ENF and Mandatory EIR.

##### 1. New withdrawal or Expansion in withdrawal of:

- a. 2,500,000 or more gpd from a surface water source; or
2. New interbasin transfer of water of 1,000,000 or more gpd or any amount determined significant by the Water Resources Commission.
  3. Construction of one or more new water mains ten or more miles in length.
  4. Provided that the Project is undertaken by an Agency, New water service to a municipality or water district across a municipal boundary through New or existing pipelines, unless a disruption of service emergency is declared in accordance with applicable statutes and regulations.

##### (b) ENF and Other MEPA Review if the Secretary so Requires.

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<sup>1</sup> See 301 CMR 11.02(a): "Any permit, license, certificate, variance, approval, or other entitlement for use, granted by an Agency for or by reason of a Project."

1. New withdrawal or Expansion in withdrawal of 100,000 or more gpd from a water source that requires new construction for the withdrawal.
2. New withdrawal or Expansion in withdrawal of 500,000 or more gpd from a water supply system above the lesser of current system-wide authorized withdrawal volume or three-years' average system-wide actual withdrawal volume.
3. Construction of one or more new water mains five or more miles in length.
4. Construction of a new drinking WTP with a Capacity of 1,000,000 or more gpd.
5. Expansion of an existing drinking WTP by the greater of 1,000,000 gpd or 10% of existing Capacity.
6. Alteration requiring a variance in accordance with the Watershed Protection Act, unless the Project consists solely of one single family dwelling.
7. Non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking water supply for purpose of forest harvesting activities.

The MEPA process involves the public disclosure of possible environmental and social impacts which may result from the project, including those listed above and are inclusive of Environmental Justice interests. The process requires a public comment period. The project(s) may exceed the following MEPA thresholds 301 CMR 11.03(4)(a) and (b). A detailed evaluation of MEPA applicability should be revisited once a conceptual design is selected and advanced.

### **7.3.6 Massachusetts Historical Commission**

To satisfy the historical notification requirements of the MA GPs per Section 106 of the National Historic Preservation Act (54 USC 306108) and M.G.L. c. 9, §§ 26 through 27C and its implementing regulations at 950 CMR 71.00, a Project Notification Form (PNF) is required to be submitted to the Massachusetts Historical Commission (MHC; MHC also serves as the State Historic Preservation Officer (SHPO)), geographically pertinent Tribal Historic Preservation Officers (THPOs), and the Massachusetts Board of Underwater Archeological Resources (MA BUAR), as applicable. The PNF will contain a description of the project site and surrounding area, recent photos, project drawings (if available), and a review of the State and Federal Registers of Historic Places.

The SHPO and geographically pertinent THPOs are also required to be notified if a federal action is required. Notification of the MA BUAR is also required if a project is located within a waterbody or waterway.

Preparation of a PNF typically requires one to two weeks. MHC has up to 30 days to respond to PNFs in writing.

### **7.3.7 Massachusetts Endangered Species Act**

The Project Sites are also within the limits of Priority Habitats of Rare Species (PH 1673 and 1335), as mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) in the NHESP Atlas (15<sup>th</sup> edition, August 2021). Activities within Priority Habitat are subject to NHESP review under the Massachusetts Endangered Species Act (MESA), under M.G.L. c.131A and its implementing regulations under 321 CMR 10.00, while activities within Estimated Habitat are subject to NHESP review under the MAWPA.

Coordination with NHESP may include the preparation of a Rare Species Information Request to determine the number and types of species located within the potential project areas. This information will be used to identify the potential impact of the project(s) on rare and endangered species and their habitat. NHESP has up to 30 days to respond to these requests.

In upland areas where a Notice of Intent is not required the project(s) will be required to file a MESA *Project Review Checklist* to NHESP. Similar to other permit applications, the *Project Review Checklist* includes a narrative description of the proposed project, existing conditions and rare species habitat, and design drawings. The application also includes a filing fee from which the state is not exempt. If the areas are within identified wetlands or other areas subject to MAWPA (and/or local wetlands bylaw) jurisdiction, then a NOI must be prepared for Conservation Commission review; this NOI is then simultaneously submitted to NHESP in lieu of a separate *Project Review Checklist*.

In response, NHESP will determine whether the project will result in a “Take” of a State-listed Species. If NHESP determines that the project will not result in a Take or can be conditioned to avoid a Take (e.g., time of year restrictions, rare species surveys and/or protection plans), then further coordination and permitting is not required apart from species survey and/or protection plans (if applicable).

If NHESP determines that the project will result in an unavoidable Take, the work must be authorized under a Conservation and Management Permit (CMP). Most projects do not require a CMP, which can add months or years to the permitting process depending on the species, surveys, and other requirements, to determine a Net Benefit plan for the species and/or their habitat.

NHESP has up to 60 days from receipt of a *Project Review Checklist* filed under MESA to render their determination. In the event an NOI under the MAWPA (and Chapter 15) is required, NHESP’s reviews under MESA and the MAWPA can be streamlined as part of the NOI application. Under these circumstances, their regulatory review period is reduced to 30 days.

Table 7-1 summarizes each alternative’s permitting requirements.

**TABLE 7-1**  
Alternative Specific Permitting Requirements for New Sources

Conceptual Project	Town	ORW	Wetlands Protection Bylaw / Code	MassDEP Estimated Wetlands	WMA <sup>1</sup>	WPA / WPB <sup>2</sup>	MESA <sup>3</sup>	MEPA <sup>4</sup>	WQC <sup>5</sup>	Section 404 <sup>6</sup>
1. Southwest Intake	Belchertown	Yes	Yes Chapter 290	Yes Wetlands Onsite	No <sup>1</sup>	Yes	Yes: PH 1224 Along Winsor Dam Road, Not at Intake	Yes	Yes	Yes
2. West Intake	Shutesbury	Yes	Yes "Shutesbury General Wetlands Protection Bylaw"	Yes Wetlands Onsite	No <sup>1</sup>	Yes	Yes: PH 1673 Water Intake and Landward Not along State Forest Road	Yes	Yes	Yes
3. Northwest Regional Groundwater Supply	Wendell	No	Yes, "Town of Wendell, Massachusetts General Wetlands Protection Bylaw"	Yes Wetlands Along Route	Yes <sup>1</sup>	Yes	No	Yes	Only if Well within Wetland	No
4. Northeast Regional Groundwater Supply	Petersham	No	No	Yes Wetlands Along Route	No <sup>1</sup>	Yes	Yes: PH 1673 Quabbin Reservoir in Petersham	Yes	No	If Wells is sited within Federal Wetland
5. Southeast Intake	Hardwick	Yes	No	Yes Wetlands Onsite	No <sup>1</sup>	Yes	Yes: PH 1335 At Intake	Yes	Yes	Yes

1. Massachusetts Water Management Act. New intakes managed by MWRA would likely be covered under MWRA's permitted withdrawal, but the WMA permitted withdrawal would need to be amended to list any new intakes. However, additional analysis is needed if alternative moves forward to determine if the increase in withdrawal remains below MWRA's permitted withdrawal and if a new intake at the Quabbin Reservoir would be considered a new withdrawal point. New WMA permitted withdrawals would be needed for groundwater withdrawals in excess of 100,000 gpd. Confirm demand for groundwater alternatives relative to the 100,000 gpd threshold if any of the groundwater alternatives move forward.
2. Massachusetts Wetlands Protection Act or Local Wetlands Protection Bylaw
3. Massachusetts Endangered Species Act
4. Massachusetts Environmental Protection Act
5. Water Quality Certification
6. Section 404 Authorization

## 7.4 Other Approvals

Table 7-2 provides a synopsis of the permits described above and several other key permits which should be considered.

**TABLE 7-2**

Required Permits and Approvals for Quabbin Water System Expansion

Permit / Approval	Permitting Authority	US and Massachusetts Code	Applicability
<b>Other Drinking Water Review</b>			
Interbasin Transfer Act (ITA) Approval	Massachusetts Water Resources Commission (WRC)	313 CMR 4.00 Regulates the transfer of water outside of a major basin	<ul style="list-style-type: none"> <li>Applicable if waters are transferred outside of the Chicopee River Drainage Basin.</li> </ul>
<b>Land Use</b>			
Article 97 Land Conversion	Massachusetts Legislature	Article 97 of the Massachusetts Constitution Regulates the protection of existing conservation land designated under Article 97.	<ul style="list-style-type: none"> <li>Municipal Conservation Commission must vote unanimously that the land is surplus to municipal, conservation and open space needs.</li> <li>Municipal Town Meeting (or City Council) must vote (2/3 majority) in support of the disposition to remove the land from protected status.</li> <li>Subject to MEPA review.</li> <li>Land protected by Article 97 requires a 2/3 vote of the Legislature before it can be disposed of and there is a "no net loss" policy.</li> <li>If approved, the Bill must be signed by the governor.</li> <li>Portions of the project are located within Article 97 Lands</li> </ul>
<b>Other Federal Review</b>			
NPDES <sup>1</sup> Construction General Permit (CGP)	US Environmental Protection Agency (EPA)	40 CFR Part 122 and 314 CMR 3.00 Regulates point source discharges during active construction for sites over 1 acre	<ul style="list-style-type: none"> <li>Required for active construction</li> <li>A Stormwater Pollution Prevention Plan (SWPPP) must be prepared and submitted to EPA</li> </ul>
NPDES Dewatering and Remediation General Permit (DRGP)	EPA	40 CFR Part 122 and 314 CMR 3.00 Regulates dewatering of foundation sumps when discharged to federal waters.	<ul style="list-style-type: none"> <li>Facilities with construction dewatering of groundwater or stormwater for sites less than one acre and for either short- or long-term dewatering of foundation sumps</li> </ul>

<b>Permit / Approval</b>	<b>Permitting Authority</b>	<b>US and Massachusetts Code</b>	<b>Applicability</b>
<b>Utilities and Roadways</b>			
Amtrak License Agreement for Occupancy	AMTRAK	License agreement to work within AMTRAK's right of way, if applicable	<ul style="list-style-type: none"> <li>Required for any AMTRAK railroad crossings</li> </ul>
Utility Permit, Right of Entry Permit, Longitudinal Occupancy Permit	CSX	License agreement to work within CSX's right of way, if applicable	<ul style="list-style-type: none"> <li>Required for any CSX railroad crossings</li> </ul>
8(m) Permit	MWRA	Section 8(m) of Chapter 372 of the Acts of 1984 Regulates work within the MWRA's easements or other properties	<ul style="list-style-type: none"> <li>Requests the MWRA to issue an 8(m) Permit. Section 8(m) of Chapter 372 of the Acts of 1984 enables the Authority to issue permits to other entities to build, construct, excavate, or cross within an easement or other property interest held by the Authority</li> </ul>
State Highway Access Permit	Massachusetts Department of Transportation (MassDOT)	Regulates work within state owned highways	<ul style="list-style-type: none"> <li>Required for work within a state highway and on state bridges/tunnels</li> </ul>
Local Road Opening Permits	Municipal Highway Department	Regulates road closures	<ul style="list-style-type: none"> <li>Required to work on a road which may need to be closed temporarily</li> </ul>
Department of Conservation and Recreation (DCR) Access Permit	DCR	Regulates work within DCR owned land.	<ul style="list-style-type: none"> <li>Required to work on a road owned by the DCR, of which, the Quabbin is.</li> </ul>
<b>Other Municipal Reviews</b>			
Engineering Plans, Site Plan and Zoning Approvals	Municipal departments such as DPW, planning, engineering, etc.	Regulates engineering design plans	<ul style="list-style-type: none"> <li>Review is at the local level and each town should be consulted</li> </ul>
Private Utilities	Electric, Gas, Telephone, Cable	Regulates work around private utilities	<ul style="list-style-type: none"> <li>Private utilities should be consulted prior to onset of work</li> </ul>
1. National Pollutant Discharge Elimination System			

## 7.5 New Source Approval

New source alternatives include:

- Groundwater Supply
- Surface Water Supply

### 7.5.1 Groundwater

All new groundwater wells must be developed in compliance with the Massachusetts Drinking Water Regulations (310 CMR 22.21), and the Water Management Act. The process of developing a new groundwater supply is described in Chapter 4 of the MassDEP Guidelines for Public Water Systems. This is a step-by-step process involving site screening, pump testing, and water quality testing.

In general, developing a public water supply well requires finding a site that meets several conditions, including:

- Water Quantity
- Land Protection
- Water Quality

#### 7.5.1.1 Water Quantity

To design a water works system that will be adequate to meet present and future needs of a community, it is necessary to estimate present and future rates of consumption. Future consumption may be estimated from predicted population trends and undeveloped parcel build-out projections and using future per capita consumption estimates. Note that this study did not include an evaluation of future water needs, but that should be conducted if any of the conceptual projects are advanced.

Water consumption for a community varies from hour to hour throughout any day and from day to day throughout any year. To adequately supply a community with water, the distribution system must have the capacity to meet water consumption needs during the peak rate of consumption occurring at any time during the year. If desired, the distribution system must also deliver adequate fire flow to any point in the system.

To successfully develop a new public water supply well, the subsurface hydrogeological conditions must be appropriate to supply the required water quantity. This can only be known for certain by installation of a test well and conducting a pump test. However, it may be possible to estimate the potential yield of wells in various areas using existing available data. Groundwater wells can generally be divided into two categories: wells that withdraw from overburden aquifers, and bedrock wells. Most public water supply wells are developed in overburden aquifers because available data can be used to predict areas that may produce high yield wells. Bedrock wells generally depend on fractures in the bedrock and are much less predictable.

Overburden wells are wells that withdraw from soil above the bedrock. The productivity of the well greatly depends on soil parameters including depth of soil, grain size, and distribution. Soils that contain fine material, such as silt and clays, generally do not allow water to flow freely, and the productivity of the well is typically limited to less than 10 gpm. Soils that consist of larger particles such as sands and gravel may be suitable for high yield wells. High yield wells are also ideally located in deep aquifers. Wells draw water from the surrounding soil by lowering the water table close to the well, using gravity to

pull water toward the well. The deeper the aquifer, the more gravitational force can be used to pull water toward the well. Also, deeper aquifers have greater storage potential and are less influenced by seasonal water level fluctuations and droughts.

If an overburden well does not appear feasible, a bedrock well may be a viable alternative. Bedrock wells do not have the limitation of needing to be located within an overburden aquifer. Although the yield of a bedrock well is unpredictable, it is advisable to look for an area that appears to have adequate recharge, such as near the convergence of streams. A bedrock well site still needs to meet Zone I requirements, and Zones II and III will need to be delineated and protected as described below.

Although geophysical methods are being routinely used for exploration of groundwater, at times it becomes a challenge because of various factors such as geometry and depth of the aquifer and the yield of groundwater. Further, in the absence of surface manifestations of structures favorable for groundwater occurrence, and instead of depending on one particular geophysical method, an integrated geophysical strategy plays an indispensable role not only in mapping and understanding the nature of aquifers, but also ensures a better success rate of exploration.

The USGS has collected hydrogeological studies and maps prepared throughout the years by various scholars and governmental departments. A thorough evaluation of hydrogeological mapping will be recommended if further consideration is given to developing a public groundwater well. For this study, approximate locations for potential groundwater explorations were determined based on areas with high groundwater availability and favorability according to USGS panels.

#### **7.5.1.2 Land Protection**

To successfully develop a new public water supply well, in addition to siting a well with adequate water quantity, the surrounding lands must also be adequately protected from potential contaminants to protect the water quality. This requirement is regulated by MassDEP. MassDEP defines various zones with differing levels of protection required for each zone.

Zone I is the protective radius required around a public water supply well or wellfield. This area should be owned by the water supply and limited to water supply activities. If ownership of Zone I is not possible, MassDEP may approve an alternative such as a conservation restriction as described in Policy 94-03. The radius is 400 feet for wells with approved yields greater than 100,000 gpd, 100 feet for wells with approved yields less than 1,000 gpd, and determined by the following formula for wells between 1,000 gpd and 100,000 gpd:

$$\text{Zone I radius in feet} = 150 \times \log(\text{pumping rate in gpd}) - 350$$

Zone II is the actual area of an aquifer which contributes water to the well within the most severe pumping conditions that can be realistically anticipated. Defining a Zone II requires a detailed hydrogeologic study and would be completed as part of the new source approval process. Note that determining the Zone II of a bedrock well is more difficult and uncertain than for an overburden well.

Zone III is the surface watershed in which the well is located, excluding those downgradient portions that do not contribute water to the well under extreme pumping conditions. The upgradient portion can be delineated using topographic mapping, but the

downgradient boundary must be set based on hydrogeological conditions with input from MassDEP.

Zones II and III do not have to be owned by the public water supply, but they do need to be protected with municipal controls (bylaws, ordinances, or health regulations) that meet MassDEP Wellhead Protection Zoning and Non-Zoning Controls 310 CMR 22.21(2). As examples of the types of limitations on land use, the following land uses must be prohibited in the Zone II and/or the Zone III:

- Road salt storage
- Snow stockpiling from salted roads
- Landfills
- Automobile junkyards
- Hazardous waste facilities
- Petroleum, fuel oil and heating oil bulk stations and terminals
- Certain types of wastewater treatment or disposal works
- Storage of fertilizers

Note that the above list is not exhaustive. Refer to 310 CMR 22.21(2) for further details. Additional research would be required to determine whether an available vacant parcel satisfies Zone II and III requirements.

Siting a well on protected land, such as Article 97 land in the Quabbin Watershed, would ensure a highly safeguarded water source with the required protective radius but would require approval from regulatory agencies including MWRA and Article 97 regulatory approval. While MWRA assumes that the community or communities would own and operate the groundwater systems, MWRA could facilitate permanent water supply easements (with the support of DCR, EEA, and other agencies) on protected watershed lands. MWRA would work with the community or communities to determine appropriate well locations relative to natural water resources such as streams and surface waters.

#### **7.5.1.3 Water Quality**

To successfully develop a new public water supply well, in addition to the water quantity and land protection requirements described above, the water quality of the well must also be adequate to meet public water supply regulations. This can only be known for certain by installation of a test well and sampling the ground water, which is completed as part of the new source approval process. However, siting the well in a location where the contributory area is undeveloped and pristine will help to improve the possibility that the water quality will be adequate.

If contaminants are discovered in the well as part of the new source approval process, depending on the type of contaminants and the concentration, it may be possible to treat the water to meet water quality regulations. It may also be necessary to treat the water to adjust the hardness and/or reduce the corrosivity. In any case, a chemical injection facility may be required at a minimum to provide a chlorine residual for protection of the distribution system's quality.

#### **7.5.1.4 Process for Developing a Groundwater Source**

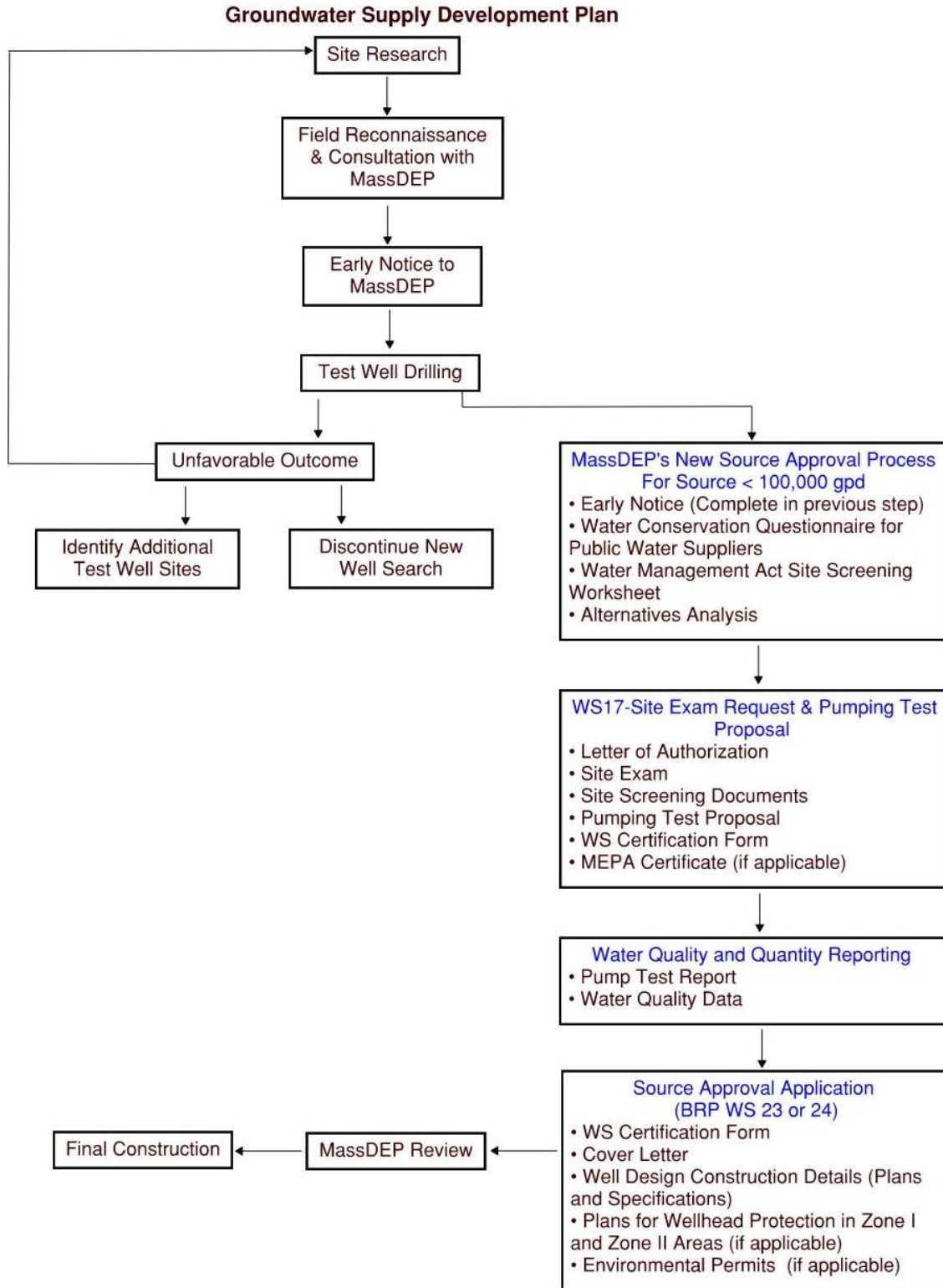
After an initial evaluation, if a community decides to pursue developing a groundwater system, a more in-depth evaluation is recommended to confirm an acceptable probability

of success. Following this preliminary evaluation, the water supplier will need to follow the MassDEP New Source Approval process, which is set forth in the Groundwater Supply Protection section of the Massachusetts Drinking Water Regulations (310 CMR 22.21). This is a step-by-step process that results in MassDEP approval of a new PWS source. The process differs for wells with yields greater or smaller than 100,000 gpd and depending upon whether the source is in a bedrock aquifer, confined sand and gravel aquifer, unconfined sand and gravel aquifer, or spring.

The process would consist of the following general steps for wells with yields smaller than 100,000 gpd:

- Preliminary evaluation and discussions with property owners (if necessary)
- Test drilling
- Preliminary new source permitting
- Procure land
- Construct production well(s)
- Conduct pump test(s)
- Water Quality and Quantity Reporting
- Source Approval Application (BRP WS 23)
- Final new source permitting
- Design and Construct Well Facility
- Site Inspection of Permanent Works and Final Source Approval

The schematic on the following page summarizes the groundwater supply development process.



**7.5.2 Surface Water**

MassDEP requires each water system to draw its raw water from the best available source that is economically reasonable and technically possible. A surface water supply includes all tributary streams and drainage basins, natural lakes, and artificial reservoirs or impoundments used as sources of water by a PWS.

Massachusetts general law requires water suppliers to obtain the consent and approval of MassDEP before acquiring lands for the construction, operation, or protection of a water supply. MassDEP Drinking Water Guidelines Chapter 3 is dedicated to Surface Water Supply Development. Development of a surface water supply requires construction and maintenance of a surface water treatment facility in conformance to the Surface Water Treatment Rule (SWTR). If water quality is excellent, it is possible to obtain a filtration waiver, limiting the required treatment to two forms of disinfection, such as ultraviolet disinfection and chlorination.

For this project, it is assumed that the filtration waiver for the existing Quabbin surface WTP will extend to new intakes and surface WTPs, but future evaluation will be required if projects with new surface WTPs proceed. Filtration could be required where intakes cannot be constructed in deep water or if localized water quality cannot consistently meet filtration avoidance. Further study will be required to identify water quality challenges associated with water age, maintenance of chlorine residual, and formation of disinfection byproducts due to the extensive lengths of transmission mains from the surface water intakes to the communities.

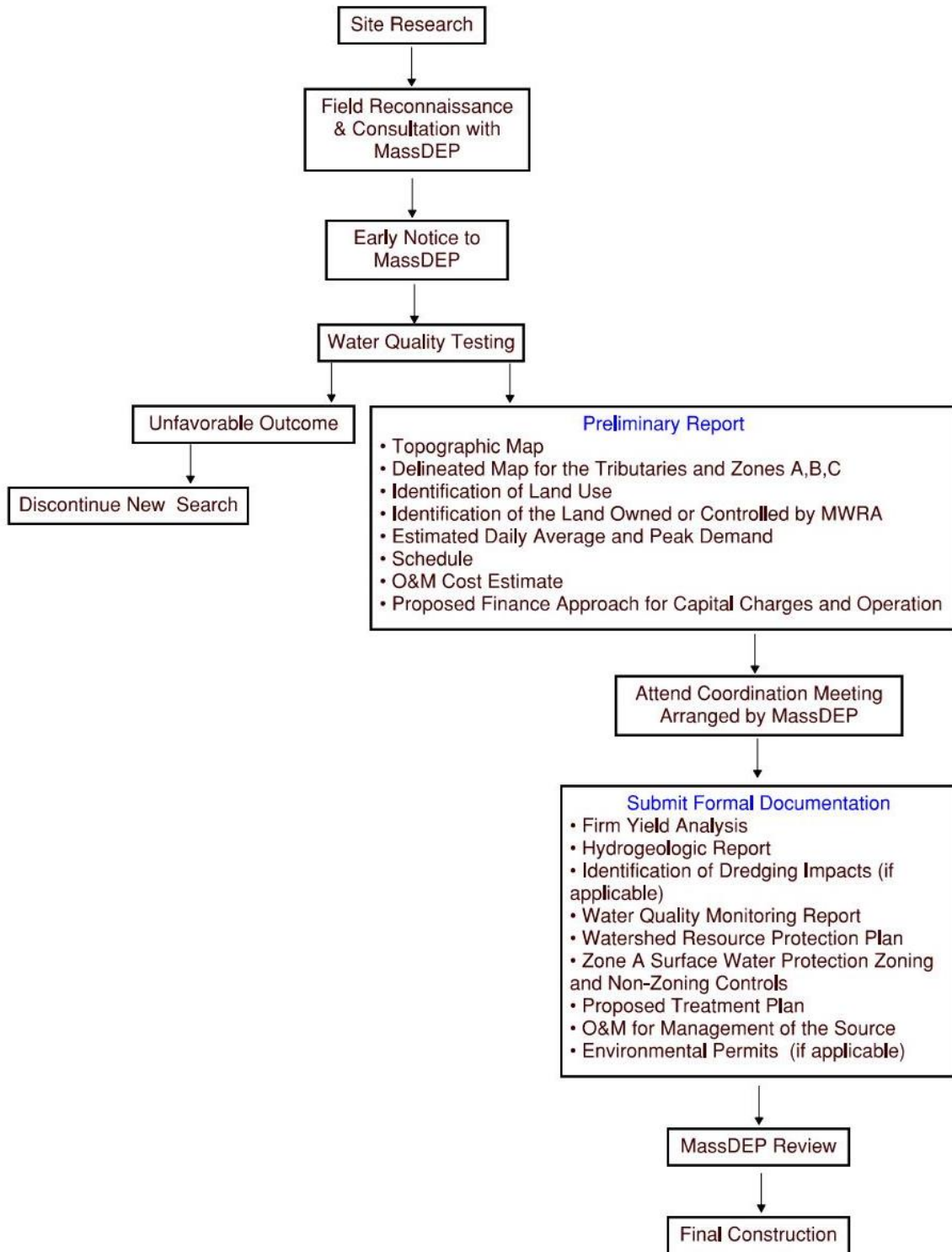
**7.5.2.1 Process for Developing a Surface Water Source**

If a new surface water source is pursued, the MassDEP New Source Approval process would need to be followed, which is set forth in the Surface Water section of the Massachusetts Drinking Water Regulations (310 CMR 22.20A). Prior to placing a new or inactive surface water source on-line, the proponent must apply for and obtain new source approval from the MassDEP Drinking Water Program. The Source Approval process, including applicable permits, would be needed for a new surface water source. The process would consist of the following general steps:

- Submit Preliminary Report
- Conduct Site Visit
- Attend Coordination Meeting
- Submit Formal Documentation

The schematic on the following page summarizes the surface water supply development process.

Surface Water Supply Development Plan



### 7.5.3 Interconnecting with Neighboring Water Systems

As an alternative to developing an entirely new water supply (groundwater or surface water), one option to consider is the possibility of interconnecting with a neighboring municipal water supply system. Considerations include the following:

- Proximity between existing water system and new service area
- Available capacity in existing system
- Willingness of the neighboring water system to sell water and amount of excess capacity

The Quabbin Reservoir Watershed communities could consider interconnecting with neighboring water communities that may have additional excess capacity. Some potential considerations include the following. Note that further study would be needed to determine the feasibility of these potential interconnections.

- Proposed Pelham Service Area to existing Amherst Water System.
  - Note that the Amherst Water Systems currently supplies water to some customers in Pelham.
- Proposed Pelham Service Area to existing Belchertown Water District Water System.
- Proposed Wendell Service Area to existing Orange Water System.
- Proposed Petersham Service Area to existing Athol Water System.

Interconnecting the Quabbin Reservoir Watershed communities to neighboring existing water systems would typically require construction of a new transmission main. Although the primary purpose of this transmission main would be to interconnect the two service areas and thereby eliminate the need for a second water supply, a transmission main along this route could provide water service to additional parcels along the route. Additionally, the transmission main size would depend on whether the transmission main is utilized to provide fire protection.

### 7.5.4 Design and Construct Water Storage Tank

A WST is necessary to provide equalization storage, fire storage, and to regulate the pressure in the distribution system, as discussed in Section 4.

The WST should be set at an elevation to determine the primary pressure zone. Design of the WST will include final selection of a location for the WST. The WST should be located at a ground elevation as close as possible to the intended hydraulic grade of the service area to minimize the height that the WST needs to stand above the ground. Ideally, the WST would be located on the opposite end of the distribution system from the water supply. However, given the relative elevations and the property available, it may be satisfactory to locate the distribution system on the same property as the water supply. This will need to be determined during future design if the conceptual projects move forward.

The design of the WST will also include an evaluation of the types of WST available, and determine which type is most suitable and economical in terms of short- term capital and long-term maintenance costs.

The WST's design and construction may be concurrent with the new source development and must be completed prior to connecting any services to the distribution system.

### **7.5.5 Design and Construct Distribution System**

The distribution system consists of a network of interconnected water mains, connecting the new source with the water storage tanks, booster pump stations, PRVs and all of the services. It is anticipated that construction of each water main would include providing a service connection to each intended service, which is typically laid up to the property line with a curb stop for future connection by the property owner. Consideration should be given to the construction phases and facilities that need to be online prior to connecting new customers.

## **7.6 MWRA Application Process**

Communities that could be supplied by MWRA from the Quabbin Reservoir would need to complete the MWRA application process described below in order to become an MWRA community (this process would not be applicable to communities where MWRA would facilitate development of groundwater sources, as the community or communities would own and operate the groundwater systems independently of MWRA).

Required steps for connection to the MWRA are generally as follows:

1. Undertake comprehensive water supply planning and adopt effective demand management measures. MWRA's Enabling Act criteria require water conservation, local source protection and maintenance, assessment of feasibility of local sources, the adoption of Water Management Plan, and water use surveys.
2. Document justification and need for connecting to the MWRA Water System.
3. Meet with MWRA to formally begin the process of admission.
4. Meet with the Water Resources Commission. Undertake an Interbasin Transfer Act (ITA) requirements review to determine if a "Determination of Insignificance" or "Significant" transfer approval process is required.
5. Evaluate the scope of work relative to MEPA review thresholds and proximity of Environmental Justice (EJ) communities.
6. Conduct a MEPA/MEPA EJ pre-filing consultation and EJ outreach and coordination (if/as required).
7. Prepare an Expanded Environmental Notification Form (EENF) with request for Single Environmental Impact Report (EIR) and respond to public comments. Confirm permit requirements and mitigation measure(s) requirements.
8. Prepare a Single EIR, including draft Section 61 Findings, for MEPA review.
9. Obtain approval of the Legislature and Governor. The approval of the Legislature and Governor can occur at any time in the process.

10. Submit an application to MWRA Advisory Board and to MWRA Board of Directors. There is no application form per se; the application consists of a compilation of documentation developed in the preceding steps.

A checklist of the application content is provided in MWRA's *Steps for Admission of New Communities to the MWRA Water System* included in Appendix A. Any community joining the MWRA must comply with MWRA Operating Policy #10 Admission of New Community to MWRA Water System. The policy requires that any new community requesting to join the MWRA show that their water demands will not have any negative impact on existing MWRA water communities, water quality, reliability, hydraulic performance, the environment, or watershed communities. This information must be compiled into an application package, which is subject to approval by the MWRA Advisory Board and Board of Directors (Step 10 above).

Admission to the MWRA water system requires that interested communities demonstrate local support for the application. A majority vote to approve joining the MWRA's Water System by the City or Town council is required, and/or by Town Meeting. In the case of a Water District, a majority vote of its governing board is required. If a community will receive water through a neighboring distribution system ("water wheeling"), approval from the existing MWRA community that is conveying the water to the new community seeking admission is required.

## **7.7 Water Quality Considerations**

Before any expansion of the MWRA system, a thorough evaluation of water quality will be essential, with an emphasis on the impact of fully transitioning a community to MWRA water.

The expansion projects evaluated in this study aim to provide the Quabbin Reservoir Watershed communities with water either directly from the Quabbin Reservoir or from newly developed groundwater wells, with appropriate treatment considered in both cases. As a result, blending water from different sources—such as combining water from existing groundwater wells with surface water from the Quabbin Reservoir or new wells—is not applicable to this study.

However, because a complete transition to MWRA water from the Quabbin Reservoir or to new groundwater wells is under consideration for the communities involved, any change in water sources and quality may introduce water quality challenges, which must be thoroughly assessed. Identifying necessary operational practices and establishing monitoring protocols before and during the transition is essential to ensure a smooth and safe conversion.

Six of the Quabbin Reservoir Watershed communities (Barre, Belchertown, Hardwick, Ludlow, Orange, and Ware) have existing COM PWSs and associated supply sources, distribution piping, and potentially other water supply infrastructure such as pump stations and water storage tanks. For any future system expansions serving communities with existing public water systems and supply infrastructure, it is essential to assess the potential impact of changing the water source on the current infrastructure and water quality. Variations in pH levels, corrosion control methods, and disinfection practices—along with their byproducts—between the existing and new sources may affect water quality and compliance with the Safe Drinking Water Act (SDWA).

The remaining six communities (New Salem, Pelham, Petersham, Phillipston, Shutesbury, and Wendell) do not have existing distribution piping or other water supply infrastructure but the impact to existing users of changing the sources of supply should still be considered.

Wheeling of water between communities must also be considered, as water is moved from the source of supply (either a new surface water intake or new groundwater well) through the wheeling community to the receiving community. In this case, water chemistry and quality may vary as water transitions from one community to the next.

### **7.7.1 Concerns with Changing Water Supply Sources**

Potential concerns associated with a full transition to MWRA water or to newly developed groundwater sources include:

- pH and alkalinity
- Lead and copper solubility and corrosion
- Hardness
- Chlorine residual, taste and odor and nitrification
- Disinfection by-product
- Aesthetic concerns (flow reversal in pipes, change in disinfectant)
- Presence of regulated contaminants

#### **7.7.1.1 pH and Alkalinity**

Different water sources often have varying pH levels and alkalinity, which can impact the system's pipes, fixtures, and overall water stability.

#### **7.7.1.2 Lead and Copper Solubility and Corrosion**

Corrosion of lead and copper pipe can result in lead and copper entering the distribution system, which can result from changing to a new water source that is corrosive. Corrosion control can be used to reduce the potential of lead and copper entering the system. These measures can include pH adjustments, corrosion control inhibitors, or alkalinity adjustments.

#### **7.7.1.3 Hardness**

A change in the hardness of the water can affect the scaling and buildup in pipes, including plumbing fixtures and water heaters at customer taps.

#### **7.7.1.4 Chlorine Residual, Taste, Odor, and Nitrification**

Chlorine residuals, taste and odor, and nitrification are concerns when changing water sources. It is important to maintain an adequate chlorine residual to reduce the formation on disinfection by-products. Aesthetically, taste and odor can be a concern if the chlorine residual is not adequate. Increases in water age leading to decreases in free chlorine can lead to nitrification concerns. Nitrification results in bacterial growth and further decreases in free chlorine.

#### **7.7.1.5 Disinfection By-Products**

Disinfection by-products form when natural organic matter and disinfectants react in the treated water. Free chlorine in the water readily reacts with natural organic matter and

can reduce the presence of DPBs in the water. Changing disinfection methods could lead to changes in the chemical balance of the water and how it interacts with the existing system. Additionally, a new water source may have a different organic composition such that disinfection can lead to formation of different byproducts.

#### **7.7.1.6 Aesthetic Concerns**

Increases in turbidity and discoloration of the water are potential concerns when changing water sources. These outcomes can be the result of changes in flow direction within distribution piping (from water entering the distribution system at different points of the system) or water chemistry, which can disturb existing scale or deposits in pipes and release previously trapped contaminants.

Water from different sources could have distinct tastes, odors, and appearances that may be noticeable by consumers, leading to customer complaints even if the water is safe to drink.

#### **7.7.1.7 Presence of Regulated Contaminants**

New water sources may have different levels of contaminants that are regulated under the Safe Drinking Water Act (SDWA) compared to existing sources. These contaminants are grouped into several categories, including microbial contaminants, inorganic chemicals (e.g., arsenic, lead, copper, nitrate/nitrite), organic chemicals (e.g., volatile organic compounds such as those found in petroleum products, pesticides and herbicides, and polychlorinated biphenyls (PCBs)), disinfection byproducts, radionuclides, and other emerging contaminants (e.g., PFAS (per- and polyfluoroalkyl substances) a group of man-made chemicals that resist degradation and can persist in the environment and human body, linked to cancer, immune system effects, and developmental issues, and pharmaceuticals and personal care products (PPCPs)).

When transitioning to a new source, it is important to consider existing pipe tuberculation and corrosion issues that could arise from changing water quality.

### **7.7.2 Future Evaluations**

For this study, it is assumed that communities would be fully served by the MWRA if they connect to the MWRA system, or that they would be fully served from new groundwater wells, as summarized in Table 7-3. Proper planning, thorough evaluation, and close monitoring are critical when switching water sources to ensure the communities receive safe, high-quality drinking water without unexpected issues.

To allow sufficient time for implementing mitigation measures and proper monitoring, an assessment of the potential impacts on the community and regulatory compliance should be conducted early in the planning phase of a proposed MWRA connection.

Further evaluations that can be conducted to assess the impact of changing sources include:

- Water quality models to evaluate corrosion control (e.g., lead and copper solubility). Model results may be used as a guide to inform decisions related to additional chemical treatment (e.g., corrosion control inhibitors).
- Water-age modeling to evaluate water age and chlorine residual and address potential concerns for nitrification. Regarding water age, the pipe sizes specified in

- this report should be reviewed when a community connects to ensure a proper balance between pipe velocity and water age.
- Hydraulic modeling, which includes storage tank turnover.
  - Increased water quality monitoring during new source development, and during and after the transition period.
  - Unidirectional flushing of existing water distribution systems can be conducted prior to transitioning to MWRA water to clean lines and minimize the impact of flow reversal in the system.

### **7.7.3 Assumed Infrastructure to Address Transition to New Supply**

As discussed in Section 4.3.5, it is assumed that new WTPs will be required for each conceptual project to treat raw surface water from the Quabbin Reservoir and raw groundwater.

Additionally, there could be a need for further chemical treatment than has been identified in this study for a few reasons:

- Individual preferences or regulatory requirements of the towns receiving water, such as fluoride addition or corrosion control.
- To address different water chemistry entering existing distribution systems as described above, such as pH adjustment, corrosion inhibitors, or booster disinfection.

Evaluating the preferences of the different communities or the specific impact on existing distribution systems due to changes in water chemistry are beyond the scope of this study. As projects advance, careful evaluation of water quality changes, concerns, and impacts must be conducted to determine the need for additional treatment at each community entry point. In the case that chemical feed facilities are required at each community, a MassDEP drinking water permit would be required for a treatment facility.

**TABLE 7-3**

Water Quality Considerations for Future Evaluation of Conceptual Projects

<b>Community</b>	<b>Existing Distribution System</b>	<b>Proposed Direct Connection to Treated Quabbin Water<sup>2</sup></b>	<b>Proposed New Groundwater Supply</b>	<b>Water Wheeling through 2<sup>nd</sup> Community</b>
Barre	Yes	X	X	Yes (Hardwick: SW)
Belchertown	Yes	Yes	X	X
Hardwick	Yes	Yes	X	X
Ludlow	Yes	X	X	Yes (Belchertown: SW)
New Salem	X	Yes	Yes	Yes (Wendell: GW or Shutesbury: SW)
Orange	Yes	X	X	Yes (New Salem: SW)
Pelham <sup>1</sup>	X	X	X	Yes (Belchertown: SW)
Petersham	X	X	Yes	X
Phillipston	X	X	Yes	X
Shutesbury	X	Yes	Yes	Yes (New Salem: GW)
Ware	Yes	Yes	X	X
Wendell	X	X	Yes	Yes (New Salem: SW)

1. Assumed supply from Town of Amherst would be discontinued.

2. Proposed direct connection to treated Quabbin water would be supplied from a new intake and not from the existing CVA since it does not have excess capacity.

GW = Groundwater; SW = Surface Water

**Tighe&Bond**

**SECTION 8**

## **Section 8**

# **Conclusions and Recommendations for Further Study**

The purpose of this study was to evaluate the feasibility of expanding water supply to 12 communities within the Quabbin Reservoir Watershed and identify critical infrastructure needed to provide water to the communities. The study included development of service areas for communities without existing COM PWSs, analyzing water demands for study communities, identifying concept-level projects for new infrastructure that would expand MWRA's ability to supply new communities within the study area, and development of planning level OPCCs for the conceptual projects. The conceptual expansion projects included new surface water intakes and new groundwater supply alternatives that demonstrated how water from these new sources could be conveyed to the communities in the study area.

Due to the conceptual level of the potential expansion projects presented in this study, there are several assumptions and limitations. Specific locations for the new supply sources, WSTs, pump stations, PRVs, and WTPs cannot be determined at this conceptual level of the project. Pipeline routing locations may need to be adjusted. Many cost and permitting factors cannot be fully evaluated at this time. Assumptions were made for the purposes of OPCC development, which are stated in this Report. Additional studies are required to refine the infrastructure components and OPCCs if any of the conceptual expansion projects are advanced.

### **8.1 Summary and Conclusions**

The following findings of the evaluations presented in this study provide information that can inform future discussions with the Quabbin Reservoir Watershed communities regarding options for new sources of supply:

- Service areas were developed for the Quabbin Reservoir Watershed communities listed below. These Towns don't have existing COM PWSs with the exception of Hardwick. A service area was developed for Hardwick since the existing COM PWS for Hardwick Center is very small and does not serve the entire town center. Extensions to the three other small COM PWSs in Hardwick (Wheelwright Water District, Gilbertville Water District and Eagle Hill School) were included in the analysis.
  - Hardwick
  - New Salem
  - Pelham
  - Petersham
  - Phillipston
  - Shutesbury
  - Wendell
- The extent of the supply alternatives considered in each of these seven communities was generally limited to the Town Centers.

- Expansion did not supply the entire Town for the following reasons:
  - Low population density outside of the Town Centers.
  - Excessive lengths of water main required to serve a limited number of customers would be cost prohibitive.
  - High water age in the distribution system due to lack of turnover and storage within water mains serving a low number of customers.
- The existing service areas were used for the Towns listed below, which all have COM PWSs. No expansion beyond the current service area was generally assumed unless a community provided information on specific users that needed public water supply.
  - Belchertown
  - Ludlow
  - Ware
  - Barre
  - Orange
- Demands were estimated for study communities using the following methods:
  - Communities with existing COM PWSs: 2022-2023 ADD and MDD as reported in the ASRs filed with MassDEP for each community.
  - Communities without existing COM PWSs: estimated using customer usage categories and population served. Note that this method was used for Ludlow, which is primarily served by the SWSC, since actual demand data for Ludlow were not available for this study.
- The Quabbin Reservoir supplies water to Chicopee, Wilbraham and South Hadley Fire District No. 1 which is treated at the Brutsch WTF and transported via the CVA. Ware, Belchertown, and Ludlow are adjacent to these facilities. However, MWRA analyses indicated that the Brutsch WTF and CVA do not have existing excess capacity. As such, expansion alternatives utilizing supply from the Brutsch WTF and CVA were assumed to be infeasible.
- The Quabbin Aqueduct flows by gravity conveying water from the Quabbin Reservoir to the Wachusett Reservoir. The Quabbin Aqueduct passes through Hardwick and Barre, where the depth of the aqueduct ranges from approximately 300 feet to 700 feet of cover. Engineering evaluations by Tighe & Bond and MWRA engineering staff determined that potential supply from new connections to the Quabbin Aqueduct have a low feasibility due to the size and complexity of designing and constructing a safe withdrawal connection.
- Potential new sources of supply included groundwater exploration alternatives and new surface water intake alternatives.
  - Approximate locations for potential groundwater explorations were determined based on areas with high groundwater availability and favorability per USGS mapping and were further refined with a preference for undeveloped and publicly accessible land. Many of the locations coincide with Article 97 Open Space.

The potential groundwater exploration locations presented in this plan are conceptual. They do not represent an exhaustive list of possible well sites,

nor do they imply a preference for specific locations. Detailed groundwater siting studies would be required to ensure adequate protection of new sources and to prevent any negative impact from related infrastructure on nearby natural resources.

- Approximate new intake locations were selected to function under all MWRA's drought conditions. Four potential new intakes were identified that could potentially supply all 12 of the study communities. Three of these were advanced for further evaluation, which could potentially supply ten of the study communities. Locations were selected that were contiguous with the remainder of the Quabbin Reservoir under drought conditions.
- Five conceptual expansion projects to serve the Quabbin Reservoir Watershed communities were selected from the potential groundwater and surface water alternatives for further evaluation. These included the following:
  - Conceptual Project 1 – Southwest Intake
    - Supplies Belchertown, Ware, Ludlow and Pelham
  - Conceptual Project 2 – West Intake
    - Supplies New Salem, Wendell, Shutesbury and Orange
  - Conceptual Project 3 – Northwest Regional Groundwater Supply
    - Supplies New Salem, Wendell, and Shutesbury
  - Conceptual Project 4 – Northeast Regional Groundwater Supply
    - Supplies Phillipston and Petersham
  - Conceptual Project 5 – Southeast Intake
    - Supplies Hardwick and Barre
- New surface water and groundwater supply sources would need significant infrastructure improvements including, but not limited to, the following.
  - New surface water supply sources:
    - Raw water intake structure
    - Screens and airburst system
    - Raw water pumps, pump house and piping
    - Water treatment plant including finished water pumps
  - New groundwater supply sources:
    - Groundwater wells
    - Raw water piping
    - Water treatment plant
  - Further study is required to determine a comprehensive list of infrastructure needs.
- Water transmission main routes were identified to connect proposed intakes and groundwater sources to each community. Proposed transmission lengths are extensive due to the distances between communities included in the regional conceptual projects and distances from sources. Water age within the transmission and distribution systems may be excessive resulting in water quality concerns.

- Booster pump stations and PRVs needed along the transmission mains and connection points to study community service areas to maintain adequate system pressures were determined based on a hydraulic analysis. The total number of pump station and PRVs needed are summarized as follows (note that these do not include raw water and finished water pumping for surface water supplies or well pumping for groundwater supplies):
  - Southwest Intake Conceptual Project No. 1:
    - One pump station
    - Three PRVs
  - West Intake Conceptual Project No. 2:
    - Five pump stations
    - Two PRVs
  - Northwest Regional Groundwater Supply Conceptual Project No. 3:
    - One pump station
    - Two PRVs
  - Northeast Regional Groundwater Supply Conceptual Project No. 4:
    - Two pump stations
  - Southeast Intake Conceptual Project No. 5:
    - Three pump stations
    - Two PRVs
- WSTs needed to provide equalization storage, emergency storage and fire protection storage, where applicable, were determined. Storage was also included to avoid pumping into and out of closed systems. The total number of tanks needed for each conceptual project are summarized as follows:
  - Southwest Intake Conceptual Project No. 1:
    - Two WSTs
  - West Intake Conceptual Project No. 2:
    - Seven WSTs
  - Northwest Regional Groundwater Supply Conceptual Project No. 3:
    - Three WSTs
  - Northeast Regional Groundwater Supply Conceptual Project No. 4:
    - Three WSTs
  - Southeast Intake Conceptual Project No. 5:
    - Two WSTs
- Drinking WTP considerations vary between surface water and groundwater supplies. The goal was to identify components of the WTPs to provide budgetary cost information. However, there are other potential treatment alternatives, and the assumed components are not intended to be representative of the sole option.

- Planning level OPCCs were developed for the five conceptual expansion projects. The OPCCs have several assumptions and limitations due to the conceptual nature of this study. In addition, there are many project costs that cannot be quantified at this conceptual stage of project development (e.g., permitting, planning and pre-design, etc.). Table 8-1 summarizes the OPCCs for each conceptual project.

**TABLE 8-1**  
Opinion of Probable Construction Costs (OPCCs)

<b>Conceptual Expansion Project</b>	<b>Conceptual Project Cost - 2024 Dollars (In \$ Million)</b>
1. Southwest Intake	\$ 170.25
2. West Intake	\$ 215.39
3. Northwest Regional Groundwater Supply	\$ 112.36
4. Northeast Regional Groundwater Supply	\$ 70.10
5. Southeast Intake	\$ 113.08

- Potential grant funding opportunities were identified. Many drinking water funding opportunities exist.
- This study did not evaluate or consider cost per person, or effects on existing or future water rates.
- Permitting considerations include drinking water and public health permitting, environmental permitting, and other required approvals including new source approvals. The potential permitting requirements for the conceptual projects are extensive. Actual permits required cannot be known at this conceptual level of the study and should be refined if any of the conceptual projects are advanced.

## **8.2 Recommendations for Further Study**

The evaluations presented in this study are conceptual in nature and subject to several assumptions and limitations. The intent of this study is to provide a starting point for evaluating the feasibility of expanding water supply to the Quabbin Reservoir Watershed communities. The information provided in this study will provide a valuable framework for discussions between the MWRA and communities interested in exploring potential new sources of supply. If any of the study communities would like to pursue the potential supply alternatives presented in this study, additional studies will be required to establish specific infrastructure requirements and associated costs. Proposed service areas would need to be refined, and demand estimates confirmed. Potential challenges with water quality due to high water age would need to be addressed, approvals secured for extensive permitting requirements, and funding sources determined. This Section outlines additional studies and evaluations that are needed to advance discussions on potential expansion of supply to the Quabbin Reservoir Watershed communities.

- **Service Areas**
  - Further study is needed to confirm and refine the extents of the service areas developed for study communities.
  - Water supply to potential users not within the existing service areas of COM PWSs for Towns within the study area needs to be determined.

- It was assumed that the service area for each community would be fully supplied should they connect to a new supply source. It is possible that some communities would intend to join as partially served or emergency only, although that may be cost prohibitive due to the extensive infrastructure improvements needed to supply the Quabbin Reservoir Watershed communities. The extent of supply should be established during conversations with interested communities during the early stages of the projects.
- The capacity of the existing distribution system for communities with COM PWSs considering the proposed connection point and water wheeling, as applicable, should be evaluated if the projects are advanced.
- **Water Demands**
  - Water demands were estimated for communities without COM PWSs and for Ludlow using customer usage categories and population served. These estimates need to be confirmed and refined.
  - Demands for communities with existing COM PWSs were estimated based on average and maximum day demands from ASRs. These estimates should be confirmed as potential expansion projects are advanced.
  - This study estimated demands for current day conditions. If expansion is considered, projections of community demands into the future should be conducted to adequately size infrastructure and supply.
  - As projects progress, the estimated demands could be updated to reflect the authorized withdrawals under the WMA for the COM PWSs in Barre, Belchertown, Orange, and Ware
- **Water Quality**
  - Future study is needed to identify potential water quality concerns which might require future evaluation should expansions proceed as detailed below:
  - The approach for this study consisted of a desk top review of each community's drinking water quality relative to that of potential new sources based primarily on CCRs. It was assumed that potential new supply sources would be the primary source for the service areas of the study communities. However, potential concerns with blending will need to be addressed if any communities are interested in being partially served by the new supply source.
  - If a community with an existing COM PWS chooses to be fully served by a new source, there would be a transition period during which the existing distribution system will become acclimated to the new source water. Studies will be required to maintain corrosion control and disinfection during this time and following the transition period to ensure compliance with drinking water standards. Additional needs for chemical treatment facilities may be identified as part of these analyses.
  - Potential water quality impacts from high water age are discussed under applicable infrastructure sections below, which is an important consideration that will need further study.
- **Potential Expansion Alternatives**

- **Groundwater System Alternatives**
  - Specific locations for new groundwater wells cannot be determined at this conceptual level of the project. Potential areas to evaluate siting new groundwater supplies are provided as a starting point. Additional evaluations will be needed to determine the location of new groundwater wells.
  - This study assumed that a suitable well location is available at the yields indicated. This should be confirmed with a well siting study if projects are advanced. Additional evaluation of the potential groundwater exploration areas is needed to determine actual aquifer yields. The possibility of finding high yield areas outside of the USGS mapped areas should also be considered and evaluated if alternatives are advanced, as there are several existing non-community and community system wells in each of the study communities that are outside the USGS mapped areas.
  - Further considerations regarding permitting requirements are needed for the groundwater system alternatives. Any proposed well within the Quabbin Watershed and Article 97 Open Space would require jurisdictional review and approval by the MWRA and other regulatory agencies. While MWRA assumes that the community or communities would own and operate the groundwater systems, MWRA could facilitate permanent water supply easements (with the support of DCR, EEA, and other agencies) on protected watershed lands that would allow for a highly protected water supply. MWRA would work with the community or communities to determine appropriate well locations relative to natural water resources such as streams and surface waters.
  - Further preliminary evaluations, test drilling, water quality testing and identification of potential additional treatment needs would have to be conducted if any of the potential groundwater exploration alternatives are pursued. Additional considerations for a groundwater alternative include:
    - Preliminary new source permitting
    - Land procurement or easement (if necessary)
    - Construction of production well(s)
    - Pump test(s)
    - Final New Source Permitting
    - Design and construction of well facility
    - Wellhead protection compliance process
    - Site inspection of permanent works and final source approval
- **Surface Water System Alternatives**
  - At this conceptual level, approximate locations for intake locations were selected but the feasibility of these potential intakes cannot be determined without further study. This study assumed the new surface water intake facilities are suitable at the approximate locations indicated for each conceptual project, or that it is possible

to find suitable alternate locations. Additional studies are needed to confirm and refine the potential new intake locations and associated infrastructure.

- Further study will be required to identify water quality challenges associated with water age, maintenance of chlorine residual, and formation of disinfection byproducts due to the extensive lengths of transmission mains from the surface water intakes to the communities.
  - An updated bathymetric survey is needed to confirm and refine the location of new intakes at suitable elevations to be functional under all of MWRA's drought conditions.
  - It is assumed that the Quabbin Reservoir has adequate excess capacity to provide supply for the new surface water intakes. This should be confirmed as the projects are advanced considering any recent new withdrawals from the Quabbin.
- **Infrastructure Components** - While there are many options for water treatment and infrastructure components, assumed water treatment and infrastructure components used for the development of OPCCs are presented. There are other potential treatment and infrastructure component alternatives that may be more well suited for the conceptual projects as additional details are determined, such as to address community specific needs and preferences. Potential additional measures may be required that are not included in this study that can only be identified during future phases of project development. Further detailed analysis of raw water source development, water treatment and infrastructure components are needed if any of the conceptual projects move forward. Engineering design criteria should be refined and updated as additional project details are determined. Ownership and operational responsibilities will need to be determined and refined if any of the potential expansion alternatives are implemented.

Specific locations for WSTs, pump stations, PRVs, and WTPs cannot be determined at this conceptual level of the project. Water transmission and distribution main routing locations may need to be adjusted.

- **Water Transmission and Distribution Mains**

- As noted above, water transmission and distribution main routing may change as further studies are conducted if any of the conceptual projects are advanced. More detailed routing studies should be performed taking into consideration cost, traffic, environmental and local community impacts.
- Wetland crossings were avoided where possible. However, if wetlands crossings are needed, that can be addressed in future permitting tasks if the alternative is advanced.
- Bridges and culverts were identified along the water main routes based on aerial imagery but should be confirmed if any of the conceptual projects are advanced.
- The need to provide fire protection should be determined which impacts the minimum water main diameter.

- Water quality considerations should be evaluated due to the extensive lengths of transmission mains serving some communities that have low demands. This could result in high storage volumes and associated water quality deterioration due to high water age.
- Communities may wish to consider infrastructure improvements such as roadway upgrades relative to potential water main installations and coordinate where possible to minimize community impacts and reduce costs.
- **Booster Pump Stations and Pressure Reducing Valves**
  - Existing HGLs for Towns with COM PWSs should be confirmed or identified where data gaps remained following the information review.
  - Approximate HGLs were determined for towns without existing COM PWSs. These HGLs should be refined as service areas are adjusted confirming that appropriate pressures are provided to potential customers.
  - HGLs were set to target distribution system pressures of 35 to 80 psi within service areas. In some instances, there may be pressures higher than 80 psi due to the topography of the service area. Locations where potential PRVs to individual homes or groups of homes are needed where there may be high distribution system pressures should be determined at later stages of project design.
  - Transmission main pressures between service areas were set at a maximum of 200 psi to minimize intermediate pump stations, PRVs and storage needed. This maximum pressure should be confirmed considering community preferences and potential changes in pipeline routing.
  - A siting study is needed to determine suitable locations for pump stations and PRVs. Approximate locations were assumed for this study, which should be refined as further project details are determined. This study presents one option for layout out the transmission system for each conceptual project. There are other potential options for designing the transmission system layout and HGLs. Further hydraulic analysis is recommended if projects are advanced to refine HGLs, confirm suitable pressures in the mains, and refine alignments.
- **Water Storage Tanks**
  - A WST siting study is needed to determine suitable locations for the WSTs. Approximate locations were assumed for this study, which should be refined as further project details are determined.
  - Intermediate WSTs were provided in the conceptual projects to avoid pumping into and out of closed systems. Potential adverse impacts to water quality should be considered due to the high storage volumes and associated water quality deterioration due to high water age. Benefits to water storage should be weighed against impacts to water age.

- A detailed water quality and water age analysis should be conducted prior to sizing and siting WSTs for the conceptual projects if they are advanced.
- The need to provide fire protection should be further evaluated which impacts the water tank sizing.
  - The needed fire storage assumed for WSTs within service areas should be confirmed and refined as needed.
  - Sizing of components to provide fire protection for buildings with high fire flow requirements is outside of the scope of this study. Fire flow sizing, including for residential buildings, would need further evaluation if the conceptual projects move forward.
- The type of tank (e.g. elevated or ground) should be evaluated and the need for split tanks should be considered. Tank geometry should be refined as projects are advanced.
- Intermediate WSTs were assumed to be pumped storage ground level tanks located on the upstream side of the associated intermediate pump stations approximately 20 feet in height. Two exceptions are the intermediate WSTs for the transmission main to Belchertown in Conceptual Project No. 1 and for the transmission main to Orange in Conceptual Project No. 2. Because these transmission mains supply PRVs that serve pressure reduced zones, it is assumed that these intermediate WSTs would consist of elevated tanks at the service area hydraulic grade. A siting analysis should be conducted if these projects move forward to determine if a suitable location at a higher elevation is available for a ground level tank.
- **Drinking Water Treatment Plants**
  - Components for drinking WTPs were compiled with the goal of identifying components to provide budgetary cost information. However, there are other potential treatment alternatives, and the assumed components are not intended to be representative of the sole option.
  - Further evaluation will be required as projects advance to address community-specific needs and preferences (for example, with respect to chloramines, corrosion control, blending considerations, etc.). Where needed or desired, these potential additional measures may require additional treatment equipment at additional costs. The number of raw water pumps and finished water pumps should be refined.
  - Treatment for groundwater sources will be highly dependent on the water quality of the new wells. Common water quality considerations, which will require further study, include disinfection, corrosion control, hardness, PFAS, pH adjustment, iron and manganese, volatile organic compounds, and arsenic. It cannot be known at this conceptual project stage what treatment will be needed at the treatment plants and additional evaluations will be needed.

- It is assumed that the filtration waiver for the existing Quabbin surface WTP will extend to new intakes and surface WTPs, but future evaluation will be required if projects with new WTPs proceed. Filtration could be required such as where intakes cannot be constructed in deep water or if localized water quality cannot consistently meet filtration avoidance.
  - In prior MWRA expansion evaluations, it was assumed that corrosion control and fluoride treatment would be undertaken by the individual communities, with treatment specific to the requirements and decisions of the individual community. However, at this level of conceptual study where specificity is limited, the evaluation must be based on generalized treatment requirements, such as pH adjustment for corrosion control, with the understanding that further evaluation will be needed as projects advance. The treatment facilities and the associated OPCCs are based on assuming pH adjustment for corrosion control, but the addition of fluoride is highly specific to individual communities and is therefore not included. This can be updated as needed if the projects are advanced.
  - Treatment with chloramines in lieu of chlorine is a potential option that would be beneficial where there is potential for high water age. The OPCCs developed for this plan are based on residual disinfection using chlorine but alternate disinfectants should be evaluated if projects advance.
- **Cost Estimates**
    - Planning level OPCCs were developed for the five conceptual expansion projects. These OPCCs should be used as an estimate of the relative magnitude of investment required for the projects. If the communities and MWRA advance any of the conceptual expansion projects, a more detailed analysis of the OPCCs should be developed as the projects are refined and designed.
      - The OPCCs have several assumptions and limitations due to the conceptual nature of this study.
      - In addition, there are many project costs and factors that cannot be quantified at this conceptual stage of project development (e.g., permitting, planning and pre-design, etc.). Assumptions were made for the purposes of OPCC development, which are stated in the Report.
    - Additional studies are required to refine the infrastructure components and OPCCs if any of the conceptual expansion projects are advanced.
    - Detailed evaluations of water quality considerations, hydraulic requirements, and siting locations (for siting and construction of transmission and distribution mains, tanks, pump stations, surface water intakes, and treatment buildings and for siting and development of groundwater wells) were not conducted and will require further evaluation as projects move forward. The results of these analyses will result in changes in the OPCCs.

- **Grant Funding Sources**

- The eligibility for funding is dependent on the agency and type of loan or grant supplied. For example, most of the financing administered by the USDA is applicable only to small and rural towns and would require the eligible individual towns in this study to apply for the loan. Funding geared towards larger communities or populations is also available. Other funding alternatives such as betterment assessments, management districts, and considering a tax base are available. As project ownership is refined, applicability of grant funding sources should be evaluated.

- **Implementation Considerations**

- Many factors affecting potential required permits cannot be fully evaluated at this time. As project details are refined, the applicability of potential required permits should be determined.
- Permitting and the MWRA admission process are important to schedule. The duration of these will be dependent on the conceptual project, infrastructure components and locations selected as projects are advanced. It is recommended that permit requirements are established early to facilitate the planning process.
- Further evaluations should be conducted to assess the impact of changing sources. Proper planning, thorough evaluation, and close monitoring are critical when switching water sources to ensure the communities receive safe, high-quality drinking water without unexpected issues. To allow sufficient time for implementing mitigation measures and proper monitoring, an assessment of the potential impacts on the community and regulatory compliance should be conducted early in the planning phase of a potential source change.
- Potential project phasing should be considered. Extending supply to communities closer to potential new sources may be possible before communities located at farther distances. Other connection points to study communities may become known as community interest is gained and water demands are refined. Potential infrastructure sizing and water quality should be evaluated in detail in the short and long term throughout project development and construction.
- Since the proposed conceptual projects are regional in nature, the upstream community must connect to the new supply before downstream communities, unless additional sections of transmission mains are installed.

**APPENDIX A**

MWRA's Steps for Admission of New  
Communities to the MWRA System

## **STEPS FOR ADMISSION OF NEW COMMUNITIES TO THE MWRA WATER SYSTEM**

Communities seeking admission to MWRA must complete the following steps:

- Undertake comprehensive water supply planning and adopt effective demand management measures. MWRA's Enabling Act criteria require water conservation, local source protection and maintenance, assessment of feasibility of local sources, the adoption of Water Management Plan, and water use surveys. Typically, these efforts begin prior to the formal start of the admission process which is frequently, although not always, marked by the submission of an initial MEPA document. Communities typically look to MWRA after they have determined that conservation and local sources alone are not sufficient or feasible to meet water supply needs.
- Demonstrate acceptance of admission, by majority vote of city council if a city or majority vote of Town Council if a town. In the instance of a water district, a majority vote of its governing board is required.
- Obtain applicable regulatory approvals. This often includes Massachusetts Environmental Policy Act and Interbasin Transfer Act (ITA) reviews.

The MEPA regulations list specific thresholds that trigger MEPA review, including: a) a new Interbasin Transfer of 1 mgd or more, or any amount determined significant by the Water Resources Commission; b) new water service to a municipality or district if the project is undertaken by an agency, and c) construction of one or more pipelines 5 miles in length.

Water Resources Commission review under the ITA is triggered by actions that increase the ability to transfer water (or wastewater) out of a donor basin. WRC may find transfers of 1 mgd or less to be insignificant if certain criteria are met. The level of review associated with "A Determination of Insignificance" is less than the review associated with a "Significant" transfer. For "Significant" transfers, WRC requires that communities seeking admission to MWRA follow a prescribed EIR scope that addresses donor basin and receiving area criteria derived from the ITA. The EIR represents the application to the WRC. MEPA review must be completed before WRC may hold hearings or approve (or deny) the interbasin transfer.<sup>1</sup>

- Obtain approval of the Legislature and Governor. The approval of the Legislature and Governor can occur at any time in the process.
- Submit an application to Advisory Board and to MWRA Board of Directors. There is no application form per se; the application consists of a compilation of documentation developed in the preceding steps. A checklist of the application contents is found on the next page.

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<sup>1</sup> Following a Draft EIR and Final EIR (DEIR and FEIR), MEPA review may also include a Supplemental FEIR (SFEIR) or a Notice of Project Change.

- It is important to note that the time required to complete the preceding steps is highly variable.

<b>Contents of A Community's Application to MWRA and Advisory Board (Based on Enabling Act Criteria and OP#10, Admission of New Communities to Waterworks System)</b>
• Information on water demand from MWRA (typical peak, emergency peak, and average use).
• Documentation that no water supply source has been abandoned without a DEP declaration
• Documentation that no local supply source feasible for development has been identified by the community or DEP.
• Documentation that Effective Demand Management Measures have been established; detailed description of water conservation and water accountability programs undertaken
• Water use survey of users consuming more than 20 million gallons/year
• Description of municipal zoning and non-zoning measures designed to protect local sources of supply
• Disaggregation of community's total water consumption by customer class
• Documentation on 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.
• Copy of signed legislation documenting approval of Legislature and Governor
• MEPA Sign-off (Certificate of Adequacy)
• WRC Approval of Interbasin Transfer, if applicable.
• Documentation of acceptance of admission, by majority vote of city council if a city or majority vote of Town Council if a town or majority vote of governing board if a water district.

