

Technical Memorandum

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Date: May 20, 2016

Subject: Hingham-Hull-Cohasset Water System
Evaluation of Future Needs and Alternatives for New Water Sources

Environmental Partners Group, Inc. (EPG) was retained by Aquarion Water Company (AWC) to prepare an estimate of future water demand projections and complete a desk top evaluation of new source options for the Hingham-Hull-Cohasset (HHC) water system. The purpose of this study was to evaluate the need and feasibility of a new water supply source(s) for the HHC Water Supply System.

Background

The AWC HHC water system has a registered withdrawal volume of 3.51 MGD under the Water Management Act (WMA). During the past five years, annual water demands have been close to the exceeding the registered annual average WMA withdrawal limit, with the average annual water demand between 2011 and 2015 of 3.35 MGD. In addition, Aquarion has had difficulty meeting peak seasonal water demands. As a result, AWC retained the services of EPG to complete a Raw Water Delivery Optimization Study for the HHC water system (Attachment A). The study was completed in December 2014 and the results identified various improvements to increase the delivery capacity, reliability, and flexibility of the water supply system. Aquarion has completed a number of the improvements that were recommended in the study, including pump and equipment upgrades at three raw water sources, a new raw water main in the northern section of the system, the reactivation of the Fulling Mill Cistern, and a number of smaller, ancillary, raw water improvements. A summary of the existing sources and Massachusetts Department of Environmental Protection (MADEP)-approved Zone II pumping rates is presented in Table 1. Note that the registered annual average WMA withdrawal limit is not equal to the sum of the individual source withdrawal volumes.

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Table 1. HHC Sources and Approved Zone II Pumping Rates

Source ID	Source Name	Status	Approved Zone II Pumping Rate (gpm)	Approved Zone II Combined Pumping Rate (gpm)	Estimated Capacity (gpm)
4131000-01S	Accord Pond	Active	2,000*	2,000	1,500
4131000-02G	Free Street Well 2	Active	1,253	1,253	500
4131000-09G	Free Street Well 2A	Active			955
4131000-08G	Free Street Well 4	Active	563	563	563
4131000-05G	Free Street Well 3	Active	250	351	350
4131000-13G	Free Street Well 5	Active	351		
4131000-03G	Scotland Street Well 1	Active	1,078	1,078	700
4131000-10G	Scotland Street Well 1A	Active	750		325
4131000-04G	Downing Street Well	Inactive	284	284	Inactive
4131000-06G	Prospect Street Well	Active	269	269	250
4131000-11G	Fulling Mill Well 1	Active	431	941	430
4131000-12G	Fulling Mill Well 2	Active	264		265
4131000-03S	Fulling Mill Cistern	Active	941		500
Total (gpm)			8,434	6,739	5,960
Total (MGD)			12.14	9.70	8.58

*Accord Pond Approved Pumping Rate based on Pump Specifications, not Zone II

The study recommendations also included the evaluation of developing a new water supply source to increase the current WMA withdrawal limit and/or increase operational flexibility. Based on the recommendations of the Raw Water Delivery Optimization Study, AWC has requested EPG investigate the development of a new water supply source including new groundwater supply well(s) and the purchase of water from a whole sale provider. This technical memorandum summarizes the results of the investigation, including an assessment of future water demand projections to determine future potential needs

Demand Projections

In April 2015, EPG contacted the Department of Conservation and Recreation (DCR) to request that they complete a water demand projection for the HHC water system. DCR responded in May 2015 (Attachment B) that there was insufficient data to allow for an estimate of future water needs. DCR's main concern was the high amount of unaccounted for water for the period 2010 through 2014. As a result, EPG proceeded with the completion of water demand projections for HHC using the General Water Needs Forecasting Methodology for Public Water Supply Systems developed by

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the Massachusetts Water Resources Commission (General Methodology). This memorandum provides details on the methods and results of the water demand projections for the period between 2016 and 2036.

EPG examined and reviewed three population projections, five years of water usage data, five years of Town employment data, and information provided by the Hingham and Hull Town Planner offices. Population projections for the towns of Hingham, Hull, and Cohasset were obtained from the University of Massachusetts Donahue Institute (UMass) and the Metropolitan Area Planning Council (MAPC). Water usage data was gathered from Aquarion's MADEP Annual Statistical Reports (ASRs) for the years 2011 to 2015. Town employment data for the towns of Hingham, Hull, and Cohasset was obtained from the Massachusetts Department of Revenue's Division of Local Services for the years 2011 to 2015.

Population projections for each town within the water system service area were used to project future water demands. The UMass population projections were released in December 2013 and were based on the most recent Census in 2010; population projections were made in 5-year increments from 2015 to 2030. The MAPC population projections were released in January 2014 and projections were made in 10-year increments from 2020 to 2030 for both a status-quo scenario and a stronger region scenario.

This study incorporated all of the available population projections. Each data set was linearly interpolated annually from 2015 to 2030 for each of the three towns within the service area. From the existing average population data, a year over year average percent change was calculated and used to estimate the population in each town from 2031 through 2036. This data was then aggregated to calculate the service population of the water system. Service population considers town residents that are not connected to the system, out-of-town residents who are connected to the system, and seasonal population changes. It was estimated that from 2011 to 2015 approximately 100% of Hingham and Hull residents were supplied with drinking water from the Aquarion's water system. The number of Cohasset residents supplied with drinking water from Aquarion's water system was estimated using the number of water meters in Cohasset and the average number of residents per meter in Hingham and Hull. To project the future service population within Cohasset it was assumed that the population of the portion of Cohasset served by the HHC system would grow at the same rate as the town's overall population. The additional seasonal population of the system was calculated as the difference

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between the summer population served and the winter population served as recorded in the 2015 ASR. It was assumed that the seasonal population lives within the service area 6 months of the year.

Residential average daily water demand (Residential ADD) was projected in this study by multiplying the future service population by the projected residential consumption rate, in gallons per capita per day (GPCD). This study used two approaches to estimate future residential consumption rates: (1) the Water Conservation Standard (WCS) value of 65 GPCD and (2) an average of 53 GPCD based on Aquarion's metered residential water use and calculated water system service populations between 2011 and 2015.

A recent Water Data Analysis of the HHC system completed by Amy Vickers & Associates, Inc. in September 2015 found that large numbers of residential and non-residential customers have been miscoded in the system's meter data files. This finding suggests that the reported ASR values of residential water use may be inaccurate. Including a scenario with the higher GPCD values from the WCS provides a factor of safety in case the average value calculated from the ASRs is lower than the actual value.

EPG estimated future non-residential demands using the DCR General Methodology. Non-residential average daily water demand (Non-Residential ADD) was projected by multiplying the average water usage per employee (Non-Residential ADD / number of employees) by the projected employment for the service area. The average Non-Residential ADD for the period 2011 to 2015 was used along with employment data to calculate the average water usage per employee: 24.16 gallons per day per employee. Town employment data for the years 2011 through 2015 was reviewed to determine the average annual change in employment in each of the three towns in the service area. Each town's average annual change in employment was weighted by the number of water meters in town to calculate the service area's average annual change in employment over the last six years. The average annual change in employment was then used to project employment in the water service area through 2036. The General Methodology assumes reductions of per employee water usage of 10% over the first 10 years to account for anticipated increases in water efficiency.

The General Water Needs Forecasting Methodology allows for additional non-residential water demand to be included in the projection to account for large expected deviations from current usage trends that are not accounted for in the population or employment growth projections. These values

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are typically derived from input from the water supplier or Town Planner and are typically used when an exceptionally large development is expected or if a water intensive industry is moving to town.

The Hull Director of Community Planning suggested that the only project that may need to be accounted for is a new resort development that is currently being discussed with the State. The Director indicated that this project is in preliminary stages but is expected to include 168 residences, 148 hotel rooms, and 43,000 square feet of commercial development. This project is incorporated into the demand projections over a 3-year period beginning in 2019, with an estimated usage rate of 100 gallons per day per hotel room. The additional residences and commercial development associated with this project are assumed to be accounted for in the regular growth projections.

The Hingham Town Planner (HTP) advised on eight proposed development projects that were considered above and beyond regular expansion for the town. A summary of these developments is presented below in Table 2.

Table 2. Hingham Development Projects

Project Name	Description	First Year Incorporated into Projections	Estimated ADD (MGD)
Bristol Brothers (Part 1)	90-unit assisted living facility	2016	0.006
Avalon Apartments	190 unit apartment complex	2017	0.033
Beal Street (Selectmen's Office)	70-unit assisted living facility	2017	0.005
Beal Street (Alliance)	300 unit apartment complex	2018	0.052
South Shore Industrial Park (SSIP)	State-approved priority development area. No applications to HTP at this time	2019	0.140
Bristol Brothers (Part 2)	Large development of mixed-use commercial and residential space expected. No applications to HTP at this time	2021	0.190
Industrial Park District North	Expansion of Derby Street Shops. No applications to HTP at this time	-	0.000
Sharp Street / Abington Street	Developers have purchased land but no plans currently exist	-	0.000

Each of the above ADD estimates from Table 2 were phased into the demand projections proportionally over three years, beginning in the year indicated. Apartment complex ADD was estimated using the number of units, the average household size in Hingham, and the GPCD scenario. Assisted living facility ADD was estimated using only the number of units and the GPCD scenario. The South Shore Industrial Park ADD was taken from the 2013 report entitled *South Shore*

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Industrial Park Demand and Supply Evaluation by Tata & Howard, Inc. It is indicated in the report that the ADD estimate was provided by the Town of Hingham for this project. The Bristol Brothers (Part 2) ADD was similarly taken from the 2013 report. It is indicated in the report that this ADD estimate is based on the estimated sewer usage for the development (provided by the Town of Hingham) with additional demand added for irrigation. The total ADD of the additional non-residential water demand is 0.440 MGD (with all projects full phased into the demand projection in 2023).

Unaccounted-for-Water (UAW) is the amount of water flowing into the distribution system from the water treatment plant that is not accounted for by the sum of consumption meters and confidently estimated municipal uses. Aquarion's average UAW value as reported on the ASRs between 2011 and 2015 is 20.9%, a value too high to allow the DCR to complete a demand projection for the system, as discussed above. AWC has taken (and continues to take) significant measures to attempt to reduce the UAW of the system, these measures include:

- Monthly leak detection and an investigation into permanent leak-detecting loggers
- Improved leak tracking and an investigation into leak volume estimating
- A metering program for the system bleeders that are used to prevent freezing in shallow mains
- Hiring of EPG to implement an existing district metering program
- Investigation and evaluation of low-flow and no-flow customers
- Large customer meter testing and calibration
- Old meter replacement program
- Investigation into municipal water usage and public field irrigation
- Historic analysis of UAW and confidently estimated municipal usage
- Evaluation of water treatment plant loss calculations
- Investigation into adjacent water system interconnections
- Nighttime flow analysis
- Evaluating feasibility of reducing system hydraulic gradelines
- Bi-weekly conference calls to monitor the status of the UAW reduction action items

Three Unaccounted-for Water (UAW) percentages were used to project UAW through 2036. The projection used the recommended WCS limit of 10%, the average UAW value of 20.9%, and a value

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of 15% to demonstrate a realistic scenario in which UAW is reduced as part of the ongoing water conservation efforts that AWC has undertaken. The General Water Needs Forecasting Methodology estimates water treatment plant losses separate from UAW. Water treatment plant losses are calculated as the difference between raw water withdrawals and finished water production as reported on a water system's ASRs. The average water treatment plant losses for the HHC water system between 2011 and 2015 were 0.09 MGD. The water treatment plant losses are projected by maintaining the average historic water treatment plant losses as a percentage of total average daily water demand (Total ADD): 2.8% between 2011 and 2015. The HHC Water Treatment Plant employs a drinking water waste recycling system, where wastewater generated from drinking water residuals processing is decanted and returned to the head of the plant. Hypothetically, this recycling system would result in no water treatment plant losses. It is possible that a portion of the calculated water treatment plant losses are related to raw water main leaks or inconsistent source meter calibrations.

Total ADD is calculated as the sum of each of the categories discussed above: Residential ADD, Non-Residential ADD, Additional Non-Residential ADD, UAW, and WTP Losses. Total ADD projections represent the total amount of raw water withdrawals for the system and are directly comparable to the WMA withdrawal limit. Six separate Total ADD projections were calculated by using two separate demand scenarios (54 GPCD and 65 GPCD) and three separate UAW scenarios (10%, 15%, and 20.9%). The projected Total ADDs with varying UAW for 2016 through 2036 are presented below for the low and high demand scenarios with the WMA Registered Withdrawal Limit in Figures 1 and 2, respectively.

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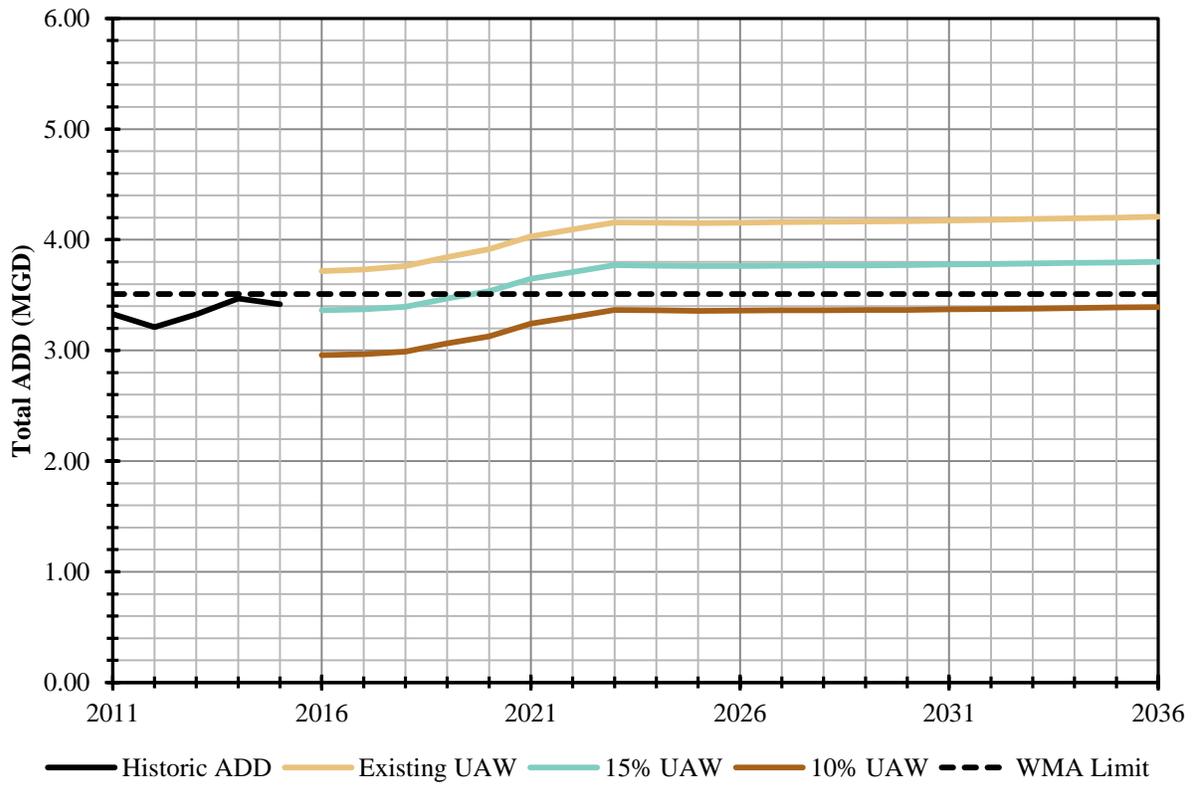


Figure 1. Projected Total ADD 2016-2036 – Historic Average Residential Demand

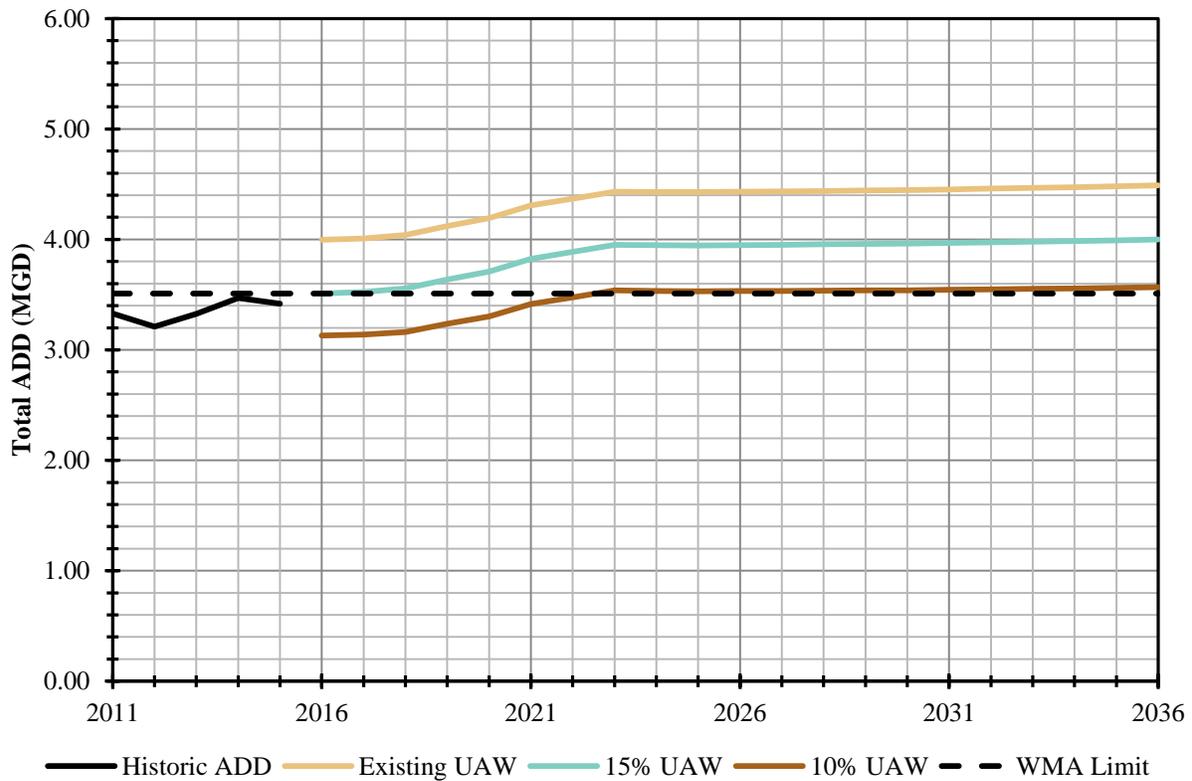


Figure 2. Projected Total ADD 2016-2036 – WCS Recommended Residential Demand

Under both demand scenarios, the projected Total ADD grows modestly between 2016 and 2018, between 0.3% and 0.8%. Starting in 2019, projected Total ADD grows between 1.4% and 3.5% under both demand scenarios until 2023, with the highest growth occurring between 2020 and 2021 with the incorporation of the Bristol Brothers (Part 2) development. Projected Total ADD growth returns to pre-development levels in 2024, with the growth ranging from 0.0% to 0.2% through 2036 under both demand scenarios. Total ADD under both demand scenarios is projected to range from 2.96 to 4.00 MGD in 2016. By 2036, Total ADD under both demand scenarios is projected to have grown between 11% and 13% from 2016, to values between 3.40 and 4.50 MGD. The General Methodology allows for the addition of a 5% buffer to the projected Total ADD at the discretion of MADEP. Using a 5% buffer would result in projected Total ADD values between 3.56 and 4.71 MGD in 2036.

EPG considered two specific demand scenarios by varying the GPCD value used. Within each demand scenario, three levels of UAW were used to account for potential variances in system UAW

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moving into the future. This variety of demand and UAW values provides a range of future system demands over six distinct scenarios. It would be reasonable to assume that actual future system demand will fall somewhere inside of the range provided. The maximum, minimum, and average projected Total ADD for 2016 through 2036 for the six scenarios is presented below in Figure 3 with the system's registered annual average withdrawal volume of 3.51 MGD. The Total ADD values shown in Figure 3 do not include the 5% buffer discussed above.

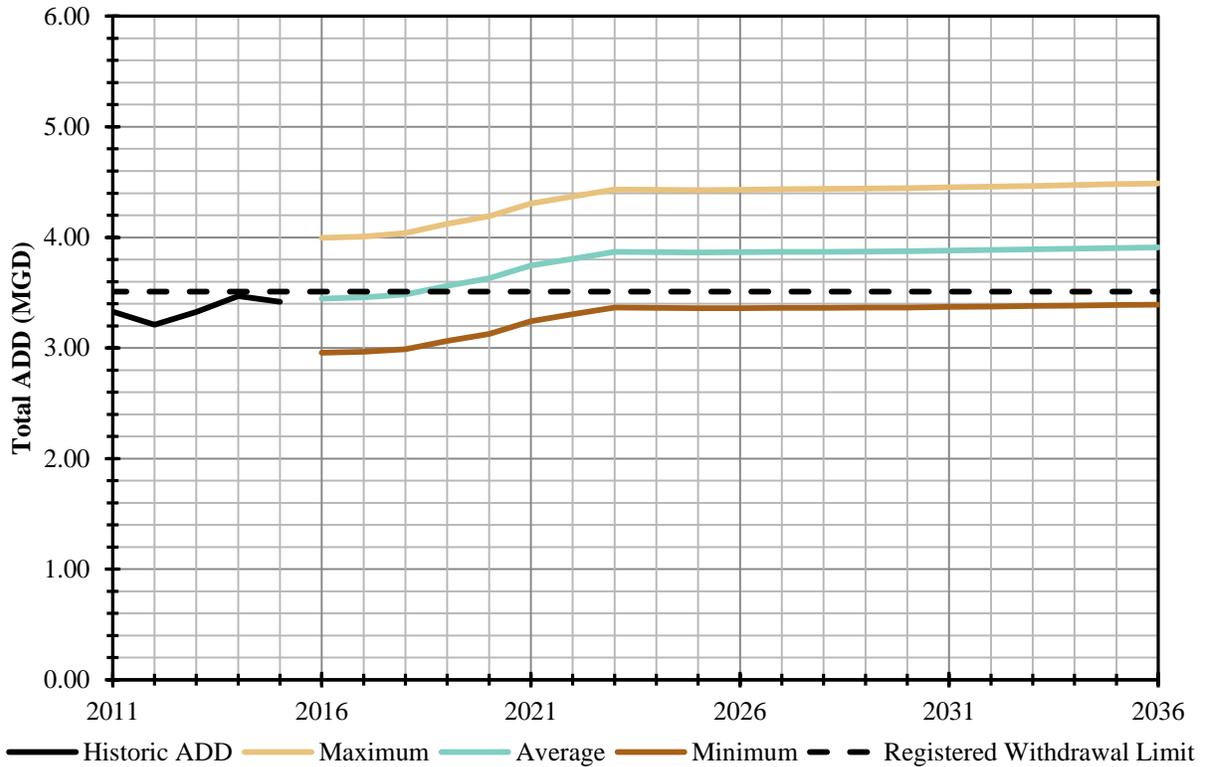


Figure 3. Projected Total ADD Range 2016-2036

The average projected Total ADD exceeds the WMA registered annual average withdrawal volume in 2019 and every year thereafter. The minimum projected Total ADD remains below the WMA registered annual average withdrawal volume beyond the limits of this demand projection.

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Groundwater Exploration Inventory and Preliminary Site Screening

EPG collected existing available information from previous groundwater exploration studies, including the location of test wells and observation wells previously installed by AWC. This information is displayed on two maps provided in Attachment C. The maps also display candidate groundwater exploration sites. The candidate sites were determined based on the size and status of parcels (developed/undeveloped), proximity to groundwater aquifers, and any relevant existing available information acquired from previous groundwater exploration studies. The maps also display potential environmental impact areas, including: Areas of Critical Environmental Concern (ACEC), Priority Habitats for Rare and Endangered Species (Priority Habitat), Vernal Pools, and Waste Transfer Stations.

Available information regarding former test wells shown on the maps, including diameter, depth, depth to groundwater, pumping rate (if applicable), and any documented soil conditions, are presented in Table 1 (Attachment D). Additional information on each of the candidate groundwater exploration sites, including the approximate location of the site, the number of parcels and parcel owner(s), and comments on any potential issues with the site, is presented in Table 2 (Attachment D).

Note that a number of the candidate groundwater exploration sites are located within the Weir River Sub-Basin (depicted on both maps provided in Attachment C). The Weir River Sub-Basin is designated as a High Stress basin according to the Massachusetts Water Resources Commission. This designation has been an obstacle to permitting new sources for the HHC System in the past and would likely be a major barrier to the activation of any new sources within the Weir River Sub-Basin.

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Feasibility of Wholesale Purchase of Water

An alternative to developing a new source of water supply for the HHC water system is the purchase of wholesale water from a nearby water system. Preliminary inquiries into the possibility of supplying wholesale finished water were made for the following suppliers/communities:

- Weymouth
- Massachusetts Water Resources Association (MWRA)
- Brockton/Aquaria
- Cohasset

The results of the preliminary inquiries are documented below for each water supplier:

Weymouth

The Town of Weymouth obtains water from five groundwater wells and the Weymouth Great Pond surface water supply system. Drinking water for the town is produced at two water treatment facilities: the Arthur J. Bilodeau Water Treatment Plant (which treats water from all five groundwater supplies) and the Great Pond Water Treatment Plant (which treats water from the Weymouth Great Pond surface water supply system). The Town of Weymouth currently has a registered WMA annual average withdrawal volume of 4.51 MGD and WMA withdrawal permit for 0.49 MGD. Their current authorized combined withdrawal under the WMA is 5.0 MGD, and their current average daily demand is approximately 4.3 MGD.

There are two existing interconnections between Weymouth's water system and the HHC water system. The interconnection on Fresh River Avenue consists of a valve vault with an 8 inch cast-iron main in the HHC main service zone. The second interconnection is located on High Street and consists of a vault with an 8inch asbestos cement water main in the HHC main service zone. Both of these locations would require water main and instrumentation upgrades to adequately serve as an active interconnection between the two water systems.

The former South Weymouth Naval Air Station is currently under construction to become a new development community with over 3,000 housing units and 900,000 square feet of commercial space

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referred to as “Southfield”. The current preliminary anticipated average day water demand for Southfield is 1.5 MGD. Southfield, Weymouth, and the MWRA are currently engaged in water supply discussions. According to the projects MEPA certificate, the MWRA is planning to expand its distribution system into Weymouth to either provide water directly to Southfield. In addition, the principal developer of Southfield is also actively investigating options to obtain water from the MWRA through the City of Quincy. In this scenario, MWRA would provide water to North Weymouth and Weymouth in turn would provide an equivalent amount of water to Southfield. The results of these negotiations are ongoing and will determine the feasibility of Aquarion engaging in a wholesale purchase agreement with the Town of Weymouth.

MWRA

The Massachusetts Water Resources Authority (MWRA) was created by the Massachusetts Legislature in December, 1984 (Chapter 372 of the Acts of 1984, “The Acts”) to operate, regulate, finance, and modernize the waterworks and sewerage system serving cities, towns, and special service districts in the greater metropolitan Boston area. The admission of new members to the MWRA water works system is governed by Chapter 372, Section 8(d) of the Acts. By law, the MWRA may only extend the waterworks system to new communities if the following six (6) conditions have been met:

- 1) The safe yield of the MWRA watershed system, only on the advice of the Division, is sufficient to meet such new projected demand.
- 2) No existing or potential water supply source for the local body has been abandoned unless MADEP has declared the source is unfit for drinking and cannot be economically restored for drinking purposes.
- 3) A water management plan has been adopted by the local body after approval by the Water Resources Commission established by Section 8A of Chapter 21A of the General Laws.
- 4) Effective demand management measures have been established including, but not limited to, the establishment of leak detection and other appropriate water system rehabilitation programs.
- 5) A local water supply source feasible for development has not been identified by the local body or the MADEP.

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- 6) A water use survey has been completed which identifies all users in the area of the local body that consume in excess of twenty million gallons per year.

Once the MWRA has established that the above 6 conditions have been met, the addition of a new member community to the MWRA system will require:

- Approval by the Massachusetts legislature and governor of Massachusetts. The membership of a new community must be signed into law pursuant to Chapter 372, section 8(d) of the Acts.
- The preparation, filing, and approval of both an Environmental Notification Form (ENF) and an Environmental Impact Report (EIR) with the Massachusetts Environmental Protection Agency (MEPA). This step is required pursuant to 301 CMR 11.25(7).
- Approval of the Massachusetts Water Resources Commission (WRC) that the conditions of the Interbasin Transfer Act have been met or do not apply. The procedures and criteria for which the WRC will base their decision are pursuant to 313 CMR Section 4.
- Establishment of entrance and connection fees based on the service area's average day demand.
- The design and construction of a service connection to the MWRA.

After these approvals are met, an application is submitted for approval by the MWRA Board of Directors and the MWRA Advisory Board.

As with Weymouth, the feasibility of a connection between the MWRA and the HHC water system largely depends on the resolution of water supply for the Southfield development in South Weymouth. If the MWRA expands to reach the Southfield development, the distance to the closest connection point will be greatly reduced. Currently, the closest potential MWRA interconnection point for AWC is in Quincy.

Brockton

The City of Brockton's main water supply is the Silver Lake Water Treatment Plant. The City also supplements its water supply from a regional water treatment plant located in North Dighton, Massachusetts which withdraws and treats water from the Taunton River and is operated by Aquaria Water, LLC (Aquaria). Based on the Agreement between Aquaria and the City of Brockton (dated

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May 22, 2002), Brockton has the unrestricted right to sell water to a third party. Alternatively, the City of Brockton may agree to allow third party communities to wheel water from the Plant through the Brockton Supply System. In this case, Aquaria would then have to pay Brockton a transport fee for wheeled water entering Brockton's Supply System based on Brockton's expenses for administration, operation, maintenance, and repair of the Supply System. The City of Brockton has a registered WMA annual average withdrawal volume 11.1 MGD and their current average daily demand is approximately 9.2 MGD.

To connect Aquarion's water distribution system to Brockton's water system, an interconnecting water main through Rockland would be necessary. An evaluation of connection alternatives would be necessary to determine the most favorable route from Brockton's system to Aquarion's. This evaluation would consider the size, age, and location of water mains in Brockton, Rockland, and Hingham; hydraulic grade lines in the three towns and a determination if booster pump stations or pressure-reducing devices are needed; and locations and configurations of instrumentation, including a meter vault. Several other issues that would have to be considered include the following:

- Water quality - water age should be considered when connecting to Brockton to ensure there are no issues with disinfection by-products. In addition, since water will be entering the system from a new direction, there is a potential for temporary water quality disruptions due to flow reversals.
- Intermunicipal Agreement - a connection with Brockton would require the development and execution of an Intermunicipal Agreement
- Design and Permitting – all permitting and design of the new facilities must be approved by MADEP and other regulatory agencies. In particular, assessment of the applicability of the Interbasin Transfer Act is required.
- Brockton will likely require a hydraulic assessment of their distribution system to verify that there are no negative impacts to their system. All infrastructure upgrades required for the Brockton water system would likely be paid for by Aquarion, unless negotiated otherwise.

Under a separate Contract with the Abington/Rockland Joint Water Works (ARJWW), EPG is preparing a hydraulic model of the ARJWW water system. This model is anticipated to be completed in the spring of 2017.

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Cohasset

The Cohasset Water Department supplies water to the town with two surface water reservoirs and one groundwater wellfield. Aquarion currently has an agreement in place with the Cohasset Water Department and the Linden Ponds Retirement Community (located in Hingham) under which Cohasset supplies water to the Linden Ponds complex through an interconnection with the HHC system. The average amount of water wheeled through the HHC system from Cohasset to Linden Ponds over the past 5 years was 37 million gallons per year, as reported in the 2009 to 2014 ASRs. The existing interconnection between the systems is located on Chief Justice Cushing Highway and consists of a finished water pumping station owned and operated by the Cohasset Water Department. The pumping station contains three booster pumps to accommodate for an increase in hydraulic head from the Cohasset system to the HHC system at the interconnection location. Additionally, the station is fitted with modern instrumentation (flow, pressure, water quality) and communications equipment, already integrated into AWC's SCADA system. The existing agreement between Aquarion and Cohasset as well as the existing interconnection infrastructure provides an ideal starting point for Aquarion to purchase additional wholesale water from Cohasset. Several issues that would have to be considered include the following:

- Cohasset WMA Limits – Cohasset will likely require system demand projections and an updated safe yield analysis to confirm that they have available water for wholesale.
- Intermunicipal Agreement – a new and/or supplemental Intermunicipal Agreement between AWC and Cohasset would have to be developed and executed.
- Permitting – all permitting must be approved by MADEP and other regulatory agencies, particularly assessment of the applicability of the Interbasin Transfer Act.

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Conclusions

The AWC HHC water system has a registered annual average withdrawal volume of 3.51 MGD under the Water Management Act (WMA). Projected demands for the water system vary based on residential consumption and system unaccounted for water, but the average projection exceeds the registered volume within the next three years. Despite continuing efforts to reduce the amount of UAW, it is reasonable to assume that in order for Aquarion to reliably meet the future demands of the HHC water system, a new source of water will be required.

To assist in the search for a new water supply source, former hydrogeological investigations and state and local municipal/environmental data was compiled, analyzed, and displayed on maps within the HHC service area (Attachment B). Twenty-two candidate groundwater exploration sites were identified and defining characteristics of the sites are tabulated (Attachment C). The majority of candidate groundwater exploration sites are located within the Weir River Sub-Basin. The process of permitting and registering a new source is lengthy and requires significant effort; a successful test well within the Weir River Sub-Basin would require additional permitting effort and negotiations with the state because the Sub-Basin is designated as “Highly Stressed”. The implementation of a test well program would require coordination and negotiations with homeowners, the Town of Hingham, and the Massachusetts Department of Conservation and Recreation (DRC) for access and use of candidate groundwater exploration site land. The development of any future groundwater supply site will required AWC to own or control the entire Zone I boundary (400 ft radius around the well head) which is equivalent to approximately 11.5 acres.

This report also summarized initial investigations into the purchase of wholesale raw water from four potential water suppliers. Two of the community suppliers, the MWRA and Weymouth, are currently engaged in wholesale water purchase discussions for a new community development planned in Weymouth. The results of this wholesale water purchasing agreement would significantly impact the feasibility of wholesale water purchase from either supplier; one potential scenario would be the expansion of the existing MWRA system to the new community development, resulting in reduced infrastructure investments from Aquarion to make a connection to the MWRA system. Alternatively, The City of Brockton likely has the capacity to supply the HHC system with wholesale water, but significant infrastructure investments could be necessary to facilitate the interconnection. Lastly, the Cohasset water system has an existing agreement with the HHC water system through which

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Cohasset supplies a retirement community within Hingham with water. The existing infrastructure for the current arraignment provides an ideal opportunity for a new wholesale water purchasing agreement with little infrastructure investments. The ability and willingness of Cohasset to provide the HHC water system with the necessary amount of water is still to be determined. With any wholesale water purchase agreement, particular attention must be paid to water quality and the effects of mixing between two separate water systems. Previous local interconnection agreements nearby the HHC system have resulted in significant water quality concerns. The long term cost effects of a wholesale water purchase agreement would also have to be investigated more closely.

A third option for expanding the HHC system's water supply would be to apply for a new WMA permit with the system's existing sources. This would require that AWC complete pump tests on all groundwater supply sources and apply for a WMA permit to increase the registered withdrawal limit up to the safe yield of the supply. Note that the summary of sources presented in Table 1 estimated the total operational capacity of the system as 6.35 MGD and the sum of Zone II Pumping rates is 6.01 MGD. If there are groundwater supplies which can sustain higher yields than currently registered, they could be permitted for increased withdrawals under the WMA. The conditions required for an increase in the WMA annual average withdrawal limit are as follows:

- The water supplier must demonstrate a need for an increased withdrawal volume
- The water supplier must demonstrate that they are capable of achieving a new withdrawal volume
- The water supplier must reduce UAW to 10% of Total ADD

Despite continued efforts by Aquarion to reduce UAW, it is unlikely that re-permitting the existing sources will be able to be completed in the near future because of the 10% UAW requirement, despite an emphasis by AWC on reducing UAW.

One other potential option for increasing AWC's water supply which is beyond the scope of this report, but could be considered, is the expansion of the Accord Reservoir. The ARJWW recently expanded their reservoir by dredging. Dredging could increase the usable water of Accord Pond. A new intake pipe to allow for lower water withdrawals could increase the safe yield of Accord Pond.

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Recommendations

Based upon the results of the evaluation of future needs and alternatives for new water sources, Environmental Partners makes the following recommendations:

- Continue to vigorously implement UAW reduction measures and should apply for a new WMA permit for existing sources as soon as 10% UAW is achieved.
- Pursue more information on wholesale water agreements with the water suppliers discussed above, particularly with the MWRA. Wholesale water agreement study should focus on the following:
 - Cost estimates, including preliminary planning and cost estimating for the necessary infrastructure to support any new interconnection.
 - Interconnection effects on water quality and water system hydraulic gradelines.
- Begin a test well program at the candidate groundwater exploration sites identified above. Candidate site EPG-5 should be the first site investigated based on the totality of information discussed in the Groundwater Exploration section. Precedence should then be given to other candidate sites owned by AWC, and then to any candidate sites outside of the Weir River Sub-Basin. AWC should make preliminary inquiries to landowners located at candidate sites to gauge their response to a sale or easement proposition if a test well is proven successful.

ATTACHMENT A

***RAW WATER SYSTEM OPTIMIZATION STUDY
(DECEMBER 23, 2014)***

DRAFT

ATTACHMENT B

DCR LETTER (MAY 5, 2015)

DRAFT



May 5, 2015

Jeff Farrell
Aquarion Hingham/Hull Water Company
900 Main Street
Hingham, MA 02043

Dear Mr. Farrell:

I would like to thank you and your staff for working with staff at the Department of Conservation and Recreation's Office of Water Resources (OWR) to discuss data needed to develop water needs forecasts (demand projections) for your water supply system. OWR is in the process of reviewing water needs forecasts completed prior to the implementation of the Permit Extension Act. Public water suppliers who received official water needs forecasts from OWR in 2009, but who did not receive permit renewals as a result of the Permit Extension Act (enacted in 2010 and subsequently amended in 2012), are receiving revised forecasts based on updated census and projection data if BOTH of the following criteria are met:

- The 2010 population reported by the Census Bureau for the community served by the public water supplier differed by 5% or more from the 2010 population *estimate* used by OWR in the original forecast; **and**
- This difference represents a 2010 water demand difference of 0.1 million gallons per day (MGD) or more, assuming 65 gallons per capita per day.

In Aquarion's case, both these criteria are met.

To develop demand projections, our staff follows the water needs forecasting policy and methodology adopted by the Water Resources Commission (WRC) (available at <http://www.mass.gov/dcr/watersupply/WaterNeedsForecastingMethology.htm>). Data for developing projections are based on the information contained in the annual statistical reports (ASRs) filed with the Massachusetts Department of Environmental Protection (MassDEP) for the years 2010 through 2014, employment projections prepared by your regional planning agency and population projections prepared by UMASS Donahue Institute, and information concerning water use patterns and service area.

OWR staff has concluded that the data currently available are not sufficient to allow an estimate of future water needs for your water supply system. The key issue of concern is the high unaccounted-for water amounts for the years 2010 through 2014. Therefore, OWR recommends that a temporary allocation be determined, if Aquarion decides to apply for a WMA permit. OWR, in consultation with MassDEP, will determine the temporary allocation volume during the

COMMONWEALTH OF MASSACHUSETTS · EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS

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www.mass.gov/dcr



Charles D. Baker
Governor

Karyn E. Polito
Lt. Governor

Matthew A. Beaton, Secretary, Executive
Office of Energy & Environmental Affairs

John P. Murray, Commissioner
Department of Conservation & Recreation

permit renewal process. Please note that this temporary allocation replaces the forecast issued to Aquarion by OWR in 2009.

The temporary allocation will include water to meet Aquarion's short-term needs and to fulfill its obligations to supply water to neighboring communities. In talking to MassDEP, they noted that Aquarion is registered for 3.51 mgd. Current water use for the past five years has averaged 3.38 mgd, with a range from 3.17 to 3.57 mgd. If Aquarion decides to apply for a WMA permit, OWR will examine the latest water use data and work with you to determine if any unanticipated water users will be hooking up to your system.

The temporary allocation process is intended to give you time to collect the data required to document past and current water use. As stated in the WRC's water needs forecasting policy and methodology, MassDEP requires those permitted with temporary allocations to collect and submit the data needed to calculate current water use and future needs within four years of the permit issuance date. Once the data are determined to be sufficient, OWR staff will work with you to complete a forecast of water needs for the remaining years of your WMA permit, and MassDEP may modify your permit to reflect the forecast.

Thank you for your cooperation with this process. If you have any questions, please contact Michele Drury at 617-626-1366.

Sincerely,



Anne Carroll
Director,
Office of Water Resources

ecc:

Michele Drury, DCR OWR	Kathleen Baskin, EOEEA
Daniel Lawrence, Aquarion	Jen D'Urso, MassDEP
Ronit Goldstein, Aquarion	Stephen Olson, Environmental Partners Group
Jonathan Hobill, DEP SERO	Jennifer Pederson, MWWA (per request)
Duane Levangie, MassDEP	Carol Harris, Woodard and Curran (per request)

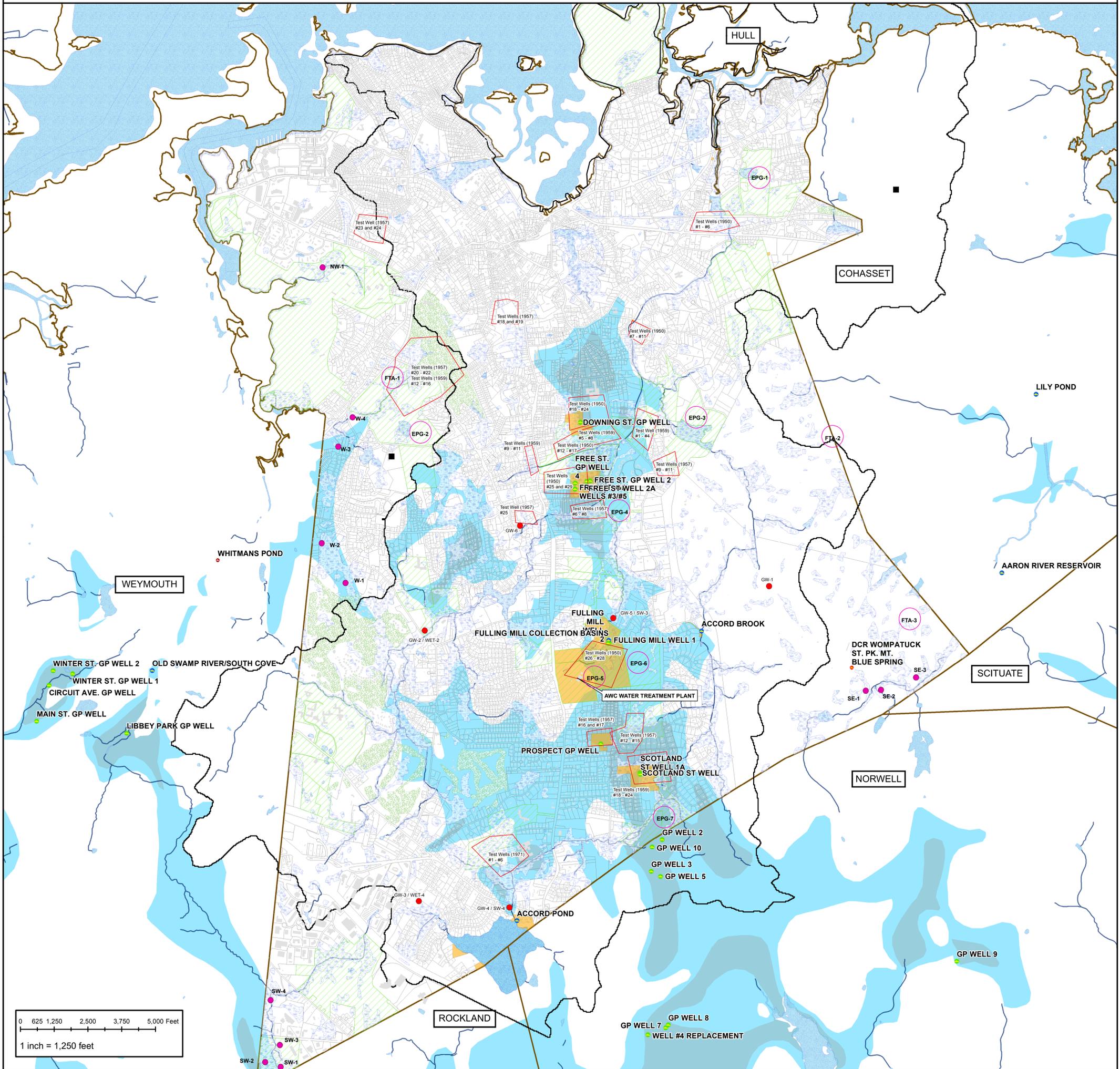
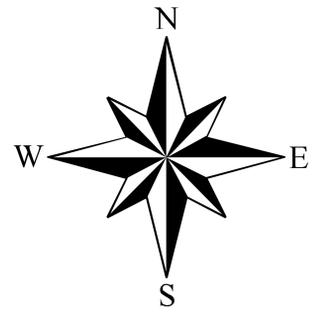
ATTACHMENT C

GROUNDWATER EXPLORATION MAPPING

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Aquarion Water Company New Source Study

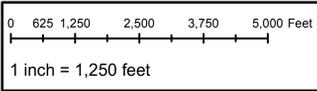
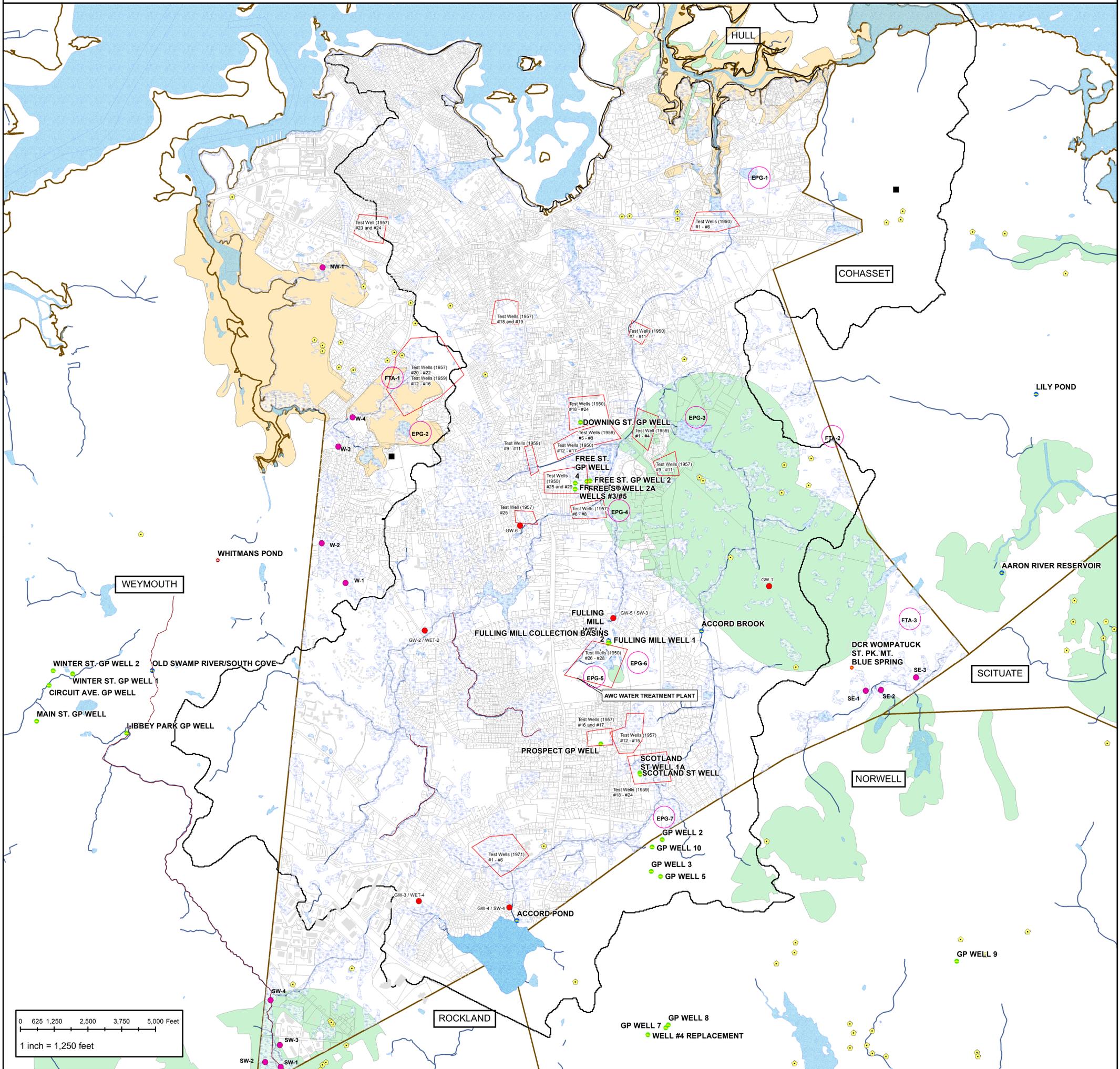
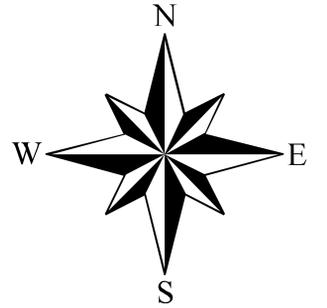


Legend

- | | | | |
|--|---|---|---|
| ● Community Groundwater Source | Town Border | Weir River Sub-Basin | ● Approximate Location of Former Well |
| ● Surface Water Intake | Parcels | High Yield Aquifer | Proposed Exploration Site (800' Wide) |
| ● Non-Community Groundwater Source | Developable Parcels | Medium Yield Aquifer | ● Former Proposed Exploration Site |
| ● Emergency Surface Water | AWC Property | Stream | |
| ■ Transfer Station | Structures | Water Body | |
| | Golf Courses | Wetlands | |



Aquarion Water Company New Source Study



Legend

- | | | | |
|--|---|--|---|
| ● Community Groundwater Source | Town Border | ● Vernal Pools | Approximate Location of Former Well |
| ● Surface Water Intake | Parcels | ACEC | Proposed Exploration Site (800' Wide) |
| ● Non-Community Groundwater Source | Structures | Priority Habitat | ● Former Proposed Exploration Site |
| ● Emergency Surface Water | Weir River Sub-Basin | — Stream | |
| ■ Transfer Station | | Water Body | |
| | | Wetlands | |

ATTACHMENT D

GROUNDWATER INFORMATION TABLES

DRAFT

Table 1. Former Well Information

Grouping	Well Name	Well Diameter (inches)	Well Depth	Depth to Groundwater	Pumping Rate (gpm)	Soil Conditions / Groundwater Favorability	Comments
1950 Investigation	Test Well 1	2.5	19'-10"		8		
	Test Well 2	2.5	22'-2"		20	Medium sand and gravel. Ledge or rock below.	
	Test Well 3	2.5	17'-0"		15		
	Test Well 4	2.5	9'-5"				
	Test Well 5	2.5	34'-1"		8		
	Test Well 6	2.5	27'-5"				
	Test Well 7	2.5	74'-4"		11		
	Test Well 8	2.5	44'-10"				
	Test Well 9	2.5	15'-9"				
	Test Well 10	2.5	11'-8"	4'-0"			
	Test Well 11	2.5	22'-0"				
	Test Well 12	2.5	29'-4"	4'-5"	40	Sharp gravel and sand. Ledge below.	
	Test Well 13	2.5	65'-5"				
	Test Well 14	2.5	56'-7"				
	Test Well 15	2.5	69'-3"				
	Test Well 16	2.5	67'-7"				
	Test Well 17	2.5	77'-0"				
	Test Well 18	2.5	68'-4"	6'-1"			
	Test Well 18A	2.5	63'-0"		52	Medium sand and gravel. Pumped water would not clear.	
	Test Well 19	2.5	59'-7"				
	Test Well 20	2.5	26'-2"				
	Test Well 21	2.5	21'-9"				
	Test Well 22	2.5	3'-0"				
	Test Well 22-A	2.5	3'-2"				
	Test Well 22-B	2.5	6'-6"				
	Test Well 22-C	2.5	22'-10"				
	Test Well 23	2.5	9'-5"				
	Test Well 23-A	2.5	9'-5"				
	Test Well 23-B	2.5	5'-10"				
Test Well 23-C	2.5	7'-0"					
Test Well 24	2.5	66'-11"	7'-9"	25	Medium to fine sand. Ledge below.		
Test Well 25	2.5	106'-8"		42	Medium to fine sand and gravel. Some clay.		
Observation Well 25	2.5	95'-0"					
Observation Well 25A	2.5	80'-0"	3'-8"	156			
Test Well 26	2.5	30'-8"					
Test Well 27	2.5	29'-9"					
Test Well 28	2.5	36'-8"					
Test Well 29	2.5	72'-2"	1'-4"	160	Sand and gravel, spots of clay. Pumped freely without wash.		
1957 Investigation	Test Well 1	2.5	23'-2"	1'-0"			Not Located on Map
	Test Well 2	2.5	64'-2"	0'-0"			Not Located on Map
	Test Well 3	2.5	23'-7"	1'-6"			Not Located on Map
	Test Well 4	2.5	26'-1"	3'-3"			Not Located on Map
	Test Well 5	2.5	36'-11"				Not Located on Map
	Test Well 6	2.5	71'-8"		21	Sand. Some clay and sharp gravel.	
	Test Well 7	2.5	80'-4"		41	Gray sand and sharp gravel. Soil is tight.	
	Test Well 8	2.5	64'-6"	0'-6"	35	Sand and sharp gravel. Traces of clay. Soil is tight.	
	Test Well 9	2.5	42'-10"	0'-9"			
	Test Well 10	2.5	28'-0"	2'-6"			
	Test Well 11	2.5	27'-6"	1'-2"			
	Test Well 12	2.5	36'-2"	3'-5"			
	Test Well 13	2.5	3'-0"	2'-2"			
	Test Well 14	2.5	5'-0"	2'-2"			
	Test Well 15	2.5	36'-8"	2'-2"			
	Test Well 16	2.5	17'-0"				
	Test Well 17	2.5	36'-0"				
	Test Well 18	2.5	22'-6"	0'-6"			
	Test Well 19	2.5	21'-0"	0'-6"			
	Test Well 20	2.5	20'-0"				
	Test Well 21	2.5	20'-0"				
	Test Well 22	2.5	15'-5"				
	Test Well 23	2.5	32'-3"	2'-2"			
	Test Well 24	2.5	28'-0"	0'-6"			
	Test Well 25	2.5	36'-0"	2'-1"			
1959 Investigation	Test Well 1	2.5	75'-1"	8'-3"			
	Test Well 2	2.5	72'-0"	4'-6"			
	Test Well 3	2.5	66'-0"				
	Test Well 4	2.5	36'-0"				
	Test Well 5	2.5	51'-0"				
	Test Well 6	2.5	57'-0"				
	Test Well 7	2.5	67'-0"				
	Test Well 8	2.5	65'-6"				
	Test Well 9	2.5	44'-9"	0'-10"	10	Brown sand and gravel. Soil is tight.	
	Observation well 9A	2.5	39'-0"	0'-10"			
	Test Well 10	2.5	30'-2"	0'-6"			
	Test Well 11	2.5	10'-6"	0'-6"			
	Test Well 12	2.5	19'-9"	1'-0"			
	Test Well 13	2.5	4'-8"	2'-0"			
	Test Well 14	2.5	46'-6"				
	Test Well 15	2.5	15'-3"	4'-0"			
	Test Well 16	2.5	24'-3"	4'-0"			
	Test Well 17	2.5	28'-0"	7'-4"			Not Located on Map
	Test Well 18	2.5	38'-1"	1'-8"			
	Test Well 19	2.5	13'-0"	0'-0"			
	Test Well 19A	2.5	41'-9"	0'-0"	20	Fine to medium gray sand and gravel. Soil too tight after 15'.	
	Test Well 20	2.5	43'-0"	0'-0"			
	Test Well 21	2.5	34'-8"				
	Test Well 22	2.5	41'-0"	0'-0"			
Test Well 23	2.5	40'-8"	0'-2"				
Test Well 24	2.5	19'-6"					
1971 Investigation	Test Well 1	2.5	27'-6"	0'-0"			
	Test Well 2	2.5	21'-10"	0'-0"			
	Test Well 3	2.5	23'-0"	0'-0"			
	Test Well 4	2.5	17'-0"	0'-0"			
	Test Well 5	2.5	39'-0"	0'-8"			
	Test Well 6	2.5	24'-0"	0'-8"			
2003 Groundwater Monitoring	GW-1		21'-6"	9'-6"		Coarse brown sand.	
	GW-2		12'-4"	8'-8"		Gravel. Ledge below.	
	GW-3		13'-6"	4'-3"		Orange sand with minor silt.	
	GW-4		13'-10"	4'-8"		Gray silt with fine sand.	
	GW-5		16'-6"	8'-4"		Gravel with coarse sand/silt.	
	GW-6		10'-1"	9'-4"		Medium sand. Ledge below.	

Table 2. Candidate Groundwater Exploration Sites

Proposed Exploration Site	Location	# of Parcels	Parcel Owner(s)	Potential Issues	Other Comments
EPG-1	Between Weir Street and Ash Street.	2	Benedictine Fathers, Inc. / Jordan and Carolyn Alexander	Multiple parcels, one of which has an existing home. Known ledge nearby.	
EPG-2	North of Hobart Street. Within More- Brewer Park	1	Town of Hingham Conservation	Conservation land. Previous unsuccessful test wells nearby. Hingham Transfer Station nearby. Located within ACEC.	
EPG-3	South of Popes Lane. At Triphammer Pond.	2	Town of Hingham Conservation	Multiple parcels. Conservation land. Located within Priority Habitat.	
EPG-4	South of Free Street. At Fulling Mill Brook.	2	Penny Collins-Siridee Trustee / The Fulling Mill Brook Farm Trust	Multiple parcels. Existing owner has an active farm. Located within Priority Habitat.	
EPG-5	Immediately east of AWC Water Treatment Plant.	2	Aquarion Water Company	Previously unsuccessful test wells nearby.	
EPG-6	Near Fulling Mill collection ponds.	1	Town of Hingham	Previously unsuccessful test wells nearby.	
EPG-7	East of Richard Road. Norwell line.	2	Town of Hingham Conservation	Multiple parcels. Conservation land. Existing Norwell groundwater wells are nearby.	
FTA-1	South of Newbridge Street. Within More-Brewer Park	3	Town of Hingham Conservation / Matthew Galvin	Multiple parcels, including private homeowner. Conservation land. Located within ACEC.	Identified in 2007 Fracture Trace Analysis by Geosphere Environmental Management, Inc.
FTA-2	Off of Doane Street, Cohasset. On Cohasset line.	2	Commonwealth of Massachusetts (DCR)	DCR Land. Portion of Zone I in Cohasset.	Identified in 2007 Fracture Trace Analysis by Geosphere Environmental Management, Inc.
FTA-3	South of Beechwood Street. Cohasset line. Within Wompatuck State Park.	1	Commonwealth of Massachusetts (DCR)	DCR Land.	Identified in 2007 Fracture Trace Analysis by Geosphere Environmental Management, Inc.
NW-1	South of Hockley Drive. Within Bare Cove Park	1	Town of Hingham Recreation	Recreation Land. Tidal river nearby. Located within ACEC.	Identified in 2008 New Source Study by Tata & Howard, Inc.
W-1	West of Old Ward Street.	2	Edith Margetts / Black Rock Country Club	Multiple parcels, including country club and a private homeowner. Tidal river nearby.	Identified in 2008 New Source Study by Tata & Howard, Inc.
W-2	West of Ward Street. Weymouth Line.	1	Hingham Conservation Commission	Conservation land. Tidal river nearby.	Identified in 2008 New Source Study by Tata & Howard, Inc.
W-3	North of Manatee Road	1	Weymouth Light & Power Company	Multiple parcels would be needed to secure Zone I. Hingham Transfer Station nearby. Tidal river nearby.	Identified in 2008 New Source Study by Tata & Howard, Inc.
W-4	East of French Street. At Fresh River.	3	C Spirito Inc. / Fresh River Avenue Nominee Trust	Multiple parcels. Hingham Transfer Station nearby. Tidal river nearby. Located within ACEC.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SE-1	Near Union Street at Aaron River. Within Wompatuck State Park.	1	Commonwealth of Massachusetts (DCR)	DCR land.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SE-2	Near Union Street at Aaron River. Within Wompatuck State Park.	1	Commonwealth of Massachusetts (DCR)	DCR land.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SE-3	Near Union Street at Aaron River. Scituate line. Within Wompatuck State Park.	1	Commonwealth of Massachusetts (DCR)	DCR land.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SW-1	South of Sharp Street. Rockland line.	1	Rockman Realty LLC	Southfield development nearby. Located within Priority Habitat.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SW-2	South of Sharp Street. Weymouth line.	1	Rockman Realty LLC	Southfield development nearby. Located within Priority Habitat.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SW-3	South of Sharp Street.	1	Rockman Realty LLC	Southfield development nearby. Located within Priority Habitat.	Identified in 2008 New Source Study by Tata & Howard, Inc.
SW-4	North of Sharp Street. Weymouth line.	2	Town of Hingham / Unknown	Multiple parcels.	Identified in 2008 New Source Study by Tata & Howard, Inc.