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REPORT

April 2021

TOWN OF
Barnstable
MASSACHUSETTS

Source Exploration Report (Volume I)

55 Walkers Brook Drive, Suite 100, Reading, MA 01867 (HQ)
Tel: 978.532.1900

April 26, 2021

Mr. Hans Keijser
Supervisor
Barnstable Water Supply Division
Department of Public Works
47 Old Yarmouth Rd.
Hyannis, MA 02601

Re: Study for New Public Drinking Sources for the Barnstable Water System
New Source Exploration Report

Dear Mr. Keijser:

We are pleased to submit to the Town of Barnstable, Barnstable Water Supply Division the attached New Source Exploration Report. This document presents the results of the test well drilling conducted for the Hyannis Water System, focusing on alternatives to obtain additional water supply.

We wish to acknowledge the assistance of Mr. Michael Gorenstein, Project Manager, who assisted the project team in gathering and evaluating background information for this project. Bruce Adams, PE and Kevin MacKinnon, PG, PHg of Weston & Sampson worked on the project. We thank you for this opportunity to be of assistance.

Very truly yours,

WESTON & SAMPSON,

Kevin MacKinnon, PG, CG, PHg
Senior Technical Leader, Water Resources

EXECUTIVE SUMMARY

Weston & Sampson, on behalf of the Hyannis Water System, has completed a preliminary test well investigation to locate new water supply sources to resolve water production and water quality deficiencies identified in the March 2019 New Sources Alternatives Evaluation Report. The previous evaluation concluded that the current supply deficit of 1.87 million gallon per day (MGD) in 2020 is expected to grow to 3.23 MGD in 20 years (2040). In following with the recommendations of that report, Weston & Sampson initiated a groundwater supply investigation at the seven highest ranked sites.

After the construction of a total of nine test wells across the seven sites, six of those wells were deemed hydrogeologically favorable for additional testing, which included 4-hour pumping tests. These short-term pumping tests were designed to evaluate potential yield and identify any water quality concerns. The results of the short-term pumping tests served to identify four locations capable of providing at least 500 gpm (0.72 MGD) with a single production well installed. One site (Site E) however was dropped from further consideration due to the shallow nature of the deposits and concern relative to the long-term yield and vulnerability to potential contamination and drought(s). This leaves Sites C, B and D for further consideration. Site C is located north of Route 6 within the Bridge Street Conservation Area, Site B is located north of Route 6 west off Old Jail Lane, while Site D is located within the West Barnstable Conservation Area.

The conceptual costs to develop each of the sites for a 1500 gpm (2.16 MGD) water supply were described in the 2019 New Sources Evaluation Report. These costs are now further refined based on the yield, quality, and location information provided in this study. Each site is unique and probable costs were estimated based on the conceptual potential of each site. The significant unknown is whether each site could support multiple wells to produce a total of 2.16 MGD. Further hydrogeological investigation is required to answer this question. Estimated costs to develop Sites C, B and D are $25.4, $19.6 and $22.2 million dollars, respectively. Cost estimates provided include wells, pump stations, treatment facilities, connection mains, transmission mains, engineering design, as well as contingency.

Weston & Sampson recommends conducting additional test well drilling at Site C. Once two to three locations within Site C are identified, these withdrawals should be permitted with sources approximating 500 to 750 gpm each for a total of 1,500 gpm (2.16 MGD). It is our expectation that the permitting and construction of a source capable of supplying an additional 2.16 MGD of treated groundwater will cost approximately $25.4 M and be complete by 2026. Weston & Sampson also recommends that the HWS should conduct additional test well drilling at Site B to better understand the withdrawal potential of that large parcel. If favorable for the remaining future water supply deficit (1.07 MGD), the HWS should consider purchasing the necessary land area (including required Zone I's) to preserve it for future development.

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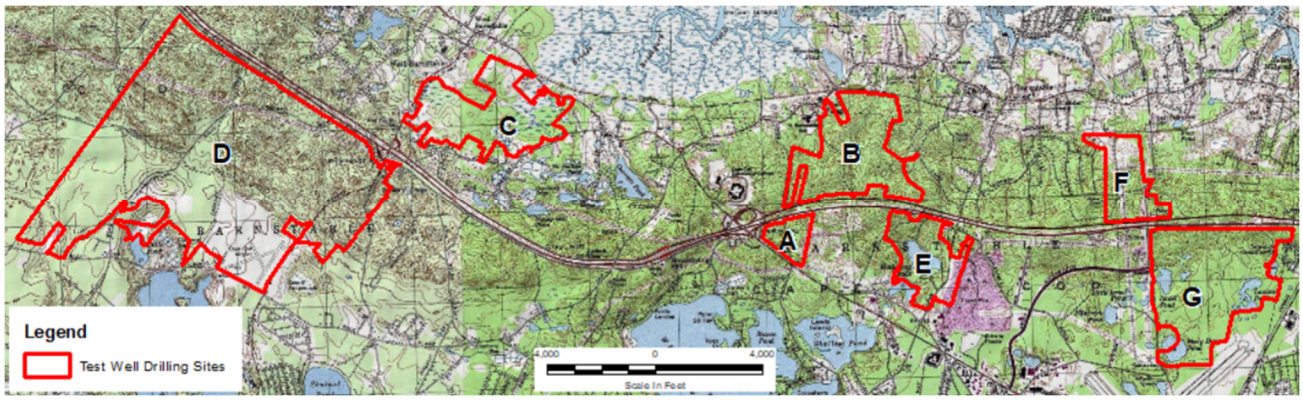
1.0 INTRODUCTION

In March of 2019, Weston & Sampson submitted the New Sources Alternatives Evaluation Report to the Town of Barnstable (the Town) summarizing findings with regard to an evaluation of water supply and treatment options for sources located within the Hyannis Water System (HWS). The evaluation provided in the report concluded that the current supply deficit of 1.87 MGD in 2020 will grow to 3.23 MGD in 20 years (2040). The final report recommended that the Town initiate an investigation and development of additional sources of groundwater supply in concert with currently planned water system improvements. Seven locations, shown in Figure 1 below, were identified to be favorable at the conclusion of a GIS-based site screening and ranking process. These seven locations were subsequently chosen to be the subject of a preliminary test well investigation program. The hydrogeologic and water quality results of that test well program are summarized in this report followed by a revised cost evaluation for source development.

In following with the recommendations of the March 2019 report, Weston & Sampson and associated drilling subcontractors initiated a groundwater supply investigation at the seven sites located in Barnstable (Figure 1). The sites, designated as Site A through Site G, were accessed and investigated over a four-month period that began on January 23, 2020 and ended on May 19, 2020. During this time, Weston & Sampson oversaw the drilling and installation of eleven (11) borings, nine (9) test wells and two (2) observation wells. Seven (7) of the test wells were constructed within borings advanced using sonic drilling methods, while the remaining test wells and observation wells were advanced and constructed within borings using drive-and-wash drilling methods. If a test well was found to be favorable, a 4-hour pumping test was conducted and evaluated for yield and water quality. This was completed on six of the test wells that were constructed. This report describes the test well drilling effort, the results obtained, the analyses of the data collected, and provides recommendations for the next steps with respect to infrastructure and required permitting.

Figure 1: Site Map



Site Names: Site A – Rt 132/Rt 6
Site B – North of Rt. 6 (off Old Jail Ln)
Site C – Bridge St. Conservation Area
Site D – West Barnstable Conservation Area
Site E – Hathaway's Pond
Site F – County Farm
Site G – Fish and Wildlife

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2.0 WORK PERFORMED

Due to the limitations of traditional test well drilling and testing used in New England, two methods of drilling were employed. At sites where the groundwater depth was relatively shallow (<28 feet), 2 ½ -inch diameter drive and wash drilling methods were used. In areas where groundwater levels were greater than 28 feet, the 4 ¼ -inch diameter sonic drilling method was used. The primary limitation was the ability to employ suction lift when pumping the test well. At sites where groundwater was shallow, centrifugal pumps were used to lift the water on suction. At sites with a deeper groundwater table, submersible pumps were temporarily installed into the larger diameter casing and pumped to the surface. Sites E and C were drilled using the 2 ½ -inch drive and wash methodology while sites A, B, D, F, and G were evaluated with the 4 1/4 – inch sonic method.

2.1 Test Well Drilling (Site E and Site C)

On January 23, 2020, the Denis L. Maher Company mobilized a test well drilling rig to Site E (Figure 2, Attachments) to advance one boring. Site E is located within the boundaries of the Barnstable Fire District and was accessed through 45 Phinney's Lane. Subsurface conditions were investigated at this location by advancing a 2.5-inch test boring using the drive and wash drilling method. Once the COVID-19 restrictions had lifted, a second boring and test well was advanced and constructed on Site C (Figure 3, Attachments) using this drilling methodology between May 13, 2020 and May 19, 2020. Site C is located within the village of West Barnstable and the West Barnstable Fire District and was accessed through Hinckleys Lane, between 230 and 240 Church Street. Generalized descriptions of the materials observed in the borings advanced on Site E and Site C are provided below. Table 1 provides the well construction detail. Boring logs are provided in Appendix A.

Site E (Hathaway's Pond): Test Well TW-1E-20
TW-1E-20 (Figure 2, Attachments) was advanced to refusal at a depth of 76 feet below ground surface (ft bgs). The materials encountered are as follows:

- 0 – 28' light brown fine to coarse SAND, little fine gravel, trace silt
- 28 – 35' light brown fine to coarse SAND, trace fine gravel
- 35 – 49' light brown and gray very fine to medium SAND, little to some silt
- 49 – 56' gray poorly graded very fine to fine SAND, trace silt
- 56 – 76' gray very fine SAND and silt
- 76' refusal (bent casing)

Materials within the upper 35 feet of the test well boring consisted primarily of fine to coarse sand. As the boring progressed below 35 feet, percentages of fine sands and silts increased. To maximize saturated thickness and available drawdown to a production well in this location, a 12-foot screen was set from 28 to 40 ft bgs and exposed by pulling back on the 2.5-inch casing. Once the well was constructed, the well was developed using a diaphragm pump for a period of two hours and then rated using a centrifugal pump, pumping the discharged water to waste.

To rate TW-1E-20, a short-duration test was conducted, and drawdown during this test was estimated with a vacuum gauge that was installed prior to the test on top of the casing. Units on the vacuum gauge are in inches of mercury (in. Hg). When the vacuum pressure on the test well is measured where

the gauge is installed, an estimate of drawdown is made. The conversion for one inch of mercury is approximately 1.13 feet of water.

During the 15-minute short-duration test, TW-1E-20 pumped at approximately 75 gallons per minute (gpm) with a vacuum pressure reading of 25 in. Hg. This corresponds to a drawdown of approximately 15.25 feet, considering a casing stick-up of 3.0 feet and a static water level of 10.0 feet from the top of the well casing (ft toc). The specific capacity of the test well is therefore 4.92 gpm/ft of drawdown (75 gpm/15.25 ft). This specific capacity value is generally considered low because this well-rating method often overestimates drawdown and underestimates the specific capacity. The subsequent 4-hour pumping test provides additional data to evaluate potential yield at this location and will be discussed in a subsequent section of this report.

Site C (Bridge Street Conservation Area): Test Well TW-1C-20
TW-1C-20 (Figure 3, Attachments) was advanced to refusal at a depth of 85 ft bgs. The materials encountered are as follows:

- 0 – 14' gray CLAY, trace Sand, trace Gravel
- 14 – 21' brown, fine to medium SAND, some gray Clay, little f-c Gravel, trace Silt
- 21 – 35' brown, medium to coarse SAND, trace Gravel, trace Silt, trace Clay
- 35 – 42' brown, medium to coarse SAND, trace fine Gravel, trace Silt
- 42 – 85' brown, coarse SAND, trace fine Gravel, trace Silt

Materials from 0 to 14 ft bgs consisted primarily of clay. From 14 to 21 ft bgs, percentages of sand increased, and percentages of clay decreased. From 21 to 42 ft bgs, materials consisted of medium to coarse sand, and from 42 to 85 ft bgs, materials consisted of coarse sand. To maximize saturated thickness and available drawdown to a production well in this location, a 12-foot screen was set from 73 to 85 ft bgs and exposed by pulling back on the 2.5-inch casing. Once the well was constructed, the well was developed using a diaphragm pump for a period of two hours and then rated using a centrifugal pump, pumping the discharged water to waste.

To rate TW-1C-20, a short-duration test was conducted, and drawdown during this test was estimated with a vacuum gauge that was installed prior to the test on top of the casing. Units on the vacuum gauge are in inches of mercury (in. Hg). When the vacuum pressure on the test well is measured where the gauge is installed, an estimate of drawdown is made. The conversion for one inch of mercury is approximately 1.13 feet of water.

During the 15-minute short-duration test, TW-1C-20 pumped at approximately 75 gpm with a vacuum pressure reading of 17 in. Hg. This corresponds to a drawdown of approximately 15.05 feet, considering a casing stick-up of 2.33 feet and a static water level of 1.83 ft toc. The specific capacity of the test well is therefore 4.98 gpm/ft of drawdown (75 gpm/15.05 ft). This specific capacity value is generally considered low because this well-rating method often overestimates drawdown and underestimates the specific capacity. The subsequent 4-hour pumping test provides additional data to evaluate potential yield at this location. This test will be discussed in a subsequent section of this report.

2.2 Test Well Sonic Drilling (Site A, Site B, Site D, Site F and Site G)

Between February 18, 2020 and March 12, 2020, Cascade Drilling assisted Weston & Sampson with subsurface investigations at five (5) sites throughout Barnstable, Massachusetts by advancing seven 6-inch test borings using the sonic drilling methodology. A total of seven (7) test wells with 4.25-inch PVC casings were constructed in these borings. Figures showing each site and the locations of the test wells are attached to this letter report, and descriptions for each boring are provided below and presented according to the date on which they were advanced. The first of the subsurface investigations using sonic drilling methods was initiated on Site D, on February 18, 2020. The last of the subsurface investigations using sonic drilling methods was initiated on Site G, on March 12, 2020. Table 1 summarizes the test wells constructed in these borings, and drilling logs showing the composition of the materials observed in each of the borings are available in Appendix A.

Site D (West Barnstable Conservation Area): Test Well TW-2D-20
TW-2D-20 (Figure 4, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 1' dark brown TOPSOIL
- 1 – 3' brown very fine SAND and Silt
- 3 – 6' brown very fine to coarse SAND and Gravel, trace Silt
- 6 – 12' brown poorly graded very fine to fine SAND and Silt, trace Gravel
- 12 – 19' brown moderately graded very fine to fine SAND, trace Silt
- 19 – 30' gray to brown very fine SAND and Silt, little cobbles, trace clay
- 30 – 48' brown moderately graded fine SAND, trace Gravel
- 48 – 83' brown poorly graded very fine to fine SAND and Silt, trace Gravel
- 83 – 100' brown fine to coarse SAND, trace Gravel
- 100' End of Boring

Materials within the upper 80 feet of the TW-2D-20 boring consisted mostly of fine sand and silt. From 80 to 100 feet, materials were primarily composed of well graded fine to coarse sand. To maximize saturated thickness and available drawdown to a production well in this location, a 10-foot screen was set from 90 to 100 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site D (West Barnstable Conservation Area): Test Well TW-1D-20
TW-1D-20 (Figure 4, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 1' dark brown TOPSOIL
- 1 – 3' orange – brown very fine SAND and Silt, trace Gravel
- 3 – 7' dense, brown SILT, little Clay
- 7 – 8' COBBLES
- 8 – 20' dense, brown, well graded very fine to fine SAND, little Silt, occasional Cobbles
- 20 – 26' dense, brown, very fine to fine SAND and Silt, little Gravel and Cobbles
- 26 – 30' dense, brown, well graded v. f. to f. SAND, little Gravel, trace Silt, trace Clay
- 30 – 32' dense, gray to brown, fine to coarse SAND and Silt, trace Gravel, trace Clay

- 32 – 57' very dense, brown, well graded, v. f. to f. SAND, little Silt, little Gravel, trace Clay
- 57 – 80' dense, brown, moderately graded, very fine to fine SAND, little Gravel, little Silt
- 80 – 90' dense, brown, moderately graded, v. f. to f. SAND, trace Gravel, trace Silt
- 90 – 100' brown, moderately graded, fine to coarse SAND, trace Gravel
- 100' End of Boring

Materials within the top 20 feet of the boring consisted of alternating layers of fine sand and silt. From 20 to 90 feet, materials consisted of alternating layers of dense to very dense sand with concentrations of silt varying from 1% to 50% and percentages of gravel varying from 1% to 20%. Materials from 90 to 100 feet consisted of moderately graded, fine to coarse sand with trace amounts of gravel and silt. In an effort to maximize saturated thickness and available drawdown to a production well in this location, a 10-foot screen was set from 90 to 100 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site F (County Farm): Test Well TW-1F-20
TW-1F-20 (Figure 5, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 74' light brown and grayish brown SILT and very fine Sand, trace Gravel
- 74 – 89' light brown, moderately graded, fine to medium SAND, trace Silt
- 89 – 90' dense, gray SILT and Clay
- 90 – 100' light brown, moderately graded, very fine to fine SAND, trace Silt
- 100' End of Boring

Materials from 0 to 74 feet consisted primarily of silt and very fine to fine sand, and from 74 to 89 feet materials consisted of fine to medium sand. At 89 feet, a one-foot thick interval of dense silt and clay was observed, and from 90 to 100 feet very fine to fine sand was observed. To maximize saturated thickness and available drawdown to a production well in this location, a 6-foot screen was set from 72 to 78 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site B (North of Rt. 6): Test Well TW-1B-20
TW-1B-20 (Figure 6, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 62' grayish brown and light brown SILT and very fine SAND
- 62 – 70' light brown very fine to fine SAND, trace Silt
- 70 – 100' dense, grayish brown SILT and very fine SAND, trace Gravel
- 100' End of Boring

Materials from 0 to 62 feet consisted of silt and very fine sand. From 62 to 70 feet, materials consisted of very fine to fine sand, and from 70 to 100 feet, materials consisted of silt and very fine sand. To maximize saturated thickness and available drawdown to a production well in this location, a 6-foot screen was set from 66 to 72 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site B (North of Rt. 6): Test Well TW-2B-20
TW-2B-20 (Figure 6, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 49' brown SILT and very fine SAND
- 49 – 58' brown medium to coarse SAND
- 58 – 89' dense, brown, very fine to fine SAND and SILT
- 89 – 100' light brown medium to coarse SAND
- 100' End of Boring

Materials from 0 to 49 feet consisted of silt and very fine sand. From 49 to 58 feet, materials consisted of medium to coarse sand, and from 58 to 89 feet, materials consisted of fine sand and silt. From 89 to 100 feet, materials consisted of medium to coarse sand. To maximize saturated thickness and available drawdown to a production well in this location, a 10-foot screen was set from 90 to 100 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site A (Rt 132/Rt 6): Test Well TW-1A-20
TW-1A-20 (Figure 7, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 10' brown very fine SAND and SILT
- 10 – 70' brown very fine to medium SAND, trace to little Silt, trace Gravel
- 70 – 86' brown fine to coarse SAND, trace to little Gravel, trace Silt
- 86 – 90' dense brown SILT and moderately graded very fine SAND, trace Gravel
- 90 – 100' no recovery
- 100' End of Boring

Materials from 0 to 10 feet consisted of fine sand and silt, and from 10 to 70 feet, materials consisted of fine to medium sand with trace to little concentrations of silt. From 70 to 86 feet, observed sediments consisted of fine to coarse sands and trace to little concentrations of gravel, and from 86 to 90 feet, materials consisted of silt and fine sand. Materials were not recovered from 90 to 100 feet. To maximize saturated thickness and available drawdown to a production well in this location, a 10-foot screen was set from 80 to 90 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Site G (Fish & Wildlife): Test Well TW-1G-20
TW-1G-20 (Figure 8, Attachments) was advanced to a depth of 100 ft bgs. The materials encountered are as follows:

- 0 – 30' brown and gray fine to medium SAND, trace to little Silt, trace to little gravel
- 30 – 63' light brown, well graded, f to c SAND, trace fine to coarse gravel, trace silt
- 63 – 65' light brown SILT, little f. to m. SAND, trace fine to coarse gravel, trace silt
- 65 – 70' light brown, well graded f. to c. SAND, trace fine to coarse gravel, trace silt
- 70 – 78' gray, mostly SILT, trace fine sand

- 78 – 83' gray, poorly graded m. to c. SAND, little silt, trace fine to medium gravel
- 83 – 85' gray, poorly graded fine SAND, some silt, little fine to coarse gravel, little clay
- 85 – 100' brown, well graded fine to coarse SAND, little silt, trace fine to coarse gravel
- 100' End of Boring

Materials from 0 to 70 feet consisted of alternating layers of fine to medium and fine to coarse sand with trace to little concentrations of silt and trace to little concentrations of gravel. A layer of silt was observed from 70 to 78 feet. From 78 to 100 feet, alternating layers of poorly graded and well graded fine to coarse sands were observed. To maximize saturated thickness and available drawdown to a production well in this location, a 10-foot screen was set from 90 to 100 ft bgs and exposed by pulling back on the 6-inch override casing. Once the well was constructed, the well was developed for a period of two hours to remove fine materials from the coarser sediments around the well screen.

Table 1: Test Well Details

Site Name	Well ID	Start Date	Finish Date	Depth of Boring (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Slot Size	Depth to Ground water (ft bgs)
Hathaway's Pond	TW-1E-20	1/23/20	1/27/20	76	28	40	30/60	7
Bridge St Conservation Area	TW-1C-20	5/13/20	5/19/20	85	73	85	30	-0.5
W Barnstable Conservation Area	TW-2D-20	2/18/20	2/19/20	100	90	100	40	47
	TW-1D-20	2/20/20	2/24/20	100	90	100	30	48
County Farm	TW-1F-20	2/24/20	2/26/20	100	72	78	40	47.6
North of Rt. 6	TW-1B-20	2/27/20	2/28/20	100	66	72	30	47.9
	TW-2B-20	3/2/20	3/3/20	100	90	100	40	33.13
Rt 132 / Rt 6	TW-1A-20	3/4/20	3/5/20	100	80	90	40	41.89
Fish & Wildlife	TW-1G-20	3/11/20	3/12/20	100	90	100	30	31.93

2.3 4-Hour Pumping Tests

Of the nine (9) test wells constructed during this investigation, six (6) test wells were deemed favorable enough to administer 4-hour pumping tests, including: TW-2D-20, TW-1F-20, TW-2B-20, TW-1G-20, TW-1C-20 and TW-1E-20. Materials found within the borings of the remaining three test wells were found to be unsuitable for further testing. Water levels during the tests were measured and recorded by hand with a Solinst water level meter. Pumping tests conducted on wells constructed with 2.5-inch steel casings were pumped with a centrifugal pump, and pumping tests conducted on wells constructed with 4.25-inch PVC casings were pumped with a 3-inch submersible pump. Table 2 below shows test wells with dates on which pumping tests were conducted, the diameters of the wells and the pumps that were used during pumping tests.

Table 2: Test Well Diameters and Rating Test Details

Site Name	Well ID	Date of Pumping Test	Casing Diameter (inches)	Model/Type of Pump Used
W Barnstable Conservation Area	TW-2D-20	2/19/2020	4.25 PVC	3-inch submersible
County Farm	TW-1F-20	2/26/2020	4.25 PVC	3-inch submersible
North of Rt. 6	TW-2B-20	3/3/2020	4.25 PVC	3-inch submersible
Fish & Wildlife	TW-1G-20	3/12/2020	4.25 PVC	3-inch submersible
Bridge St Conservation Area	TW-1C-20	5/19/2020	2.5 Steel	Centrifugal
Hathaway's Pond	TW-1E-20	6/5/2020	2.5 Steel	Centrifugal

Static water levels were measured and recorded in all the test wells prior to initiating 4-hour pumping tests. All test wells were rated during the 4-hour pumping tests. Pumping water levels were measured and recorded within the test wells during the 4-hour pumping tests every minute for the first ten minutes, every ten minutes for the remainder of the first hour and then every thirty minutes for the remainder of the tests. Water level data recorded during the pumping tests are attached in Appendix B.

Prior to the shutdown of each 4-hour pumping test, water quality samples were collected. The water quality samples were submitted to a Massachusetts certified laboratory for analysis of secondary contaminants (turbidity, TDS, color, odor, pH, alkalinity, sulfate, chloride, hardness, calcium, magnesium, aluminum, potassium, iron, manganese, silver, copper, and zinc), coliform bacteria, lead, 1,4-dioxane, nitrate/nitrite, inorganic compounds, perchlorate, volatile organic compounds (VOCs), synthetic organic compounds (SOCs), radionuclides and PFAS. A summary of the water quality results is shown in Table 6 and discussed below. A full summary of water quality results is attached to this letter report in Appendix C. Detailed water quality results from the laboratory are also attached to this letter report in Appendix D (Volume II).

3.0 RESULTS

3.1 Theoretical Yield of Test Well Locations

As described in the work performed section above, 4-hour pumping tests were conducted on the six test wells listed in Table 2. Pumping water levels were recorded throughout the pumping tests, and evaluations of aquifer parameters were determined such that estimates of potential yields for final production wells at these locations could be calculated. Water level data was measured with an electronic water level meter, and recorded water level data is attached in Appendix B. Water quality results are subsequently summarized, and full water quality laboratory reports received by Weston & Sampson are attached in Appendix C.

Initial yield ratings of test well locations that did not undergo 4-hour pumping tests are listed in Table 3 below. 4-hour pumping tests at these locations were not conducted, because initial yields were calculated to be insufficient for further consideration. Results at locations where 4-hour pumping tests were conducted are also detailed in Table 3 and described immediately below.

Table 3: Potential Yield Estimations

Site ID	Well ID	Pumping Rate (gpm)	Static (ft TOC)	Maximum Drawdown[1] (ft)	S.C.[2] (gpm/ft)	Well Depth (ft bgs)	Available Water[3] (ft)	Potential Yield[4] (gpm)
Site A	TW-1A-20	26	44.84	31.00	0.84	90	33.11	28
Site C	TW-1C-20	75	1.83	1.01	74.26	85.00	68.5	5087
Site E	TW-1E-20	75	11.54	1.92	39.06	40.00	14.46	565
Site D	TW-2D-20	26	47	2.00	13.00	100	40.7	529
Site D	TW-1D-20	16	48	50.00	0.32	100	39.52	13
Site F	TW-1F-20	26	47.6	15.00	1.73	78	22.35	39
Site B	TW-2B-20	26	35.83	2.60	10.00	100	51.87	519
Site B	TW-1B-20	26	47.9	20.00	1.30	72	15.83	21
Site G	TW-1G-20	27	34.68	17.89	1.49	100	53.07	79

Notes:
1. Drawdown = Maximum Pumping Level – Static Water Level
2. Specific Capacity = Pumping Rate/Drawdown
3. Available Water = Well Depth – (Static – Stickup) – Screen Length – 5 Foot Safety Factor
4. Potential Yield = Specific Capacity * Available Water
5. Gray highlight = the test well was found not to be suitable for a 4-hour pumping test due to the low potential yield.

4-Hour Pumping Test at TW-1C-20

The 4-hour pumping test on TW-1C-20 was conducted at an approximate pumping rate of 75 gpm. The maximum drawdown observed in the observation well located 2 feet away during the test was 1.01 feet and was measured just prior to shutdown (minute 240). Specific capacity and available water were calculated to be 74.26 gpm/ft and 68.5 ft. Potential yield calculated from the specific capacity and available water is 5,087 gpm at this test well location. A summary of these calculations is provided in Table 3.

4-Hour Pumping Test at TW-1E-20

The 4-hour pumping test on TW-1E-20 was conducted at an approximate pumping rate of 75 gpm. The maximum drawdown observed in the observation well located 2 feet away during the test was 1.92 feet. This measurement was first observed at minute 90 during the test, and the pumping level stabilized at this level for the remainder of the test. Specific capacity and available water were calculated to be 39.06 gpm/ft and 14.46 ft. Potential yield calculated from the specific capacity and available water is 565 gpm at this test well location. A summary of these calculations is provided in Table 3.

4-hour Pumping Tests on 4-Inch Test Wells

With pumping water levels and pumping rates measured and recorded during the 4-hour pumping tests, evaluations of aquifer parameters and potential yields for each 4.25-inch test well were made. Pumping rates on all the 4.25-inch test wells were consistently observed and recorded at 26 to 27 gpm. Static water levels in each of the 4.25-inch wells were greater than 30 feet deep from the top of each well's casing (ft TOC), with the minimum static water level measured in TW-1G-20 at 34.68 ft TOC, and the maximum static water level measured in TW-1F-20 at 47.6 ft TOC. Drawdowns from the 4-hour pumping tests were calculated by subtracting static water levels from pumping water levels recorded throughout the pumping tests. Maximum drawdowns during the 4-hour pumping tests consistently occurred immediately prior to the shutdowns of the pumping tests. By dividing pumping rates by maximum drawdowns, the specific capacities of each test well were calculated. Available water in each well was then calculated by subtracting static water levels, screen lengths and a 5-foot safety factor from the depths of each well. After these calculations were made, potential yields were calculated by multiplying the specific capacities by the available water in each well. Results are presented in Table 3. Hand data measured and recorded during the 4-hour pumping tests are attached in Appendix B.

Capacity Summary

Table 4 below summarizes the sites investigated and identified as possessing a potential yield suitable for the development of a public drinking water supply source for the HWS. As shown in the table, test well TW-1C-20 has the greatest potential yield at 5,087 gpm, followed by TW-1E-20 at 565 gpm, TW-2D-20 at 529 gpm, and finally TW-2B-20 at 519 gpm.

Table 4: Highest Ranked Sites by Yield

Site ID / Location	Well ID	Potential Yield (gpm)
Bridge St. Conservation Area (Site C)	TW-1C-20	5,087
Hathaway's Pond (Site E)	TW-1E-20	565
West Barnstable Conservation Area (Site D)	TW-2D-20	529
North of Rt. 6 (Site B)	TW-2B-20	519

3.2 Water Quality

Table 5 below provides a summary of the water quality results from samples collected just prior to the shutdowns of the 4-hour pumping tests conducted on six test wells during this test well investigation. As mentioned in the Work Performed section above, all water quality samples collected were submitted to a Massachusetts certified laboratory and analyzed for secondary contaminants (turbidity, TDS, color, odor, pH, alkalinity, sulfate, chloride, hardness, calcium, magnesium, aluminum, potassium, iron, manganese, silver, copper, and zinc), coliform bacteria, lead, 1,4-dioxane, nitrate/nitrite, inorganic

compounds, perchlorate, volatile organic compounds (VOCs), synthetic organic compounds (SOCs), radionuclides and PFOS/PFOA. A table summarizing all the water quality results from laboratory reports that Weston & Sampson received are attached in Appendix C.

Table 5: Water Quality Results Summary

Analyte	TW-2B-20 3/3/20	TW-1C-20 5/19/20	TW-2D-20 2/19/20	TW-1E-20 1/27/20	TW-1F-20 2/26/20[7]	TW-1G-20 3/12/20[7]	Max. Contaminant Level (MCL)
Total Fe (mg/L)	0.078	0.131	0.054	ND[1]	0.194	ND	0.3 mg/L
Total Mn (mg/L)	ND	ND	0.041	ND	0.028	ND	0.05 mg/L
pH	6	5.8	6.2	5.7	5.6	6	6.5 - 8.5
Total Pb (mg/L)	ND	ND	0.0078	ND	ND	ND	TT[2] 0.015 mg/L
Perchlorate (mg/L)	0.000088	0.000082	0.000077	0.000054	0.000084	ND	0.002 mg/L
Chloroform (mg/L)	0.00053	0.00077	0.0016	0.001	0.0059	0.0022	0.07
PFAS 6[3] (ng/L)	ND	11.23[4]	ND	ND	ND	ND	20 ppt
Other PFAS (NEtFOSAA[5]) (ng/L)	1.86	ND	ND	ND	ND	ND	N/L[6]

Notes:
1) ND = Not Detected
2) TT = Treatment Technique. If > 10% of tap water samples tested exceed the action level of 0.015 mg/L, additional steps must be taken for water treatment.
3) The sum concentration of the six PFAS compounds regulated by the current MassDEP MCL including PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).
4) Three of six PFAS compounds proposed by MassDEP for regulation were detected: PFHxS, PFOA, PFOS
5) NEtFOSAA = N-Methyl Perfluorooctanesulfonamidoacetic Acid
6) N/L = Not Listed
7) Sites sampled for completeness, however not favorable for development due to limited yield potential

Of the analytes shown in Table 5, pH is the only analyte that falls outside established MCLs in Massachusetts. pH is listed in Massachusetts as a secondary contaminant and has a listed secondary maximum contaminant level (SMCL) range, where results from analyses should not fall outside 6.5 – 8.5. Results from water quality samples collected at each site show pH levels below the established SMCL range for Massachusetts. Manganese, lead, perchlorate, chloroform, PFAS and N-Methyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA) are analytes detected in some of the analyses shown in Table 5, but all of the results are below SMCL, MCL and proposed standards. Results for perchlorate were detectable in all the wells where water quality samples were collected and analyzed, but all the results are below the Massachusetts MCL of 0.002 mg/L. Chloroform, the only volatile organic compound that was detected throughout the investigation, showed results in all of the wells, but the results are below the established federal MCL and the Massachusetts Office of Research and Standards Guidelines (ORSG) of 0.07 mg/L. Of the 19 per- and polyfluoroalkyl substances (PFAS) analyzed for during this investigation, four (4) PFAS compounds were detected: NEtFOSAA, PFHxS, PFOA, and PFOS. NEtFOSAA was detected in TW-2B-20 at 1.86 parts per trillion (ppt) and PFHxS, PFOA and PFOS were detected in TW-1C-20 at 2.24 ppt, 2.21 ppt and 9.11 ppt. The sum concentration of PFAS compounds detected in TW-1C-20 is 11.23 ppt, 8.77 ppt below the Massachusetts Total PFAS Maximum Contaminant Level of 20 ppt. Massachusetts has recently enacted the Total PFAS MCL of 20 ppt be applied to six PFAS contaminants: PFOS, PFOA, PFHxS, PFNA, PFHpA and PFDA. DEP Policy also states that any detection of PFAS

would require re-sampling, as well as quarterly sampling to verify compliance. If an upward trend in concentration is identified, treatment would be the next step.

Summary of Water Quality

After review of the extensive water quality samples collected and tested for the six test wells evaluated, Sites B and D would rank the highest, followed by Sites C, and E. Based on criteria set by HWS, Site E will be eliminated for further consideration at this time due to the shallow nature of the deposits. Shallow sites like this (<40 ft) are more vulnerable to drought, potential contamination sources and are often require additional treatment as they are deemed under the influence of surface water.

Due to the increasing threat and treatment expense of the emerging contaminant known as PFAS in drinking water within the Sagamore Lens, the Barnstable Water Supply Division (HWS) recently commissioned Sole Source Consulting to evaluate the distribution of PFAS within Barnstable. Using surface water bodies as a surrogate for groundwater, 21 samples were collected from surface water bodies in the summer of 2020. PFAS compounds were present in every surface water body tested. Total detected PFAS concentrations in these surface water bodies ranged from 252 ng/l to 2.5 ng/l. This range is quite similar to the source well testing conducted in 2019, in which PFAS-6 concentrations in groundwater from WSD public drinking water supply wells ranged from 525 ng/l to 50 ng/l. Overlay mapping of the two studies' sample results present a clear picture and correlation that high concentration areas in surface water and groundwater results translate to high concentration of PFAS in pumping wells.

It is recommended that these two studies (Sole Source Consulting, Barnstable Water Supply Division) be used in conjunction with the results of this study to assess the potential risk in further developing a new source of supply for the WSD. The studies suggest that background concentrations likely due to septic systems as well as potential atmospheric deposition are as high as 10 ng/L in Barnstable. Higher concentrations of PFAS in the aquifer are thought to be from point sources, which include the Barnstable County Fire Training Facility, the Municipal Airport, and the Town's Water Pollution Control Facility in Hyannis. These point sources have contributed to PFAS exceedances at the Mary Dunn Wellfield, Airport Wells, Maher Wells, Straightway Wells, as well as the Barnstable Fire District Wells.

Upon review of the Sole Source Consulting study results, it is generally understood that any source developed in Barnstable has a risk of detection of PFAS. Given that fact, Site C will remain a potential alternative for water supply development with consideration given to the potential costs related to treatment of PFAS. Sites B and D represent lower risk areas for further development of a groundwater supply source. These two sites are located in areas that are represented in the previous studies as having background level concentrations of PFAS in the aquifer. Sites C represents a higher risk area given its location relative to the plumes identified and discussed above.

4.0 COST ANALYSIS

In March 2019, the Town of Barnstable received the New Sources Alternatives Evaluation Report from Weston & Sampson that included an overview of cost estimates for the development of new groundwater sources. Cost estimates were originally presented for six sites, Site A through Site F. A seventh site (Site G) was subsequently added and included in the current well exploration program described in this report. Four of the seven sites from this test well investigation produced favorable results with respect to yield, and two of those sites ranked highest with respect to water quality results as well as possessing a lower risk for future PFAS contamination. Three sites total (Sites B, D, and C) will ultimately be recommended for further analysis and are compared in this section from a cost perspective. Since the capacity of Sites B and D are different from Site C, they will be discussed separately below.

As previously discussed, the current supply deficit is approximately 1.87 mgd, or 1,300 gpm. Based on test well pumping data and analysis, the expected well capacity of a single well at Sites B and D is expected to be approximately 500 gpm. To provide sufficient supply to meet the deficit, at least three wells would be needed at those sites. Each of the wells would be required to provide at least 433 gpm on a continuous basis to satisfy the supply deficit. For planning purposes, we recommend that the initial site be developed to provide at least 2.2 mgd (1,500 gpm) from at least three wells that would be operated a maximum of 85% of the time to satisfy the current deficit of 1.87 mgd.

Based on the preliminary data thus far (2 ½-inch test well drilling), the expected capacity of Site C is approximately 5,000 gpm. Practically speaking, given the grain size of the materials observed in the expected screened interval for TW-1C-20, a final single production well constructed at this location could be expected to produce approximately 1,000 gpm. To provide sufficient supply to meet the deficit, at least two wells would be needed at this site. Each of the wells would be required to provide at least 650 gpm on a continuous basis to satisfy the supply deficit. For planning purposes, we recommend that the initial site be developed to provide at least 2.2 mgd (1,500 gpm) from at least two wells that would be operated a maximum of 85% of the time to satisfy the current deficit of 1.87 mgd. To stay ahead of the increasing demands in future years, it would be prudent to provide for greater well and treatment capacity if the next round of hydrogeological investigation indicates additional water is available from the selected site.

The future (2040) supply deficit is projected to be 3.23 mgd (2,245 gpm), or an additional 1.36 mgd (945 gpm). This is about 75% of the current supply deficit. In the future, assuming demands increase as projected, an additional site should be developed in a similar fashion to the current plan with multiple wells, as further described below.

A qualitative summary of the two sites and the test well locations that produced these results is shown in Table 6. Water quality concerns are also noted.

Table 6: General and Qualitative Summary of Well Exploration Program

Location	Site ID	Test Well ID	Potential Yield (gpm)	Depth (feet)	Water Quality Concerns
North of Rt. 6	Site B	TW-2B-20	519	100	None
W. Barnstable Conservation Area	Site D	TW-2D-20	529	100	Manganese
Bridge St. Conservation Area	Site C	TW-1C-20	5,087	85	PFAS

The conceptual costs to develop each of the various sites for a 2.5 million gallon per day (mgd) water supply was described in the 2019 New Sources Evaluation Report. These costs are now further refined based on known factors, including the location of the test well site(s), estimated well yield(s) and treatment needs. Each site is unique and probable costs were estimated based on the conceptual potential of each site. The significant unknown is whether each site could support multiple wells to produce a total of at least 2.2 mgd. Further hydrogeological investigation is required to answer this question. As a result, the well spacing and yields discussed for each site are for planning purposes only. Based on the anticipated yield and water quality concern(s) summarized in Table 6, Site D, B, and C show the most promise for development. It is likely that multiple wells located on a combination of sites will be required to achieve the minimum 2.2 mgd capacity goal. Although, further hydrogeological investigation is required to finalize source capacity estimates for each site, it should be noted that the probability of identifying a high yield site is highest at Site C.

4.1 Wells

The number of wells is based on producing a total of 2.2 mgd supply without redundancy. As discussed above, further hydrogeological investigation is required to determine the capacity of each Site. As discussed, we recommend that the initial site be developed to provide at least 2.2 mgd (1,500 gpm) from at least two to three wells (depending on the site) that would be operated a maximum of 85% of the time to satisfy the current deficit of 1.87 mgd. For comparison we evaluated potential well spacing within Sites B and D, to support up to five wells. Site B could fit five wells with 1,000 foot spacing. Site D is the largest and could fit five wells with over 1,500 foot spacing. Spacing for three wells could be greater, but actual groundwater availability could push the wells closer together. Site C would only require two wells, located approximately 1,000 feet apart.

4.2 Well Pump Station, Access Roads and Water Mains

Each well would include a small building to house the pump controls and pumping equipment. A gravel roadway, 8" raw water connecting main, and power cables would be necessary from each well to the centrally located treatment facility. A paved access road and treated water connecting water main will also need to be constructed to bring water from the treatment facility to the main road and a 12" transmission main from the facility to the nearest road.

Table 7: New Well, Pump Station, Roadway and Water Main Probable Cost– 2.5 mgd

Site ID	Test Well ID	Wells (No.)	Depth (feet)	Well Costs	Well Pump Station Costs	Road & Site Water Main Costs	Total Cost (Ea)
Site B	TW-2B-20	3	100	$1,200,000	$900,000	$600,000	$2,700,000
Site D	TW-2D-20	3	100	$1,200,000	$900,000	$600,000	$2,700,000
Site C	TW-1C-20	2	85	$700,000	$600,000	$400,000	$1,700,000

4.3 Treatment Station

Base level chemical treatment, is assumed to be implemented for any new groundwater source within the HWS and accounts for pH adjustment, sequestration, corrosion control and disinfection. A centrally located treatment station would provide for the above chemical treatment. The probable cost to construct a base level chemical treatment station with a capacity of 2.2 mgd is $2,200,000.

4.4 Filtration Plant

As discussed in the previous report, additional levels of treatment/filtration may be required depending on constituents found in the water. Iron and manganese are typically treated with greensand pressure filtration. We have assumed that iron and manganese concentrations above 0.06 mg/l and 0.02 mg/l, respectively, will be treated. PFAS would require GAC or resin filtration. We have assumed that PFAS concentrations above 10 ug/l, which is half of the current regulatory limit, will be treated. Additionally, removal of iron and manganese should precede GAC filtration for PFAS removal.

The probable cost to construct a 2.2 mgd greensand pressure filtration/treatment addition to the chemical treatment facility is $7,000,000. The concentrations of combined iron and manganese are 0.8, 0, and 0.131 mg/L for well sites B, D, and C respectively. The chance that the final production wells will have elevated levels of these two constituents initially or in later years is significant. We recommend that the cost of an iron and manganese removal greens and pressure filtration plant be included for both sites.

Table 8: Projected Costs for New Groundwater Wells with Treatment

Level of Treatment	Cost @ 2.2 mgd Design Flow
Treatment Station	$2.2M
Filtration Plant	$7.0M

The cost summary is presented below in Table 9. Engineering and contingency amounts are included as a percentage of construction costs. The table assumes that each site is developed individually and can yield 2.2 mgd. As additional exploration of suitable sites is conducted and additional water quality analyses become available, the sites of wells, water mains, and the treatment facility can be determined, and the probable costs can be refined.

All three sites include the probable cost for treatment of iron and manganese with greensand pressure filtration. This will provide for similar treated water quality compared to other HWS sources which are scheduled to receive similar greensand pressure filtration treatment in the near future. Due to the high yield, lower cost, and proximity to the existing HWS system, we suggest that the next phase of hydrogeologic investigation be conducted on Site C. If Site C does not yield the required 2.2 mgd, then additional investigation at site B could be necessary.

Table 9: Supply Development Cost Estimate – 2.5 mgd

Site ID	Wells & Pump Stations	Treatment Facilities	Transmission Mains[1]	Engineering 18%	Contingency 15%	Total Cost[1]
Site C	$1,700,000	$12,700,000	$4,300,000	$3,400,000	$3,300,000	$25,400,000
Site B	$2,700,000	$9,200,000	$2,500,000	$2,600,000	$2,600,000	$19,600,000
Site D	$2,700,000	$9,200,000	$4,400,000	$3,000,000	$2,900,000	$22,200,000

Notes: 1) Transmission main costs provided include cost to construct the water main in the roadways from the site to the treatment plant (assumed to be near Site B) and includes construction and paving.

P:\MA\Barnstable MA\New Source Exploration Study\Test Well Drilling\Test Well Report\Barnstable New Source Exploration Study Final Report (4.26.21).docx

5.0 CONCLUSIONS / RECOMMENDATIONS

Preliminary hydrogeological investigations were performed at seven sites across Barnstable. Four of those sites proved to be hydrogeologically favorable with sufficient yield (> 500 gpm). After review of the yield expectations, water quality results, and recent PFAS sampling conducted by others (Sole Source Consulting), three sites are recommended for further study and development. Those three sites include Site C, referred to in this report as the Bridge Street Conservation Area, Site B, referred to as the site 'north of Rt. 6' and the West Barnstable Conservation Area (Site D). In an effort to advance into the permitting phase for a new source approval at one or both sites, further test well drilling, aquifer and water quality testing is recommended in an effort to 1) identify the most favorable location on those properties for the development of multiple groundwater supply wells, and 2) collect additional hydrogeologic information required to initiate the new source approval permitting process with MassDEP.

Due to the highly favorable yield expectations and the expectation that PFAS treatment may ultimately be required at all sites developed within the study area, Weston & Sampson recommends conducting additional test well drilling at Site C. Once two locations within Site C are identified, these withdrawals should be permitted with sources approximating 750 gpm each for a total of 1,500 gpm (2.16 MGD). It is our expectation that the permitting and construction of a source capable of supplying an additional 2.16 MGD of treated groundwater will cost approximately $25.4 M and be complete by 2026.

Weston & Sampson also recommends that the HWS should conduct additional test well drilling at Site C and B to better understand the additional withdrawal potential at those two sites. If favorable for the remaining future water supply deficit (1.07 MGD), the HWS should consider purchasing the necessary land area (including required Zone I's) to preserve it for future development.

FIGURES

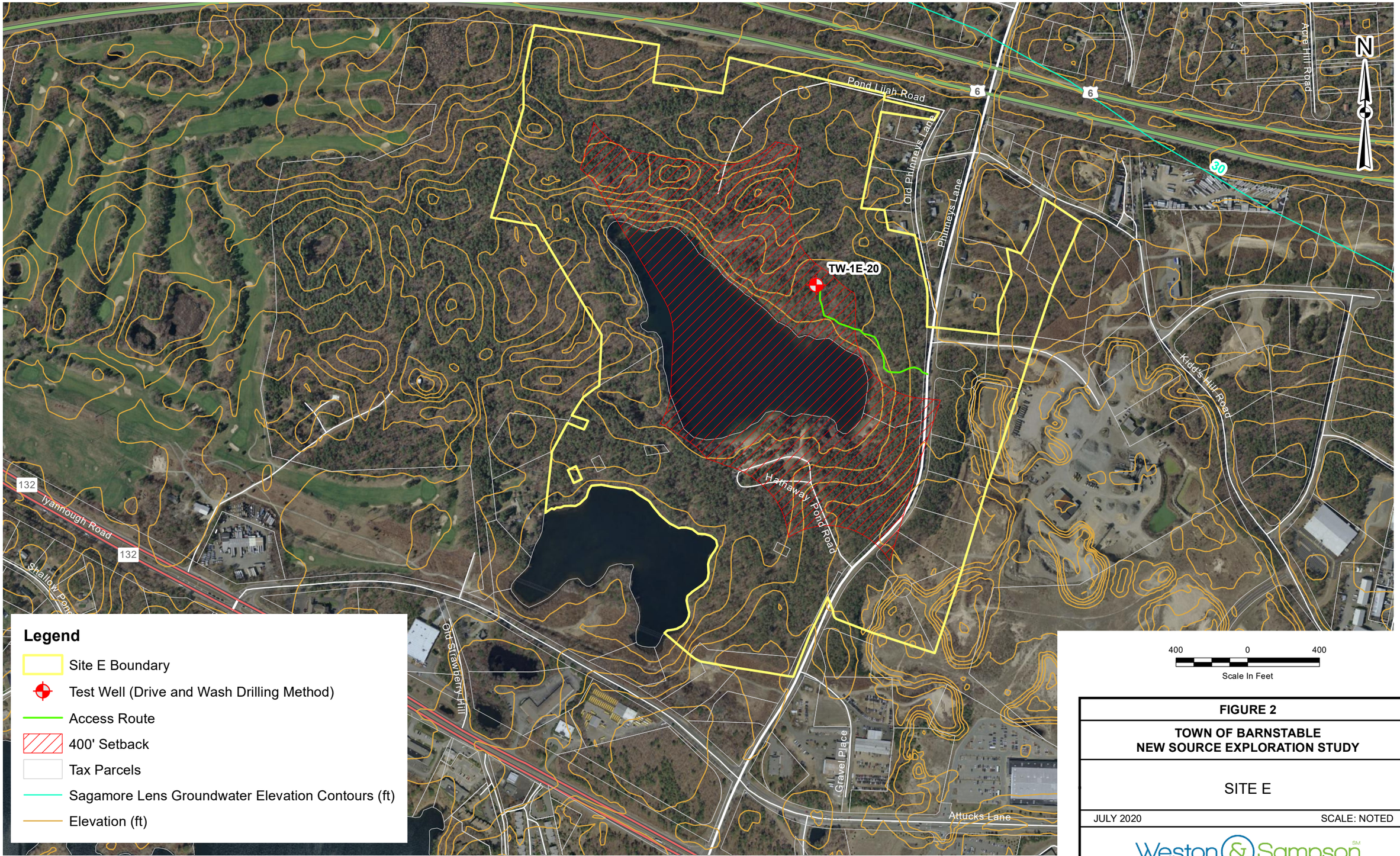

FIGURE 2

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE E

JULY 2020 SCALE: NOTED

Weston & Sampson SM

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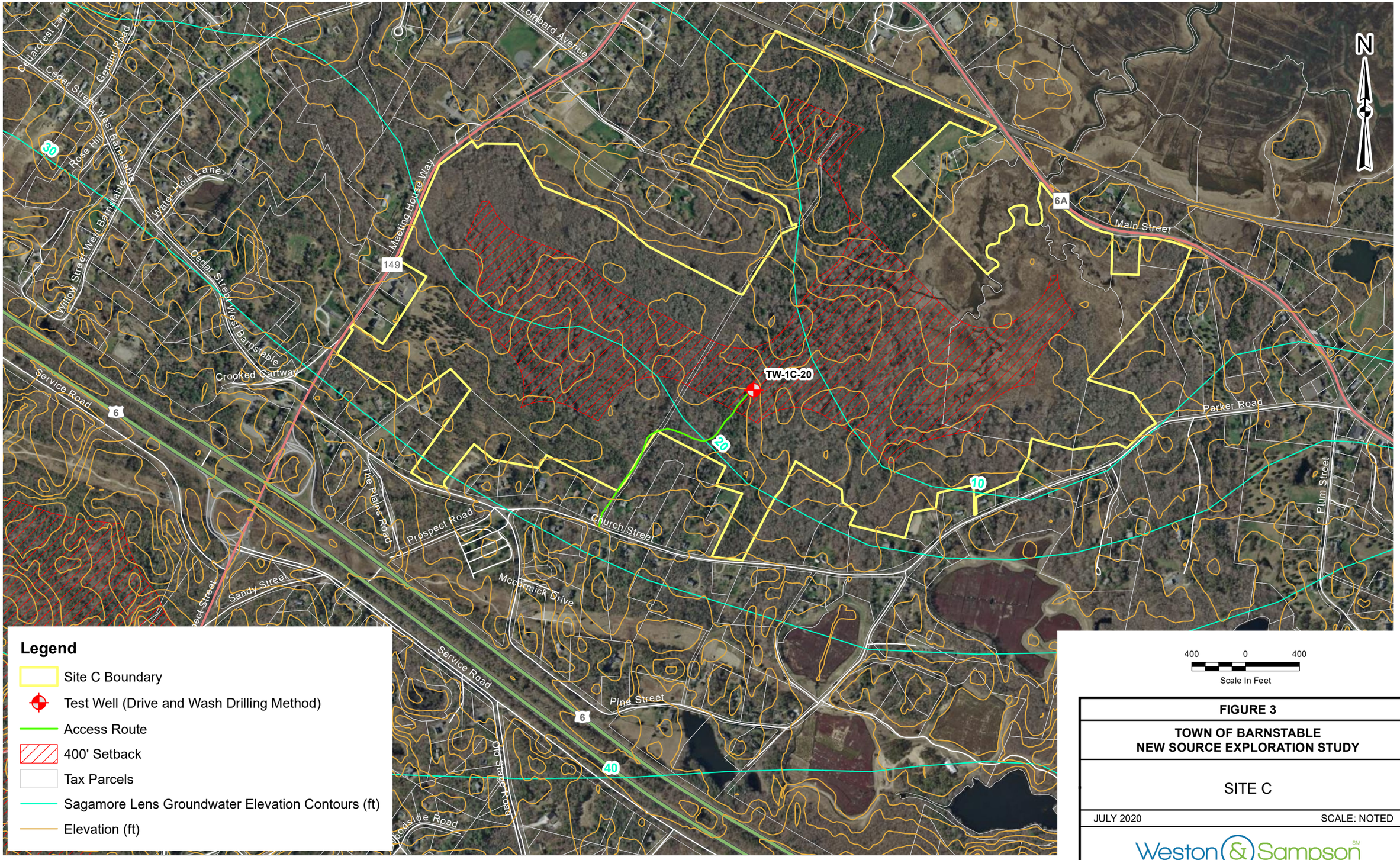

FIGURE 3

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE C

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Weston & Sampson SM

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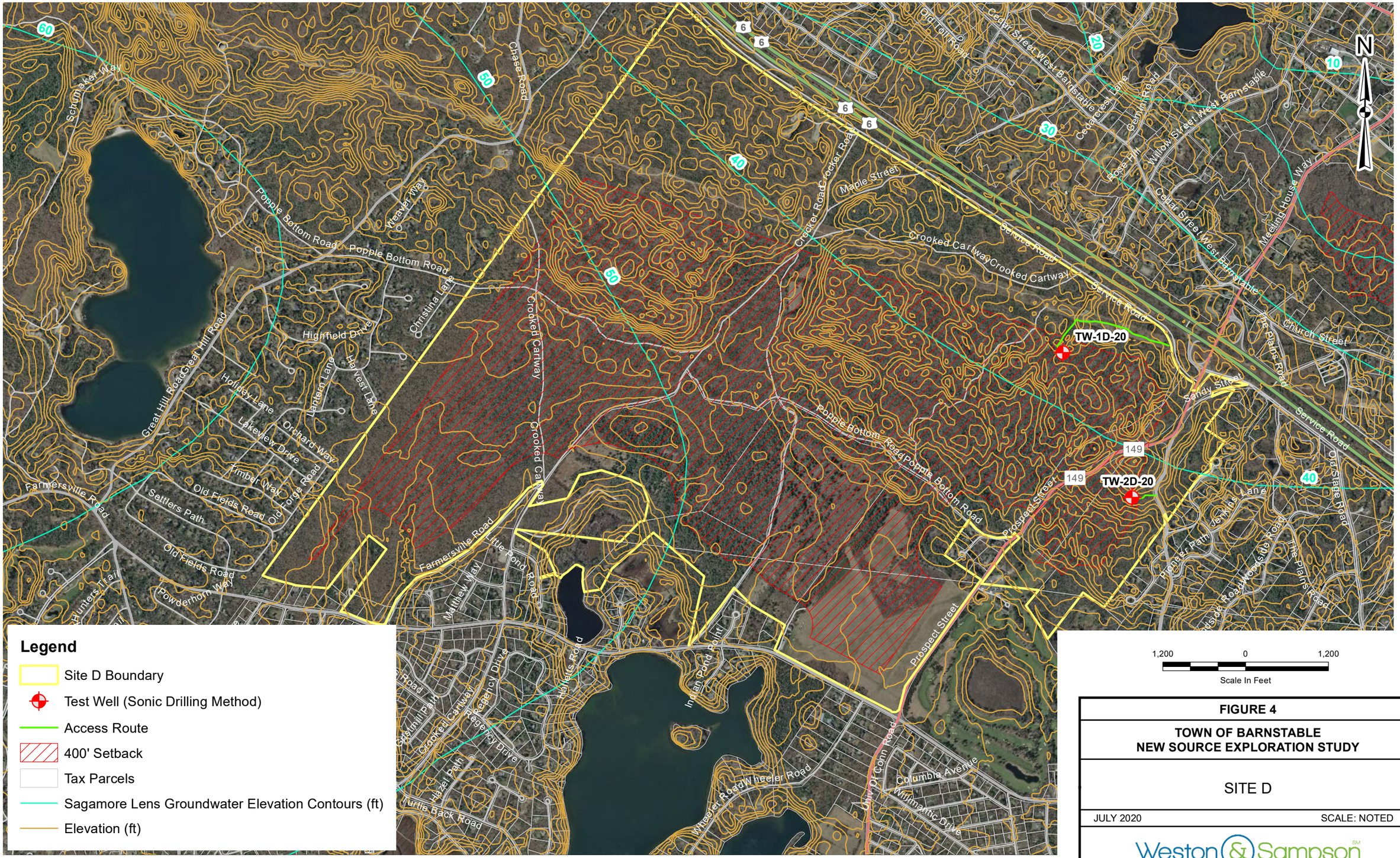

Legend

- Site D Boundary
- Test Well (Sonic Drilling Method)
- Access Route
- 400' Setback
- Tax Parcels
- Sagamore Lens Groundwater Elevation Contours (ft)
- Elevation (ft)

1,200 0 1,200

Scale In Feet

FIGURE 4

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE D

JULY 2020 SCALE: NOTED

Weston & Sampson

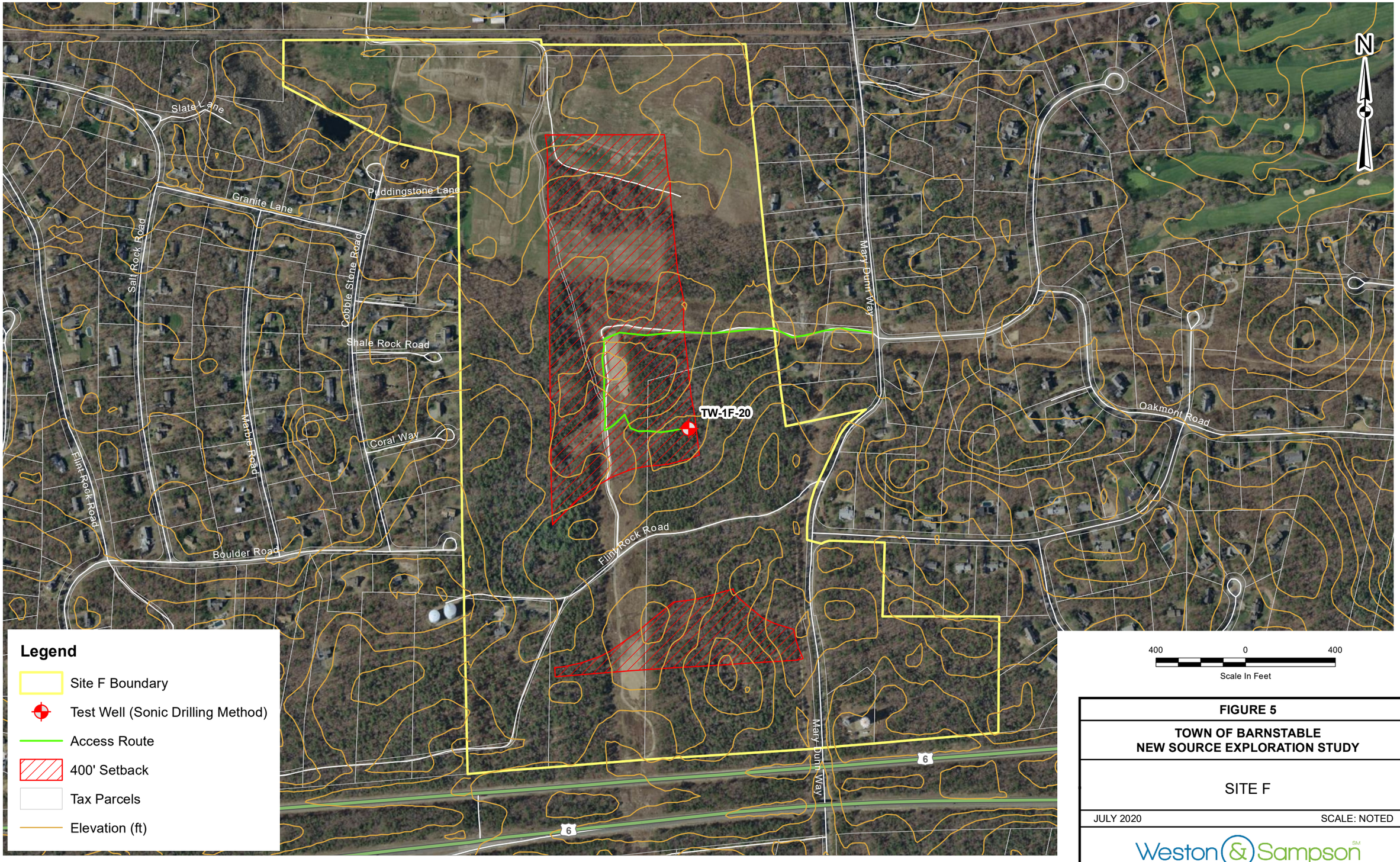

FIGURE 5

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE F

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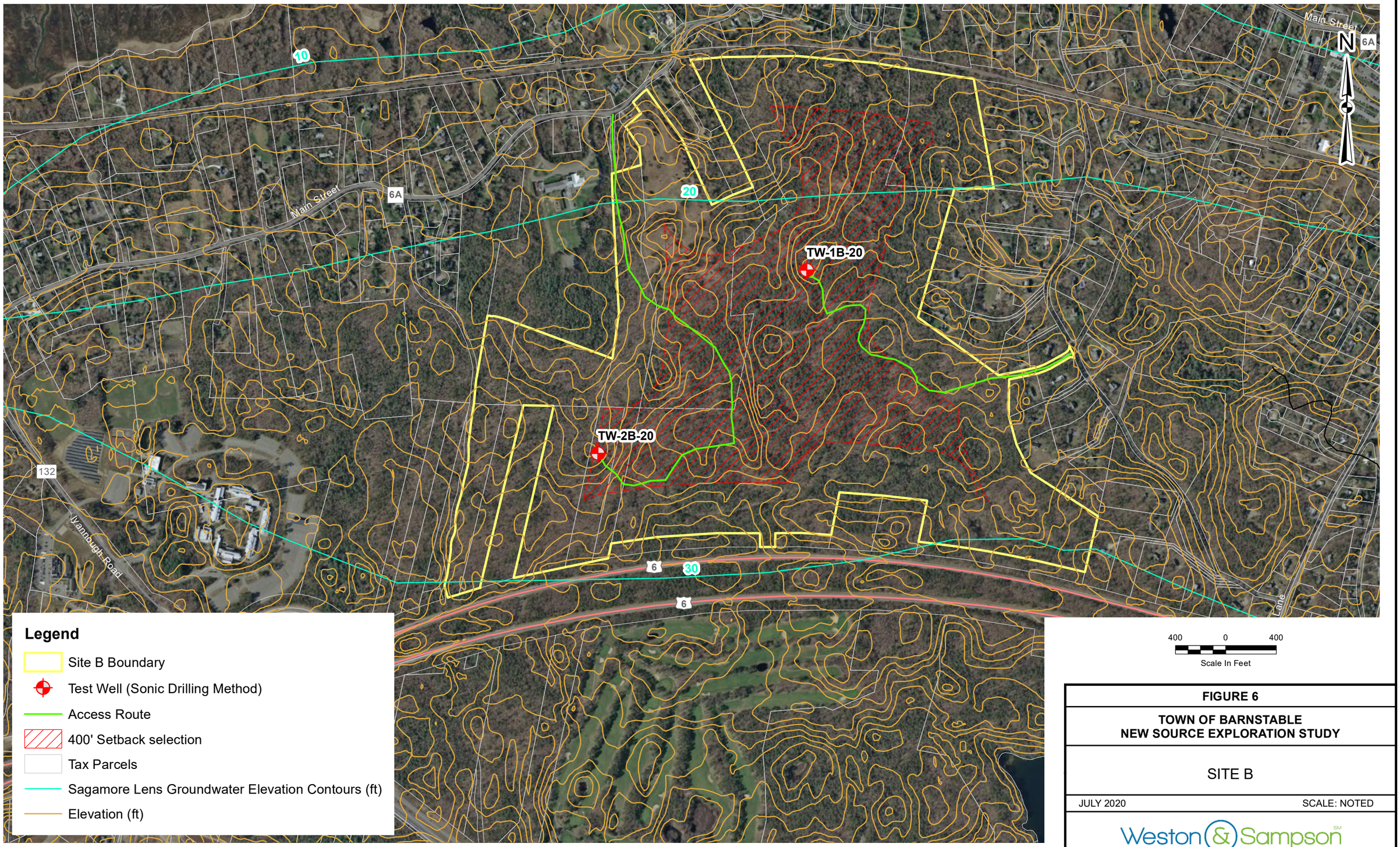

FIGURE 6

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE B

JULY 2020 SCALE: NOTED

Weston & Sampson

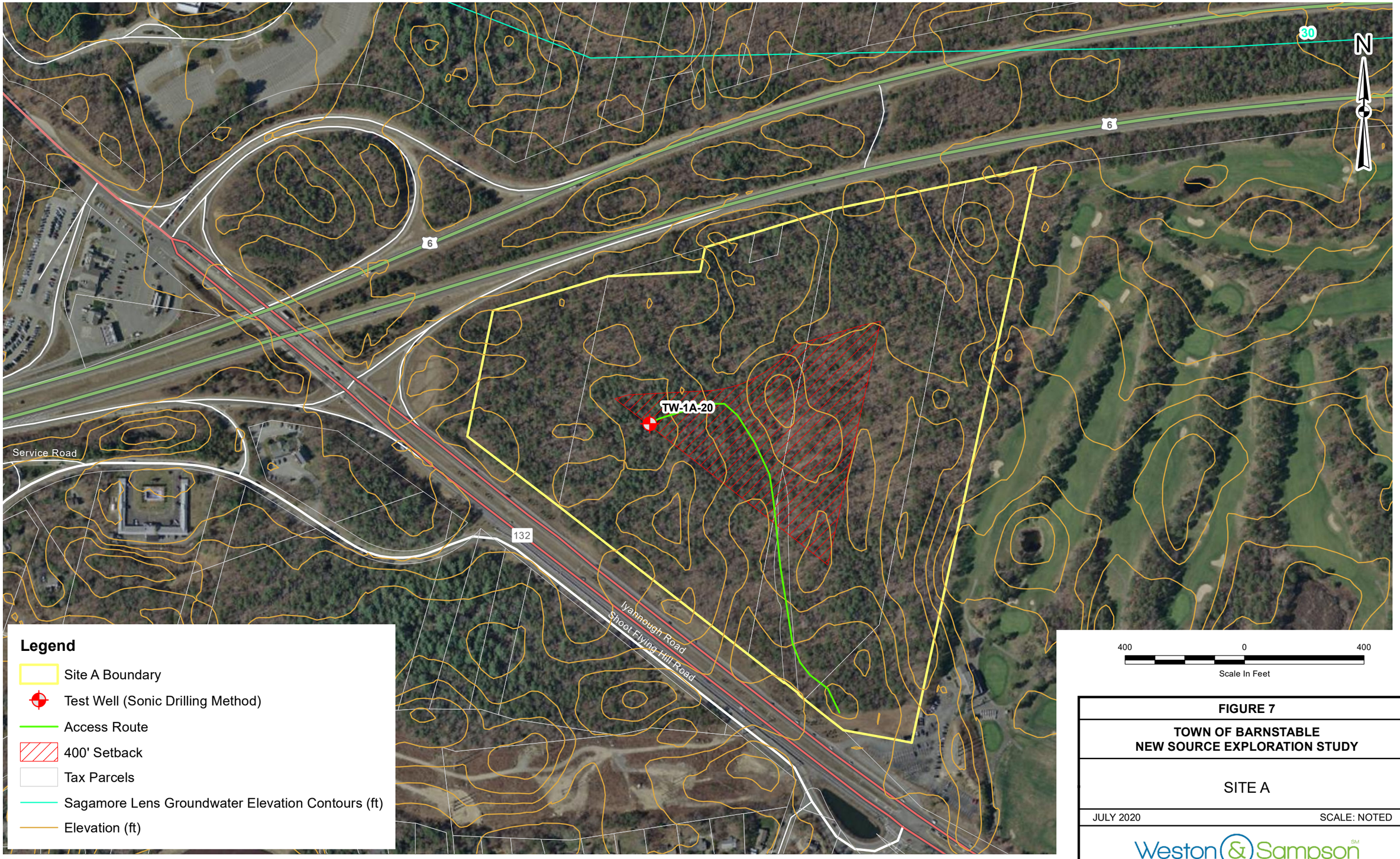

FIGURE 7

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE A

JULY 2020 SCALE: NOTED

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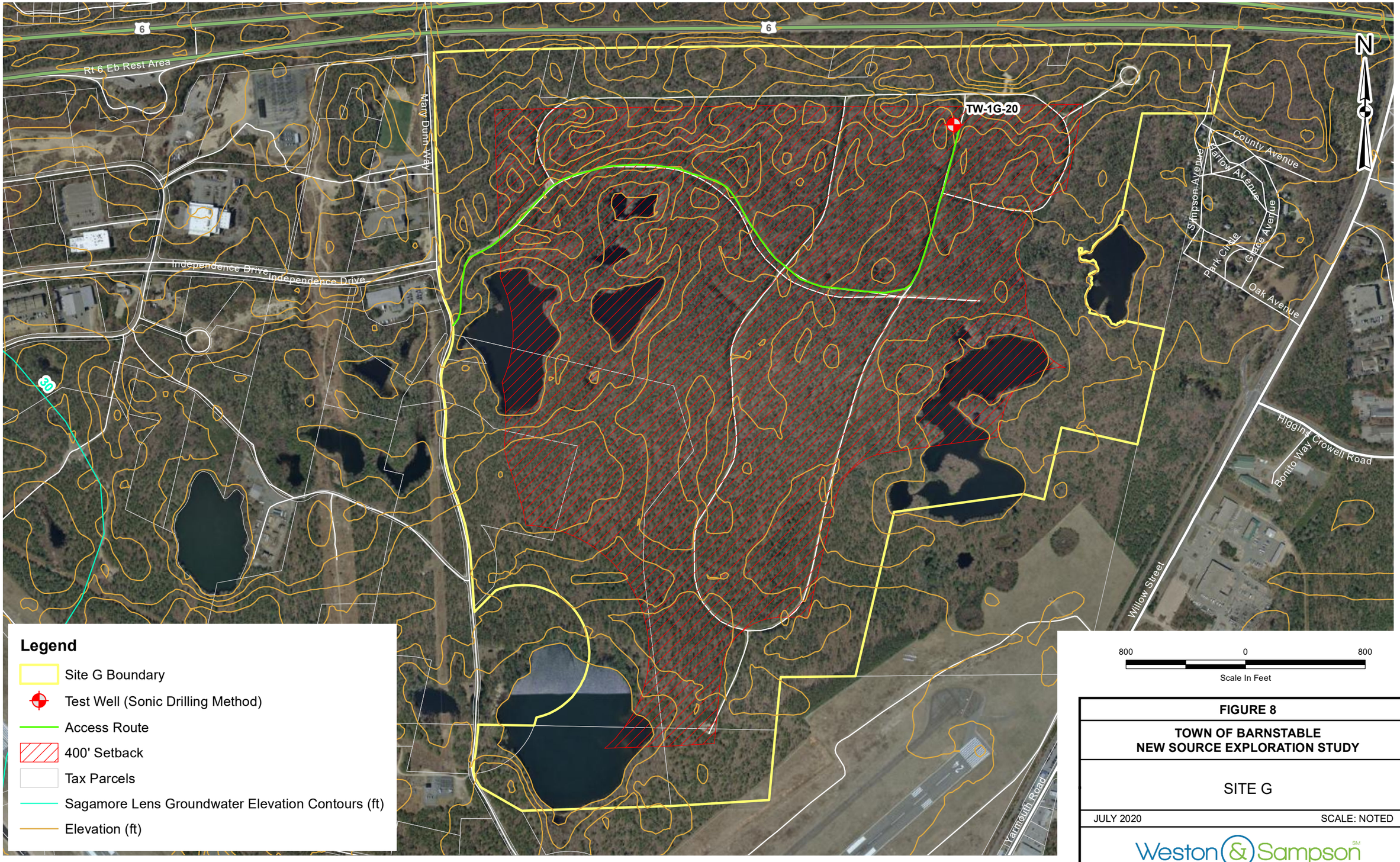

Legend

- Site G Boundary
- Test Well (Sonic Drilling Method)
- Access Route
- 400' Setback
- Tax Parcels
- Sagamore Lens Groundwater Elevation Contours (ft)
- Elevation (ft)

FIGURE 8

TOWN OF BARNSTABLE
NEW SOURCE EXPLORATION STUDY

SITE G

JULY 2020 SCALE: NOTED

Weston & Sampson

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APPENDIX A
BORING LOGS

Weston & Sampson

PROJECT	REPORT OF BORING No.	TW-1E-20
New Source Exploration Study Barnstable, MA	SHEET	1 OF 3
	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	981090.296402, 2712615.91833
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft) 43.89	DATUM NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START 1/23/20	DATE END 1/27/20

SAMPLER: Drive and wash

CASING: Driven steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		8.28		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Light brown, very fine to coarse SAND, little fine Gravel, trace Silt		SAND, little Gravel
5									
10									
15									
20									
25									
30							Light brown, fine to coarse SAND, trace fine Gravel		SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 28-40 ft bgs, exposed 28-40 ft bgs, developed 2 hours, Q = 75 gpm @ 25 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1E-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No.	TW-1E-20
		SHEET	2 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	981090.296402, 2712615.91833		
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft)	43.89	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	1/23/20	DATE END	1/27/20

SAMPLER: Drive and wash

CASING: Steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		8.28		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Light brown to gray, very fine to medium SAND, little Silt		SAND, Silt
40									
45							Gray, very fine to medium SAND, some Silt		
50							Gray, poorly graded very fine to fine SAND, trace silt		SAND
55									
60							Gray, very fine SAND and silt		SAND and Silt
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 28-40 ft bgs, exposed 28-40 ft bgs, developed 2 hours, Q = 75 gpm @ 25 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1E-20

PROJECT	REPORT OF BORING No.	TW-1E-20
New Source Exploration Study	SHEET	3 OF 3
Project Name	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	981090.296402, 2712615.91833		
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft)	43.89	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	1/23/20	DATE END	1/27/20

SAMPLER: Drive and wash

CASING: Steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		8.28		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Gray, very fine SAND and silt		SAND and Silt
75							Refusal @ 76'		Refusal @ 76'
80									
85									
90									
95									
100									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 28-40 ft bgs, exposed 28-40 ft bgs, developed 2 hours, Q = 75 gpm @ 25 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1E-20

Weston & Sampson	PROJECT New Source Exploration Study Barnstable, MA	REPORT OF BORING No. SHEET Project No. CHKD BY	TW-2D-20 1 OF 3 2170766 Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	959592.480603, 2714160.33138		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	84.64	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	2/18/20	DATE END	2/19/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel casing

CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
02/19/20		47		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Dark brown topsoil		TOPSOIL
							Brown, very fine SAND and Silt		Fine SAND and Silt
5							Brown, very fine to coarse SAND and Gravel, trace Silt		SAND and Gravel
10							Brown, poorly graded, very fine to fine SAND and Silt, trace Gravel		Fine SAND and Silt
15							Brown, very fine to fine moderately graded SAND, trace Silt		Fine SAND
20									
25							Gray to brown, very fine SAND and Silt, little cobbles, trace clay		Fine SAND and Silt
30							Brown, moderately graded, fine SAND, trace Gravel		Fine SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2D-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No.	TW-2D-20
		SHEET	2 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	959592.480603, 2714160.33138
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 84.64	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 2/18/20	DATE END 2/19/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel casing

CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
02/19/20		47		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Brown, moderately graded, fine SAND, trace Gravel		Fine SAND
40									
45									
50							Brown, poorly graded, very fine to fine SAND and Silt, trace Gravel		Fine SAND and Silt
55									
60									
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2D-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No.	TW-2D-20
		SHEET	3 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	959592.480603, 2714160.33138
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 84.64	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 2/18/20	DATE END 2/19/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
02/19/20		47		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Brown, poorly graded very fine to fine SAND and Silt, trace Gravel		Fine SAND and Silt
75									
80									
85							Brown, fine to coarse SAND, trace Gravel		SAND
90									
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2D-20

Weston & Sampson

PROJECT	REPORT OF BORING No.	TW-1D-20
New Source Exploration Study	SHEET	1 OF 3
Barnstable, MA	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	958593.015773, 2716259.20409		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	85.47	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	2/20/20	DATE END	2/24/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel Casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		45.1		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Dark brown topsoil		TOPSOIL
							Orange-brown, very fine SAND and Silt, trace Gravel		SAND and Silt
5							Dense, brown SILT, little clay		SILT
							COBBLES		COBBLES
10							Dense, brown, well graded, very fine to fine SAND, little Silt, occasional cobbles		SAND, little Silt
15									
20							Dense, brown, very fine to fine SAND and Silt, little gravel and cobbles		SAND and Silt, little Gravel
25							Dense, brown, well graded, very fine to fine SAND, little Gravel, trace Silt, trace Clay		SAND, little Gravel
30							Dense, gray to brown, fine to coarse SAND and Silt, trace Gravel, trace Clay		SAND and Silt
							Very dense, brown, well graded, very fine to fine SAND, little Silt, little Gravel, trace Clay		Fine SAND, little Silt, little Gravel

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 16 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1D-20

Weston & Sampson	PROJECT New Source Exploration Study Project Name	REPORT OF BORING No. SHEET Project No. CHKD BY	TW-1D-20 2 OF 3 2170766 Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	958593.015773, 2716259.20409		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	85.47	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	2/20/20	DATE END	2/24/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel casing

CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		45.1		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Very dense, brown, well graded, very fine to fine SAND, little Silt, little Gravel, trace Clay		Fine SAND, little Silt, little Gravel
40									
45									
50									
55									
60							Dense, brown, moderately graded, very fine to fine SAND, little Gravel, little Silt		
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 16 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1D-20

Weston & Sampson SM

PROJECT	REPORT OF BORING No.	TW-1D-20
New Source Exploration Study	SHEET	3 OF 3
Project Name	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	958593.015773, 2716259.20409		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	85.47	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	2/20/20	DATE END	2/24/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel Casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		45.1		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Dense, brown, moderatelty graded, very fine to fine SAND, little Gravel, little Silt		Fine SAND, little Silt, little Gravel
75									
80							Dense, brown, moderately graded, fine SAND, trace Silt, trace Gravel		Fine SAND
85							Dense, brown, moderately graded very fine to fine SAND, trace Gravel		
90							Brown, moderately graded medium SAND, trace Gravel		Fine to coarse SAND
95							Brown fine SAND		
							Brown, moderately graded, fine to coarse SAND		
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 16 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1D-20

Weston & Sampson	PROJECT New Source Exploration Study Barnstable, MA	REPORT OF BORING No. SHEET Project No. CHKD BY	TW-1F-20 1 OF 3 2170766 Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	988504.952335, 2715169.45091		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	72.66	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	2/24/20	DATE END	2/26/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel Casing

CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		44.06		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Brown TOPSOIL		TOPSOIL
5							Light brown SILT and very fine Sand, trace Gravel		SILT and very fine Sand
10							Dense, light brown, moderately graded very fine SAND and Silt, trace Gravel		
15									
20							Dense, light brown SILT and moderatly graded very fine Sand, trace Gravel		
25									
30									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 72-78 ft bgs, exposed 72-78 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1F-20

Weston & Sampson	PROJECT: New Source Exploration Study — Project Name	REPORT OF BORING No.	TW-1F-20
		SHEET	2 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	988504.952335, 2715169.45091
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 72.66	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 2/24/20	DATE END 2/26/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		44.06		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Dense, light brown SILT and moderately graded very fine Sand, trace Gravel		SILT and very fine Sand
							Light brown, very fine to coarse SAND and Gravel, trace Silt		SAND and Gravel
40									
45									
50									
55							Dense, grayish brown SILT and very fine Sand		SILT and very fine Sand
60									
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 72-78 ft bgs, exposed 72-78 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1F-20

Weston & Sampson

PROJECT	REPORT OF BORING No.	TW-1F-20
New Source Exploration Study	SHEET	3 OF 3
Project Name	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	988504.952335, 2715169.45091		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	72.66	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	2/24/20	DATE END	2/26/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		44.06		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Dense, grayish brown SILT and very fine Sand		SILT and very fine Sand
75							Light brown fine to medium SAND, trace Silt		Very fine to medium SAND
80							Light brown, moderately graded very fine to fine SAND, trace Silt		
85							Light brown, moderately graded fine SAND, trace Silt		
							Dense, gray SILT and Clay		SILT and Clay
90							Light brown, moderately graded, very fine to fine SAND, trace Silt		Fine SAND
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 72-78 ft bgs, exposed 72-78 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1F-20

Weston & Sampson

PROJECT	REPORT OF BORING No.	TW-1B-20
New Source Exploration Study	SHEET	1 OF 3
Barnstable, MA	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	978401.977868, 2716799.79412		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	66.10	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	2/27/20	DATE END	2/28/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		39.49		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Brown TOPSOIL		TOPSOIL
							Dense, light brown SILT and very fine Sand, little Clay		SILT and fine Sand
5							Dense, gray and grayish brown SILT and Clay		SILT and Clay
10							Dense, light brown SILT and very fine Sand, trace Clay		
15							Dense, grayish brown, moderately graded very fine SAND and Silt, trace Gravel		SILT and fine SAND
20									
25									
30							Dense, grayish brown SILT and very fine Sand, trace Gravel		

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 66-72 ft bgs, exposed 66-72 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1B-20

PROJECT	REPORT OF BORING No.	TW-1B-20
New Source Exploration Study	SHEET	2 OF 3
Project Name	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	978401.977868, 2716799.79412		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	66.10	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	2/27/20	DATE END	2/28/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		39.49		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Dense, grayish brown SILT and very fine Sand, trace Gravel		SILT and fine Sand
40									
45									
50									
55									
60									
65							Light brown very fine to fine SAND, trace Silt		Fine SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 66-72 ft bgs, exposed 66-72 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1B-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No.	TW-1B-20
		SHEET	3 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	978401.977868, 2716799.79412
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 66.10	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 2/27/20	DATE END 2/28/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		39.49		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Dense, grayish brown SILT and very fine Sand, trace Gravel		SILT and fine Sand
75									
80									
85									
90									
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 66-72 ft bgs, exposed 66-72 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1B-20

Weston & Sampson	PROJECT: New Source Exploration Study, Barnstable, MA	REPORT OF BORING No. TW-2B-20	SHEET 1 OF 3	Project No. 2170766	CHKD BY Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	976745.980434, 2715346.16666		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	66.17	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	3/2/20	DATE END	3/3/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		32.95		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Dark brown TOPSOIL		TOPSOIL
5							Brown SILT and very fine Sand		SILT and very fine SAND
10									
15									
20							Brown very fine SAND and Silt		
25									
30							Dense brown SILT and very fine Sand		

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2B-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No. TW-2B-20; SHEET 2 OF 3; Project No. 2170766; CHKD BY Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	976745.980434, 2715346.16666
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 66.17	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 3/2/20	DATE END 3/3/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		32.95		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Dense brown SILT and very fine Sand		SILT and very fine SAND
40									
45									
50							Brown medium to coarse SAND		SAND
55									
60							Dense, brown, very fine to fine SAND and Silt		Fine SAND and Silt
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2B-20

Weston & Sampson	PROJECT New Source Exploration Study Project Name	REPORT OF BORING No. SHEET Project No. CHKD BY	TW-2B-20 3 OF 3 2170766 Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	976745.980434, 2715346.16666		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	66.17	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	3/2/20	DATE END	3/3/20

SAMPLER:	4.75" Core Barrel Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		32.95		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Dense, brown, very fine to fine SAND and Silt		Fine SAND and Silt
75									
80									
85									
90							Light brown medium to coarse SAND		SAND
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch ss screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-2B-20

Weston & Sampson

PROJECT	REPORT OF BORING No.	TW-1A-20
New Source Exploration Study	SHEET	1 OF 3
Barnstable, MA	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	975350.751307, 2713092.90178		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	72.74	DATUM	NAD83/NAVD88
WSE REP:	Jesse Schwalbaum	DATE START	3/4/20	DATE END	3/5/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel Casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		38.39		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Brown, very fine SAND and Silt		Very fine SAND and Silt
10							Brown, moderately graded, very fine to medium SAND, trace Gravel, trace Silt		Very fine SAND
20							Dense, Brown, very fine SAND, little Silt, trace Gravel		
30							Dense, brown, very fine to fine SAND, trace Silt		

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 80-90 ft bgs, exposed 80-90 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1A-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No. TW-1A-20; SHEET 2 OF 3; Project No. 2170766; CHKD BY Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	975350.751307, 2713092.90178		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	72.74	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START	3/4/20	DATE END	3/5/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		38.39		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Dense, brown, very fine to fine SAND, trace Silt		Very fine to fine SAND
40							Brown, moderately graded, very fine to medium SAND, trace Gravel, trace Silt		
45									
50							Brown, moderately graded, very fine to fine SAND, little Silt, trace Gravel		
55									
60									
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 80-90 ft bgs, exposed 80-90 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1A-20

Weston & Sampson	PROJECT: New Source Exploration Study, Project Name	REPORT OF BORING No.	TW-1A-20
		SHEET 3 OF 3	
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	975350.751307, 2713092.90178
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 72.74	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Jesse Schwalbaum	DATE START 3/4/20	DATE END 3/5/20

SAMPLER: 4.75" Core Barrel
Sonic drilling method
CASING: Steel Casing

CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/14/20		38.39		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Brown, fine to medium SAND, trace Silt, trace Gravel		Fine to coarse SAND
75									
80							Brown, fine to coarse SAND, little Gravel, trace Silt		
85							Dense, brown SILT and moderately graded very fine Sand, trace Gravel		SILT and very fine Sand
90							No Recvovery		No Recovery
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 80-90 ft bgs, exposed 80-90 ft bgs, developed 2 hours, Q = 26 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1A-20

Weston & Sampson	PROJECT: New Source Exploration Study, Barnstable, MA	REPORT OF BORING No. TW-1G-20; SHEET 1 OF 3; Project No. 2170766; CHKD BY Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	992638.856626, 2712877.86163		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	56.84	DATUM	NAD83/NAVD88
WSE REP:	Nathaniel Parker	DATE START	3/11/20	DATE END	3/12/20

SAMPLER: 4.75" Core Barrel; Sonic drilling method
CASING: Steel Casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
03/12/20		31.93		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Brown fine to medium SAND, trace Silt, trace Gravel, trace Cobbles		Fine to medium SAND
5									
10									
15									
20							Gray, poorly graded fine SAND, little Silt, trace Gravel		
25							Gray, poorly graded fine SAND, little Gravel, trace Silt, trace Cobbles		
30							Dark brown and gray, poorly graded fine to medium SAND, little Silt, little fine to coarse Gravel		
							Light brown, well graded fine to coarse SAND, trace fine to coarse Gravel, trace Silt		Fine to coarse SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 27 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1G-20

Weston & Sampson	PROJECT: New Source Exploration Study Project Name	REPORT OF BORING No.	TW-1G-20
		SHEET	2 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	992638.856626, 2712877.86163		
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft)	56.84	DATUM	NAD83/NAVD88
WSE REPRESENTATIVE:	Nathaniel Parker	DATE START	3/11/20	DATE END	3/12/20

SAMPLER:	4.75" Core Barrel
	Sonic drilling method
CASING:	Steel casing
CASING SIZE:	6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
03/12/20		31.93		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Light brown, well graded fine to coarse SAND, trace fine to coarse Gravel, trace Silt		Fine to coarse SAND
40									
45									
50									
55									
60									
65							Light brown SILT, little fine to medium Sand		SILT
							Light brown, well graded fine to coarse SAND, trace fine to coarse Gravel, trace Silt		Fine to coarse SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 27 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1G-20

Weston & Sampson	PROJECT: New Source Exploration Study – Project Name	REPORT OF BORING No.	TW-1G-20
		SHEET	3 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Cascade Drilling	BORING LOCATION (ft)	992638.856626, 2712877.86163
FOREMAN	Rob Maillet	GROUND SURFACE ELEV. (ft) 56.84	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Nathaniel Parker	DATE START 3/11/20	DATE END 3/12/20

SAMPLER: 4.75" Core Barrel; Sonic drilling method
CASING: Steel Casing
CASING SIZE: 6.0" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
03/12/20		31.93		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Gray, mostly SILT, trace fine Sand		SILT
75									
80							Gray, poorly graded medium to coarse SAND, little Silt, trace fine to medium Gravel		Medium to coarse SAND
							Gray, poorly graded fine SAND, some Silt, little fine to coarse Gravel, little Clay		Fine SAND, some Silt
85							Brown, well graded fine to coarse SAND, little Silt, trace fine to coarse Gravel		Fine to coarse SAND
90									
95									
100							End of Boring		End of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 4.25-inch pvc screen from 90-100 ft bgs, exposed 90-100 ft bgs, developed 2 hours, Q = 27 gpm.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1G-20

Weston & Sampson	PROJECT New Source Exploration Study Barnstable, MA	REPORT OF BORING No. SHEET Project No. CHKD BY	TW-1C-20 1 OF 3 2170766 Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	964474.038718, 2717175.2048		
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft)	15.51	DATUM	NAD83/NAVD88
WSE REP:	Nathaniel Parker	DATE START	5/13/20	DATE END	5/19/20

SAMPLER: Drive and wash

CASING: Driven steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/19/20		-0.5		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
0							Gray CLAY, trace Sand, trace Gravel		CLAY
5									
10									
15							Brown, fine to medium SAND, some gray Clay, little fine to coarse Gravel, trace Silt		Fine to Medium SAND, some Clay, little Gravel
20									
25							Brown, medium to coarse SAND, trace Gravel, trace Silt, trace Clay		Medium to Coarse SAND
30									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	TW	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 73-85 ft bgs, exposed 73-85 ft bgs, developed 2 hours, Q = 75 gpm @ 17 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1C-20

Weston & Sampson℠

PROJECT	REPORT OF BORING No.	TW-1C-20
New Source Exploration Study	SHEET	2 OF 3
Project Name	Project No.	2170766
	CHKD BY	Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	964474.038718, 2717175.2048
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft) 15.51	DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Nathaniel Parker	DATE START 5/13/20	DATE END 5/19/20

SAMPLER: Drive and wash

CASING: Steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/19/20		-0.5		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
35							Brown, medium to coarse SAND, trace fine Gravel, trace Silt		Medium to coarse SAND
40									
45							Brown, coarse SAND, trace fine Gravel, trace Silt		Coarse SAND
50									
55									
60									
65									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 73-85 ft bgs, exposed 73-85 ft bgs, developed 2 hours, Q = 75 gpm @ 17 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1C-20

Weston & Sampson	PROJECT New Source Exploration Study Project Name	REPORT OF BORING No.	TW-1C-20
		SHEET	3 OF 3
		Project No.	2170766
		CHKD BY	Kevin MacKinnon

BORING Co.	Denis L. Maher Company	BORING LOCATION (ft)	964474.038718, 2717175.2048
FOREMAN	Joe Boyle	GROUND SURFACE ELEV. (ft)	15.51 DATUM NAD83/NAVD88
WSE REPRESENTATIVE:	Nathaniel Parker	DATE START	5/13/20 DATE END 5/19/20

SAMPLER: Drive and wash

CASING: Steel casing

CASING SIZE: 2.5" ID

GROUNDWATER OBSERVATIONS

DATE	TIME	WATER AT (ft bgs)	CASING AT	STABILIZATION TIME
05/19/20		-0.5		

DEPTH (feet)	CASING (blows/ft)	SAMPLE No.	SAMPLE REC/PEN (in)	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
70							Brown, coarse SAND, trace fine Gravel, trace Silt		Coarse SAND
75									
80									
85							End of Boring		End of Boring
90									
95									
100									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
Boring location and ground surface elevation found using GIS and LiDAR.
Set 1 ¼-inch ss screen from 73-85 ft bgs, exposed 73-85 ft bgs, developed 2 hours, Q = 75 gpm @ 17 “Hg.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. TW-1C-20

APPENDIX B
WATER LEVEL DATA

TW-2D-20

Date	Elapsed Minutes	Water Level	Drawdown (ft)	Pumping Rate (gpm)
2/19/2020	0	47.05	0	
2/19/2020	1	48.92	1.87	
2/19/2020	2	48.96	1.91	
2/19/2020	3	48.97	1.92	
2/19/2020	4	48.97	1.92	
2/19/2020	5	48.98	1.93	
2/19/2020	6	48.98	1.93	
2/19/2020	7	48.98	1.93	
2/19/2020	8	48.98	1.93	
2/19/2020	9	48.98	1.93	
2/19/2020	10	48.98	1.93	26
2/19/2020	20	48.99	1.94	
2/19/2020	30	49	1.95	
2/19/2020	40	49.01	1.96	
2/19/2020	50	49.01	1.96	
2/19/2020	60	49.01	1.96	
2/19/2020	90	49.02	1.97	
2/19/2020	120	49.04	1.99	
2/19/2020	150	49.05	2	
2/19/2020	180	49.06	2.01	
2/19/2020	240	49.07	2.02	SHUTDOWN

TW-1F-20

Date	Elapsed Minutes	Water Level	Drawdown (ft)	Pumping Rate (gpm)
2/26/2020	0	47.63	0	
2/26/2020	1	62	14.37	
2/26/2020	2	62.99	15.36	
2/26/2020	3	63.1	15.47	
2/26/2020	4	63.13	15.5	
2/26/2020	5	63.15	15.52	
2/26/2020	6	63.17	15.54	
2/26/2020	7	63.17	15.54	
2/26/2020	8	63.17	15.54	
2/26/2020	9	63.17	15.54	
2/26/2020	10	63.17	15.54	26
2/26/2020	20	63.19	15.56	
2/26/2020	30	63.2	15.57	
2/26/2020	40	63.2	15.57	
2/26/2020	50	63.21	15.58	
2/26/2020	60	63.22	15.59	
2/26/2020	90	63.24	15.61	
2/26/2020	120	63.25	15.62	
2/26/2020	150	63.26	15.63	
2/26/2020	180	63.27	15.64	
2/26/2020	240	63.3	15.67	SHUTDOWN
2/26/2020	241	48.15	0.52	
2/26/2020	242	47.91	0.28	
2/26/2020	243	47.88	0.25	
2/26/2020	244	47.86	0.23	
2/26/2020	245	47.85	0.22	
2/26/2020	246	47.85	0.22	
2/26/2020	247	47.85	0.22	

TW-2B-20

Date	Elapsed Minutes	Water Level	Drawdown (ft)	Pumping Rate (gpm)
3/3/2020	0	33.25	0	
3/3/2020	1	35.51	2.26	
3/3/2020	2	35.62	2.37	
3/3/2020	3	35.66	2.41	
3/3/2020	4	35.68	2.43	
3/3/2020	5	35.69	2.44	
3/3/2020	6	35.7	2.45	
3/3/2020	7	35.71	2.46	
3/3/2020	8	35.72	2.47	
3/3/2020	9	35.72	2.47	
3/3/2020	10	35.73	2.48	26.5
3/3/2020	20	35.77	2.52	
3/3/2020	30	35.79	2.54	
3/3/2020	40	35.81	2.56	
3/3/2020	50	35.82	2.57	
3/3/2020	60	35.83	2.58	
3/3/2020	90	35.83	2.58	
3/3/2020	120	35.85	2.6	
3/3/2020	150	35.87	2.62	
3/3/2020	180	35.86	2.61	
3/3/2020	240	35.88	2.63	SHUTDOWN
3/3/2020	241	33.65	0.4	
3/3/2020	242	33.51	0.26	
3/3/2020	243	33.46	0.21	
3/3/2020	244	33.44	0.19	
3/3/2020	245	33.43	0.18	

TW-1G-20

Date	Time	Elapsed Time	Water Level (ft TOC)	Drawdown (ft)	Pumping Rate (gpm)
3/12/2020	11:00	0	34.68	0	
3/12/2020	11:01	1	50.6	15.92	
3/12/2020	11:02	2	52	17.32	
3/12/2020	11:03	3	52.18	17.5	
3/12/2020	11:04	4	52.21	17.53	
3/12/2020	11:05	5	52.22	17.54	
3/12/2020	11:06	6	52.24	17.56	
3/12/2020	11:07	7	52.25	17.57	
3/12/2020	11:08	8	52.27	17.59	
3/12/2020	11:09	9	52.28	17.6	
3/12/2020	11:10	10	52.29	17.61	
3/12/2020	11:20	20	52.32	17.64	26.64
3/12/2020	11:30	30	52.38	17.7	
3/12/2020	11:40	40	52.41	17.73	
3/12/2020	11:50	50	52.42	17.74	
3/12/2020	12:00	60	52.41	17.73	
3/12/2020	12:30	90	52.43	17.75	
3/12/2020	13:00	120	52.46	17.78	
3/12/2020	13:30	150	52.47	17.79	
3/12/2020	14:00	180	52.5	17.82	
3/12/2020	14:30	210	52.56	17.88	
3/12/2020	15:00	240	52.57	17.89	SHUTDOWN
3/12/2020	15:01	241	35.2	0.52	
3/12/2020	15:02	242	34.75	0.07	
3/12/2020	15:03	243	34.72	0.04	
3/12/2020	15:04	244	34.71	0.03	
3/12/2020	15:05	245	34.7	0.02	

TW-1C-20

Date	Time	Elapsed Time	Water Level (ft TOC)	Drawdown (ft)	Pumping Rate (gpm)
5/19/2020	13:45	0	2.28	0	
5/19/2020	13:46	1	2.76	0.48	
5/19/2020	13:47	2	2.81	0.53	
5/19/2020	13:48	3	2.85	0.57	
5/19/2020	13:49	4	2.87	0.59	
5/19/2020	13:50	5	2.89	0.61	
5/19/2020	13:51	6	2.91	0.63	
5/19/2020	13:52	7	2.92	0.64	
5/19/2020	13:53	8	2.93	0.65	
5/19/2020	13:54	9	2.94	0.66	
5/19/2020	13:55	10	2.95	0.67	
5/19/2020	14:05	20	3.03	0.75	75
5/19/2020	14:15	30	3.07	0.79	
5/19/2020	14:25	40	3.11	0.83	
5/19/2020	14:35	50	3.13	0.85	
5/19/2020	14:45	60	3.15	0.87	
5/19/2020	15:15	90	3.19	0.91	
5/19/2020	15:45	120	3.23	0.95	
5/19/2020	16:15	150	3.25	0.97	
5/19/2020	16:45	180	3.27	0.99	
5/19/2020	17:15	210	3.28	1	
5/19/2020	17:45	240	3.29	1.01	SHUTDOWN
5/19/2020	17:46	241	2.85	0.57	
5/19/2020	17:47	242	2.8	0.52	
5/19/2020	17:48	243	2.76	0.48	
5/19/2020	17:49	244	2.74	0.46	

TW-1E-20

Date	Time	Elapsed Time	Water Level (ft TOC)	Drawdown (ft)	Pumping Rate (gpm)
6/5/2020	11:00	0	10.23	0	
6/5/2020	11:01	1	11.1	0.87	
6/5/2020	11:02	2	11.9	1.67	
6/5/2020	11:03	3	11.95	1.72	
6/5/2020	11:04	4	11.99	1.76	
6/5/2020	11:05	5	12.01	1.78	
6/5/2020	11:06	6	12.02	1.79	
6/5/2020	11:07	7	12.03	1.8	
6/5/2020	11:08	8	12.04	1.81	
6/5/2020	11:09	9	12.05	1.82	
6/5/2020	11:10	10	12.05	1.82	
6/5/2020	11:20	20	12.09	1.86	75
6/5/2020	11:30	30	12.11	1.88	
6/5/2020	11:40	40	12.12	1.89	
6/5/2020	11:50	50	12.13	1.9	
6/5/2020	12:00	60	12.13	1.9	
6/5/2020	12:30	90	12.15	1.92	
6/5/2020	13:00	120	12.15	1.92	
6/5/2020	13:30	150	12.15	1.92	
6/5/2020	14:00	180	12.15	1.92	
6/5/2020	14:30	210	12.15	1.92	
6/5/2020	15:00	240	12.15	1.92	SHUTDOWN
6/5/2020	15:01	241	10.48	0.25	
6/5/2020	15:02	242	10.4	0.17	
6/5/2020	15:03	243	10.38	0.15	
6/5/2020	15:04	244	10.36	0.13	
6/5/2020	15:05	245	10.33	0.1	
6/5/2020	15:06	246	10.31	0.08	
6/5/2020	15:07	247	10.32	0.09	
6/5/2020	15:08	248	10.31	0.08	
6/5/2020	15:09	249	10.3	0.07	
6/5/2020	15:10	250	10.3	0.07	
6/5/2020	15:20	260	10.26	0.03	
6/5/2020	15:30	270	10.24	0.01	

APPENDIX C
WATER QUALITY RESULTS (SUMMARY)

Analytes		EPA (mg/L)	ORSG (mg/L)	SMCL/MMCL (mg/L)	TW-2B-20 3/3/2020	TW-1C-20 5/19/2020	TW-2D-20 2/19/2020	TW-1E-20 1/27/2020	TW-1F-20 2/26/2020	TW-1G-20 3/12/2020
Volatile Organics	Dichlorodifluoromethane		1.4		ND	ND	ND	ND	ND	ND
	Chloromethane	0.003			ND	ND	ND	ND	ND	ND
	Vinyl chloride	0.002		0.002	ND	ND	ND	ND	ND	ND
	Bromomethane		0.01		ND	ND	ND	ND	ND	ND
	Chloroethane				ND	ND	ND	ND	ND	ND
	Trichlorofluoromethane				ND	ND	ND	ND	ND	ND
	1,1-Dichloroethene	0.007		0.007	ND	ND	ND	ND	ND	ND
	Methylene chloride	0.005			ND	ND	ND	ND	ND	ND
	Methyl tert butyl ether			0.02 - 0.04	ND	ND	ND	ND	ND	ND
	trans-1,2-Dichloroethene	0.1		0.1	ND	ND	ND	ND	ND	ND
	1,1-Dichloroethane			0.07	ND	ND	ND	ND	ND	ND
	2,2-Dichloropropane				ND	ND	ND	ND	ND	ND
	cis-1,2-Dichloroethene	0.07		0.07	ND	ND	ND	ND	ND	ND
	Chloroform	0.07	0.07		0.00053	0.00077	0.0016	0.001	0.0059	0.0022
	Bromochloromethane				ND	ND	ND	ND	ND	ND
	1,1,1-Trichloroethane	0.2		0.2	ND	ND	ND	ND	ND	ND
	1,1-Dichloropropene				ND	ND	ND	ND	ND	ND
	Carbon tetrachloride	0.005		0.005	ND	ND	ND	ND	ND	ND
	1,2-Dichloroethane	0.005		0.005	ND	ND	ND	ND	ND	ND
	Benzene	0.005		0.005	ND	ND	ND	ND	ND	ND
	Trichloroethene				ND	ND	ND	ND	ND	ND
	1,2-Dichloropropane	0.005		0.005	ND	ND	ND	ND	ND	ND
	Bromodichloromethane				ND	ND	ND	ND	ND	ND
	Dibromomethane				ND	ND	ND	ND	ND	ND
	cis-1,3-Dichloropropene		0.0004		ND	ND	ND	ND	ND	ND
	Toluene	1		1	ND	ND	ND	ND	ND	ND
	trans-1,3-Dichloropropene		0.0004		ND	ND	ND	ND	ND	ND
	1,1,2-Trichloroethane	0.005		0.005	ND	ND	ND	ND	ND	ND
	1,3-Dichloropropane				ND	ND	ND	ND	ND	ND
	Tetrachloroethene				ND	ND	ND	ND	ND	ND
	Dibromochloromethane				ND	ND	ND	ND	ND	ND
	1,2-Dibromoethane				ND	ND	ND	ND	ND	ND
	Chlorobenzene	0.1		0.1	ND	ND	ND	ND	ND	ND
	1,1,1,2-Tetrachloroethane				ND	ND	ND	ND	ND	ND
	Ethylbenzene	0.7		0.7	ND	ND	ND	ND	ND	ND
	p/m-Xylene				ND	ND	ND	ND	ND	ND
	o-Xylene				ND	ND	ND	ND	ND	ND
	Styrene	0.1		0.1	ND	ND	ND	ND	ND	ND
	Isopropylbenzene				ND	ND	ND	ND	ND	ND
	Bromoform				ND	ND	ND	ND	ND	ND
	1,1,2,2-Tetrachloroethane				ND	ND	ND	ND	ND	ND
	1,2,3-Trichloropropane				ND	ND	ND	ND	ND	ND
	Xylenes, Total[1]			10	ND	ND	ND	ND	ND	ND
	n-Propylbenzene				ND	ND	ND	ND	ND	ND
	Bromobenzene				ND	ND	ND	ND	ND	ND
	1,3,5-Trimethylbenzene				ND	ND	ND	ND	ND	ND
	o-Chlorotoluene				ND	ND	ND	ND	ND	ND
	p-Chlorotoluene				ND	ND	ND	ND	ND	ND
	tert-Butylbenzene				ND	ND	ND	ND	ND	ND
	1,2,4-Trimethylbenzene				ND	ND	ND	ND	ND	ND
	sec-Butylbenzene				ND	ND	ND	ND	ND	ND
	p-Isopropyltoluene				ND	ND	ND	ND	ND	ND
	1,3-Dichlorobenzene				ND	ND	ND	ND	ND	ND
	1,4-Dichlorobenzene			0.005	ND	ND	ND	ND	ND	ND
	n-Butylbenzene				ND	ND	ND	ND	ND	ND
	1,2-Dichlorobenzene			0.6	ND	ND	ND	ND	ND	ND
	1,2-Dibromo-3-chloropropane	0.0002		0.0002	ND	ND	ND	ND	ND	ND
	1,2,4-Trichlorobenzene	0.07		0.07	ND	ND	ND	ND	ND	ND
	Hexachlorobutadiene				ND	ND	ND	ND	ND	ND
	Naphthalene		0.14		ND	ND	ND	ND	ND	ND
	1,2,3-Trichlorobenzene			0.07	ND	ND	ND	ND	ND	ND

Analytes		EPA (mg/L)	ORSG (mg/L)	SMCL/MMCL (mg/L)	TW-2B-20 3/3/2020	TW-1C-20 5/19/2020	TW-2D-20 2/19/2020	TW-1E-20 1/27/2020	TW-1F-20 2/26/2020	TW-1G-20 3/12/2020
	1,4-Dioxane		0.0003		ND	ND	ND	ND	ND	ND
Total Metals	Aluminum, Total	0.05 to 0.2		0.05 to 0.2	ND	ND	ND	ND	ND	ND
	Antimony, Total	0.006		0.006	ND	ND	ND	ND	ND	ND
	Arsenic, Total	0.01		0.01	ND	ND	ND	ND	ND	ND
	Barium, Total	2		2	0.0011	0.0104	ND	0.0045	0.004	0.0014
	Beryllium, Total	0.004		0.004	ND	ND	ND	ND	ND	ND
	Cadmium, Total	0.005		0.005	ND	ND	ND	ND	ND	ND
	Calcium, Total				2.33	18.6	3.83	2.03	1.56	2.4
	Chromium, Total	0.1		0.1	ND	ND	ND	ND	ND	ND
	Copper, Total	TT[1] 1.3		TT 1.3	ND	ND	0.021	ND	ND	ND
	Iron, Total	0.3		0.3		0.131	0.054	ND	0.194	ND
	Lead, Total	TT 0.015		TT 0.015	ND	ND	0.0078	ND	ND	ND
	Magnesium, Total				1.45	8.6	1.55	1.54	1.48	1.47
	Manganese, Total	0.05	0.3	0.05	ND	ND	0.041	ND	0.028	ND
	Mercury, Total	0.002		0.002	ND	ND	ND	ND	ND	ND
	Nickel, Total		0.1		ND	ND	ND	ND	ND	ND
	Potassium, Total				ND	ND	ND	ND	ND	ND
	Selenium, Total	0.05		0.05	ND	ND	ND	ND	ND	ND
	Silver, Total			0.1	ND	ND	ND	ND	ND	ND
	Sodium, Total		20		8.98	**74.6**	9.88	9.17	11.6	9.12
	Thallium, Total	0.002		0.002	ND	ND	ND	ND	ND	ND
	Zinc, Total			5	ND	ND	ND	ND	ND	ND
	Hardness				11.8	81.8	15.9	11.4	10	12
	Perchlorate			0.002	0.000088	0.000082	0.000077	0.000054	0.000084	ND
General Chemistry	Turbidity			TT	ND	ND	0.45	ND	ND	0.24
	Odor @ 60 C			3 threshold odor numbers	ND	ND	ND	ND	ND	ND
	Color, Apparent	15 color units		15 color units	ND	8	ND	ND	ND	ND
	Alkalinity, Total				6.9	26.3	10.8	4.5	4.4	10.2
	Solids, Total Dissolved			500	34	320	66	43	25	29
	Cyanide, Total	0.2		0.2	ND	ND	ND	ND	ND	ND
	Fluoride	4		4	ND	ND	ND	ND	ND	ND
	pH (H)			6.5-8.5	**6**	**5.8**	**6.2**	**5.7**	**5.6**	**6**
	Nitrogen, Nitrite			1	ND	ND	ND	ND	ND	ND
	Nitrogen, Nitrate			10	ND	1.4	ND	ND	ND	ND
Bacteria	Coliform, Total	5%[2]	N/A	N/A	Negative	Negative	Negative	Negative	Negative	Negative
	Escherichia Coli	5%	N/A	N/A	Negative	Negative	Negative	Negative	Negative	Negative
Anions	Chloride	250		250	14.5	167	14.3	16	18.1	13.1
	Sulfate	250		250	3.44	5.76	6.52	6.09	4.94	6.61
Radionuclides	Radon (pCi/L)			10000	236	376	280	402	207	224
	Gross Alpha Activity (pCi/L)	15	–	15	<3	<3	<3	0.92	<3	<3
	Radium 226 (pCi/L)	5	–	5	<1	<1	<1	0.37	<1	<0.1
	Radium 228 (pCi/L)	5	–	5	<1	<1	<1	0.4	<1	<1
	Uranium ug/l	30	–	30	<1	<1	<1	<1	<1	<1
Synthetic Organic Compounds (SOCs)	Alachlor	0.002		0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Atrazine	0.003		0.003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Carbofuran	0.04		0.04	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
	Chlordane	0.002		0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Dibromochloropropane			0.0002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	2,4-D	0.07		0.07	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Endrin	0.002		0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Ethylene dibromide			0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Heptachlor	0.0004		0.0004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
	Heptachlor epoxide	0.0002		0.0002	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006
	Lindane	0.0002		0.0002	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007
	Methoxychlor	0.04		0.04	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Pentachlorophenol	0.001		0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Toxaphene	0.003		0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2,4,5-TP	0.05		0.05	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025
	Benzo(a)pyrene			0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Dalapon	0.2		0.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Di(2-ethylhexyl) adipate	0.4		0.4	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
	Di(2-ethylhexyl) phthalate	0.006		0.006	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Dinoseb	0.007		0.007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Hexachlorobenzene	0.001		0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Hexachlorocyclopentadiene	0.05		0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Oxamyl (Vydate)	0.2		0.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Picloram	0.5		0.5	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013
	Simazine	0.004		0.004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001