

Memorandum

To George Meservey, Director of Planning & Community Development

CC Betsy Shreve, AICP, AECOM Project Director
James Begley, LSP, MT Environmental
AECOM PRB Team

Subject **Town of Orleans, MA**
Water Quality and Wastewater Planning
Task Number 12.1.B – NT Demonstration Projects
Task 12.1.B.2 - Technical Memorandum for Eldredge Park Permeable Reactive
Barrier Demonstration Project – September 2018 Groundwater Monitoring
Quarterly Report - Final

Project Number 60476644

From Thomas Parece, P.E., AECOM Project Manager

Date March 4, 2019

1. Executive Summary

The Eldredge Parkway Demonstration Test Permeable Reactive Barrier (PRB) was installed at the parking lot area southwest of the Nauset Middle School in November 2016. Baseline groundwater monitoring was completed before the PRB installation. Groundwater monitoring since implementation has included sampling events in 2017 (January, March, June and September) and 2018 (January, April and September). The results of the September 2018 groundwater monitoring event are presented in this memorandum.

This memorandum is the first to present new data since the PRB was modified by extending it to the north in June 2018. A portion of the area originally targeted for assessment of PRB performance to the north of the PRB installed in 2016 had been found to be outside of the area of influence of the PRB due a difference in groundwater flow direction in this northerly area. Consistent with the Adaptive Management Approach, a modification of the Demonstrations Test PRB was implemented. This modification included extending the PRB treatment line to the north to intercept and treat nitrate in groundwater along this untreated flow path.

While groundwater flow at the location has been found to be complex, some clear trends have developed that provide for interpretation of PRB performance to date. Based on multiple lines of evidence including groundwater flow direction, dissolved organic carbon concentrations (DOC) in groundwater derived from the injected PRB emulsified vegetable oil (EVO) substrate, and reductions in nitrate concentration, the PRB is performing well in the monitored area downgradient of the PRB. Monitoring wells within the groundwater time of travel downgradient of the PRB extension line indicate almost complete removal of nitrate in groundwater with observed increases in DOC concentrations.

2. Background

This purpose of this technical memorandum is to provide an update of quarterly groundwater monitoring results as part of the Eldredge Parkway Permeable Reactive Barrier demonstration program. In addition to presenting baseline and quarterly groundwater monitoring data, this memorandum also summarizes PRB construction with emulsified vegetable oil (EVO) substrate injections for the Eldredge Park demonstration test site. AECOM Technical Services, Inc. (AECOM) PRB Technical Team (AECOM and MT Environmental Restoration) prepared this technical memorandum for the Town of Orleans. AECOM is providing water quality and wastewater planning and engineering services to the Town to reduce excessive nitrogen loading to the Town's ponds, estuaries and embayments.

3. Introduction

- A. The full Project represents the first to implement a "Hybrid" approach under the Cape Cod 208 Water Quality Plan, which has been approved by both the United States Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protection (MassDEP). The Project goal is to reduce the nitrate load to impacted estuaries in the most cost effective manner by maximizing the use of several non-traditional technologies (Coastal Habitat Restoration, Aquaculture, and Permeable Reactive Barriers) in combination with limited centralized wastewater treatment.
- B. PRBs are a non-traditional treatment technology with the potential to reduce the levels of nitrate in the groundwater by treating groundwater biologically before it reaches sensitive surface water bodies such as estuaries.
- C. The results of the demonstration will be incorporated into an overall Adaptive Management Plan which will be implemented to evaluate the impacts of the selected technologies to reduce nitrogen loading to surface water. AECOM will continue to work closely with the Town and the regulatory agencies including the Cape Cod Commission (CCC) and MassDEP, in implementing the Adaptive Management Plan as it is critical to obtaining one of the first watershed permits granted by MassDEP.
- D. The PRB Demonstration Test aims to provide data to assess the cost effectiveness and applicability of PRBs as a treatment alternative for the Town. It is expected that the test will demonstrate the level of nitrate removal that can be achieved with PRBs and provide data to prepare a full scale design. The Demonstration Tests will be evaluated by the following performance objectives:
 - 1) Achieve satisfactory distribution of the EVO substrate into the subsurface soils;
 - 2) Establish and maintain necessary dissolved organic carbon concentrations and anaerobic (reducing) conditions in the groundwater while maintaining groundwater flow throughout the targeted treatment area;
 - 3) Demonstrate reduced nitrate concentrations and the mass of nitrate transported in groundwater (nitrate flux) through groundwater monitoring;
 - 4) Evaluate performance through compliance monitoring and assessment of treated water quality, including potential secondary water quality affects, through a groundwater monitoring program;
 - 5) Evaluate the life expectancy of the EVO and time frame for technology performance;
 - 6) Evaluate potential impacts to sensitive receptors (surface water, private wells, etc.); and
 - 7) Obtain data for engineering evaluations and to optimize full scale design and implementation to meet nitrate reduction targets.

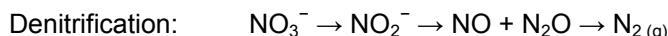
4. Demonstration Test Location

- A. The Eldredge Parkway Demonstration Test site is located in the parking lot area between the Nauset Middle School playing fields and the Town-owned Eldredge Park baseball field. The demonstration site is owned by Nauset Public Schools. The Nauset Regional School Committee granted permission to install monitoring wells and conduct the PRB Demonstration Test at this location. Town Cove is located approximately 2,400 feet to the northeast of the PRB Demonstration Test site. Groundwater in this area generally flows in a northeasterly direction, toward Town Cove (Figure 1). Localized variation in groundwater flow direction has been observed at the Demonstration Test site with flow to the northeast and flow to the east southeast.
- B. Existing groundwater monitoring wells were identified at the Nauset Regional Middle School (NRMS) in the recreational field and parking lot area providing background groundwater quality data. These wells were installed in 1992 as part of an ongoing program to monitor groundwater in the vicinity of the NRMS wastewater treatment facility's leaching fields. An irrigation well for Eldredge Park was also identified near the corner of Eldredge Park and South Orleans Road with an available boring log and groundwater quality data.

5. Demonstration Test Overview

A. PRB Treatment Process Description

- 1) PRBs are a passive treatment technology, designed in this application to intercept and treat nitrate in groundwater through biological denitrification before groundwater reaches downgradient surface waters. The PRB treatment zone is located in the groundwater saturated zone below the water table, where amendments are injected along a line to form the PRB. PRBs are typically oriented perpendicular to the direction of groundwater flow and rely on the natural groundwater gradient to carry the contaminant through the PRB (ITRC, 2011). The system is permeable because the amendments added are designed not to interfere with groundwater flow.
- 2) The PRB in-situ (in place in the ground) treatment method typically introduces a carbon food substrate into the aquifer, allowing naturally occurring microbes in the aquifer to consume the carbon substrate while respiring oxygen and creating anoxic conditions (without oxygen) favorable for denitrifying bacteria. Under anoxic or anaerobic conditions, maximum energy is gained by microbes using nitrate as an electron acceptor (denitrification reaction). Nitrate is the preferred electron acceptor to soil microbes after dissolved oxygen in the groundwater is consumed. This process of bacterial metabolism results in the conversion of nitrate to inert nitrogen gas and requires both anoxic conditions and sufficient food substrate for bacterial growth.



B. Demonstration Test Layout

The initial PRB Demonstration test line (November 2016) was oriented northwest to southeast (perpendicular) to the northeasterly regional groundwater flow direction and was approximately 110 feet long. Future full-scale PRBs or sections or PRBs are anticipated to be longer (500 to 3,000 feet, depending on the location). Demonstration Test locations are shorter in length, selected to assess construction/implementation, and allow intensive monitoring of groundwater conditions in the vicinity of the PRB. A 30 foot vertical treatment interval was selected extending down from near the top of the groundwater table into saturated soils for the initial Demonstration Test PRB line. Additional injection details are included in Table 4-1.

The PRB Demonstration Test extension line installed in June 2018 was oriented to intercept flow coming more from the west in the area north of the existing PRB, and then flowing through part of the existing field of groundwater monitoring wells. The PRB extension included injection of emulsified vegetable oil (EVO) along a line approximately 110 feet long with 20 injection points in the grass area adjacent to the Middle School parking lot as shown on Figure 1. The south end of the injection line overlapped the previous PRB injection line, oriented northwest to southeast, installed in November 2016. The new injection points were oriented roughly south to north in two parallel offset rows. A 38 foot vertical treatment injection interval was selected extending down from near the water table in saturated soils for the PRB extension. The completed PRB line including the extension intercepts groundwater flow along a line approximately 200 feet in length, formed in a wide-angle V pattern to intercept groundwater flow from both the southwest and northwest. A Technical Memorandum with PRB extension construction details was completed in December 2018 (AECOM, December 2018).

C. Reactive Amendment Application Method

PRBs have been designed and implemented through several construction methods. During this demonstration test, direct-push methods were used to place the EVO substrate in the subsurface. Direct-push injection is a method of soil boring modified with a down-hole injection screen and tubing used for placement of organic carbon electron donor EVO substrate. The direct-push injections are temporary injection points that are sealed following injection.

D. PRB Demonstration Test Substrate and System Details

An EVO solution with a larger droplet size was used during both injection events and was selected so that the EVO droplets will adhere to sand grains in the formation to minimize the advection, or distribution, of EVO after injection. EVO adheres to the sandy aquifer material in the treatment zone and provides a slow release of soluble organic carbon compounds that are distributed by advection, dispersion, and diffusion in groundwater. A larger droplet size also maximizes the persistence of the carbon substrate within the PRB. Terra System's 60 percent Large Droplet Slow Release EVO for Nitrate Reduction (SRS-NR) was used. The SRS NR is a modified formulation developed so that the emulsion is "stickier" to further reduce migration after injection and increase persistence. Sodium lactate was also added to the injection solution for the extension to supply additional quick release carbon substrate to jumpstart treatment. During both injection events, sodium bicarbonate was added as a pH buffer with the EVO in order to establish more favorable pH conditions for denitrifying bacteria. The 60 percent EVO solution was delivered to the site and additives were mixed with water making an approximately 15 and 14 percent EVO solution for injection in the November 2016 and June 2018 respectively. Representative PRB design parameters are summarized below:

PRB installation methodology and field injection activities are summarized in two installation reports (AECOM, March 2017 and AECOM, December 2018).

Table 4-1 - Summary of Design Parameters for Permeable Reactive Barrier Demonstration Test

Parameter	November 2016 Demonstration	June 2018 Extension
Area Description	Parking lot between the playing fields at Eldredge Park	Eldredge Park edge of soccer field by the parking lot
Depth to Ground Water	Approximately 30 to 34 feet below grade	Approximately 30 to 34 feet below grade
Demonstration Test PRB Length	110 feet	110 feet
Injection Interval	38 to 68 feet below grade	32 to 70 feet below grade
Injection Point Spacing	10 feet	10-foot 2-row grid (5-6 foot plus radius of influence)
Injection Points	17	20
Injection Pore Volume	12 percent (assumed effective porosity of 25 percent)	12 percent (assumed effective porosity of 25 percent)
Total Injection Volume (gal)	10,800	14,800
Injection Volume Per Point (gal)	600 (Three points received 720, 820, 860 gal in order to use the remainder of the EVO.)	~750
Injection Flow Rate (gpm)		~4.62
EVO Dilution	15.5 percent	14.2 percent
Total 60% EVO (gal)	2,620	3,696
Total Lactate (gal)	0	225

6. Permitting

The EPA Underground Injection Control (UIC) Program is responsible for regulating the construction, operation, permitting, and closure of injection wells that place fluids underground for storage and disposal. The UIC Program requirements were developed by EPA and designed to be adopted by states. The Massachusetts Department of Environmental Protection (MassDEP) UIC Program is defined in 310 CMR 27.00: Underground Injection Control Regulations and details the regulation of injection of fluids within Massachusetts.

To implement the Demonstration Test with the initial injection in November 2016, a UIC permit application (MassDEP form BRPWS 06) was filed with MassDEP under the category “Aquifer Remediation.” Similar injections of carbon substrates to enhance biodegradation of chemicals in groundwater have been commonly implemented in Massachusetts. Many of these sites are exempt from the UIC registration process if the injections are conducted for waste site cleanup in accordance with the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000) or similar federal statutes. In implementing the Demonstration Test all injections associated with the PRB complied with the requirements of the Massachusetts UIC regulations and the MCP requirements, including all required monitoring. MassDEP issued UIC Registration ID#MAS41A224209-5B6 for the Demonstration Test in September 2016. Plans for the extension were provided to the MassDEP and MassDEP approved the PRB extension injection event under the existing UIC registration #MAS41A224209-5B6 in April 2018.

7. PRB Demonstration Test Performance Monitoring

A. General

Performance monitoring of the PRB Demonstration Test is being implemented to assess nitrate reduction, concentrations of biogeochemical indicators, and the distribution of the injected reagents. The monitoring program is designed to be dynamic and modified to respond to observations, adjusting the monitoring as necessary.

Groundwater samples are collected from selected monitoring wells in the Demonstration Test area. The monitoring well network included multi-level monitoring wells and single monitoring wells upgradient and downgradient of the PRB within the regional flow system. These wells were originally aligned in two transects oriented from southwest to northeast with additional monitoring wells located cross gradient in the vicinity of the PRB and more regional monitoring wells around the PRB area. Additional monitoring wells have been installed to evaluate placement of the PRB extension and now form a third monitoring transect oriented northwest to southeast. The monitoring network plan view is presented on Figure 1 and PRB monitoring well transects are shown on Figure 2. Cross sections Transect 1 A-A', Transect 2 (B-B', and Transect 3 (C-C' are shown with nitrate data on Figure 3, Figure 4, and Figure 5, respectively. Transect 3 Cross section C-C' will help assess performance of the PRB extension implemented in June 2018. The monitoring wells upgradient and downgradient of the PRB are used to evaluate changes to nitrate concentrations and groundwater quality based on PRB performance. Monitoring wells downgradient of the PRB are located at selected distances from the PRB along the transects to assess distance of emulsion travel, extent of reducing conditions for denitrification, and the potential for metals mobilization. The wells are also used for collection of groundwater elevation data for monitoring groundwater flow.

B. Sampling Method, Frequency, and Analyses

Groundwater samples are collected using a submersible pump. Groundwater quality parameters measured in the field include pH, oxidation reduction potential (ORP), dissolved oxygen (DO), specific conductivity, temperature, and turbidity. Field parameters are monitored with the use of a multi-parameter probe in a flow-through cell. Samples are collected after field water quality parameters stabilize.

Groundwater samples were collected prior to EVO injection to provide a comparative baseline to evaluate performance of the Demonstration Test. Baseline groundwater samples were analyzed to determine pre-treatment concentrations of nitrate and other indicator parameters. Concentration change in the treatment area relative to concentrations at upgradient monitoring wells is indicative of the impact of the PRB. Several synoptic water level monitoring events were conducted prior to the start of injections to assess the groundwater flow direction and gradient. Monitoring well construction details are provided in Table 1 and elevation data is included in Table 2.

The first post-injection sampling event following the initial PRB injection was a stand-alone sampling event approximately 7 weeks after the injections with samples collected on January 5, 2017 and January 10, 2017. Following first post injection sampling, groundwater sampling is being performed quarterly for a projected period of three years. Primary objectives of the post-injection sampling are to:

- 1) Assess potential reduction in nitrate concentrations in groundwater compared to baseline samples and/or wells upgradient of the PRB;
- 2) Identify distance traveled by EVO emulsion and DOC;
- 3) Identify extent of generated reducing conditions;
- 4) Evaluate potential for reduction in aquifer permeability as a result of EVO application;
- 5) Evaluate persistence of EVO emulsion and anaerobic conditions favorable for denitrifying bacteria after PRB injection; and
- 6) Assess changes in groundwater monitoring parameters as a result of the PRB.

As a result of the generation of reducing conditions in groundwater, temporary mobilization of some metals native to the aquifer material may result. Table 6-1 presents an overview of the Demonstration Test performance monitoring analyses and relevance to the PRB Demonstration Test. The monitoring program was designed to be dynamic and continuously evaluated to adjust the selected monitoring parameters and frequency of monitoring based on data collected and observations.

Table 6-1 - Summary of Potential Analyses for Groundwater Performance Evaluation

Parameter	Relevance to PRB Demonstration Test
Nitrate	Primary groundwater compound targeted for treatment.
Nitrite	Intermediate nitrogen species from the aerobic nitrification of ammonia to nitrate.
Ammonia	Reduced inorganic nitrogen species that occurs in proximity of septic system leach fields and landfills.
TKN	Total Kjeldahl Nitrogen (TKN) is the total concentration of organic nitrogen and ammonia.
Total Nitrogen	Analyses provide a summation of all organic and inorganic nitrogen species in groundwater as a result of leach fields and landfill.
CENSUS-DNA (Denitrifying Bacteria)	Analysis quantifies relative abundance of denitrifying bacteria.
Metals (Fe, Mn, As)	Mobility of metals can be impacted by groundwater geochemistry changes, notably pH and ORP.
DOC	Dissolved Organic Carbon (DOC) is the limiting factor in enhancing denitrification-and is increased by injection of EVO. DOC tracks the area of influence of the PRB.
Sulfate	Sulfate will decrease with generation of sufficiently anaerobic conditions favorable for sulfate-reducing bacteria.
pH	Denitrification optimal pH (6.0 and 8.5). Groundwater pH can decrease as a result of fermentation of injected carbon substrates.
ORP	Oxidation-reduction potential (ORP) will decrease with generation of reducing conditions following injection of carbon substrate.
Chloride	Chloride concentrations indicate potentially infiltrating stormwater.
Alkalinity	Denitrification reactions generate alkalinity (3.57 mg of CaCO ₃ for each mg of nitrate reduced).
Boron	Boron is present in laundry detergents and is an indicator of groundwater flow emanating from leach fields.

8. PRB Demonstration Test Performance Monitoring Results To Date

1) Historical Data

A summary of baseline, post-injection, and prior quarterly sampling results is found in Appendix A.

2) Q-6 September 2018

The sixth post-injection quarterly sampling (Q-6) event occurred on September 19, 2018, September 20, 2018, and September 25, 2018, approximately 22 months after the first injections (November 2016) and 3 months after the extension injections (June 2018). During the September 2018 quarterly sampling event, groundwater samples were collected from 38 monitoring wells and analyzed for nitrate, nitrite, ammonia, total nitrogen, chloride, sulfate, DOC, dissolved iron, and dissolved manganese. One additional monitoring well upgradient of the PRB was sampled and analyzed for select parameters. Several monitoring wells were also analyzed for arsenic. Parameters, such as water level, pH, temperature, DO, ORP, conductivity, and turbidity, were also measured in the field. Additionally, water levels were collected from monitoring wells outside of the core monitoring well network.

a) Assessment of Groundwater Flow Through the PRB September 2018

Groundwater elevations calculated from the September 2018 data were interpolated to develop groundwater contour lines (Figure 6, Figure 7, and Figure 8).

b) Assessment of Groundwater Chemistry Data

Nitrate concentration data for baseline and quarterly sampling is included in Table 3 and on the cross-sections shown in Figures 3, Figure 4 and Figure 5.

Nitrate concentrations at the Transect 2 wells generally had similar concentrations to the April 2018 event. MW-B2010C and MW-B2020C on Transect 2 were non-detect at both sampling events. MW-B2020B nitrate increased from 2.4 mg/L in April to 3.06 mg/L in September, however, this is still lower than all other prior sampling events indicating a downward trend.

The monitoring wells on Transect 1 closest to the 2016 PRB injection line overlap with those on Transect 3. Due to current understanding of groundwater flow direction and the decision to implement the PRB extension, Transect 3 will be used to assess PRB performance in this area going forward. Transect 3 wells closest to the PRB extension showed a significant decrease in nitrate concentration compared with the April 2018 data collected prior to the PRB extension injections in June 2018. Samples collected from MW-B1010C located approximately 10 feet downgradient of the PRB extension and MW-B1020B located approximately 20 feet downgradient of the PRB extension were non-detect for nitrate (<0.03 mg/L), compared with concentrations of 18.3 and 9.7 mg/L, respectively, in April 2018. The DOC concentration also increased significantly at these wells. The DOC increased from 13 mg/L in April to 321 mg/L in September at MW-B1010C and increased from 5.43 mg/L in April to 668 mg/L in September at MW-B1020B. MW-B1020C nitrate concentration decreased from 9.7 mg/L in April to 1.92 mg/L in September and the DOC increased from 6.02 mg/L to 45.5 mg/L.

MW-BX1B and MW-BX1C located in the PRB extension injection zone also had much lower nitrate concentration in September compared to April. MW-BX1B had a nitrate concentration of 28.5 mg/L in April and non-detect in September and MW-BX1C had a nitrate concentration of 27.7 mg/L in April and 5.77 mg/L in September. These wells are located near the upgradient edge of the PRB extension zone and are part of Transect 3 C-C'. Monitoring wells MW-BX2A, MW-BX2B, and MW-BX2C located approximately 45 feet upgradient of the PRB extension along Transect 3 had high nitrate concentrations in April (baseline for these newer wells) and again in September with concentrations of 10.8, 9.5, and 42.8 mg/L in September respectively. Samples were collected for arsenic analyses from six monitoring wells including upgradient monitoring wells MW-4 and MW-BX2A, MW-BX2B, and

MW-BX2C; MW-BX1C located within the PRB extension injection areas; and monitoring wells MW-2010C and MW-2020B downgradient of the PRB. Of the six monitoring wells sampled and analyzed for arsenic, five were non-detect (<0.0025 mg/L). MW-B2010C, had an arsenic concentration of 0.06 mg/L which above the arsenic Massachusetts Maximum Contaminant Level (MCL) groundwater standard 0.010 mg/L. MW-2010C is in an area affected by the PRB. Sample results indicate that the groundwater is anaerobic under reducing condition with a negative oxidation-reduction potential and some mobilization of naturally occurring metals (iron, manganese and arsenic) is expected. These metals are also expected to precipitate downgradient where more aerobic conditions are encountered. Monitoring wells located further downgradient will be tested during the next sampling event to determine the extent of dissolved metal migration.

The observed DOC concentrations in groundwater can now be used to roughly estimate groundwater velocity through the treatment area. DOC is subject to biological degradation and therefore is not a conservative tracer. However, an approximation of groundwater velocity can be made with the data. Monitoring wells located up to 20 feet downgradient of the PRB extension were found to have significantly increased DOC concentrations. Groundwater sampling occurred approximately 90 days following the PRB extension injections indicating a groundwater velocity of at least 0.2 feet/day. Monitoring wells MW-B1050A, MW-B1050B, and MW-B1050C located approximately 30 feet downgradient have not shown increased DOC concentrations during this time frame indicating the groundwater velocity is less than 0.3 feet per day. Based on a groundwater velocity of 0.22 feet per day DOC concentration increases and potentially reduced nitrate concentrations can be expected at monitoring wells MW-B1050A and MW-B1050B, and MW-B1050C approximately 140 days following the PRB extension injections (by December 2018).

9. Summary, Schedule, and Coordination

The groundwater data collected in September 2018 indicates that the PRB treatment area as defined by increased DOC concentrations, decreased oxidation-reduction potential, and reduced nitrate concentrations has been expanded to the north with the installation of the PRB extension.

In summary the completed PRB Demonstration Test milestones include:

- PRB groundwater monitoring network installation;
- Baseline groundwater quality data collection and analysis;
- Initial PRB construction with injection of EVO in November 2016;

Modification of the PRB with an expansion of the treatment line to the north; and

Post-injection water quality data collection and analysis. The current plan includes collecting quarterly samples for a period of three years from the initial injection event in November 2016. Periodic reporting will be conducted to share results and observations with the Town, regulatory agencies, and the public. The next quarterly monitoring event is expected to occur in December 2018.

10. References

AECOM - Technical Memorandum Final for Preliminary Engineering Work Plan for Permeable Reactive Barriers. May 19, 2016.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Overview of Baseline Sampling, Injection Activities and Post-Injection Groundwater Monitoring – Final. March 1, 2017.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – January 2017 Groundwater Monitoring Quarterly Report – Final. March 1, 2017.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – March 2017 Groundwater Monitoring Quarterly Report – Final. June 25, 2017.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – June 2017 Groundwater Monitoring Quarterly Report – Final. February 5, 2018.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – September 2017 Groundwater Monitoring Quarterly Report – Final. March 13, 2018.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – January 2018 Groundwater Monitoring Quarterly Report – Final. May, 2018.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – April 2018 Groundwater Monitoring Quarterly Report – Final. June, 2018.

AECOM - Technical Memorandum for Eldredge Park Permeable Reactive Barrier Demonstration Project – PRB Extension – Final. December, 2018.

Cape Cod Commission - Cape Code Regional Wastewater Management Plan Technology Assessment – Conventional Infrastructure, March 2013.

Cape Cod Commission - Cape Cod Area Wide Water Quality Management Plan Update, June 2015.

Interstate Technology & Regulatory Council (ITRC) - Permeable Reactive Barrier: Technology Update (PRB-5), November 2011.

Terra Systems - Personal communications with Michael Lee, PhD, 2016.

11. List of Appendices

Appendix A – Historical Monitoring Data

Appendix B – Monitoring Well Coordinates

Appendix C – Analytical Laboratory Reports

Tables

This Page Intentionally Left Blank.

Table 1 Orleans Monitoring Well Construction Details

Well ID	Surface Elevation (ft)	TOC Elevation (ft)	Total Well Depth (ft bgs)	Screen Beginning Depth (ft bgs)	Screen End Depth (ft bgs)	Top Screen Elevation (ft)	Bottom Screen Elevation (ft)	Mid-Screen Elevation (ft)	Screen Length (ft)	Inst. Date	Location
MW-12A	45.6	45.57	80.0	70.0	80.0	-24.40	-34.40	-29.40	10.0	October 2016	Eldredge Park
MW-12B	45.6	45.58	65.0	55.0	65.0	-9.40	-19.40	-14.40	10.0	October 2016	Eldredge Park
MW-12C (Repaired)	45.6	45.36								April 2018	Eldredge Park
MW-BU1A	43.7	43.48	80.0	70.0	80.0	-26.30	-36.30	-31.30	10.0	September 2016	Eldredge Park
MW-BU1C	44.0	43.65	50.0	40.0	50.0	4.00	-6.00	-1.00	10.0	September 2016	Eldredge Park
MW-BU2A	45.1	44.56	80.0	70.0	80.0	-24.90	-34.90	-29.90	10.0	October 2016	Eldredge Park
MW-BU2B	45.1	44.70	65.0	55.0	65.0	-9.90	-19.90	-14.90	10.0	October 2016	Eldredge Park
MW-BU2C	45.1	44.68	50.0	40.0	50.0	5.10	-4.90	0.10	10.0	October 2016	Eldredge Park
MW-BC1C	42.5	42.50	50.0	40.0	50.0	2.50	-7.50	-2.50	10.0	September 2016	Eldredge Park
MW-BC2C	43.81	43.5	55.0	45.0	55.0	-1.48	-11.48	-6.48	10.0	October 2016	Eldredge Park
MW-B1010C	44.9	44.46	55.0	45.0	55.0	-0.10	-10.10	-5.10	10.0	October 2016	Eldredge Park
MW-B1020B	44.6	44.18	65.0	55.0	65.0	-10.40	-20.40	-15.40	10.0	October 2016	Eldredge Park
MW-B1020C	44.5	44.10	50.0	40.0	50.0	4.50	-5.50	-0.50	10.0	October 2016	Eldredge Park
MW-B1050A	43.9	43.42	80.0	70.0	80.0	-26.10	-36.10	-31.10	10.0	October 2016	Eldredge Park
MW-B1050B	43.9	43.54	65.0	55.0	65.0	-11.10	-21.10	-16.10	10.0	October 2016	Eldredge Park
MW-B1050C	44.9	43.55	50.0	40.0	50.0	4.90	-5.10	-0.10	10.0	October 2016	Eldredge Park
MW-B1075B	43.5	43.29	65.0	55.0	65.0	-11.50	-21.50	-16.50	10.0	October 2016	Eldredge Park
MW-B2010C	45.0	44.70	55.0	45.0	55.0	0.00	-10.00	-5.00	10.0	October 2016	Eldredge Park
MW-B2020B	44.9	44.50	65.0	55.0	65.0	-10.10	-20.10	-15.10	10.0	October 2016	Eldredge Park
MW-B2020C	44.8	44.45	50.0	40.0	50.0	4.80	-5.20	-0.20	10.0	October 2016	Eldredge Park
MW-B2050A	44.6	44.06	80.0	70.0	80.0	-25.40	-35.40	-30.40	10.0	October 2016	Eldredge Park
MW-B2050B	44.6	44.28	65.0	55.0	65.0	-10.40	-20.40	-15.40	10.0	October 2016	Eldredge Park
MW-B2050C	44.6	44.17	50.0	40.0	50.0	4.60	-5.40	-0.40	10.0	October 2016	Eldredge Park
MW-B2075A	44.6	44.23	75.0	65.0	75.0	-20.40	-30.40	-25.40	10.0	March 2017	Eldredge Park
MW-B2100	44.6	44.23	45.0	35.0	45.0	9.60	-0.40	4.60	10.0	September 2016	Eldredge Park
MW-BC3	44.2	43.86	65.0	55.0	65.0	-10.80	-20.80	-15.80	10.0	March 2017	Eldredge Park
MW-BX1B	45.6	45.38	65.0	55.0	65.0	-9.40	-19.40	-14.40	10.0	March 2017	Eldredge Park
MW-BX1C	45.37	45.7	50.0	40.0	50.0	5.37	-4.63	0.37	10.0	March 2017	Eldredge Park
MW-1R	44.40	47.2	45.0	35.0	45.0	9.40	-0.60	4.40	10.0	April 2018	Eldredge Park
MW-BX2A	46.40	46.1	80.0	70.0	80.0	-23.60	-33.60	-28.60	10.0	April 2018	Eldredge Park
MW-BX2B	46.40	46.1	65.0	55.0	65.0	-8.60	-18.60	-13.60	10.0	April 2018	Eldredge Park
MW-BX2C	46.47	46.0	50.0	40.0	50.0	6.47	-3.53	1.47	10.0	April 2018	Eldredge Park
MW-BN1A	44.50	44.0	80.0	70.0	80.0	-25.50	-35.50	-30.50	10.0	April 2018	Eldredge Park
MW-BN1B	44.40	43.9	65.0	55.0	65.0	-10.60	-20.60	-15.60	10.0	April 2018	Eldredge Park
MW-BN1C	44.38	44.2	50.0	40.0	50.0	4.38	-5.63	-0.63	10.0	April 2018	Eldredge Park
MB-BN2C	45.21	44.9	45.0	35.0	45.0	10.21	0.21	5.21	10.0	April 2018	Eldredge Park
MW-BM050A	44.68	44.3	80.0	70.0	80.0	-25.32	-35.32	-30.32	10.0	April 2018	Eldredge Park
MW-BM050B	44.80	44.4	65.0	55.0	65.0	-10.20	-20.20	-15.20	10.0	April 2018	Eldredge Park
MW-BM050C	44.80	44.4	50.0	40.0	50.0	4.80	-5.20	-0.20	10.0	April 2018	Eldredge Park
MW-BC4A	43.50	43.0	80.0	70.0	80.0	-26.50	-36.50	-31.50	10.0	April 2018	Eldredge Park

Table 1 Orleans Monitoring Well Construction Details

Well ID	Surface Elevation (ft)	TOC Elevation (ft)	Total Well Depth (ft bgs)	Screen Beginning Depth (ft bgs)	Screen End Depth (ft bgs)	Top Screen Elevation (ft)	Bottom Screen Elevation (ft)	Mid-Screen Elevation (ft)	Screen Length (ft)	Inst. Date	Location
MW-BC4B	43.50	43.1	65.0	55.0	65.0	-11.50	-21.50	-16.50	10.0	April 2018	Eldredge Park
MW-BC4C	43.50	43.2	50.0	40.0	50.0	3.50	-6.50	-1.50	10.0	April 2018	Eldredge Park

Notes:
N/A = Not Available

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-1	Eldredge Park	11/3/2016	41.31	30.10	11.21
MW-1	Eldredge Park	11/14/2016	41.31	30.20	11.11
MW-1	Eldredge Park	1/18/2017	41.31	30.43	10.88
MW-1	Eldredge Park	1/27/2017	41.31	30.25	11.06
MW-1	Eldredge Park	2/24/2017	41.31	29.50	11.81
MW-1	Eldredge Park	4/25/2017	41.31	28.17	13.14
MW-1	Eldredge Park	6/29/2017	41.31	28.37	12.94
MW-1	Eldredge Park	9/13/2017	41.31	N/A	N/A
MW-1	Eldredge Park	1/10/2018	41.31	28.15	13.16
MW-1	Eldredge Park	4/18/2018	41.31	N/A	N/A
MW-1	Eldredge Park	9/20/2018	41.31	28.65	12.66
MW-11	Eldredge Park	11/3/2016	45.14	34.20	10.94
MW-11	Eldredge Park	11/14/2016	45.14	34.20	10.94
MW-11	Eldredge Park	1/18/2017	45.14	34.42	10.72
MW-11	Eldredge Park	1/27/2017	45.14	33.31	11.83
MW-11	Eldredge Park	2/24/2017	45.14	33.87	11.27
MW-11	Eldredge Park	4/25/2017	45.14	32.84	12.30
MW-11	Eldredge Park	6/29/2017	45.14	32.82	12.32
MW-11	Eldredge Park	9/13/2017	45.14	N/A	N/A
MW-11	Eldredge Park	1/10/2018	45.14	32.89	12.25
MW-11	Eldredge Park	4/19/2018	45.14	30.30	14.84
MW-11	Eldredge Park	9/20/2018	45.14	33.95	11.19
MW-11S	Eldredge Park	11/3/2016	45.25	34.15	11.10
MW-11S	Eldredge Park	11/14/2016	45.25	34.25	11.00
MW-11S	Eldredge Park	1/18/2017	45.25	34.51	10.74
MW-11S	Eldredge Park	1/27/2017	45.25	34.36	10.89
MW-11S	Eldredge Park	2/24/2017	45.25	33.93	11.32
MW-11S	Eldredge Park	4/25/2017	45.25	32.92	12.33
MW-11S	Eldredge Park	6/29/2017	45.25	32.90	12.35
MW-11S	Eldredge Park	9/13/2017	45.25	32.95	12.30
MW-11S	Eldredge Park	1/10/2018	45.25	32.97	12.28
MW-11S	Eldredge Park	4/19/2018	45.25	30.39	14.86
MW-11S	Eldredge Park	9/20/2018	45.25	33.00	12.25
MW-12A	Eldredge Park	11/3/2016	45.57	34.40	11.17
MW-12A	Eldredge Park	11/14/2016	45.57	35.01	10.56
MW-12A	Eldredge Park	1/18/2017	45.57	34.71	10.86
MW-12A	Eldredge Park	1/27/2017	45.57	34.57	11.00
MW-12A	Eldredge Park	2/23/2017	45.57	34.16	11.41
MW-12A	Eldredge Park	4/25/2017	45.57	33.85	11.72
MW-12A	Eldredge Park	6/29/2017	45.57	33.17	12.40
MW-12A	Eldredge Park	9/12/2017	45.57	33.17	12.40
MW-12A	Eldredge Park	1/8/2018	45.57	33.19	12.38
MW-12A	Eldredge Park	4/18/2018	45.57	30.77	14.80
MW-12A	Eldredge Park	9/19/2018	45.57	33.29	12.28

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-12B	Eldredge Park	11/3/2016	45.58	34.50	11.08
MW-12B	Eldredge Park	11/14/2016	45.58	34.90	10.68
MW-12B	Eldredge Park	1/18/2017	45.58	34.79	10.79
MW-12B	Eldredge Park	1/27/2017	45.58	34.64	10.94
MW-12B	Eldredge Park	2/23/2017	45.58	34.24	11.34
MW-12B	Eldredge Park	4/25/2017	45.58	33.70	11.88
MW-12B	Eldredge Park	6/29/2017	45.58	33.21	12.37
MW-12B	Eldredge Park	9/12/2017	45.58	33.12	12.46
MW-12B	Eldredge Park	1/8/2018	45.58	33.30	12.28
MW-12B	Eldredge Park	4/18/2018	45.58	30.80	14.78
MW-12B	Eldredge Park	9/19/2018	45.58	33.35	12.23
MW-12C (Existing)	Eldredge Park	11/3/2016	46.61	36.27	10.34
MW-12C (Existing)	Eldredge Park	11/14/2016	46.61	35.99	10.62
MW-12C (Existing)	Eldredge Park	1/18/2017	46.61	36.21	10.40
MW-12C (Existing)	Eldredge Park	1/27/2017	46.61	36.06	10.55
MW-12C (Existing) ¹	Eldredge Park	2/23/2017	46.61	36.30	10.31
MW-12C (Existing) ¹	Eldredge Park	4/25/2017	46.61	34.95	11.66
MW-12C (Existing) ¹	Eldredge Park	6/29/2017	46.61	34.79	11.82
MW-12C (Existing) ¹	Eldredge Park	9/13/2017	46.61	13.00	33.61
MW-12C (Existing) ¹	Eldredge Park	1/8/2018	46.61	26.50	20.11
MW-12C (Existing) ¹	Eldredge Park	4/18/2018	46.61	N/A	N/A
MW-12C (Repaired)	Eldredge Park	9/19/2018	45.36	33.31	12.05
MW-2	Eldredge Park	11/3/2016	44.82	33.65	11.17
MW-2	Eldredge Park	11/14/2016	44.82	33.83	10.99
MW-2	Eldredge Park	1/18/2017	44.82	34.03	10.79
MW-2	Eldredge Park	1/27/2017	44.82	33.91	10.91
MW-2	Eldredge Park	2/24/2017	44.82	33.43	11.39
MW-2	Eldredge Park	4/25/2017	44.82	32.68	12.14
MW-2	Eldredge Park	6/29/2017	44.82	32.54	12.28
MW-2	Eldredge Park	9/13/2017	44.82	32.15	12.67
MW-2	Eldredge Park	1/10/2018	44.82	32.55	12.27
MW-2	Eldredge Park	4/19/2018	44.82	30.07	14.75
MW-2	Eldredge Park	9/20/2018	44.82	32.67	12.15
MW-4	Eldredge Park	11/3/2016	46.57	35.53	11.04
MW-4	Eldredge Park	11/14/2016	46.57	35.71	10.86
MW-4	Eldredge Park	1/18/2017	46.57	35.98	10.59
MW-4	Eldredge Park	1/27/2017	46.57	35.83	10.74
MW-4	Eldredge Park	2/24/2017	46.57	35.48	11.09
MW-4	Eldredge Park	4/25/2017	46.57	35.63	10.94
MW-4	Eldredge Park	6/29/2017	46.57	34.41	12.16
MW-4	Eldredge Park	9/13/2017	46.57	34.52	12.05
MW-4	Eldredge Park	1/10/2018	46.57	34.42	12.15
MW-4	Eldredge Park	4/19/2018	46.57	31.15	15.42
MW-4	Eldredge Park	9/19/2018	46.57	N/A	N/A

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-8	Eldredge Park	October 2016	46.16	35.30	10.86
MW-8	Eldredge Park	11/14/2016	46.16	35.22	10.94
MW-8	Eldredge Park	1/18/2017	46.16	35.62	10.54
MW-8	Eldredge Park	1/27/2017	46.16	35.50	10.66
MW-8	Eldredge Park	2/24/2017	46.16	35.12	11.04
MW-8	Eldredge Park	4/25/2017	46.16	24.51	21.65
MW-8	Eldredge Park	6/29/2017	46.16	34.03	12.13
MW-8	Eldredge Park	9/13/2017	46.16	34.21	11.95
MW-8	Eldredge Park	1/10/2018	46.16	N/A	N/A
MW-8	Eldredge Park	4/19/2018	46.16	N/A	N/A
MW-8	Eldredge Park	9/19/2018	46.16	N/A	N/A
MW-B1010C	Eldredge Park	11/3/2016	44.46	33.60	10.86
MW-B1010C	Eldredge Park	11/14/2016	44.46	33.98	10.48
MW-B1010C	Eldredge Park	1/18/2017	44.46	33.97	10.49
MW-B1010C	Eldredge Park	1/27/2017	44.46	33.81	10.65
MW-B1010C	Eldredge Park	2/23/2017	44.46	33.25	11.21
MW-B1010C	Eldredge Park	4/25/2017	44.46	32.53	11.93
MW-B1010C	Eldredge Park	6/29/2017	44.46	32.15	12.31
MW-B1010C	Eldredge Park	9/12/2017	44.46	32.13	12.33
MW-B1010C	Eldredge Park	1/9/2018	44.46	32.18	12.28
MW-B1010C	Eldredge Park	4/18/2018	44.46	27.37	17.09
MW-B1010C	Eldredge Park	9/19/2018	44.46	32.32	12.14
MW-B1020B	Eldredge Park	11/3/2016	44.18	33.42	10.76
MW-B1020B	Eldredge Park	11/14/2016	44.18	33.68	10.50
MW-B1020B	Eldredge Park	1/18/2017	44.18	33.81	10.37
MW-B1020B	Eldredge Park	1/27/2017	44.18	33.66	10.52
MW-B1020B	Eldredge Park	2/23/2017	44.18	33.18	11.00
MW-B1020B	Eldredge Park	4/25/2017	44.18	32.60	11.58
MW-B1020B	Eldredge Park	6/29/2017	44.18	32.14	12.04
MW-B1020B	Eldredge Park	9/12/2017	44.18	32.01	12.17
MW-B1020B	Eldredge Park	1/9/2018	44.18	N/A	N/A
MW-B1020B	Eldredge Park	4/18/2018	44.18	29.63	14.55
MW-B1020B	Eldredge Park	9/19/2018	44.18	32.39	11.79
MW-B1020C	Eldredge Park	11/3/2016	44.10	33.16	10.94
MW-B1020C	Eldredge Park	11/14/2016	44.10	33.32	10.78
MW-B1020C	Eldredge Park	1/18/2017	44.10	33.53	10.57
MW-B1020C	Eldredge Park	1/27/2017	44.10	33.32	10.78
MW-B1020C	Eldredge Park	2/23/2017	44.10	32.80	11.30
MW-B1020C	Eldredge Park	4/25/2017	44.10	32.10	12.00
MW-B1020C	Eldredge Park	6/29/2017	44.10	31.71	12.39
MW-B1020C	Eldredge Park	9/12/2017	44.10	31.74	12.36
MW-B1020C	Eldredge Park	1/8/2018	44.10	31.74	12.36
MW-B1020C	Eldredge Park	4/18/2018	44.10	28.90	15.20
MW-B1020C	Eldredge Park	9/19/2018	44.10	31.93	12.17

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-B1050A	Eldredge Park	11/3/2016	43.42	32.84	10.58
MW-B1050A	Eldredge Park	11/14/2016	43.42	32.92	10.50
MW-B1050A	Eldredge Park	1/18/2017	43.42	32.91	10.51
MW-B1050A	Eldredge Park	1/27/2017	43.42	32.88	10.54
MW-B1050A	Eldredge Park	2/23/2017	43.42	32.54	10.88
MW-B1050A	Eldredge Park	4/25/2017	43.42	31.28	12.14
MW-B1050A	Eldredge Park	6/29/2017	43.42	31.42	12.00
MW-B1050A	Eldredge Park	9/12/2017	43.42	31.45	11.97
MW-B1050A	Eldredge Park	1/9/2018	43.42	31.46	11.96
MW-B1050A	Eldredge Park	4/18/2018	43.42	28.74	14.68
MW-B1050A	Eldredge Park	9/20/2018	43.42	31.68	11.74
MW-B1050B	Eldredge Park	11/3/2016	43.54	32.65	10.89
MW-B1050B	Eldredge Park	11/14/2016	43.54	32.72	10.82
MW-B1050B	Eldredge Park	1/18/2017	43.54	32.98	10.56
MW-B1050B	Eldredge Park	1/27/2017	43.54	32.81	10.73
MW-B1050B	Eldredge Park	2/23/2017	43.54	32.28	11.26
MW-B1050B	Eldredge Park	4/25/2017	43.54	31.45	12.09
MW-B1050B	Eldredge Park	6/29/2017	43.54	31.21	12.33
MW-B1050B	Eldredge Park	9/12/2017	43.54	31.19	12.35
MW-B1050B	Eldredge Park	1/9/2018	43.54	31.18	12.36
MW-B1050B	Eldredge Park	4/18/2018	43.54	28.35	15.19
MW-B1050B	Eldredge Park	9/20/2018	43.54	31.41	12.13
MW-B1050C	Eldredge Park	11/3/2016	43.55	32.80	10.75
MW-B1050C	Eldredge Park	11/14/2016	43.55	32.80	10.75
MW-B1050C	Eldredge Park	1/18/2017	43.55	33.02	10.53
MW-B1050C	Eldredge Park	1/27/2017	43.55	32.96	10.59
MW-B1050C	Eldredge Park	2/23/2017	43.55	32.40	11.15
MW-B1050C	Eldredge Park	4/25/2017	43.55	31.52	12.03
MW-B1050C	Eldredge Park	6/29/2017	43.55	31.21	12.34
MW-B1050C	Eldredge Park	9/12/2017	43.55	31.22	12.33
MW-B1050C	Eldredge Park	1/9/2018	43.55	31.36	12.19
MW-B1050C	Eldredge Park	4/18/2018	43.55	28.52	15.03
MW-B1050C	Eldredge Park	9/20/2018	43.55	31.55	12.00
MW-B1075B	Eldredge Park	11/3/2016	43.29	32.55	10.74
MW-B1075B	Eldredge Park	11/14/2016	43.29	32.57	10.72
MW-B1075B	Eldredge Park	1/18/2017	43.29	32.78	10.51
MW-B1075B	Eldredge Park	1/27/2017	43.29	32.62	10.67
MW-B1075B	Eldredge Park	2/23/2017	43.29	32.10	11.19
MW-B1075B	Eldredge Park	4/25/2017	43.29	31.22	12.07
MW-B1075B	Eldredge Park	6/29/2017	43.29	30.98	12.31
MW-B1075B	Eldredge Park	9/13/2017	43.29	30.93	12.36
MW-B1075B	Eldredge Park	1/9/2018	43.29	31.15	12.14
MW-B1075B	Eldredge Park	4/18/2018	43.29	29.25	14.04
MW-B1075B	Eldredge Park	9/20/2018	43.29	31.26	12.03

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-B2010C	Eldredge Park	11/3/2016	44.70	33.95	10.75
MW-B2010C	Eldredge Park	11/14/2016	44.70	34.10	10.60
MW-B2010C	Eldredge Park	1/18/2017	44.70	34.41	10.29
MW-B2010C	Eldredge Park	1/27/2017	44.70	34.21	10.49
MW-B2010C	Eldredge Park	2/24/2017	44.70	33.77	10.93
MW-B2010C	Eldredge Park	4/25/2017	44.70	33.00	11.70
MW-B2010C	Eldredge Park	6/29/2017	44.70	32.67	12.03
MW-B2010C	Eldredge Park	9/13/2017	44.70	32.52	12.18
MW-B2010C	Eldredge Park	1/10/2018	44.70	32.66	12.04
MW-B2010C	Eldredge Park	4/19/2018	44.70	30.28	14.42
MW-B2010C	Eldredge Park	9/19/2018	44.70	32.93	11.77
MW-B2020B	Eldredge Park	11/3/2016	44.50	33.90	10.60
MW-B2020B	Eldredge Park	11/14/2016	44.50	33.90	10.60
MW-B2020B	Eldredge Park	1/18/2017	44.50	34.15	10.35
MW-B2020B	Eldredge Park	1/27/2017	44.50	34.03	10.47
MW-B2020B	Eldredge Park	2/24/2017	44.50	33.50	11.00
MW-B2020B	Eldredge Park	4/25/2017	44.50	32.88	11.62
MW-B2020B	Eldredge Park	6/29/2017	44.50	32.45	12.05
MW-B2020B	Eldredge Park	9/13/2017	44.50	32.32	12.18
MW-B2020B	Eldredge Park	1/9/2018	44.50	32.58	11.92
MW-B2020B	Eldredge Park	4/19/2018	44.50	29.98	14.52
MW-B2020B	Eldredge Park	9/19/2018	44.50	32.64	11.86
MW-B2020C	Eldredge Park	11/3/2016	44.45	33.80	10.65
MW-B2020C	Eldredge Park	11/14/2016	44.45	33.98	10.47
MW-B2020C	Eldredge Park	1/18/2017	44.45	34.22	10.23
MW-B2020C	Eldredge Park	1/27/2017	44.45	34.07	10.38
MW-B2020C	Eldredge Park	2/24/2017	44.45	33.55	10.90
MW-B2020C	Eldredge Park	4/25/2017	44.45	32.90	11.55
MW-B2020C	Eldredge Park	6/29/2017	44.45	32.43	12.02
MW-B2020C	Eldredge Park	9/13/2017	44.45	32.23	12.22
MW-B2020C	Eldredge Park	1/9/2018	44.45	32.72	11.73
MW-B2020C	Eldredge Park	4/19/2018	44.45	30.01	14.44
MW-B2020C	Eldredge Park	9/19/2018	44.45	32.63	11.82
MW-B2050A	Eldredge Park	11/3/2016	44.06	33.41	10.65
MW-B2050A	Eldredge Park	11/14/2016	44.06	33.60	10.46
MW-B2050A	Eldredge Park	1/18/2017	44.06	33.88	10.18
MW-B2050A	Eldredge Park	1/27/2017	44.06	33.64	10.42
MW-B2050A	Eldredge Park	2/24/2017	44.06	33.04	11.02
MW-B2050A	Eldredge Park	4/25/2017	44.06	32.68	11.38
MW-B2050A	Eldredge Park	6/29/2017	44.06	32.12	11.94
MW-B2050A	Eldredge Park	9/13/2017	44.06	31.98	12.08
MW-B2050A	Eldredge Park	1/9/2018	44.06	32.23	11.83
MW-B2050A	Eldredge Park	4/19/2018	44.06	29.53	14.53
MW-B2050A	Eldredge Park	9/19/2018	44.06	32.35	11.71

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-B2050B	Eldredge Park	11/3/2016	44.28	33.60	10.68
MW-B2050B	Eldredge Park	11/14/2016	44.28	33.73	10.55
MW-B2050B	Eldredge Park	1/18/2017	44.28	34.00	10.28
MW-B2050B	Eldredge Park	1/27/2017	44.28	33.84	10.44
MW-B2050B	Eldredge Park	2/24/2017	44.28	33.32	10.96
MW-B2050B	Eldredge Park	4/25/2017	44.28	32.63	11.65
MW-B2050B	Eldredge Park	6/29/2017	44.28	32.20	12.08
MW-B2050B	Eldredge Park	9/13/2017	44.28	32.01	12.27
MW-B2050B	Eldredge Park	1/9/2018	44.28	32.42	11.86
MW-B2050B	Eldredge Park	4/19/2018	44.28	29.70	14.58
MW-B2050B	Eldredge Park	9/19/2018	44.28	32.40	11.88
MW-B2050C	Eldredge Park	11/3/2016	44.17	33.35	10.82
MW-B2050C	Eldredge Park	11/14/2016	44.17	33.51	10.66
MW-B2050C	Eldredge Park	1/18/2017	44.17	33.90	10.27
MW-B2050C	Eldredge Park	1/27/2017	44.17	33.87	10.30
MW-B2050C	Eldredge Park	2/24/2017	44.17	33.07	11.10
MW-B2050C	Eldredge Park	4/25/2017	44.17	32.31	11.86
MW-B2050C	Eldredge Park	6/29/2017	44.17	31.93	12.24
MW-B2050C	Eldredge Park	9/13/2017	44.17	32.07	12.10
MW-B2050C	Eldredge Park	1/9/2018	44.17	32.11	12.06
MW-B2050C	Eldredge Park	4/19/2018	44.17	27.61	16.56
MW-B2050C	Eldredge Park	9/19/2018	44.17	32.17	12.00
MW-B2075A	Eldredge Park	4/25/2017	44.23	32.40	11.83
MW-B2075A	Eldredge Park	6/29/2017	44.23	31.97	12.26
MW-B2075A	Eldredge Park	9/12/2017	44.23	31.85	12.38
MW-B2075A	Eldredge Park	1/10/2018	44.23	32.30	11.93
MW-B2075A	Eldredge Park	4/19/2018	44.23	29.44	14.79
MW-B2075A	Eldredge Park	9/20/2018	44.23	32.40	11.83
MW-B2100	Eldredge Park	11/3/2016	44.23	33.50	10.73
MW-B2100	Eldredge Park	11/14/2016	44.23	33.65	10.58
MW-B2100	Eldredge Park	1/18/2017	44.23	33.87	10.36
MW-B2100	Eldredge Park	1/27/2017	44.23	33.66	10.57
MW-B2100	Eldredge Park	2/24/2017	44.23	33.10	11.13
MW-B2100	Eldredge Park	4/25/2017	44.23	32.38	11.85
MW-B2100	Eldredge Park	6/29/2017	44.23	32.01	12.22
MW-B2100	Eldredge Park	9/12/2017	44.23	31.89	12.34
MW-B2100	Eldredge Park	1/10/2018	44.23	32.29	11.94
MW-B2100	Eldredge Park	4/19/2018	44.23	30.34	13.89
MW-B2100	Eldredge Park	9/20/2018	44.23	32.36	11.87
MW-BC1C	Eldredge Park	11/3/2016	42.50	31.36	11.14
MW-BC1C	Eldredge Park	11/14/2016	42.50	31.87	10.63
MW-BC1C	Eldredge Park	1/18/2017	42.50	31.81	10.69
MW-BC1C	Eldredge Park	1/27/2017	42.50	31.65	10.85
MW-BC1C	Eldredge Park	2/24/2017	42.50	31.14	11.36
MW-BC1C	Eldredge Park	4/25/2017	42.50	30.43	12.07
MW-BC1C	Eldredge Park	6/29/2017	42.50	30.07	12.43
MW-BC1C	Eldredge Park	9/12/2017	42.50	N/A	N/A
MW-BC1C	Eldredge Park	1/10/2018	42.50	N/A	N/A
MW-BC1C	Eldredge Park	4/19/2018	42.50	27.61	14.89
MW-BC1C	Eldredge Park	9/20/2018	42.50	30.31	12.19

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-BC2C	Eldredge Park	6/29/2017	43.52	31.61	11.91
MW-BC2C	Eldredge Park	11/3/2016	43.52	32.84	10.68
MW-BC2C	Eldredge Park	11/14/2016	43.52	N/A	N/A
MW-BC2C	Eldredge Park	1/18/2017	43.52	33.22	10.30
MW-BC2C	Eldredge Park	1/27/2017	43.52	33.08	10.44
MW-BC2C	Eldredge Park	2/24/2017	43.52	32.63	10.89
MW-BC2C	Eldredge Park	4/25/2017	43.52	31.93	11.59
MW-BC2C	Eldredge Park	9/13/2017	43.52	31.26	12.26
MW-BC2C	Eldredge Park	1/10/2018	43.52	31.70	11.82
MW-BC2C	Eldredge Park	4/19/2018	43.52	27.65	15.87
MW-BC2C	Eldredge Park	9/20/2018	43.52	32.45	11.07
MW-BC3B	Eldredge Park	4/25/2017	43.86	32.45	11.41
MW-BC3B	Eldredge Park	6/29/2017	43.86	31.90	11.96
MW-BC3B	Eldredge Park	9/12/2017	43.86	31.50	12.36
MW-BC3B	Eldredge Park	1/10/2018	43.86	32.36	11.50
MW-BC3B	Eldredge Park	4/19/2018	43.86	29.55	14.31
MW-BC3B	Eldredge Park	9/20/2018	43.86	32.47	11.39
MW-BU1A	Eldredge Park	11/3/2016	43.48	32.55	10.93
MW-BU1A	Eldredge Park	11/14/2016	43.48	32.44	11.04
MW-BU1A	Eldredge Park	1/18/2017	43.48	32.86	10.62
MW-BU1A	Eldredge Park	1/27/2017	43.48	32.74	10.74
MW-BU1A	Eldredge Park	2/24/2017	43.48	32.30	11.18
MW-BU1A	Eldredge Park	4/25/2017	43.48	31.75	11.73
MW-BU1A	Eldredge Park	6/29/2017	43.48	31.36	12.12
MW-BU1A	Eldredge Park	9/13/2017	43.48	31.21	12.27
MW-BU1A	Eldredge Park	1/10/2018	43.48	31.40	12.08
MW-BU1A	Eldredge Park	4/18/2018	43.48	28.83	14.65
MW-BU1A	Eldredge Park	9/20/2018	43.48	31.45	12.03
MW-BU1C	Eldredge Park	11/3/2016	43.65	32.50	11.15
MW-BU1C	Eldredge Park	11/14/2016	43.65	N/A	N/A
MW-BU1C	Eldredge Park	1/18/2017	43.65	32.84	10.81
MW-BU1C	Eldredge Park	1/27/2017	43.65	32.72	10.93
MW-BU1C	Eldredge Park	2/24/2017	43.65	32.25	11.40
MW-BU1C	Eldredge Park	4/25/2017	43.65	31.71	11.94
MW-BU1C	Eldredge Park	6/29/2017	43.65	31.31	12.34
MW-BU1C	Eldredge Park	9/13/2017	43.65	31.03	12.62
MW-BU1C	Eldredge Park	1/10/2018	43.65	31.30	12.35
MW-BU1C	Eldredge Park	4/18/2018	43.65	28.88	14.77
MW-BU1C	Eldredge Park	9/20/2018	43.65	31.39	12.26
MW-BU2A	Eldredge Park	11/3/2016	44.56	33.90	10.66
MW-BU2A	Eldredge Park	11/14/2016	44.56	34.03	10.53
MW-BU2A	Eldredge Park	1/18/2017	44.56	34.22	10.34
MW-BU2A	Eldredge Park	1/27/2017	44.56	34.05	10.51
MW-BU2A	Eldredge Park	2/23/2017	44.56	34.62	9.94
MW-BU2A	Eldredge Park	4/25/2017	44.56	33.25	11.31
MW-BU2A	Eldredge Park	6/29/2017	44.56	32.72	11.84
MW-BU2A	Eldredge Park	9/12/2017	44.56	32.56	12.00
MW-BU2A	Eldredge Park	1/10/2018	44.56	32.75	11.81
MW-BU2A	Eldredge Park	4/18/2018	44.56	30.26	14.30
MW-BU2A	Eldredge Park	9/20/2018	44.56	32.82	11.74

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-BU2B	Eldredge Park	11/3/2016	44.70	33.93	10.77
MW-BU2B	Eldredge Park	11/14/2016	44.70	34.07	10.63
MW-BU2B	Eldredge Park	1/18/2017	44.70	34.31	10.39
MW-BU2B	Eldredge Park	1/27/2017	44.70	34.15	10.55
MW-BU2B	Eldredge Park	2/23/2017	44.70	33.75	10.95
MW-BU2B	Eldredge Park	4/25/2017	44.70	33.10	11.60
MW-BU2B	Eldredge Park	6/29/2017	44.70	32.72	11.98
MW-BU2B	Eldredge Park	9/12/2017	44.70	32.47	12.23
MW-BU2B	Eldredge Park	1/10/2018	44.70	32.76	11.94
MW-BU2B	Eldredge Park	4/18/2018	44.70	30.26	14.44
MW-BU2B	Eldredge Park	9/20/2018	44.70	32.82	11.88
MW-BU2C	Eldredge Park	11/3/2016	44.68	33.99	10.69
MW-BU2C	Eldredge Park	11/14/2016	44.68	34.08	10.60
MW-BU2C	Eldredge Park	1/18/2017	44.68	34.30	10.38
MW-BU2C	Eldredge Park	1/27/2017	44.68	34.15	10.53
MW-BU2C	Eldredge Park	2/23/2017	44.68	34.05	10.63
MW-BU2C	Eldredge Park	4/25/2017	44.68	33.08	11.60
MW-BU2C	Eldredge Park	6/29/2017	44.68	32.64	12.04
MW-BU2C	Eldredge Park	9/12/2017	44.68	32.60	12.08
MW-BU2C	Eldredge Park	1/10/2018	44.68	32.72	11.96
MW-BU2C	Eldredge Park	1/10/2018	44.68	30.40	14.28
MW-BU2C	Eldredge Park	4/18/2018	44.68	30.40	14.28
MW-BU2C	Eldredge Park	9/20/2018	44.68	32.85	11.83
MW-BX1B	Eldredge Park	4/25/2017	45.38	33.85	11.53
MW-BX1B	Eldredge Park	6/29/2017	45.38	33.46	11.92
MW-BX1B	Eldredge Park	9/12/2017	45.38	33.43	11.95
MW-BX1B	Eldredge Park	1/8/2018	45.38	33.46	11.92
MW-BX1B	Eldredge Park	4/18/2018	45.38	31.02	14.36
MW-BX1B	Eldredge Park	9/20/2018	45.38	33.61	11.77
MW-BX1C	Eldredge Park	4/25/2017	45.37	33.29	12.08
MW-BX1C	Eldredge Park	6/29/2017	45.37	32.98	12.39
MW-BX1C	Eldredge Park	9/12/2017	45.37	32.98	12.39
MW-BX1C	Eldredge Park	1/8/2018	45.37	32.95	12.42
MW-BX1C	Eldredge Park	4/18/2018	45.37	30.10	15.27
MW-BX1C	Eldredge Park	9/20/2018	45.37	33.16	12.21
MW-BX2A	Eldredge Park	5/9/2018	46.40	31.30	15.10
MW-BX2A	Eldredge Park	9/20/2018	46.40	34.31	12.09
MW-BX2B	Eldredge Park	5/9/2018	46.40	31.14	15.26
MW-BX2B	Eldredge Park	9/20/2018	46.40	34.37	12.03
MW-BX2C	Eldredge Park	5/9/2018	46.47	31.07	15.40
MW-BX2C	Eldredge Park	9/20/2018	46.47	33.66	12.81
MW-BN1A	Eldredge Park	5/9/2018	44.50	30.08	14.42
MW-BN1A	Eldredge Park	9/20/2018	44.50	32.36	12.14
MW-BN1B	Eldredge Park	5/9/2018	44.40	29.10	15.30
MW-BN1B	Eldredge Park	9/20/2018	44.40	31.71	12.69
MW-BN1C	Eldredge Park	5/9/2018	44.38	30.34	14.04
MW-BN1C	Eldredge Park	9/20/2018	44.38	31.87	12.51
MW-BN2C	Eldredge Park	5/9/2018	45.21	30.42	14.79
MW-BN2C	Eldredge Park	9/25/2018	45.21	32.64	12.57

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
MW-BM050A	Eldredge Park	5/9/2018	44.68	29.89	14.79
MW-BM050A	Eldredge Park	9/20/2018	44.68	32.29	12.39
MW-BM050B	Eldredge Park	5/9/2018	44.80	29.81	14.99
MW-BM050B	Eldredge Park	9/20/2018	44.80	32.41	12.39
MW-BM050C	Eldredge Park	5/9/2018	44.80	29.78	15.02
MW-BM050C	Eldredge Park	9/20/2018	44.80	32.38	12.42
MW-BC4A	Eldredge Park	5/9/2018	43.50	29.48	14.02
MW-BC4A	Eldredge Park	9/20/2018	43.50	31.55	11.95
MW-BC4B	Eldredge Park	5/9/2018	43.50	28.30	15.20
MW-BC4B	Eldredge Park	9/20/2018	43.50	29.45	14.05
MW-BC4C	Eldredge Park	5/9/2018	43.50	29.47	14.03
MW-BC4C	Eldredge Park	9/20/2018	43.50	31.57	11.93

Notes:

N/A = Not Available

1. MW-12C (Existing) was damaged during winter 2017. Water elevations taken prior to the repair in April 2018 may be affected.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-4 ³		MW-8 ³		MW-12A							
	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	10/4/2016 Sample	10/4/2016 Sample	11/03/2016 ¹ Sample	1/5/2017 Sample	2/23/2017 Q1 Sample	6/28/2017 Q2 Sample	9/12/2017 Q3 Sample	1/8/2018 Q4 Sample	4/18/2018 Q5 Sample	9/19/2018 Q6 Sample
	4.50	19.70		9.70								
	-5.50											
Field Measurements												
pH (SU)	5.52	5.23	6.30	5.23	6.94	5.46	5.53	5.58	5.59	4.89	5.60	5.44
Temperature (°C)	15.54	15.87	12.65	15.87	14.38	11.78	13.81	13.91	14.02	13.62	13.7	15.3
Dissolved Oxygen (DO, mg/L)	7.89	9.58	7.99	9.58	1.13	3.69	7.03	14.81	6.92	7.65	7.99	7.33
Redox Potential (ORP, mV)	57.90	135.00	92.70	135.00	70.90	197.60	183.10	173.60	146.50	288.30	162.1	192.3
Specific Conductivity (µS/cm) ^c	171.00	190.00	170.00	190.00	667.00	572.00	550.00	537.00	518.00	563.00	483.9	445.0
Turbidity (NTU)	-	-	2.32	-	17.70	5.50	5.31	5.13	7.68	3.58	0.52	6.20
Laboratory Analyses												
Nitrogen												
Nitrate as N (mg/L)	2.45	9.24	3.51	9.24	0.783	0.669	0.849	0.786	0.794	0.242	0.676	0.627
Nitrite as N (mg/L)	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.074	<0.01	<0.01
Ammonia (mg/L)	0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.36	<0.1
Total Kjeldahl Nitrogen (TKN)	0.71	1.7	-	1.7	-	<0.2	0.4	-	-	0.22	0.57	0.4
Total Nitrogen (mg/L)	3.15	10.9	-	10.9	1	0.669	1.25	0.79	1.11	0.533	1.25	-
Anions												
Chloride (mg/L)	27.2	18.3	-	18.3	190	230	141	154	146	160	144	152
Sulfate (mg/L)	12.8	10.1	-	10.1	10	16.1	13.4	12.6	12.3	12.2	16.1	11.3
Elements												
Dissolved Iron (mg/L)	-	-	-	-	0.7	-	<0.1	<0.1	-	<0.1	<0.1	<0.1
Dissolved Manganese (mg/L)	-	-	-	-	0.325	-	0.033	<0.02	-	<0.02	0.023	<0.02
Arsenic (mg/L)	-	-	<0.0025	-	-	-	-	-	-	-	-	-
Boron (mg/L)	-	-	-	-	<0.05	-	<0.05	-	-	-	-	-
Sodium (mg/L)	-	-	-	-	-	-	98.3	-	-	-	-	-
Other												
DOC (mg/L)	<0.5	<0.5	-	<0.5	0.55	-	<0.5	2.16	0.792	1.7	1.85	0.729
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO ₃ (mg/L)	-	-	-	-	-	5	7	-	-	-	-	-

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-12B										MW-12C ^{2,3}						MW-BU1A		MW-BU1C	
	-9.4										8.36						-26.3		-36.3	
Top of Screen Elevation (ft)																				
Bottom of Screen Elevation (ft)	-19.4										-1.64									
Sampling Date	11/03/2016 ¹	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/19/2018	10/4/2016	11/03/2016 ¹	11/17/2016	1/5/2017	2/23/2017	5/9/2018	9/19/2018	10/4/2016	10/4/2016			
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Sample	Sample	Q1 Sample ⁴	D2 Baseline	Q6 Sample	Sample	Sample			
Field Measurements																				
pH (SU)	6.90	5.43	5.40	5.39	5.45	4.78	5.30	5.38	4.98	6.45	5.23	5.09	NS	5.23	5.65	5.44	5.27			
Temperature (°C)	14.50	11.82	14.18	14.37	14.56	13.80	14.1	19.2	17.50	14.08	14.42	12.60	NS	11.10	16.18	13.75	13.95			
Dissolved Oxygen (DO, mg/L)	1.05	1.16	6.39	12.40	5.51	5.67	5.45	5.41	6.93	0.83	0.68	1.61	NS	8.12	2.70	7.60	8.75			
Redox Potential (ORP, mV)	20.30	212.80	263.10	225.20	170.30	275.70	186.5	195.3	167.80	246.00	279.70	205.60	NS	221.80	93.80	70.90	130.90			
Specific Conductivity (µS/cm) ^c	231.00	243.00	235.00	253.00	257.00	249.00	230.2	233.0	178.00	216.00	156.00	199.00	NS	189.60	151.00	1464.00	351.00			
Turbidity (NTU)	8.73	1.89	0.91	2.62	1.52	1.48	0.50	140.00	-	0.60	2.58	0.84	NS	2.49	9.60	-	-			
Laboratory Analyses																				
Nitrogen																				
Nitrate as N (mg/L)	6.17	5.08	5.33	6.19	4.9	1.91	4.82	5.36	6.74	6.51	-	6.03	NS	5.47	3.78	0.443	1.97			
Nitrite as N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	NS	<0.25	0.047	-	-			
Ammonia (mg/L)	<0.1	0.19	<0.1	0.12	0.26	<0.1	<0.1	<0.1	<0.1	0.11	-	0.12	NS	0.12	0.24	0.24	<0.1			
Total Kjeldahl Nitrogen (TKN)	-	0.79	1.18	-	-	<0.2	<0.2	<0.2	1.34	-	-	1.24	NS	<0.2	0.9	0.38	0.4			
Total Nitrogen (mg/L)	6.44	5.87	6.52	6.83	4.9	1.91	4.82	-	8.08	6.51	-	7.27	NS	5.47	-	0.827	2.37			
Anions																				
Chloride (mg/L)	34.1	24.2	41.6	48.9	50.5	47.3	46.7	52.1	24.1	-	-	22.4	NS	12.4	13.7	458	96.1			
Sulfate (mg/L)	9.8	13.6	9.7	9.2	12.1	11.2	13.2	10.7	8.7	9.3	-	8.6	NS	13.9	11.8	6.9	9.1			
Elements																				
Dissolved Iron (mg/L)	0.36	-	<0.05	<0.1	-	<0.1	<0.1	<0.1	-	<0.05	-	-	NS	<0.1	3.67	0.799	0.099			
Dissolved Manganese (mg/L)	0.228	-	0.046	<0.02	-	<0.02	<0.02	<0.02	-	0.02	-	-	NS	<0.02	0.674	0.185	0.047			
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Boron (mg/L)	<0.05	-	<0.05	-	-	-	-	-	-	<0.05	-	-	NS	-	-	<0.05	<0.05			
Sodium (mg/L)	-	-	18.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Other																				
DOC (mg/L)	1.82	-	<0.5	1.02	1.1	2.29	3.66	1.11	<0.5	0.87	0.674	-	NS	3.96	2.75	<0.5	<0.5			
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	NS	-	-	<2	<2			
Alkalinity as CaCO3 (mg/L)	-	2	10	-	-	-	-	-	-	-	4	6	NS	-	-	-	-			

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at:

<http://www.hbuehrer.ch/Rechner/O2sat.html>

2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.

3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.

4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BU2A											MW-BU2B					
	-24.9											-19.9					
	-34.9											-19.9					
Top of Screen Elevation (ft)																	
Bottom of Screen Elevation (ft)																	
Sampling Date	11/03/2016 ¹	1/5/2017	2/23/2017	6/29/2017	9/12/2017	1/10/2018	4/18/2018	9/20/2018	11/03/2016 ¹	1/5/2017	2/23/2017	6/29/2017	9/12/2017	1/10/2018	4/18/2018	9/20/2018	
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																	
pH (SU)	6.73	6.00	5.72	5.68	5.72	5.23	5.70	4.75	7.11	5.94	5.73	5.68	5.75	5.24	5.60	4.77	
Temperature (°C)	14.15	11.75	13.71	14.00	14.47	13.86	14.0	14.2	14.70	12.07	14.18	14.70	15.21	14.53	14.8	14.8	
Dissolved Oxygen (DO, mg/L)	1.18	1.30	6.82	15.26	6.87	7.63	7.19	7.46	1.30	1.07	6.25	13.80	6.19	6.42	6.20	6.43	
Redox Potential (ORP, mV)	37.50	127.00	149.50	225.20	172.00	211.40	111.5	101.6	20.20	136.30	177.60	221.40	156.50	213.20	143.6	88.0	
Specific Conductivity (µS/cm) ^c	406.00	421.00	427.00	439.00	442.00	421.00	344.9	407.0	379.00	362.00	343.00	336.00	350.00	410.00	394.7	490.0	
Turbidity (NTU)	44.50	257.00	378.00	2.55	4.02	20.90	32.00	8.48	102.00	146.00	32.60	4.16	8.58	26.40	12.70	9.11	
Laboratory Analyses																	
Nitrogen																	
Nitrate as N (mg/L)	0.357	0.426	0.452	0.408	0.61	0.467	0.374	0.617	1.06	0.826	1.01	0.768	1.07	2.78	2.44	4.46	
Nitrite as N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.065	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Ammonia (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Total Kjeldahl Nitrogen (TKN)	-	<0.2	0.3	-	-	<0.2	0.4	0.43	-	<0.2	0.43	-	-	<0.2	0.31	0.32	
Total Nitrogen (mg/L)	0.357	0.426	0.76	0.408	0.834	0.532	0.78	1.06	1.06	0.826	1.44	0.768	1.07	2.78	2.75		
Anions																	
Chloride (mg/L)	103	118	117	120	123	114	98.9	112	97.3	92.2	90.7	88.3	93.2	106	115	125	
Sulfate (mg/L)	7.2	5.2	5.3	<5	<5	5.3	7.4	5.1	<5	<5	<5	<5	<5	<5	<5	<5	
Elements																	
Dissolved Iron (mg/L)	1.09	-	0.477	<0.1	-	<0.1	<0.1	<0.1	0.667	-	0.138	<0.1	-	<0.1	<0.1	<0.1	
Dissolved Manganese (mg/L)	0.18	-	0.03	<0.02	-	<0.02	<0.02	<0.02	0.088	-	<0.02	<0.02	-	<0.02	<0.02	<0.02	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Boron (mg/L)	<0.05	-	<0.05	-	-	-	-	-	<0.05	-	<0.05	-	-	-	-	-	
Sodium (mg/L)	-	-	63	-	-	-	-	-	-	-	37.2	-	-	-	-	-	
Other																	
DOC (mg/L)	<0.5	-	0.53	<0.5	0.707	1.14	1.58	0.258	0.612	-	<0.5	0.579	0.856	2.26	2.91	1.21	
Methane (µg/L)	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	11	10	-	-	-	-	-	-	18	16	-	-	-	-	-	

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BU2C										MW-BC1C	
	5.10										2.5	
Top of Screen Elevation (ft)												
Bottom of Screen Elevation (ft)	-4.90										-7.5	
Sampling Date	11/03/2016 ¹	11/17/2016	1/10/2017	2/23/2017	6/29/2017	9/12/2017	1/10/2018	4/18/2018	9/20/2018	10/4/2018	10/4/2016	4/19/2018
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Q5 Sample
Field Measurements												
pH (SU)	7.14	5.46	5.49	5.62	5.27	5.26	4.85	5.12	4.36	5.48	5.47	5.47
Temperature (°C)	15.20	14.89	12.78	14.78	15.22	15.67	14.76	15.2	15.0	13.37	13.2	13.2
Dissolved Oxygen (DO, mg/L)	1.31	2.17	2.40	5.96	11.94	5.59	6.22	6.05	6.59	7.75	7.94	7.94
Redox Potential (ORP, mV)	203.00	51.20	194.10	227.50	249.50	208.60	243.90	162.7	101.3	70.10	211.1	211.1
Specific Conductivity (µS/cm) ^c	535.00	516.00	569.00	367.00	579.00	658.00	630.00	538.2	618.0	1029.00	1122.0	1122.0
Turbidity (NTU)	11.40	14.20	5.55	7.33	2.08	11.35	3.86	5.72	5.19	-	1.13	1.13
Laboratory Analyses												
Nitrogen												
Nitrate as N (mg/L)	5.39	-	7.42	1.78	5.39	6.35	8.03	5.78	7.35	0.481	0.75	0.75
Nitrite as N (mg/L)	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01
Ammonia (mg/L)	<0.1	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN)	-	-	<0.2	0.55	-	-	<0.2	0.26	0.22	-	-	-
Total Nitrogen (mg/L)	5.39	-	-	2.32	5.39	6.35	8.03	6.04	6.04	0.481	1.19	1.19
Anions												
Chloride (mg/L)	134	-	143	96.8	146	174	165	162	169	438	279	279
Sulfate (mg/L)	<5	-	<5	<5	<5	<5	<5	<5	<5	11.5	9.2	9.2
Elements												
Dissolved Iron (mg/L)	0.817	-	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	<0.2	<0.2
Dissolved Manganese (mg/L)	0.26	-	-	0.077	0.081	-	0.076	0.078	0.078	-	0.066	0.066
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
Boron (mg/L)	<0.05	-	-	<0.05	-	-	-	-	-	-	-	-
Sodium (mg/L)	-	-	-	44.9	-	-	-	-	-	-	-	-
Other												
DOC (mg/L)	0.684	0.728	<0.5	<0.5	0.599	1.35	2.2	3.35	0.847	<0.5	1.99	1.99
Methane (µg/L)	<2	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	13	11	17	-	-	-	-	-	-	-	-

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BC2C										MW-BC3B					
	-1.48					-11.48					-10.80			-20.80		
Top of Screen Elevation (ft)																
Bottom of Screen Elevation (ft)																
Sampling Date	11/04/2016	11/17/2016	1/10/2017	2/24/2017	6/29/2017	9/13/2017	1/10/2018	4/19/2018	9/20/2018	3/27/2017	6/29/2017	9/13/2017	1/10/2018	4/19/2018	9/20/2018	
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																
pH (SU)	7.05	5.40	5.55	5.17	5.28	5.30	5.01	5.27	5.60	5.38	5.31	5.41	5.09	5.32	4.42	
Temperature (°C)	15.25	14.54	12.65	15.10	15.07	15.49	14.62	14.2	19.5	14.19	14.13	14.24	14.22	13.9	14.1	
Dissolved Oxygen (DO, mg/L)	1.65	1.67	1.87	5.73	12.16	4.94	5.20	5.01	4.13	2.50	6.98	3.29	3.27	3.40	3.41	
Redox Potential (ORP, mV)	74.80	100.70	169.00	259.10	239.90	256.70	184.90	215.0	165.2	113.80	251.90	238.30	137.40	191.4	104.5	
Specific Conductivity (µS/cm) ^c	368.00	340.00	363.00	332.00	361.00	416.00	391.00	482.7	480.0	518.00	611.00	630.00	559.00	539.0	581.0	
Turbidity (NTU)	6.00	19.20	16.60	20.40	3.76	2.62	2.40	0.37	478.00	5.69	16.40	5.82	4.65	2.82	3.62	
Laboratory Analyses																
Nitrogen																
Nitrate as N (mg/L)	4.16	-	5.91	3.32	3.42	3.13	4.25	3.26	0.407	2.2	4.59	3.45	4.26	3.45	4.96	
Nitrite as N (mg/L)	-	-	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	0.032	<0.01	<0.01	<0.01	<0.01	<0.01	
Ammonia (mg/L)	<0.1	-	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	0.91	<0.1	<0.1	<0.1	<0.1	<0.1	
Total Kjeldahl Nitrogen (TKN)	-	-	<0.2	0.92	-	-	<0.2	-	0.56	-	-	-	<0.2	-	0.31	
Total Nitrogen (mg/L)	4.43	-	-	4.24	3.42	3.13	4.33	3.61	-	2.59	4.59	3.45	4.26	3.69	-	
Anions																
Chloride (mg/L)	83.8	-	85.4	83.3	86.5	92.5	96	103	10	143	161	153	140	136	154	
Sulfate (mg/L)	6.4	-	<5	6.3	<5	<5	5.3	7	12.2	8.3	6.8	9.1	13.6	12.6	10.4	
Elements																
Dissolved Iron (mg/L)	-	-	-	<0.1	<0.1	-	<0.1	<0.2	0.131	<0.1	<0.1	-	<0.1	<0.2	<0.1	
Dissolved Manganese (mg/L)	-	-	-	0.092	0.062	-	0.063	0.05	<0.02	0.298	0.077	-	0.078	0.048	0.046	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Boron (mg/L)	-	-	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	
Sodium (mg/L)	-	-	-	41.8	-	-	-	-	-	-	-	-	-	-	-	
Other																
DOC (mg/L)	0.764	0.576	<0.5	1.54	1.68	3.32	1.67	3.31	2.68	1.86	1.02	3.79	2.36	4.95	1.65	
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	8	9	9	-	-	-	-	-	-	-	-	-	-	-	

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BX1B										MW-BX1C								
	-9.40					-19.40					5.37			-4.63					
Top of Screen Elevation (ft)																			
Bottom of Screen Elevation (ft)																			
Sampling Date	3/27/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/25/2018	3/27/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/25/2018	3/27/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/25/2018	
Type of Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																			
pH (SU)	4.67	5.05	5.03	4.04	4.77	6.56	4.44	4.70	4.80	3.89	4.59	4.82	4.44	4.70	4.80	3.89	4.59	4.82	
Temperature (°C)	13.76	14.28	14.50	13.33	14.1	14.2	13.87	14.32	14.44	13.44	14.1	13.5	13.87	14.32	14.44	13.44	14.1	13.5	
Dissolved Oxygen (DO, mg/L)	1.73	1.87	0.07	0.09	0.60	0.37	0.63	2.30	0.79	1.56	1.30	1.10	0.63	2.30	0.79	1.56	1.30	1.10	
Redox Potential (ORP, mV)	153.70	283.60	202.90	302.90	207.9	-111.6	199.90	315.80	232.40	328.60	230.9	-29.7	199.90	315.80	232.40	328.60	230.9	-29.7	
Specific Conductivity (µS/cm) ^c	367.00	446.00	470.00	468.00	456.2	574.0	521.00	473.00	447.00	499.00	450.0	499.0	521.00	473.00	447.00	499.00	450.0	499.0	
Turbidity (NTU)	29.80	326.00	19.44	68.80	100.00	218.00	0.98	55.80	7.11	5.93	0.50	26.30	0.98	55.80	7.11	5.93	0.50	26.30	
Laboratory Analyses																			
Nitrogen																			
Nitrate as N (mg/L)	11.4	34.4	39	10	28.5	<0.03	0.25	38.7	37.8	11.1	27.7	5.77	0.25	38.7	37.8	11.1	27.7	5.77	
Nitrite as N (mg/L)	0.018	<0.01	<0.01	<0.01	<0.01	0.049	0.012	<0.01	<0.01	0.074	0.016	0.118	0.012	<0.01	<0.01	0.074	0.016	0.118	
Ammonia (mg/L)	0.4	0.7	0.39	0.51	0.44	<0.1	1.09	0.5	0.22	0.18	0.37	0.16	1.09	0.5	0.22	0.18	0.37	0.16	
Total Kjeldahl Nitrogen (TKN)	-	-	-	<0.2	<0.2	2.14	-	-	-	<0.2	<0.2	2.9	-	-	-	<0.2	<0.2	2.9	
Total Nitrogen (mg/L)	12.9	37	39	10	28.5		1.52	42	37.8	11.2	27.7		1.52	42	37.8	11.2	27.7		
Anions																			
Chloride (mg/L)	43.1	41	37.9	33.4	47.1	38.5	49.6	40.8	37.3	34.5	52.6	45.9	49.6	40.8	37.3	34.5	52.6	45.9	
Sulfate (mg/L)	7.6	<5	<5	<5	8.4	44	<5	<5	<5	<5	10	18.1	<5	<5	<5	<5	10	18.1	
Elements																			
Dissolved Iron (mg/L)	<0.1	<0.1	-	<0.1	<0.1	67.6	<0.1	<0.1	-	<0.1	<0.1	24.2	<0.1	<0.1	-	<0.1	<0.1	24.2	
Dissolved Manganese (mg/L)	0.335	0.478	-	0.631	0.658	5.03	0.566	0.517	-	0.553	0.501	1.98	0.566	0.517	-	0.553	0.501	1.98	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Boron (mg/L)	-	-	-	0.052	0.056	-	-	-	-	0.052	0.057	-	-	-	-	0.052	0.057	-	
Sodium (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other																			
DOC (mg/L)	2.97	1.55	2.31	5.16	6.5	80.7	2.7	2.02	2.69	4.53	6.38	78.7	2.7	2.02	2.69	4.53	6.38	78.7	
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1010C											MW-B1020B					
	-0.10											-10.4					
	-10.10											-20.4					
Top of Screen Elevation (ft)																	
Bottom of Screen Elevation (ft)																	
Sampling Date	11/03/2016 ¹	11/17/2016	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/9/2018	4/18/2018	9/19/2018	11/04/2016 ¹	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/19/2018
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																	
pH (SU)	6.90	5.18	5.61	5.32	5.36	5.68	5.23	5.70	6.48	6.78	5.20	5.01	5.00	5.12	4.54	5.00	5.93
Temperature (°C)	14.60	14.28	12.22	14.69	15.04	15.97	13.43	14.4	15.4	13.70	11.94	14.13	14.71	15.69	13.82	14.4	21.9
Dissolved Oxygen (DO, mg/L)	0.87	0.71	0.49	1.07	1.39	0.12	2.11	2.19	0.07	1.03	0.60	2.77	1.44	0.20	0.16	5.90	4.05
Redox Potential (ORP, mV)	110.70	231.60	190.80	252.20	204.80	2.70	86.20	-28.5	-121.7	45.00	190.70	251.30	276.30	160.30	166.20	132.0	-65.0
Specific Conductivity (µS/cm) ^c	262.00	230.00	289.00	258.00	269.00	238.00	249.00	240.0	920.0	465.00	355.00	353.00	352.00	332.00	288.00	302.8	1366.0
Turbidity (NTU)	16.00	5.97	10.60	5.62	2.73	2.99	5.15	0.50	9.60	67.90	321.00	11.00	14.60	2.50	2.84	0.50	207.00
Laboratory Analyses																	
Nitrogen																	
Nitrate as N (mg/L)	13.6	-	6.74	9.94	13.8	2.49	2.76	6.66	<0.03	28.4	17.9	20.1	24.9	19.7	4.71	18.3	<0.03
Nitrite as N (mg/L)	-	-	0.509	0.474	0.171	0.185	0.052	0.026	0.049	-	<0.01	<0.01	0.158	0.076	0.091	0.028	0.02
Ammonia (mg/L)	<0.1	-	<0.1	0.18	<0.1	<0.1	0.13	0.16	<0.1	0.53	0.11	<0.1	<0.1	<0.1	0.14	<0.1	0.21
Total Kjeldahl Nitrogen (TKN)	-	-	1.36	1.95	-	-	0.88	1.03	1.9	-	1.79	2.92	-	-	<0.2	<0.2	5.48
Total Nitrogen (mg/L)	13.9	-	8.61	12.4	15.7	4.22	3.69	7.72	-	28.5	19.6	23	27.1	19.7	4.8	18.3	-
Anions																	
Chloride (mg/L)	27.5	-	24.3	25.2	24.2	23.6	22.6	21.5	27.5	49.8	33.6	34	32.3	30	25.1	25.2	35.1
Sulfate (mg/L)	-	-	23.7	16.5	11	22.6	10.8	14.3	19.9	-	<5	<5	<5	<5	6.8	6.1	33
Elements																	
Dissolved Iron (mg/L)	-	-	-	<0.1	0.143	3.88	9.69	9.62	87	2.52	-	0.153	<0.1	<0.1	<0.1	<0.1	10
Dissolved Manganese (mg/L)	-	-	-	0.234	0.324	0.996	0.531	0.6	5.78	0.948	-	0.293	0.333	0.32	0.307	0.326	0.896
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (mg/L)	-	-	-	<0.05	-	-	-	-	-	<0.05	-	0.053	-	-	-	-	-
Sodium (mg/L)	-	-	-	22.8	-	-	-	-	-	27.5	-	24.6	-	-	-	-	-
Other																	
DOC (mg/L)	-	0.696	-	13.9	16.9	21.4	13.6	13	321	-	-	1.11	3.24	3.67	6.02	5.43	668
Methane (µg/L)	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	11	31	15	-	-	-	-	-	-	9	6	-	-	-	-	-

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at:

<http://www.hbuehrer.ch/Rechner/O2sat.html>

2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.

3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.

4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1020C											MW-B1050A					
	4.50						-26.1					-36.1					
	-5.50																
Top of Screen Elevation (ft)																	
Bottom of Screen Elevation (ft)																	
Sampling Date	11/04/2016 ¹	11/17/2016	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	4/18/2018	9/19/2018	11/04/2016 ¹	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/9/2018	4/18/2018	9/25/2018
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample
Field Measurements																	
pH (SU)	6.88	5.27	5.38	5.17	5.16	5.22	4.54	5.09	5.74	7.15	5.60	5.50	5.00	5.27	5.06	5.35	6.19
Temperature (°C)	14.24	14.66	12.73	15.06	15.26	15.97	13.97	14.9	21.4	13.77	11.87	14.05	14.27	15.87	14.11	14.3	14.8
Dissolved Oxygen (DO, mg/L)	1.44	0.56	0.31	2.69	3.72	1.81	3.78	4.05	0.74	1.34	0.26	4.24	1.75	0.06	0.75	1.90	0.18
Redox Potential (ORP, mV)	50.30	106.70	194.80	292.20	277.20	161.90	204.20	150.8	29.6	43.00	142.20	226.20	264.40	174.20	129.60	182.9	-52.1
Specific Conductivity (µS/cm) ^c	242.00	227.00	269.00	253.00	247.00	161.90	201.00	212.9	228.0	612.00	505.00	1648.00	508.00	422.00	1486.00	281.5	457.0
Turbidity (NTU)	321.00	15.60	6.31	18.00	8.87	243.00	14.60	1.17	30.00	962.00	297.00	76.60	4.10	3.10	9.57	5.70	8.10
Laboratory Analyses																	
Nitrogen																	
Nitrate as N (mg/L)	10.6	-	11.1	12.6	13.9	12.4	2.97	9.7	1.92	37	26.6	11.8	26.8	26.7	4.89	13.1	11.7
Nitrite as N (mg/L)	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.033	-	0.105	<0.01	0.038	0.048	0.141	0.016	0.196
Ammonia (mg/L)	<0.1	-	0.19	<0.1	<0.1	<0.1	0.14	<0.1	0.14	1.93	1.72	0.54	0.57	1.24	0.38	0.28	0.28
Total Kjeldahl Nitrogen (TKN)	-	-	1.99	2.25	-	12.4	<0.2	<0.2	1.33	-	3.75	1.83	-	<0.2	<0.2	<0.2	1.85
Total Nitrogen (mg/L)	10.6	-	13.1	14.9	15	12.4	2.97	9.7	-	37.2	30.5	13.7	26.8	26.7	5.03	13.1	-
Anions																	
Chloride (mg/L)	25.5	-	25.6	25.6	24.8	24.1	18.7	18.7	16.7	54.8	48.9	399	48.9	41.4	429	44.8	63.7
Sulfate (mg/L)	-	-	5.6	6.1	5.8	5.8	6.7	8	20.4	-	6.1	<5	<5	<5	<5	<5	27.1
Elements																	
Dissolved Iron (mg/L)	2.23	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	5.58	4.29	-	<0.1	<0.1	-	<0.1	<0.1	41.4
Dissolved Manganese (mg/L)	0.249	-	-	0.076	0.057	0.042	0.054	0.06	0.249	0.655	-	0.18	0.654	-	0.236	0.214	1.95
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (mg/L)	0.085	-	-	0.083	-	-	-	-	-	<0.05	-	<0.05	-	-	-	-	-
Sodium (mg/L)	13.4	-	-	18.4	-	-	-	-	-	33.7	-	345	-	-	-	-	-
Other																	
DOC (mg/L)	-	0.85	-	1.02	1.34	2.19	4.52	6.02	45.5	-	-	0.808	1.85	3.72	2.83	3.96	28
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	13	11	8	-	-	-	-	-	-	24	11	-	-	-	-	-

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1050B										MW-B1050C					
	-11.1										4.9					
Top of Screen Elevation (ft)	-5.1															
Bottom of Screen Elevation (ft)	-21.1															
Sampling Date	11/04/2016 ¹	2/23/2017	6/28/2017	9/12/2017	1/9/2018	4/18/2018	9/25/2018	11/04/2016 ¹	2/23/2017	6/28/2017	9/12/2017	1/9/2018	4/18/2018	9/25/2018		
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample		
Field Measurements																
pH (SU)	7.06	5.13	5.10	5.22	4.74	5.08	3.81	7.20	5.43	5.34	5.38	4.96	5.40	5.38		
Temperature (°C)	14.08	14.27	14.70	15.48	14.19	14.5	14.1	14.55	14.95	15.06	15.77	14.51	14.9	14.6		
Dissolved Oxygen (DO, mg/L)	1.17	2.12	4.53	1.06	2.17	3.38	3.22	1.34	1.83	5.39	1.85	1.64	1.82	2.16		
Redox Potential (ORP, mV)	80.30	304.40	260.10	203.80	160.40	306.5	151.8	48.60	205.90	230.20	176.50	167.20	171.8	157.7		
Specific Conductivity (µS/cm) ^c	446.00	463.00	387.00	340.00	392.00	306.0	345.0	571.00	511.00	542.00	478.00	413.00	302.3	212.0		
Turbidity (NTU)	3.97	7.20	0.72	2.75	5.06	5.03	3.87	8.21	2.27	0.98	3.23	1.90	0.80	1.51		
Laboratory Analyses																
Nitrogen																
Nitrate as N (mg/L)	25.7	28.7	18.2	18	10.8	20.1	24.3	3.83	3.96	3.26	4.18	2	5.76	8.43		
Nitrite as N (mg/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.049	-	<0.01	<0.01	<0.01	0.088	<0.01	<0.01		
Ammonia (mg/L)	0.19	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
Total Kjeldahl Nitrogen (TKN)	-	1.85	-	-	<0.2	<0.2	<0.2	-	1.28	-	-	<0.2	<0.2	<0.2		
Total Nitrogen (mg/L)	26	30.5	18.2	18	10.8	20.1	4.05	4.05	5.24	3.26	4.4	2.08	5.76	-		
Anions																
Chloride (mg/L)	48.2	50.7	41.7	38.2	36.7	29.1	36.8	141	123	134	120	85.7	61.7	32.8		
Sulfate (mg/L)	-	<5	<5	<5	<5	<5	<5	-	20.1	15.2	14.6	17.9	22.2	15.3		
Elements																
Dissolved Iron (mg/L)	0.734	<0.1	<0.1	-	<0.1	<0.1	<0.1	0.493	<0.1	<0.1	-	<0.1	<0.1	<0.1		
Dissolved Manganese (mg/L)	0.332	0.142	0.101	-	0.115	0.128	0.147	0.146	0.042	0.057	-	0.034	0.025	0.021		
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Boron (mg/L)	<0.05	<0.05	-	-	-	-	-	<0.05	<0.05	-	-	-	-	-		
Sodium (mg/L)	26.8	16.9	-	-	-	-	-	81.6	94.5	-	-	-	-	-		
Other																
DOC (mg/L)	-	0.722	1.31	3.43	3.21	3.68	9.71	-	0.592	1.62	2.19	3.26	5.78	3.74		
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Alkalinity as CaCO3 (mg/L)	-	7	-	-	-	-	-	-	17	-	-	-	-	-		

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1075B										MW-B2010C					
	-11.5										-10					
Top of Screen Elevation (ft)	0															
Bottom of Screen Elevation (ft)	-10															
Sampling Date	11/04/2016 ¹	2/23/2017	6/28/2017	9/13/2017	1/9/2018	4/18/2018	9/25/2018	11/03/2016 ¹	11/17/2016	2/24/2017	6/28/2017	9/13/2017	1/10/2018	4/19/2018	9/20/2018	
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																
pH (SU)	7.19	5.59	5.66	5.83	5.53	5.74	4.49	7.04	5.32	5.70	6.11	6.29	6.20	6.51	6.53	
Temperature (°C)	15.20	14.20	14.74	14.93	14.13	14.6	14.2	15.12	14.58	14.81	15.39	15.69	14.71	14.6	16.9	
Dissolved Oxygen (DO, mg/L)	0.71	1.50	1.95	0.12	0.11	0.43	0.59	0.67	0.61	3.38	1.78	0.10	0.10	0.30	0.14	
Redox Potential (ORP, mV)	82.20	157.90	223.10	99.00	135.00	95.5	25.2	12.40	213.80	103.30	-41.60	-119.80	-102.10	-153.0	-133.0	
Specific Conductivity (µS/cm) ^c	631.00	1755.00	736.00	719.00	2688.00	1048.0	717.0	333.00	304.00	302.00	431.00	689.00	862.00	860.0	764.0	
Turbidity (NTU)	13.00	126.00	1.87	24.23	173.00	42.00	3.68	149.00	44.40	19.90	6.89	5.10	3.32	0.25	9.40	
Laboratory Analyses																
Nitrogen																
Nitrate as N (mg/L)	1.93	1	0.553	0.751	0.609	5.57	8.18	15.7	-	5.06	5.74	0.182	<0.03	<0.03	<0.03	
Nitrite as N (mg/L)	-	0.048	0.05	0.064	0.201	0.098	0.062	-	-	0.499	0.128	0.081	0.027	0.09	0.058	
Ammonia (mg/L)	3.73	5.26	11	12.2	14.3	17.8	9.56	0.14	-	<0.1	0.24	<0.1	0.17	0.49	0.86	
Total Kjeldahl Nitrogen (TKN)	-	7.2	-	-	14.4	17.7	10.5	-	-	14.7	-	-	1.75	-	1.93	
Total Nitrogen (mg/L)	6.36	8.25	13.6	15.1	15.3	23.4	-	16.1	-	20.3	7.69	2.26	1.75	2.34	-	
Anions																
Chloride (mg/L)	96.3	440	170	147	764	258	159	38.6	-	27.5	30	37.4	35.5	28.5	33.9	
Sulfate (mg/L)	-	25.6	28.9	26.8	31.6	24.8	15.8	11	-	24.3	39.8	73.5	57	51.5	17.8	
Elements																
Dissolved Iron (mg/L)	-	0.342	<0.1	-	0.886	0.253	<0.1	-	-	1.84	24.2	46.2	88.2	110	89.1	
Dissolved Manganese (mg/L)	-	0.119	0.111	-	0.142	0.12	0.083	-	-	0.189	1.62	2.56	5.15	5.77	4.54	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0599	
Boron (mg/L)	-	<0.05	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	
Sodium (mg/L)	-	379	-	-	-	-	-	-	-	28.5	-	-	-	-	-	
Other																
DOC (mg/L)	-	1.96	4.86	9.48	8.77	11.1	4.63	2.18	0.852	19.4	83.3	69.4	94.3	52.5	19.7	
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	11.3	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	46	-	-	-	-	-	-	16	48	-	-	-	-	-	

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2020B										MW-B2020C							
	-10.1					-20.1					4.8			-5.2				
Top of Screen Elevation (ft)																		
Bottom of Screen Elevation (ft)																		
Sampling Date	11/03/2016 ¹	11/17/2016	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	4/19/2018	9/25/2018	11/03/2016 ¹	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	4/19/2018	9/19/2018	
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																		
pH (SU)	7.00	5.22	5.05	5.10	5.04	5.45	4.95	5.62	5.82	7.00	5.12	5.09	5.60	5.76	5.16	5.85	6.11	
Temperature (°C)	14.91	14.39	12.23	14.53	14.86	15.14	14.28	14.4	14.5	15.20	12.90	15.42	15.57	15.80	14.72	14.9	17.7	
Dissolved Oxygen (DO, mg/L)	1.15	0.63	0.85	2.03	3.88	0.08	0.08	0.30	0.66	1.31	1.30	3.96	1.70	0.13	0.06	0.34	0.60	
Redox Potential (ORP, mV)	90.80	182.60	170.50	308.10	285.90	120.70	173.60	149.3	16.7	29.80	201.50	316.20	73.80	-15.70	8.50	-36.0	15.2	
Specific Conductivity (µS/cm) ^c	321.00	307.00	344.00	338.00	354.00	323.00	370.00	339.4	449.0	249.00	251.00	225.00	264.00	248.00	250.00	303.4	309.0	
Turbidity (NTU)	14.30	17.40	6.95	6.11	8.12	5.91	10.00	4.01	4.40	28.00	5.81	5.17	6.23	1.30	6.09	0.50	6.45	
Laboratory Analyses																		
Nitrogen																		
Nitrate as N (mg/L)	16.9	-	25.6	14.8	22.4	5.96	3.26	2.4	3.06	8.71	12.6	6.95	0.457	<0.03	<0.03	<0.03	<0.03	
Nitrite as N (mg/L)	0.022	-	<0.01	<0.01	<0.01	0.54	2.98	1.43	0.314	0.016	<0.01	<0.01	0.072	0.01	0.083	<0.01	0.012	
Ammonia (mg/L)	0.1	-	<0.1	<0.1	<0.1	<0.1	0.23	<0.1	0.11	0.24	<0.1	<0.1	<0.1	<0.1	0.14	0.13	<0.1	
Total Kjeldahl Nitrogen (TKN)	-	-	<0.2	3.86	-	-	4.32	-	0.91	-	<0.2	2.33	-	-	1.04	-	0.84	
Total Nitrogen (mg/L)	17.2	-	-	18.7	24.2	7.84	10.6	4.58	-	9.02	-	9.28	0.85	0.424	1.1	1.19	-	
Anions																		
Chloride (mg/L)	32.5	-	34.9	32.7	39.3	38	51.4	34.8	46.9	26.8	31	28.4	32.2	31.2	33	28.5	30.7	
Sulfate (mg/L)	7.7	-	6	7.1	6.4	29.7	19.3	37	42.5	11.6	9.7	11.9	36.8	20.9	29	27.6	19.6	
Elements																		
Dissolved Iron (mg/L)	1.2	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	17.6	1.42	-	<0.1	7.97	13.1	1.83	4.56	14.5	
Dissolved Manganese (mg/L)	0.126	-	-	0.028	0.029	0.187	0.374	0.76	3.54	1.14	-	0.067	0.964	2.08	5.09	8.28	11.1	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	<0.0025	-	-	-	-	-	-	-	-	
Boron (mg/L)	<0.05	-	-	0.054	-	-	-	-	-	<0.05	-	<0.05	-	-	-	-	-	
Sodium (mg/L)	-	-	-	21.6	-	-	-	-	-	-	-	15.2	-	-	-	-	-	
Other																		
DOC (mg/L)	1.45	0.694	<0.5	1.02	3.47	29.8	16.5	17	17.3	1.17	<0.5	2.04	23.3	14.2	11.8	7.76	11.5	
Methane (µg/L)	<2	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	20	12	8	-	-	-	-	-	-	10	7	-	-	-	-	-	

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2050A										MW-B2050B					
	-25.4					-35.4					-10.4			-20.4		
Top of Screen Elevation (ft)																
Bottom of Screen Elevation (ft)																
Sampling Date	11/03/2016 ¹	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	4/19/2018	9/19/2018	11/03/2016 ¹	2/24/2017	6/28/2017	9/13/2017	1/9/2018	4/19/2018	9/19/2018	
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	
Field Measurements																
pH (SU)	7.11	5.39	5.29	5.27	5.34	4.85	5.25	5.20	7.06	5.22	5.29	5.30	4.79	5.24	5.22	
Temperature (°C)	14.44	11.96	14.06	14.47	14.58	14.05	13.9	14.4	14.95	14.64	15.27	15.31	14.32	14.7	14.8	
Dissolved Oxygen (DO, mg/L)	0.60	0.09	0.83	1.66	0.06	0.07	0.52	0.04	1.29	3.75	5.97	1.27	1.43	1.97	1.67	
Redox Potential (ORP, mV)	0.80	182.80	251.80	217.00	98.90	147.00	197.8	156.5	80.50	304.60	242.20	169.70	156.90	203.3	168.4	
Specific Conductivity (µS/cm) ^c	540.00	520.00	550.00	505.00	509.00	660.00	520.2	412.0	512.00	645.00	502.00	510.00	495.00	435.1	271.0	
Turbidity (NTU)	50.70	8.10	14.10	26.70	5.04	4.16	10.40	5.25	123.00	4.67	5.78	0.61	1.54	0.50	1.02	
Laboratory Analyses																
Nitrogen																
Nitrate as N (mg/L)	35	39.3	27	32.8	25.5	11.6	24	22.9	4.75	3.64	5.27	3.94	1.72	4.04	4.94	
Nitrite as N (mg/L)	-	0.025	<0.010	<0.01	0.166	0.04	0.179	0.215	-	<0.010	<0.01	<0.01	0.046	<0.01	0.011	
Ammonia (mg/L)	1.05	0.87	0.89	1	0.63	0.78	0.83	0.68	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	
Total Kjeldahl Nitrogen (TKN)	-	3.32	3.5	-	-	<0.2	-	<0.2	-	1.22	-	-	<0.2	-	0.35	
Total Nitrogen (mg/L)	35.3	-	30.5	35.4	25.6	11.6	24.2	-	5.15	4.86	5.91	3.94	1.76	4.27	-	
Anions																
Chloride (mg/L)	49.9	64.5	63.3	66.8	65.8	114	75.1	69.6	123	173	124	119	121	82.4	63.9	
Sulfate (mg/L)	5.6	5.6	6.2	7.5	5.3	6.1	7.6	6.2	11.5	11.5	11	8.7	11.4	15.2	10.3	
Elements																
Dissolved Iron (mg/L)	3.2	-	<0.1	<0.1	-	<0.1	<0.2	<0.1	0.551	<0.1	<0.1	-	<0.1	<0.2	<0.1	
Dissolved Manganese (mg/L)	0.407	-	0.293	0.26	-	0.258	0.265	0.222	0.258	0.297	0.258	-	0.315	0.311	0.222	
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Boron (mg/L)	<0.05	-	<0.05	-	-	-	-	-	<0.05	<0.05	-	-	-	-	-	
Sodium (mg/L)	-	-	40	-	-	-	-	-	-	81.7	-	-	-	-	-	
Other																
DOC (mg/L)	1.61	-	1.08	1.37	5.63	2.76	5.54	2.1	1.15	1.08	0.754	5.01	4.25	4.76	2.68	
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	17	13	-	-	-	-	-	-	11	-	-	-	-	-	

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at:

<http://www.hbuehrer.ch/Rechner/O2sat.html>

2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.

3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.

4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2050C										MW-B2075A						
	4.6					-5.4					-20.40			-30.40			
Top of Screen Elevation (ft)																	
Bottom of Screen Elevation (ft)																	
Sampling Date	11/03/2016 ¹	2/24/2017	6/28/2017	9/13/2017	1/9/2018	4/19/2018	9/19/2018	3/27/2017	6/28/2017	9/12/2017	1/10/2018	4/19/2018	9/25/2018				
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample				
Field Measurements																	
pH (SU)	7.22	5.49	5.38	5.40	5.11	5.39	5.25	5.21	5.50	5.53	5.27	5.51	5.52				
Temperature (°C)	16.72	16.56	16.90	17.37	14.40	16.5	15.8	14.42	14.98	15.40	14.53	14.6	14.1				
Dissolved Oxygen (DO, mg/L)	1.09	5.76	8.95	4.51	5.82	3.09	3.22	4.08	7.83	7.02	5.27	5.47	6.64				
Redox Potential (ORP, mV)	82.50	179.50	236.30	177.90	171.50	207.7	179.7	130.70	234.90	205.30	173.40	152.7	193.6				
Specific Conductivity (µS/cm) ^c	658.00	932.00	896.00	970.00	903.00	980.0	865.0	744.00	748.00	883.00	856.00	855.0	996.0				
Turbidity (NTU)	212.00	36.10	9.68	20.03	16.10	86.50	120.00	159.00	3.85	43.20	333.00	414.00	24.90				
Laboratory Analyses																	
Nitrogen																	
Nitrate as N (mg/L)	3.01	1.68	3.05	2.19	1.41	2.9	3.47	0.348	0.539	0.676	0.762	0.642	0.81				
Nitrite as N (mg/L)	-	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
Ammonia (mg/L)	0.11	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1				
Total Kjeldahl Nitrogen (TKN)	-	0.66	-	-	<0.2	-	<0.2	-	-	-	0.31	-	0.45				
Total Nitrogen (mg/L)	3.3	2.34	3.75	2.53	1.41	2.9	-	0.35	0.779	1.09	1.07	1.33	-				
Anions																	
Chloride (mg/L)	-	251	253	278	257	270	315	246	214	261	257	268	308				
Sulfate (mg/L)	11.9	11.1	10.1	8.9	9.6	13.5	9.3	5.7	<5	5.4	6.5	7.7	7.7				
Elements																	
Dissolved Iron (mg/L)	-	0.308	<0.1	-	<0.1	<0.2	<0.1	0.119	<0.1	-	<0.1	<0.2	<0.1				
Dissolved Manganese (mg/L)	-	0.254	0.13	-	0.102	0.09	0.077	0.529	0.062	-	0.069	0.051	0.028				
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-				
Boron (mg/L)	-	<0.05	-	-	-	-	-	-	-	-	-	-	-				
Sodium (mg/L)	-	120	-	-	-	-	-	-	-	-	-	-	-				
Other																	
DOC (mg/L)	1.13	0.87	0.639	3.73	2.75	2.93	1.33	1.08	0.668	0.722	2.26	0.882	1.31				
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-				
Alkalinity as CaCO ₃ (mg/L)	-	9	-	-	-	-	-	-	-	-	-	-	-				

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at:

<http://www.hbuehrer.ch/Rechner/O2sat.html>

2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.

3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.

4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2100C										MW-BC4A		MW-BC4B		MW-BC4C		MW-BM050A		
	9.6										-26.50	-11.50	3.50	-25.32	5/8/2018		9/20/2018		
Top of Screen Elevation (ft)	-0.4										-36.50	-21.50	-6.50	-35.32	5/8/2018		9/20/2018		
Bottom of Screen Elevation (ft)															5/8/2018		9/20/2018		
Sampling Date	10/4/2016	11/03/2016 ¹	2/24/2017	6/28/2017	9/12/2017	1/10/2018	4/19/2018	9/25/2018	5/8/2018	9/20/2018	5/8/2018	9/20/2018	5/8/2018	9/20/2018	5/8/2018	9/20/2018	5/8/2018	9/20/2018	
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q5 Sample	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample	
Field Measurements																			
pH (SU)	5.26	6.98	5.46	5.27	5.41	4.93	5.32	6.09	5.34	4.32	5.40	5.37	5.21	5.90	5.90	4.83	5.90	4.83	4.83
Temperature (°C)	14.42	14.95	16.84	14.44	14.43	14.55	14.4	14.0	11.2	13.6	17.6	12.0	15.2	12.0	12.0	14.0	12.0	14.0	14.0
Dissolved Oxygen (DO, mg/L)	5.90	1.50	7.37	10.84	5.09	4.99	4.35	4.71	0.13	0.95	1.68	0.09	0.30	0.77	0.77	1.03	0.77	1.03	1.03
Redox Potential (ORP, mV)	110.50	124.70	189.80	217.40	216.7	206	172.3	85.7	74.1	119.9	164.3	120.1	173.6	27.5	27.5	32.9	27.5	32.9	32.9
Specific Conductivity (µS/cm) ^c	272.00	297.00	346.00	364.00	377	378	322.8	458.0	601.8	326.0	274.0	380.5	287.0	811.2	811.2	570.0	811.2	570.0	570.0
Turbidity (NTU)	-	8.44	OVER	5.71	2.97	2.87	0.50	10.00	14.00	3.85	520.00	4.49	over	13.20	13.20	53.20	13.20	53.20	53.20
Laboratory Analyses																			
Nitrogen																			
Nitrate as N (mg/L)	1.29	1.29	0.959	0.724	0.903	1.13	1.23	2.43	5.65	1.72	1.88	1.47	2.67	2.57	2.23	2.23	2.57	2.23	2.23
Nitrite as N (mg/L)	-	-	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.25	0.164	0.324	0.27	0.521	<0.25	<0.01	<0.01	<0.25	<0.01	<0.01
Ammonia (mg/L)	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.38	<0.1	<0.1	0.22	<0.1	<0.1	<0.1	<0.1	0.24	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN)	0.72	-	0.54	-	-	0.21	-	0.39	0.97	0.46	0.52	0.54	0.39	0.57	0.45	0.45	0.57	0.45	0.45
Total Nitrogen (mg/L)	2.01	1.29	1.5	0.724	1.31	1.33	1.57	-	0.97	0.97	0.64	0.54	0.39	0.57	0.45	0.45	0.57	0.45	0.45
Anions																			
Chloride (mg/L)	65.4	67.8	83.2	96.4	97.3	97.8	72.5	116	77.2	60.2	72.6	33.2	72.1	150	153	153	150	153	153
Sulfate (mg/L)	14.1	16.2	12.1	10	8.3	10.8	13.9	9.4	14.8	27.5	33	25.6	17.8	7.7	<5	<5	7.7	<5	<5
Elements																			
Dissolved Iron (mg/L)	0.115	-	0.147	<0.1	-	<0.1	<0.2	<0.1	0.212	<0.1	0.217	0.486	<0.1	1.83	0.143	0.143	1.83	0.143	0.143
Dissolved Manganese (mg/L)	0.126	-	0.196	0.114	-	0.102	0.096	0.119	0.176	0.075	0.428	0.173	0.278	0.211	0.163	0.163	0.211	0.163	0.163
Arsenic (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (mg/L)	<0.05	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium (mg/L)	-	-	53.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other																			
DOC (mg/L)	<0.5	0.866	0.862	0.959	0.78	2.28	2.25	1.17	6.67	11.4	14.1	9.39	7.49	1.2	1.33	1.33	1.2	1.33	1.33
Methane (µg/L)	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at:

<http://www.hbuehrer.ch/Rechner/O2sat.html>

2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.

3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.

4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BM050B	MW-BM050C	MW-BN1A	MW-BN1B	MW-BN1C	MB-BN2C	MW-BX2A	MW-BX2B	MW-BX2C
Top of Screen Elevation (ft)	-10.20	4.80	-25.50	-10.60	4.38	10.21	-23.60	-8.60	6.47
Bottom of Screen Elevation (ft)	-20.20	-5.20	-35.50	-20.60	-5.63	0.21	-33.60	-18.60	-3.53
Sampling Date	5/8/2018	5/9/2018	9/20/2018	5/9/2018	9/20/2018	5/9/2018	9/20/2018	5/9/2018	9/20/2018
Type of Sample	D2 Baseline	Q6 Sample	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample	D2 Baseline	Q6 Sample
Field Measurements									
pH (SU)	5.38	4.48	4.39	4.52	5.08	5.40	4.79	4.68	4.74
Temperature (°C)	13.4	14.6	14.0	14.1	14.4	15.4	10.9	11.1	11.6
Dissolved Oxygen (DO, mg/L)	0.01	0.30	0.00	0.26	0.86	3.75	0.00	1.12	3.79
Redox Potential (ORP, mV)	132.2	35.5	186.9	46.3	32.7	147.8	234.0	250.5	257.1
Specific Conductivity (µS/cm) ^c	1312.5	886.0	717.0	623.8	628.0	9096.0	184.0	690.0	769.4
Turbidity (NTU)	1.54	3.53	7.00	7.70	19.10	186.00	1.04	2.97	7.37
Laboratory Analyses									
Nitrogen									
Nitrate as N (mg/L)	4.9	6.39	10.1	10.6	9.66	0.942	29	27.9	39.7
Nitrite as N (mg/L)	<0.25	0.016	<0.25	0.046	0.128	<0.25	<0.01	<0.25	<0.25
Ammonia (mg/L)	0.55	1.52	0.5	1.26	9.97	<0.1	0.57	0.3	0.29
Total Kjeldahl Nitrogen (TKN)	0.37	2.15	0.59	1.16	11.4	0.32	0.25	<0.2	<0.2
Total Nitrogen (mg/L)	0.37	1.65	10.1	9.3	NS	1.16	29.2	27.9	39.7
Anions									
Chloride (mg/L)	258	115	28	70.6	109	2620	42.2	43	29.3
Sulfate (mg/L)	25.7	17.3	20.2	33.2	28.1	<5	8.6	9.6	7.3
Elements									
Dissolved Iron (mg/L)	0.537	<0.1	0.225	0.33	<0.1	2.68	<0.1	<0.1	<0.1
Dissolved Manganese (mg/L)	0.319	0.06	0.342	0.089	0.36	0.944	0.614	0.433	0.833
Arsenic (mg/L)	-	-	-	-	-	-	<0.0025	<0.0025	<0.0025
Boron (mg/L)	-	-	-	-	-	-	-	-	-
Sodium (mg/L)	-	-	-	-	-	-	-	-	-
Other									
DOC (mg/L)	2.42	2.43	3.69	6.18	4.16	1.15	5.32	4.89	4.18
Methane (µg/L)	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	-	-	-	-	-	-	-	-

Notes:

- NS - Not Sampled
- Bold - detected above the Minimum Detection Limit
- D - Duplicate
- 1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2sat.html>
- 2. MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 3. Existing wells (MW-4, MW-8, MW-12C) screen elevations were determined based on field measurement of depth to bottom of well. Actual screen depths may vary if bottom was affected by silt build-up in well.
- 4. MW-12C (existing) was damaged during snow removal at the site in Winter 2017. A sample was unable to be taken during subsequent events. It was repaired in April 2018.

Figures

This Page Intentionally Left Blank.

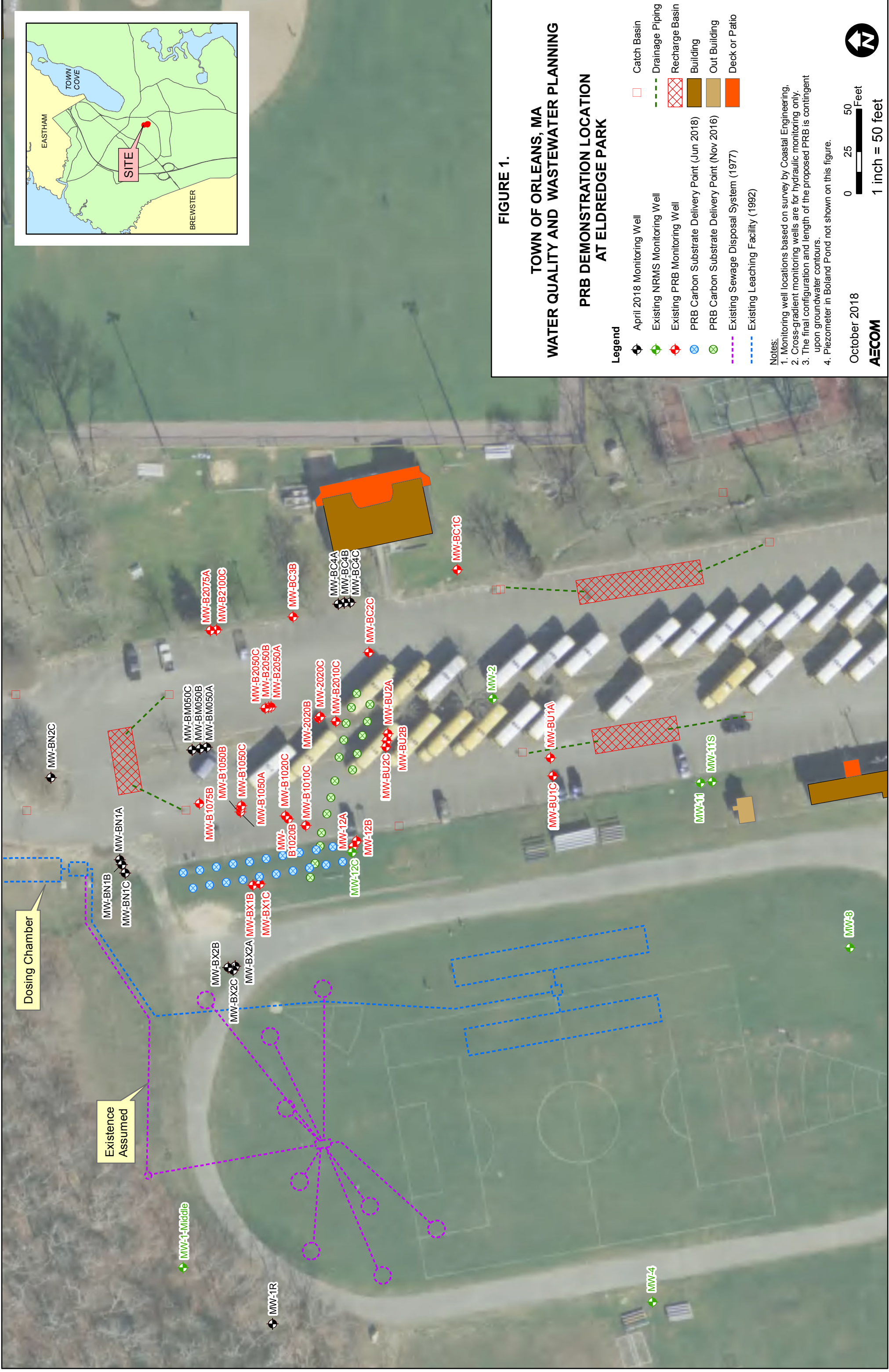
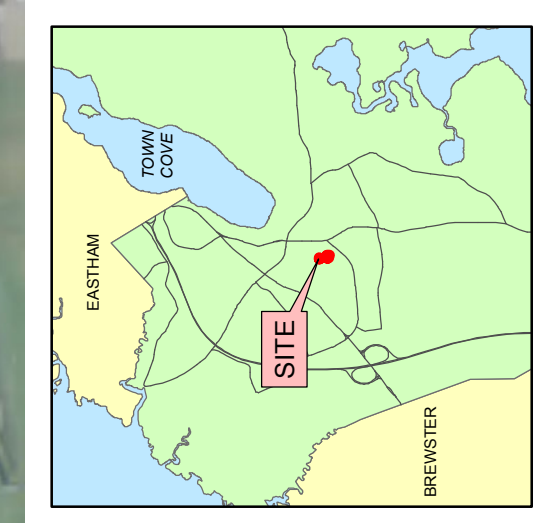


FIGURE 1.
TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING
PRB DEMONSTRATION LOCATION
AT ELDRIDGE PARK



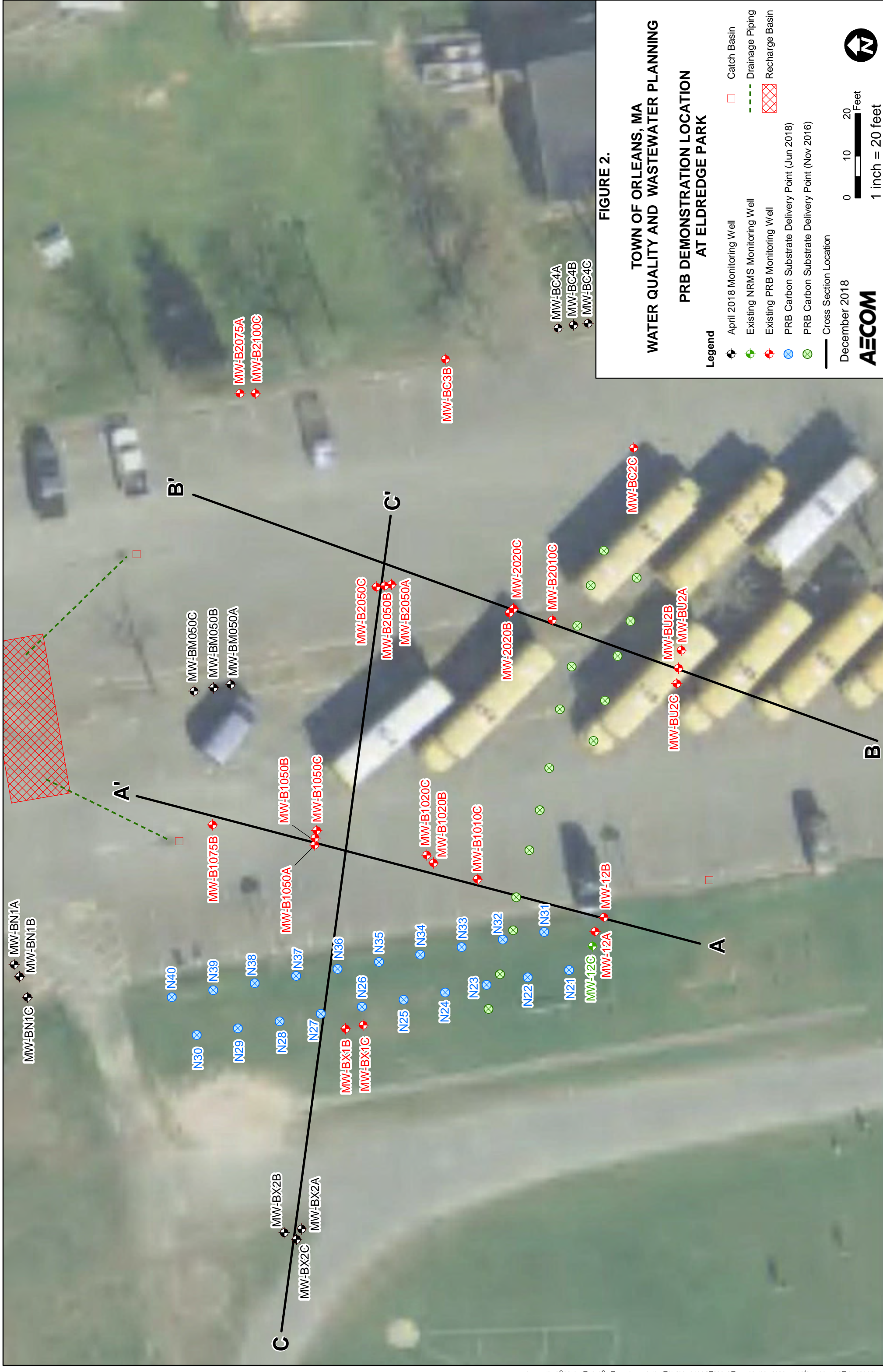


FIGURE 2.

**TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING
PRB DEMONSTRATION LOCATION
AT ELDRIDGE PARK**

- Legend**
- April 2018 Monitoring Well
 - Existing NRMS Monitoring Well
 - Existing PRB Monitoring Well
 - PRB Carbon Substrate Delivery Point (Jun 2018)
 - PRB Carbon Substrate Delivery Point (Nov 2016)
 - Catch Basin
 - Drainage Piping
 - Recharge Basin

December 2018

AECOM

0 10 20 Feet
1 inch = 20 feet

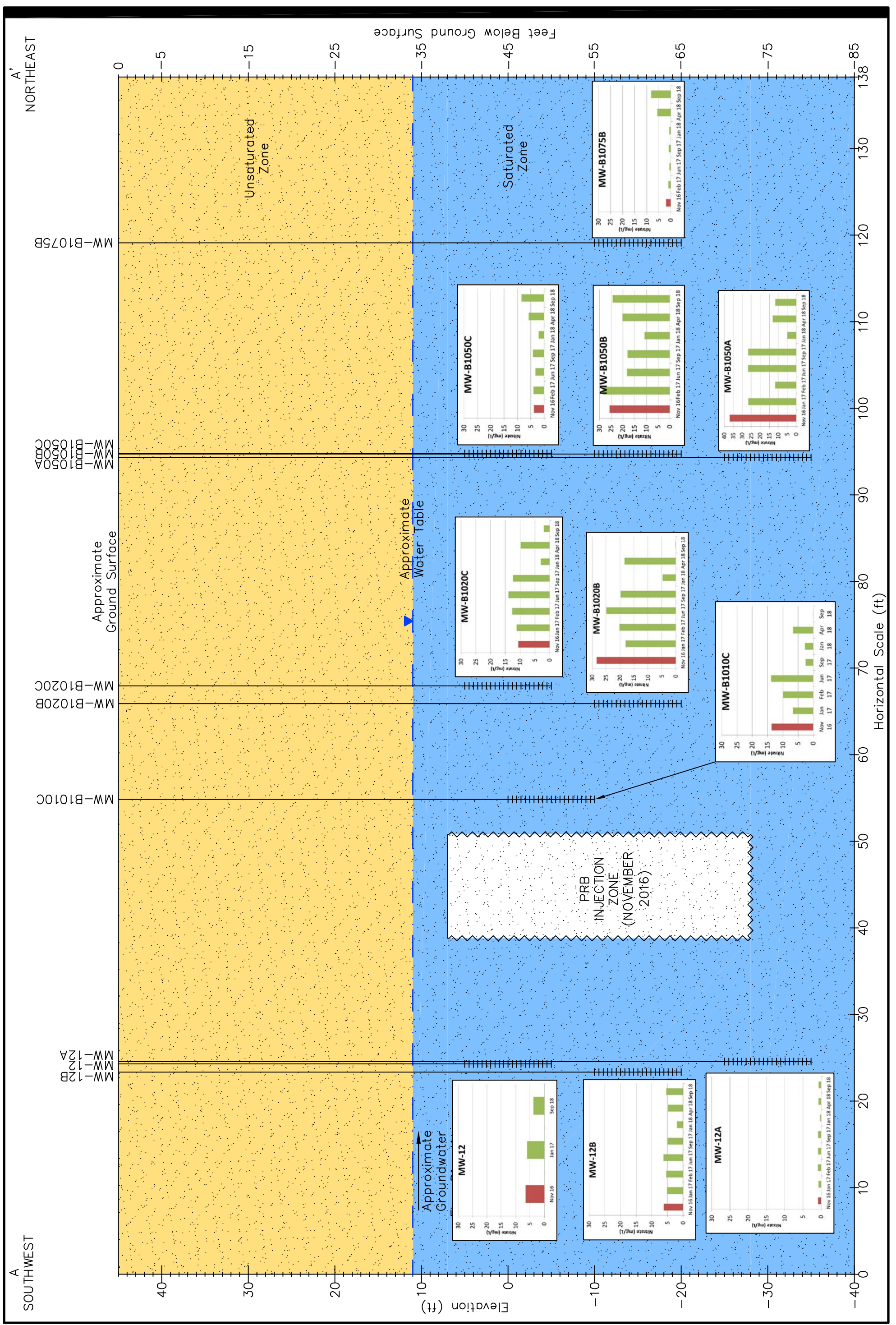
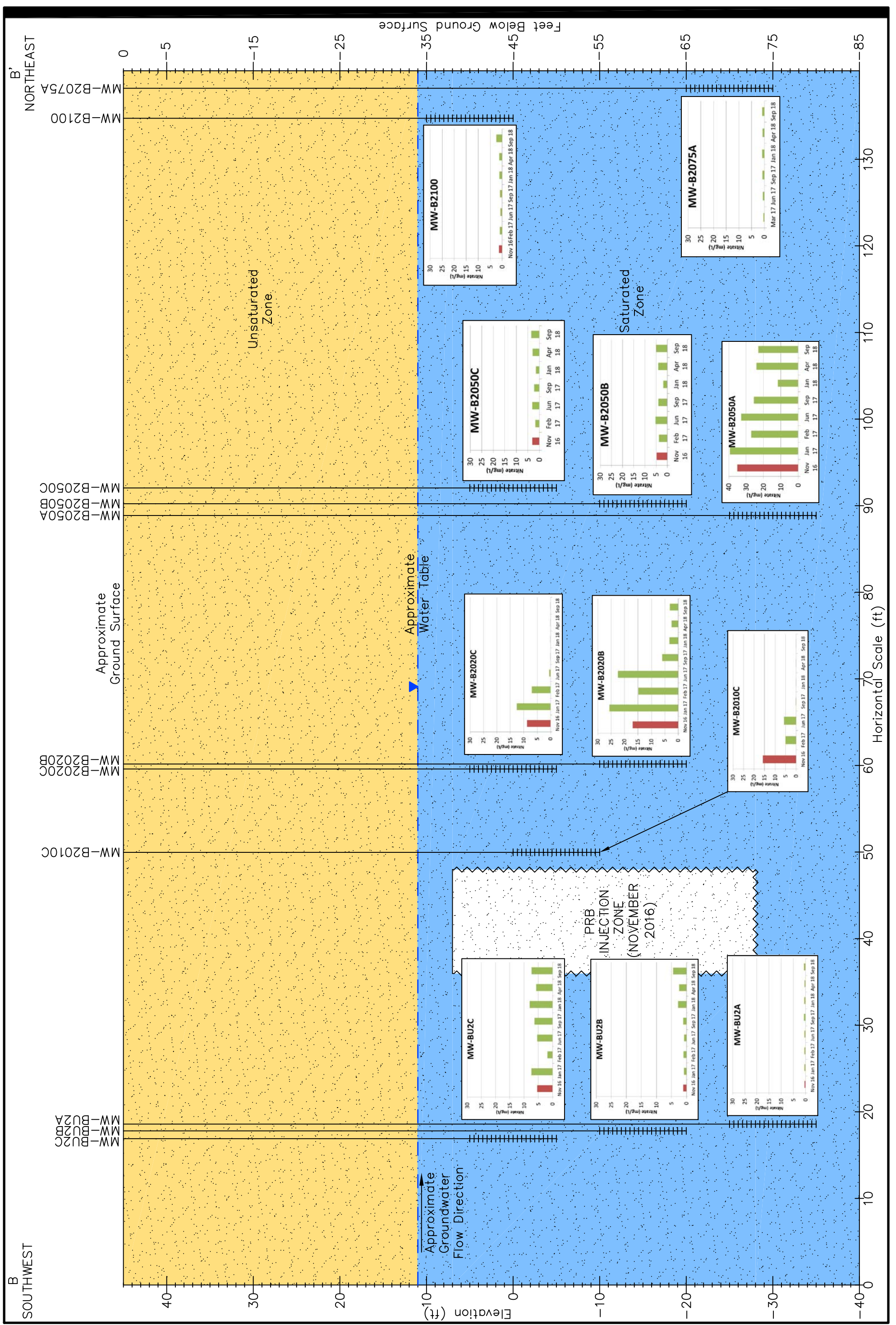
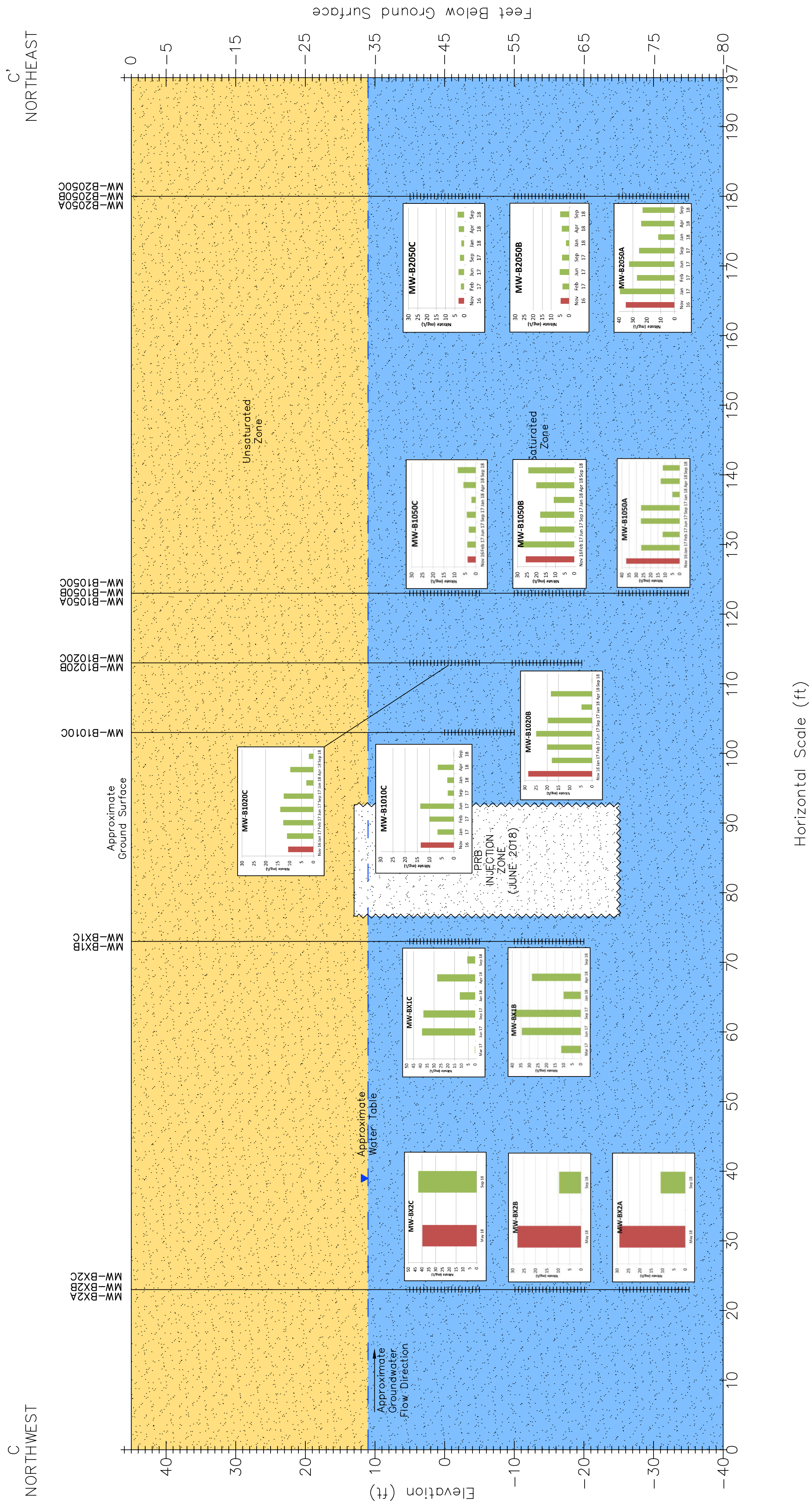


Figure: 3







NOTE: THE PROJECTION OF THE WELL LOCATIONS ARE RELATIVE TO THE PRB.

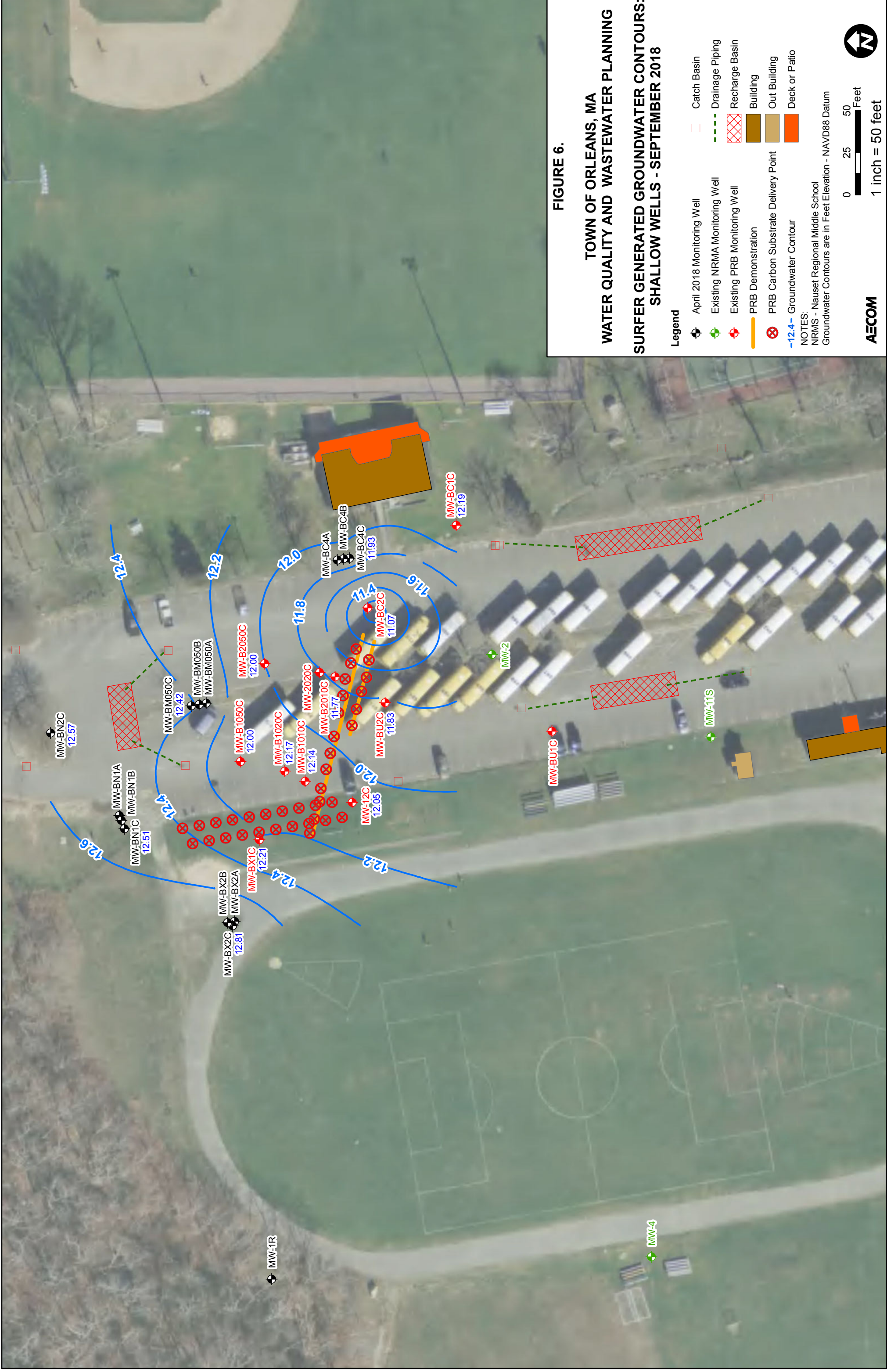


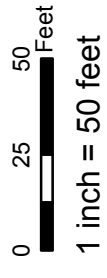
FIGURE 6.

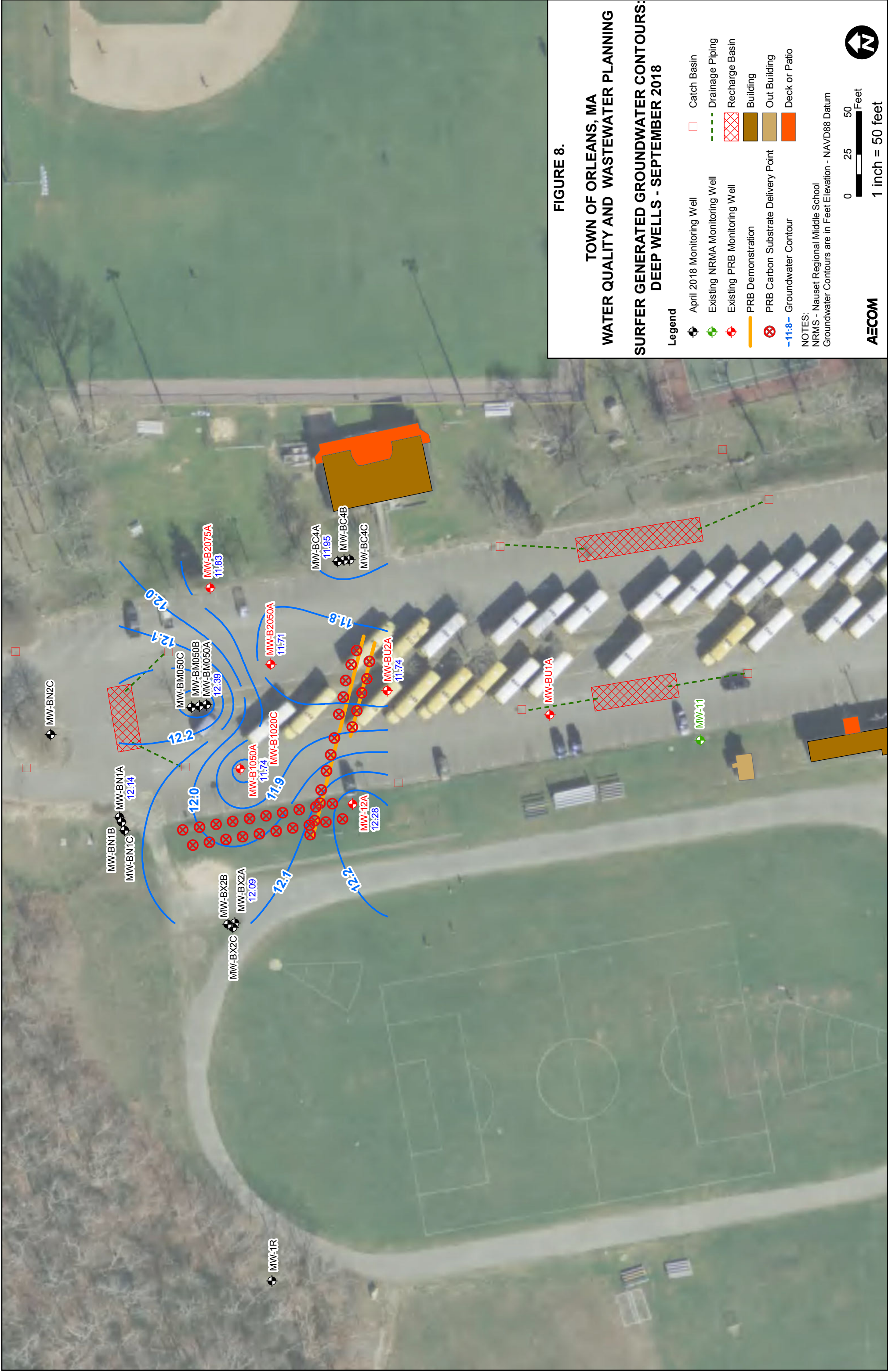
TOWN OF ORLEANS, MA
 WATER QUALITY AND WASTEWATER PLANNING
 SURFER GENERATED GROUNDWATER CONTOURS:
 SHALLOW WELLS - SEPTEMBER 2018

Legend

- April 2018 Monitoring Well
- Existing NRMMA Monitoring Well
- Existing PRB Monitoring Well
- PRB Demonstration
- PRB Carbon Substrate Delivery Point
- 12.4- Groundwater Contour
- Catch Basin
- Drainage Piping
- Recharge Basin
- Building
- Out Building
- Deck or Patio

NOTES:
 NRMMS - Nauset Regional Middle School
 Groundwater Contours are in Feet Elevation - NAVD88 Datum





Appendix A
Historical Monitoring Data

This Page Intentionally Left Blank.

Historical Monitoring Data

A. Baseline Groundwater Monitoring

Baseline and cumulative quarterly field and laboratory test results are all shown in Table 3. Baseline groundwater monitoring samples were collected on October 4, 2016, November 3, 2016 and November 4, 2016. Baseline sampling indicated nitrate concentrations ranging from 0.357 mg/L (MW-BU2A) to 37 mg/L (MW-1050A) and generally aerobic redox conditions.

B. Monitoring during Initial Injection Activities (November 2016)

During the demonstration injections, field parameters were monitored at select upgradient and downgradient wells. Overall, no distinct patterns between the field parameters (temperature, pH, dissolved oxygen, conductivity, and turbidity) were observed before, during, and immediately following the injections

Laboratory dilutions were completed by Terra Systems producing stock solutions of EVO at various dilutions to determine a reasonable correlation between turbidity and the estimated SRS-NR concentrations. Based on these dilutions and the turbidity measured, data suggests the potential for movement of the SRS-NR emulsion up to 20 feet from the injection at certain depths. However, the conductivity was variable and did not correlate to turbidity. Field visual observations did not indicate significant quantities of emulsion at the downgradient wells. There was potentially a dilute “milky” coloration to the groundwater at the 10-foot and 20-foot wells, however, these observations were soon followed by indications of “clearer” water. These observations support the target area distribution of EVO along the PRB. EVO was not observed following completion of injection indicating the injected material was stable and not migrating.

Groundwater samples were collected from seven wells on November 17, 2016 and analyzed for alkalinity and DOC. Alkalinity was measured as a potential indication of the pH buffer that was added with the injections and DOC was measured as a potential indication of the EVO. The alkalinity at the downgradient wells (MW-1010C, MW-1020C, MW-2010C, and MW-2020B) ranged from 11 to 20 mg/L, which is slightly higher than the upgradient and cross-gradient wells (MW-12C, MW-BC2C, and MW-BU2C), which ranged from 4 to 13 mg/L. DOC ranged from 0.576 to 0.852 mg/L and was similar for both upgradient/cross-gradient and downgradient wells.

C. Initial Post-Injection Sampling (7 weeks)

A total of 14 groundwater samples were collected from select wells on January 5, 2017 and January 10, 2017. The wells sampled included upgradient wells MW-12A/B/C and MW-BU2A/B/C, cross-gradient well MW-BC2C, and downgradient wells MW-B1010C, MW-B1020B/C, MW-B1050A, MW-B2020B/C, and MW-B2050A. MW-B2010C was not sampled due to snow cover.

D. Quarterly Sampling

3) Q-1 February 2017

The first post-injection quarterly sampling event occurred on February 23, 2017 and February 24, 2017 (Q-1). Four additional monitoring wells were installed and sampled in March 2017 for supplementary assessment of groundwater flow direction and nitrate concentration.

The expected lag time from PRB injection to measurable nitrate reduction in groundwater immediately downgradient of the barrier is two to four months. During this time the EVO begins to increase DOC concentrations, stimulating biological activity, which leads to an increase in the biomass of desired nitrate reducing bacteria.

The February samples were collected approximately three months post injection. Shallow groundwater monitoring wells closest to the PRB (MW-B1010C and MW-B2010C) are located approximately ten feet downgradient of the injection zone (Figure 1). The February Quarter-1 (Q-1) sample at MW-B1010C indicated an increase in DOC from less than 1 mg/L during baseline sampling (November 2016) to 14 mg/L at Q-1. The MW-B1010C nitrate concentration decreased 27 percent from 13.6 at baseline to 9.94 mg/L at Q-1. Nitrate concentration data for baseline and quarterly sampling is included in Table 3 and on the cross-sections shown in Figures 3, 4 and 5.

Monitoring well MW-B2010C laboratory results also showed an increase in DOC concentrations. DOC increased from 2.2 mg/L at baseline to 19 mg/L at Q-1. Over the same period of time, the nitrate concentration decreased 68 percent from 15.7 to 5.06 mg/L.

Significant increases in DOC were not observed at other monitoring well locations and changes in nitrate concentration also did not appear to be significant with the exception of nitrate at monitoring well B1050A, where the nitrate concentration decreased 68 percent from 37 mg/L at baseline to 11.8 mg/L at Q-1.

No significant changes for dissolved iron and manganese were noted between the baseline and Q-1 sampling. Methane was not detected in groundwater at any of the locations sampled. These results indicate no significant impacts with respect to secondary water quality had occurred. No migration of EVO material was indicated by sampling observations or test results.

4) Q-2 June 2017

The second post-injection quarterly sampling (Q-2) event occurred on June 28, 2017 and June 29, 2017, approximately seven months post injection.

During the June 2017 quarterly sampling event, groundwater samples were collected from 24 monitoring wells and analyzed for nitrate, nitrite, ammonia, total nitrogen, chloride, sulfate, dissolved iron, dissolved manganese, total alkalinity, and DOC. Field-measured parameters, such as water level, pH, temperature, DO, ORP, conductivity, and turbidity, were also measured. MW-12C has not been repaired from the damage during snow removal and was unable to be sampled. Additionally, water levels were collected from 9 monitoring wells outside of the core monitoring well network.

a) Assessment of Groundwater Flow Through the PRB June 2017

The initial PRB treatment line was composed of a series of injection points oriented northwest to southeast (perpendicular) to the northeasterly regional groundwater flow direction and is approximately 110 feet long. Depth to groundwater measurements at monitoring wells in the immediate vicinity of the PRB were completed prior to sampling during each monitoring event. The depth to water information was used to calculate water elevation and assess the direction of groundwater flow by developing contour maps of water level. Water elevation in shallow, intermediate depth, and deep wells were evaluated separately to assess flow direction at different depths.

Note that groundwater elevation can vary over time due to seasonal changes in groundwater recharge and can also change over the short term due to significant precipitation events. These changes can result in local variations in groundwater flow. Groundwater flow direction can also be in different directions at different depths below the water table, resulting in a complex 3-dimensional groundwater flow system.

MW-BX1B and MW-BX1C are intermediate and shallow wells that were installed in March 2017 approximately 20 feet northwest of where EVO was injected during the November 2016 demonstration initial injection activities. The purpose of installing MW-BX1B and MW-BX1C was to gather more information to get a better understand the groundwater flow pattern across the site and help with the interpretation of observed nitrate concentrations. High nitrate concentrations had been noted along the monitoring transects east of the selected location for these new monitoring wells (e.g. at MW-B1020C, MW-B1050B, MW-B1050A, and MW-B2020B) shown on Figure 1. No similar high nitrate concentrations were observed in monitoring wells upgradient to the southwest of the PRB (e.g. MW-12A, MW-12B, and MW-12C).

Groundwater elevations calculated from the June 2017 data were interpolated to develop groundwater contour lines and assess groundwater flow direction (See AECOM – Technical Memorandum for Eldredge Park Permeable Reactive Barriers Demonstration Project – Groundwater Monitoring Quarterly Report – Final dated February 5, 2018. Figure 6, Figure 7, and Figure 8). Based on this assessment, flow through the PRB did not appear to reach the full set of monitoring wells along the established monitoring well transects. Treated water may only be reaching the nearest monitoring wells on the north side and easterly of the PRB (e.g. MW-B1010C, MW-B2010C, MW-B2020B, and MW-B2020C). Monitoring wells further to the north along transects 1 and 2 also appeared to be affected by a local source of high nitrate concentration.

b) Assessment of Groundwater Chemistry Data June 2017

Groundwater sample locations closest to the initial PRB (MW-B1010C and MW-B2010C) are located approximately ten feet downgradient of the injection zone (Figure 1). The June Quarter-2 (Q-2) sample at MW-B1010C indicated an increase in DOC from 14 mg/L during Q-1 sampling (February 2017) to 17 mg/L at Q-2. Similarly, MW-B2010C indicated an increase in DOC from 19 mg/L during Q-1 to 83 mg/L during Q-2. The nitrate concentrations at MW-B1010C appear similar to baseline. The nitrate concentrations at MW-B2010C continued to show a concentration (5.7 mg/L) significantly below baseline (15.7 mg/L) and the oxidation-reduction potential (ORP) at MW-B2010C was negative, which indicates reducing conditions favorable to denitrification.

The DOC concentrations also increased slightly at the wells located approximately 20 feet from the injection points. MW-B1020B increased from 1.1 mg/L in Q-1 to 3.2 mg/L in Q-2, MW-B2020B increased from 1.0 mg/L in Q-1 to 3.5 mg/L in Q-2, MW-B2020C increased from 2 mg/L in Q-1 to 23 mg/L in Q-2.

Nitrate increased at upgradient monitoring wells MW-BX1B from 11.4 mg/L at Q-1 to 34.4 mg/L at Q-2, at MW-BX1C from 0.3 mg/L at Q-1 to 38.7 mg/L at Q-2. These high nitrate concentrations appear to be from a local source and are not within the target PRB treatment area.

Nitrate increased at MW-B1050A from 11.8 mg/L at Q-1 to 26.8 mg/L at Q-2, and at MW-B2020B from 14.8 mg/L at Q-1 to 22.4 mg/L at Q-2. While MW-B1050A and MW-B2020B both saw increases in nitrate concentrations, the shallow wells at those locations saw decreases in nitrate concentrations. Nitrate decreased at MW-B1050B from 28.7 mg/L at Q-1 to 18.2 mg/L at Q-2, at MW-B1050C from 4.0 mg/L at Q-1 to 3.3 mg/L at Q-2, and at MW-B2020C from 7.0 mg/L at Q-1 to 0.5 mg/L at Q-2.

Significant increases in DOC were not observed at other monitoring well locations and changes in nitrate concentration also did not appear to be significant.

It was also noted that dissolved iron increased from 1.8 mg/L at Q-1 to 24.2 mg/L at Q-2 and dissolved manganese increased from 0.2 mg/L at Q-1 to 1.6 mg/L at Q-2 in MW-B2010C. Dissolved iron increased from <0.1 mg/L at Q-1 to 8.0 mg/L at Q-2 and dissolved manganese increased from 0.1 mg/L at Q-1 to 1.0 mg/L at Q-2 in MW-B2020C. These two locations are also where the significant increases in DOC were observed. The increases in iron and manganese are also indications of the reducing conditions favorable to denitrification. No significant changes for dissolved iron and manganese were noted between the Q-1 and Q-2 sampling at other locations. Methane was not detected in groundwater at MW-B1010C but was present at 11.3 µg/L at MW-B2010C. This location demonstrated the highest increase in DOC and dissolved iron. No migration of EVO material was indicated by sampling observations or test results.

5) Q-3 September 2017

The third post-injection quarterly sampling (Q-3) event occurred on September 12, 2017 and September 13, 2017, approximately ten months post-injection. During the September 2017 quarterly sampling event, groundwater samples were collected from 24 monitoring wells and analyzed for nitrate, nitrite, ammonia, total nitrogen, chloride, sulfate, and DOC. Select groundwater samples were also analyzed for dissolved iron and dissolved manganese. Field-measured parameters, such as water level, pH, temperature, DO, ORP, conductivity, and turbidity, were also measured. Additionally, water levels were collected from 6 monitoring wells outside of the core monitoring well network.

a) Assessment of Groundwater Flow Through the PRB September 2017

Groundwater elevations calculated from the September 2017 data were interpolated to develop groundwater contour lines. These groundwater data indicated a similar pattern to the June 2017 contours and confirmed that flow through the initial PRB does not likely reach the full set of monitoring wells along the established monitoring well transects. Treated water may have only be reaching the nearest monitoring wells on the north side and easterly of the PRB. Monitoring wells along transects 1 and 2 further to the north also continued to be affected by a local source of high nitrate concentration originating upgradient to the west of MW-BX1B and MW-BX1C.

b) Assessment of Groundwater Chemistry Data

Groundwater sample locations closest to the PRB (MW-B1010C and MW-B2010C) are located approximately ten feet downgradient of the initial injection zone (Figure 1). The September Quarter-3 (Q-3) sample at MW-B1010C indicated an increase in DOC from 16.9 mg/L during Q-2 sampling (June 2017) to 21.4 mg/L at Q-3. MW-B2010C indicated a slight decrease in DOC from 83.3 mg/L during Q-2 to 69.4 mg/L during Q-3, however, this is still significantly elevated over the baseline DOC of 2.2 mg/L. The nitrate concentrations at MW-B1010C decreased to 2.5 mg/L at Q-3 compared to 13.6 mg/L at baseline. The nitrate concentrations at MW-B2010C showed a concentration (0.18 mg/L) well below baseline (15.7 mg/L) and the oxidation-reduction potential (ORP) at MW-B2010C was negative (-119.80 mV), which indicates more reducing conditions favorable to denitrification.

The DOC concentrations increased slightly at almost all other monitoring wells. The largest of these increases was noted at MW-2020B, which increased from 3.5 mg/L in Q-2 to 29.8 mg/L in Q-3 indicating this location was likely affected by the initial PRB. MW-2020B also showed a significant decrease in nitrate concentration from 22.4 mg/L in Q-2 to 6.0 mg/L in Q-3. Nitrate concentrations showed little to no change at most of the monitoring wells located 50 to 75 feet from the PRB along transect 1 (A to A'). Nitrate concentrations decreased slightly at the three 50-foot wells on Transect 2 (B to B'), with the largest decrease at MW-B2050A, from 32.8 mg/L in Q-2 to 25.5 mg/L in Q-3.

Groundwater nitrate concentrations increased at the upgradient monitoring well MW-BX1B from 34.4 mg/L at Q-2 to 39.0 mg/L at Q-3. The concentration at MW-BX1C remained high at 37.8 mg/L. These high nitrate concentrations appear to be from a local source and are not within the target PRB treatment area.

Dissolved iron increased at MW-1010C from 0.14 mg/L in Q-2 to 3.88 mg/L in Q-3. There was no major increase in dissolved manganese at this location. It was also noted that dissolved iron increased from 24.2 mg/L at Q-2 to 46.2 mg/L at Q-3 and dissolved manganese increased from 1.6 mg/L at Q-2 to 2.6 mg/L at Q-3 in MW-B2010C. Dissolved iron increased from 8.0 mg/L at Q-2 to 13.1 mg/L at Q-3 and dissolved manganese increased from 1.0 mg/L at Q-2 to 2.1 mg/L at Q-3 in MW-B2020C. Increases in iron and manganese are also indications of the reducing conditions favorable to denitrification. No significant changes for dissolved iron and manganese were noted between the Q-2 and Q-3 sampling at other locations where analyzed. No migration of EVO material was indicated by sampling observations or test results.

6) Q-4 January 2018

The fourth post-injection quarterly sampling (Q-4) event occurred on January 8, 2018 through January 10, 2018, approximately fourteen months following the initial injection. During the January 2018 quarterly sampling event, groundwater samples were collected from 24 monitoring wells and analyzed for nitrate, nitrite, ammonia, total nitrogen, chloride, sulfate, DOC, dissolved iron and dissolved manganese. Two select wells were also analyzed for boron. Field-measured parameters, such as water level, pH, temperature, DO, ORP, conductivity, and turbidity, were also measured. Water levels were also collected from seven monitoring wells outside of the core monitoring well network.

a) Assessment of Groundwater Flow Through the PRB January 2018

Groundwater elevations calculated from the January 2018 data were interpolated to develop groundwater contour lines. The groundwater data again indicated a similar groundwater flow pattern to that observed in June 2017 and September 2017. These data again confirmed that flow through the PRB does not appear to reach the full set of monitoring wells along the established monitoring well transects and treated water may only be reaching the monitoring wells approximately 20 feet north of the PRB due to groundwater flow directions.

b) Assessment of Groundwater Chemistry Data

Nitrate concentrations at sample locations closest to the initial PRB, including MW-B1010C on Transect 1 (A-A') and MW-B2010C on Transect 2 (B to B'), appear to be significantly reduced by the PRB. Graphs of nitrate and DOC concentrations show generally decreasing nitrate concentration trends and increasing DOC concentration trends. Decreasing nitrate concentrations and increasing DOC concentrations provide two lines of evidence for PRB performance. The January Quarter-4 (Q-4) sample at MW-B1010C indicated a slight decrease in DOC from 21.4 mg/L at Q-3 to 13.6 mg/L at Q-4. MW-B2010C indicated an increase in DOC from 69.4 mg/L during Q-3 to 94.3 mg/L in Q-4. The nitrate concentrations at MW-B1010C increased slightly to 2.76 mg/L, which is still well below the baseline concentration of 13.6 mg/L. The nitrate concentrations at MW-B2010C was below detection at <0.03 mg/L, dissolved oxygen was less than 0.5 mg/L, and the oxidation-reduction potential (ORP) at MW-B2010C was negative (-102.1 mV), all indicators of reducing conditions favorable to denitrification.

The monitoring wells located 20 feet from the initial PRB including MW-B1020B and MW-B1020C on Transect 1 (A to A'), and MW-2020B and MW-2020C on Transect 2 (B to B') also appeared to be significantly affected by the PRB with increased DOC concentrations and decreased nitrogen concentrations. Dissolved iron increased at MW-1010C from 3.88 mg/L in Q-3 to 9.69 mg/L in Q-4. There was no major increase in dissolved manganese at this location. It was also noted that dissolved iron increased from 46.2 mg/L at Q-3 to 88.2 mg/L at Q-4 and dissolved manganese increased from 2.6 mg/L at Q-3 to 5.2 mg/L at Q-4 in MW-B2010C. The increases in iron and manganese are also indications of the reducing conditions favorable to denitrification. No migration of EVO material was indicated by sampling observations or test results.

Nitrate concentrations also decreased at all monitoring wells located in the area approximately 50 feet north from the PRB. The largest decreases were at MW-1050A, from 26.7 mg/L in Q-3 to 4.89 mg/L in Q-4 and MW-B2050A, from 25.5 mg/L in Q-3 to 11.6 mg/L in Q-4. Nitrate was also noted to have decreased at the upgradient monitoring wells MW-BX1B and MW-BX1C from 39.0 mg/L at Q-3 to 10 mg/L at Q-4 and at MW-BX1C from 37.8 mg/L at Q-3 to 11.1 mg/L at Q-4. The lower nitrate concentrations in the area 50 feet north of the PRB were not associated with increased DOC concentrations. These nitrate test results are similar to concentrations observed during the first sampling event for MW-BX1B in March 2017. BX1B and MW-BX1C appear to be located upgradient from MW-1050A and MW-2050A based on groundwater contours. Changes in concentration in the area 50 feet north of the PRB are not likely associated with the initial PRB.

Nitrate concentration data for baseline and quarterly sampling is included in Table 3 and on the cross-sections shown in Figures 3, 4, and 5. Nitrate data are also included with January 2018 groundwater contours and flow direction for shallow, intermediate depth, and deep groundwater monitoring wells on Figure 6, Figure 7, and Figure 8 respectively, within the January 2018 Quarterly Report.

7) Q-5 April 2018

The fifth post-injection quarterly sampling (Q-5) event occurred on April 18th and 19th, 2018, approximately 17 months post-injection. During the April 2018 quarterly sampling event, groundwater samples were collected from 25 monitoring wells and analyzed for nitrate, nitrite, ammonia, total nitrogen, chloride, sulfate, DOC, dissolved iron and dissolved manganese. Two select wells were also analyzed for boron. Parameters, such as water level, pH, temperature, DO, ORP, conductivity, and turbidity, were measured in the field. Water levels were also collected from several other monitoring wells outside of the core monitoring well network.

Concurrent with this quarterly sampling event, several monitoring wells were in the process of being installed and repairs were made to existing wells. These efforts included: repairing MW-1 and installing four triplet wells and one single screen well. These were installed at various locations to allow for better assessment of groundwater flow direction and were not yet developed or sampled as part of this event.

a) Assessment of Groundwater Flow Through the PRB April 2018

Groundwater elevations calculated from the April 2018 data were interpolated to develop groundwater contour lines. The groundwater data again indicated a similar groundwater flow pattern to that observed in June 2017 and September 2017. These data again confirmed that flow through the PRB does not appear to reach the full set of monitoring wells along the established monitoring well transects and treated water may only be reaching the monitoring wells up to 20 feet north of the initial PRB due to groundwater flow directions.

b) Assessment of Groundwater Chemistry Data

Nitrate concentration data for baseline and quarterly sampling is included in Table 3 and on the cross-sections shown in Figures 3, 4 5. Nitrate data are also included with April 2018 groundwater contours and flow direction for shallow, intermediate depth, and deep groundwater monitoring wells on Figure 6, Figure 7, and Figure 8 respectively within the April 2018 Quarterly Report.

Groundwater quality at the Transect 1 wells generally showed an increase in nitrate concentration. This increase in nitrate concentration was also observed at the upgradient monitoring wells MW-BX1B and MW-BX1C. This correlation further supports the observation that this area to the north is affected by a high concentrations source, likely the section of the Nauset Regional Middle School 1977 leaching pit wastewater infiltration system located under the north end of the soccer field.

In general, the wells near the eastern half of the PRB (MW-B2020C, MW-2020B, and MW-2020C) showed a correlating trend between elevated DOC and reduced nitrate concentrations compared with the wells on the western half of the PRB (MW-B1020C, MW-1020B). The nitrate concentration at MW-B2020B continued to decrease compared to previous sampling events. MW-B2010C and MW-B2020C nitrate concentrations remained below detection having been previously reduced by effective PRB treatment in this area.

This Page Intentionally Left Blank.

Appendix B
Monitoring Well Coordinates

This Page Intentionally Left Blank.

NO.	DATE	REVISION

DATUM NOTE:

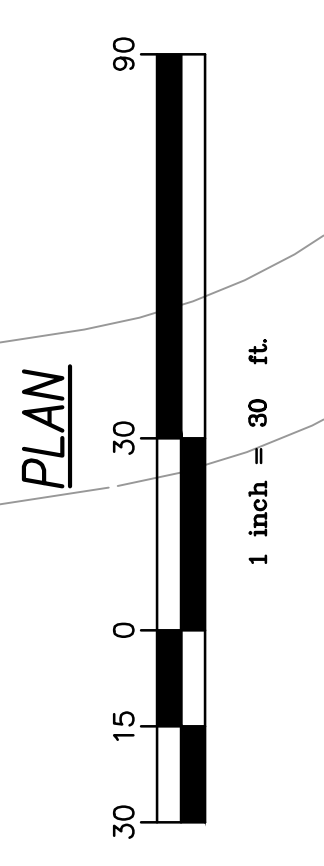
ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 1988)

LEGEND

- EXISTING**
- ▨ CATCH BASIN
 - DRAIN MANHOLE
 - ⊙ MONITORING WELL
 - ⊙ POST
 - UTILITY POLE



Point	Northing	Easting	Elevation (Top of Casing)	Elevation (Ground)
MW-1	2749504.904	1067739.369	41.31	40.8
MW-2	2749521.336	1068076.302	44.82	44.6
MW-4	2749276.673	1067718.987	46.57	46.1
MW-8	2749109.803	1067928.803	46.16	46.9
MW-11	2749198.207	1068076.362	45.14	45.4
MW-11S	2749191.446	1068072.320	45.25	45.4
MW-B2100	2749495.052	1068116.909	44.23	44.6
MW-B1	2749342.484	1068152.835	42.14	42.6
MW-B1JC	2749395.698	1068130.642	43.65	44.0
MW-B1JA	2749287.316	1068041.311	43.48	43.7
MW-B1BA	2749383.643	1068055.658	44.56	45.1
MW-B1BB	2749384.300	1068051.435	44.70	45.1
MW-B1BC	2749384.713	1068047.731	44.68	45.1
MW-12A	2749404.187	1067988.719	45.11	45.6
MW-12B	2749402.026	1067992.169	45.36	45.6
MW-12C	2749404.918	1067985.439	45.36	45.6
MW-B1010C	2749432.217	1068001.195	44.46	44.9
MW-B1020B	2749442.632	1068005.074	44.18	44.6
MW-B1030B	2749444.269	1068006.033	44.18	44.6
MW-B1050A	2749470.911	1068009.358	43.42	43.9
MW-B1050B	2749470.884	1068010.994	43.54	43.9
MW-B1050C	2749470.482	1068012.793	43.55	44.9
MW-B1050D	2749470.482	1068014.141	43.29	43.5
MW-B1050E	2749495.265	1068014.141	44.17	44.6
MW-B2050B	2749456.265	1068070.821	44.28	44.6
MW-B2050C	2749454.236	1068071.071	44.06	44.6
MW-B2050D	2749452.666	1068071.421	44.06	44.6
MW-B2050E	2749454.608	1068064.631	44.50	44.9
MW-B200C	2749423.622	1068065.677	44.45	44.8
MW-B200D	2749414.371	1068062.963	44.70	45.0
MW-B200E	2749463.571	1067965.607	45.38	45.6
MW-BX1C	2749459.414	1067966.459	45.37	45.7
MW-B2075A	2749488.741	1068116.882	44.23	44.6
MW-BX3B	2749439.779	1068124.999	44.23	44.6
MW-BX4C	2749405.864	1068133.511	43.23	43.5
MW-BX4B	2749409.342	1068133.141	43.01	43.5
MW-BX4A	2749412.976	1068132.389	43.01	43.5
MW-BX2C	2749391.812	1068103.188	43.52	43.8
MW-BM50A	2749490.952	1068047.534	44.26	44.7
MW-BM50B	2749494.971	1068046.745	44.37	44.8
MW-BM50C	2749499.643	1068045.934	44.41	44.8
MW-BM50D	2749583.275	1068029.599	44.88	45.2
MW-BN1A	2749542.435	1067980.862	44.03	44.5
MW-BN1B	2749541.222	1067978.041	43.94	44.4
MW-BN1C	2749539.31	1067973.061	44.16	44.4
MW-BX2A	2749474.077	1067917.942	46.12	46.4
MW-BX2B	2749475.227	1067915.470	46.04	46.5
MW-BX2C	2749478.214	1067917.102	46.09	46.4
MW-1R	2749451.982	1067705.820	47.21	44.4
WELL IN POND	2749703.127	1067820.655	19.89	in water
MAG Nail in P'mnt (# 2001)	2749477.822	1068054.547	44.63	
MAG Nail in P'mnt (# 2002)	2749270.648	1068090.338	44.64	



This Page Intentionally Left Blank.

Appendix C
Analytical Laboratory Reports

This Page Intentionally Left Blank.

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1809508

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.



Laurel Stoddard
Laboratory Director

REVIEWED**By ESS Laboratory at 3:44 pm, Sep 26, 2018****Analytical Summary**

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

SAMPLE RECEIPT

The following samples were received on September 19, 2018 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

<u>Lab Number</u>	<u>Sample Name</u>	<u>Matrix</u>	<u>Analysis</u>
1809508-01	MW-12A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-02	MW-12B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-03	MW-12C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-04	MW-B1010C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-05	MW-B1020B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-06	MW-B1020C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-07	MW-B2050A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-08	MW-B2050B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-09	MW-B2050C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809508-10	MW-B2020C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

- 1010A - Flashpoint
- 6010C - ICP
- 6020A - ICP MS
- 7010 - Graphite Furnace
- 7196A - Hexavalent Chromium
- 7470A - Aqueous Mercury
- 7471B - Solid Mercury
- 8011 - EDB/DBCP/TCP
- 8015C - GRO/DRO
- 8081B - Pesticides
- 8082A - PCB
- 8100M - TPH
- 8151A - Herbicides
- 8260B - VOA
- 8270D - SVOA
- 8270D SIM - SVOA Low Level
- 9014 - Cyanide
- 9038 - Sulfate
- 9040C - Aqueous pH
- 9045D - Solid pH (Corrosivity)
- 9050A - Specific Conductance
- 9056A - Anions (IC)
- 9060A - TOC
- 9095B - Paint Filter
- MADEP 04-1.1 - EPH
- MADEP 04-2.1 - VPH

Prep Methods

- 3005A - Aqueous ICP Digestion
- 3020A - Aqueous Graphite Furnace / ICP MS Digestion
- 3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
- 3060A - Solid Hexavalent Chromium Digestion
- 3510C - Separatory Funnel Extraction
- 3520C - Liquid / Liquid Extraction
- 3540C - Manual Soxhlet Extraction
- 3541 - Automated Soxhlet Extraction
- 3546 - Microwave Extraction
- 3580A - Waste Dilution
- 5030B - Aqueous Purge and Trap
- 5030C - Aqueous Purge and Trap
- 5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-12A
Date Sampled: 09/19/18 10:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/20/18 17:46	10	10	CI82017
Manganese	ND (0.020)		200.7		1	KJK	09/20/18 17:46	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-12A
 Date Sampled: 09/19/18 10:50
 Percent Solids: N/A

ESS Laboratory Work Order: 1809508
 ESS Laboratory Sample ID: 1809508-01
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:34	mg/L	CI82011
Chloride	152 (9.0)		9250		3	EEM	09/21/18 15:15	mg/L	CI82116
Dissolved Organic Carbon (Average)	0.729 (0.250)		5310B		1	CCP	09/24/18 16:13	mg/L	[CALC]
Nitrate as N	0.627 (0.030)		353.2		1	JLK	09/19/18 21:58	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/19/18 21:28	mg/L	CI81951
Sulfate	11.3 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	0.40 (0.20)		351.2		1	JLK	09/25/18 17:18	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-12B
Date Sampled: 09/19/18 11:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/20/18 18:02	10	10	CI82017
Manganese	ND (0.020)		200.7		1	KJK	09/20/18 18:02	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-12B
Date Sampled: 09/19/18 11:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:35	mg/L	CI82011
Chloride	52.1 (3.0)		9250		1	EEM	09/21/18 14:53	mg/L	CI82116
Dissolved Organic Carbon (Average)	1.11 (0.250)		5310B		1	CCP	09/24/18 16:50	mg/L	[CALC]
Nitrate as N	5.36 (0.210)		353.2		10	JLK	09/19/18 22:15	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/19/18 21:29	mg/L	CI81951
Sulfate	10.7 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	09/25/18 17:19	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-12C
Date Sampled: 09/19/18 12:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	3.67 (0.100)		200.7		1	KJK	09/20/18 18:06	10	10	CI82017
Manganese	0.674 (0.020)		200.7		1	KJK	09/20/18 18:06	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-12C
Date Sampled: 09/19/18 12:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.24 (0.10)		350.1		1	JLK	09/20/18 18:36	mg/L	CI82011
Chloride	13.7 (3.0)		9250		1	EEM	09/21/18 14:54	mg/L	CI82116
Dissolved Organic Carbon (Average)	2.75 (0.250)		5310B		1	CCP	09/24/18 17:03	mg/L	[CALC]
Nitrate as N	3.78 (0.210)		353.2		10	JLK	09/19/18 22:16	mg/L	[CALC]
Nitrite as N	0.047 (0.010)		353.2		1	JLK	09/19/18 21:30	mg/L	CI81951
Sulfate	11.8 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	0.90 (0.20)		351.2		1	JLK	09/25/18 17:20	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1010C
Date Sampled: 09/19/18 12:55
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	87.0 (0.100)		200.7		1	KJK	09/20/18 18:23	10	10	CI82017
Manganese	5.78 (0.020)		200.7		1	KJK	09/20/18 18:23	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1010C
Date Sampled: 09/19/18 12:55
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:37	mg/L	CI82011
Chloride	27.5 (3.0)		9250		1	EEM	09/21/18 14:56	mg/L	CI82116
Dissolved Organic Carbon (Average)	321 (10.0)		5310B		40	CCP	09/24/18 22:30	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	09/19/18 22:17	mg/L	[CALC]
Nitrite as N	0.049 (0.010)		353.2		1	JLK	09/19/18 21:31	mg/L	CI81951
Sulfate	19.9 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	1.90 (0.20)		351.2		1	JLK	09/25/18 17:21	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1020B
Date Sampled: 09/19/18 13:40
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	10.0 (0.100)		200.7		1	KJK	09/20/18 18:27	10	10	CI82017
Manganese	0.896 (0.020)		200.7		1	KJK	09/20/18 18:27	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1020B
Date Sampled: 09/19/18 13:40
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.21 (0.10)		350.1		1	JLK	09/20/18 18:44	mg/L	CI82011
Chloride	35.1 (3.0)		9250		1	EEM	09/21/18 14:57	mg/L	CI82116
Dissolved Organic Carbon (Average)	668 (20.0)		5310B		80	CCP	09/24/18 22:44	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	09/19/18 22:02	mg/L	[CALC]
Nitrite as N	0.020 (0.010)		353.2		1	JLK	09/19/18 21:32	mg/L	CI81951
Sulfate	33.0 (25.0)		9038		5	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	5.48 (0.40)		351.2		2	JLK	09/25/18 17:46	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1020C
Date Sampled: 09/19/18 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	5.58 (0.100)		200.7		1	KJK	09/20/18 18:31	10	10	CI82017
Manganese	0.249 (0.020)		200.7		1	KJK	09/20/18 18:31	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1020C
Date Sampled: 09/19/18 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.14 (0.10)		350.1		1	JLK	09/20/18 18:45	mg/L	CI82011
Chloride	16.7 (3.0)		9250		1	EEM	09/21/18 14:58	mg/L	CI82116
Dissolved Organic Carbon (Average)	45.5 (2.50)		5310B		10	CCP	09/24/18 23:02	mg/L	[CALC]
Nitrate as N	1.92 (0.110)		353.2		5	JLK	09/19/18 22:18	mg/L	[CALC]
Nitrite as N	0.033 (0.010)		353.2		1	JLK	09/19/18 21:33	mg/L	CI81951
Sulfate	20.4 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	1.33 (0.20)		351.2		1	JLK	09/25/18 17:28	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2050A
Date Sampled: 09/19/18 15:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/20/18 18:36	10	10	CI82017
Manganese	0.222 (0.020)		200.7		1	KJK	09/20/18 18:36	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-B2050A
 Date Sampled: 09/19/18 15:50
 Percent Solids: N/A

ESS Laboratory Work Order: 1809508
 ESS Laboratory Sample ID: 1809508-07
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.68 (0.10)		350.1		1	JLK	09/20/18 18:46	mg/L	CI82011
Chloride	69.6 (3.0)		9250		1	EEM	09/21/18 14:59	mg/L	CI82116
Dissolved Organic Carbon (Average)	2.10 (0.250)		5310B		1	CCP	09/24/18 18:25	mg/L	[CALC]
Nitrate as N	22.9 (2.01)		353.2		100	JLK	09/19/18 22:19	mg/L	[CALC]
Nitrite as N	0.215 (0.010)		353.2		1	JLK	09/19/18 21:34	mg/L	CI81951
Sulfate	6.2 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	09/25/18 17:29	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2050B
Date Sampled: 09/19/18 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/20/18 18:40	10	10	CI82017
Manganese	0.222 (0.020)		200.7		1	KJK	09/20/18 18:40	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2050B
Date Sampled: 09/19/18 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:47	mg/L	CI82011
Chloride	63.9 (3.0)		9250		1	EEM	09/21/18 15:00	mg/L	CI82116
Dissolved Organic Carbon (Average)	2.68 (0.250)		5310B		1	CCP	09/24/18 18:31	mg/L	[CALC]
Nitrate as N	4.94 (0.210)		353.2		10	JLK	09/19/18 22:20	mg/L	[CALC]
Nitrite as N	0.011 (0.010)		353.2		1	JLK	09/19/18 21:35	mg/L	CI81951
Sulfate	10.3 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	0.35 (0.20)		351.2		1	JLK	09/25/18 17:29	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2050C
Date Sampled: 09/19/18 16:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/20/18 18:44	10	10	CI82017
Manganese	0.077 (0.020)		200.7		1	KJK	09/20/18 18:44	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2050C
Date Sampled: 09/19/18 16:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:48	mg/L	CI82011
Chloride	315 (30.0)		9250		10	EEM	09/21/18 15:20	mg/L	CI82116
Dissolved Organic Carbon (Average)	1.33 (0.250)		5310B		1	CCP	09/24/18 19:09	mg/L	[CALC]
Nitrate as N	3.47 (0.210)		353.2		10	JLK	09/19/18 22:21	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/19/18 21:36	mg/L	CI81951
Sulfate	9.3 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	09/25/18 17:30	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2020C
Date Sampled: 09/19/18 17:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	14.5 (0.100)		200.7		1	KJK	09/20/18 18:48	10	10	CI82017
Manganese	11.1 (0.020)		200.7		1	KJK	09/20/18 18:48	10	10	CI82017



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2020C
Date Sampled: 09/19/18 17:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809508
ESS Laboratory Sample ID: 1809508-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/20/18 18:49	mg/L	CI82011
Chloride	30.7 (3.0)		9250		1	EEM	09/21/18 15:06	mg/L	CI82116
Dissolved Organic Carbon (Average)	11.5 (0.250)		5310B		1	CCP	09/24/18 19:21	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	09/19/18 22:22	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	09/19/18 21:37	mg/L	CI81951
Sulfate	19.6 (5.0)		9038		1	EEM	09/24/18 15:35	mg/L	CI82429
Total Kjeldahl Nitrogen as N	0.84 (0.20)		351.2		1	JLK	09/25/18 17:31	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
---------	--------	-----	-------	-------------	---------------	------	-------------	-----	-----------	-----------

Dissolved Metals

Batch CI82017 - 200.7/6010BNoDigest

Blank

Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							

LCS

Iron	2.46		mg/L	2.501		98	80-120			
Manganese	0.471		mg/L	0.5000		94	80-120			

Classical Chemistry

Batch CI81951 - [CALC]

Blank

Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							

LCS

Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			

Batch CI81952 - [CALC]

Blank

Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							

LCS

Nitrate as N	0.504		mg/L							
Nitrate/Nitrite as N	0.504		mg/L	0.5000		101	90-110			

Batch CI82011 - NH4 Prep

Blank

Ammonia as N	ND	0.10	mg/L							
--------------	----	------	------	--	--	--	--	--	--	--

LCS

Ammonia as N	0.11	0.10	mg/L	0.09994		110	80-120			
--------------	------	------	------	---------	--	-----	--------	--	--	--

LCS

Ammonia as N	1.01	0.10	mg/L	0.9994		101	80-120			
--------------	------	------	------	--------	--	-----	--------	--	--	--

Batch CI82116 - General Preparation

Blank

Chloride	ND	3.0	mg/L							
----------	----	-----	------	--	--	--	--	--	--	--

LCS

Chloride	28.0		mg/L	30.00		93	90-110			
----------	------	--	------	-------	--	----	--------	--	--	--

Batch CI82429 - General Preparation

Blank

Sulfate	ND	5.0	mg/L							
---------	----	-----	------	--	--	--	--	--	--	--

LCS

Sulfate	9.5		mg/L	9.988		95	85-115			
---------	-----	--	------	-------	--	----	--------	--	--	--



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CI82444 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.0	2.00	mg/L	20.00		110	80-120			
Batch CI82447 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.250	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.32	0.500	mg/L	5.000		106	80-120			
Dissolved Organic Carbon (2)	5.27	0.500	mg/L	5.000		105	80-120			
Dissolved Organic Carbon (Average)	5.29	0.250	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	5.25	0.500	mg/L	5.000		105	80-120	1	200	
Dissolved Organic Carbon (2)	5.18	0.500	mg/L	5.000		104	80-120	2	200	
Dissolved Organic Carbon (Average)	5.21	0.250	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

Notes and Definitions

- U Analyte included in the analysis, but not detected
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809508

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179

<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750

http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002

<http://www.maine.gov/dhhs/meecd/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002

<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424

<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313

<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006

http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752

<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809508
 Date Received: 9/19/2018
 Project Due Date: 9/26/2018
 Days for Project: 5 Day

Shipped/Delivered Via: ESS Courier

- | | |
|--|--|
| 1. Air bill manifest present? <input type="checkbox"/> No
Air No.: <u>NA</u>
2. Were custody seals present? <input type="checkbox"/> No
3. Is radiation count <100 CPM? <input type="checkbox"/> Yes
4. Is a Cooler Present? <input type="checkbox"/> Yes
Temp: <u>4.5</u> Iced with: <u>Ice</u>
5. Was COC signed and dated by client? <input type="checkbox"/> Yes | 6. Does COC match bottles? <input type="checkbox"/> Yes
7. Is COC complete and correct? <input type="checkbox"/> Yes
8. Were samples received intact? <input type="checkbox"/> Yes
9. Were labs informed about <u>short holds & rushes</u> ? <input checked="" type="checkbox"/> Yes / No / NA
10. Were any analyses received outside of hold time? <input checked="" type="checkbox"/> Yes / No |
|--|--|

- | | |
|---|---|
| 11. Any Subcontracting needed? <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
ESS Sample IDs: _____
Analysis: _____
TAT: _____
13. Are the samples properly preserved? <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
a. If metals preserved upon receipt: _____
b. Low Level VOA vials frozen: _____
Date: _____ Time: _____ By: _____
Date: _____ Time: _____ By: _____ | 12. Were VOAs received? <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
a. Air bubbles in aqueous VOAs? <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
b. Does methanol cover soil completely? <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No / <input type="checkbox"/> NA |
|---|---|

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
 a. Was there a need to contact the client? Yes / No
 Who was contacted? _____ Date: _____ Time: _____ By: _____

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	268326	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	268327	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	268337	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	268356	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	268357	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	268367	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	268324	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	268325	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	268336	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	268354	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	268355	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	268366	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	268322	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	268323	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	268335	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
03	268352	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	268353	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	268365	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	268320	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	268321	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	268334	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
04	268350	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	268351	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	268364	Yes	NA	Yes	250 mL Amber - Unpres	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809508

Date Received: 9/19/2018

05	268318	Yes	NA	Yes	VOA Vial - HCl	HCl
05	268319	Yes	NA	Yes	VOA Vial - HCl	HCl
05	268333	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
05	268348	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	268349	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	268363	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	268316	Yes	NA	Yes	VOA Vial - HCl	HCl
06	268317	Yes	NA	Yes	VOA Vial - HCl	HCl
06	268332	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
06	268346	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	268347	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	268362	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	268314	Yes	NA	Yes	VOA Vial - HCl	HCl
07	268315	Yes	NA	Yes	VOA Vial - HCl	HCl
07	268331	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
07	268344	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	268345	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	268361	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	268312	Yes	NA	Yes	VOA Vial - HCl	HCl
08	268313	Yes	NA	Yes	VOA Vial - HCl	HCl
08	268330	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
08	268342	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	268343	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	268360	Yes	NA	Yes	250 mL Amber - Unpres	NP
09	268310	Yes	NA	Yes	VOA Vial - HCl	HCl
09	268311	Yes	NA	Yes	VOA Vial - HCl	HCl
09	268329	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
09	268340	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	268341	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	268359	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	268308	Yes	NA	Yes	VOA Vial - HCl	HCl
10	268309	Yes	NA	Yes	VOA Vial - HCl	HCl
10	268328	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
10	268338	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	268339	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	268358	Yes	NA	Yes	250 mL Amber - Unpres	NP

2nd Review

Are barcode labels on correct containers?

Yes No

Are all necessary stickers attached?

Yes No

Completed

By: [Signature]

Date & Time: 9/19/18 2035

Reviewed

By: [Signature]

Date & Time: 9/19/18 2041

Delivered

By: [Signature]

Date & Time: 9/19/18 2041

CERTIFICATE OF ANALYSIS

Briley Morrill
AECOM Environment - ENSR
250 Apollo Drive
Chelmsford, MA 01824

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1809553

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.



Laurel Stoddard
Laboratory Director

REVIEWED**By ESS Laboratory at 5:28 pm, Sep 27, 2018****Analytical Summary**

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

SAMPLE RECEIPT

The following samples were received on September 20, 2018 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

<u>Lab Number</u>	<u>Sample Name</u>	<u>Matrix</u>	<u>Analysis</u>
1809553-01	MW-BC4C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-02	MW-BC4B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-03	MW-BC2C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-04	MW-B2010C	Ground Water	200.7, 3113B, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-05	MW-BX2C	Ground Water	200.7, 3113B, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-06	MW-BX2A	Ground Water	200.7, 3113B, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-07	MW-BC4A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-08	MW-BC3B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-09	MW-BU2A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-10	MW-BU2B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-11	MW-BU2C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-12	MW-BN1C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-13	MW-BN1B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-14	MW-BN1A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-15	MW-BM050C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-16	MW-BM050B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809553-17	MW-BM050A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

- 1010A - Flashpoint
- 6010C - ICP
- 6020A - ICP MS
- 7010 - Graphite Furnace
- 7196A - Hexavalent Chromium
- 7470A - Aqueous Mercury
- 7471B - Solid Mercury
- 8011 - EDB/DBCP/TCP
- 8015C - GRO/DRO
- 8081B - Pesticides
- 8082A - PCB
- 8100M - TPH
- 8151A - Herbicides
- 8260B - VOA
- 8270D - SVOA
- 8270D SIM - SVOA Low Level
- 9014 - Cyanide
- 9038 - Sulfate
- 9040C - Aqueous pH
- 9045D - Solid pH (Corrosivity)
- 9050A - Specific Conductance
- 9056A - Anions (IC)
- 9060A - TOC
- 9095B - Paint Filter
- MADEP 04-1.1 - EPH
- MADEP 04-2.1 - VPH

Prep Methods

- 3005A - Aqueous ICP Digestion
- 3020A - Aqueous Graphite Furnace / ICP MS Digestion
- 3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
- 3060A - Solid Hexavalent Chromium Digestion
- 3510C - Separatory Funnel Extraction
- 3520C - Liquid / Liquid Extraction
- 3540C - Manual Soxhlet Extraction
- 3541 - Automated Soxhlet Extraction
- 3546 - Microwave Extraction
- 3580A - Waste Dilution
- 5030B - Aqueous Purge and Trap
- 5030C - Aqueous Purge and Trap
- 5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4C
Date Sampled: 09/20/18 09:25
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 21:47	10	10	CI82111
Manganese	0.278 (0.020)		200.7		1	KJK	09/21/18 21:47	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4C
Date Sampled: 09/20/18 09:25
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 17:01	mg/L	CI82502
Chloride	72.1 (3.0)		9250		1	EEM	09/24/18 13:54	mg/L	CI82425
Dissolved Organic Carbon (Average)	7.49 (0.250)		5310B		1	CCP	09/24/18 19:34	mg/L	[CALC]
Nitrate as N	2.67 (0.220)		353.2		10	JLK	09/21/18 21:25	mg/L	[CALC]
Nitrite as N	0.521 (0.020)		353.2		2	JLK	09/21/18 20:16	mg/L	CI82146
Sulfate	17.8 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.39 (0.20)		351.2		1	JLK	09/25/18 17:33	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4B
Date Sampled: 09/20/18 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.217 (0.100)		200.7		1	KJK	09/21/18 22:04	10	10	CI82111
Manganese	0.428 (0.020)		200.7		1	KJK	09/21/18 22:04	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4B
Date Sampled: 09/20/18 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:27	mg/L	CI82502
Chloride	72.6 (3.0)		9250		1	EEM	09/24/18 13:55	mg/L	CI82425
Dissolved Organic Carbon (Average)	14.1 (0.250)		5310B		1	CCP	09/24/18 19:46	mg/L	[CALC]
Nitrate as N	1.88 (0.110)		353.2		5	JLK	09/21/18 21:28	mg/L	[CALC]
Nitrite as N	0.324 (0.010)		353.2		1	JLK	09/21/18 19:49	mg/L	CI82146
Sulfate	33.0 (25.0)		9038		5	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.52 (0.20)		351.2		1	JLK	09/25/18 17:34	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC2C
Date Sampled: 09/20/18 11:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.131 (0.100)		200.7		1	KJK	09/21/18 22:08	10	10	CI82111
Manganese	ND (0.020)		200.7		1	KJK	09/21/18 22:08	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-BC2C
 Date Sampled: 09/20/18 11:20
 Percent Solids: N/A

ESS Laboratory Work Order: 1809553
 ESS Laboratory Sample ID: 1809553-03
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:30	mg/L	CI82502
Chloride	10.0 (3.0)		9250		1	EEM	09/24/18 13:56	mg/L	CI82425
Dissolved Organic Carbon (Average)	2.68 (0.250)		5310B		1	CCP	09/24/18 19:59	mg/L	[CALC]
Nitrate as N	0.407 (0.030)		353.2		1	JLK	09/21/18 20:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 19:50	mg/L	CI82146
Sulfate	12.2 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.56 (0.20)		351.2		1	JLK	09/25/18 17:35	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2010C
Date Sampled: 09/20/18 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	89.1 (0.100)		200.7		1	KJK	09/21/18 22:12	10	10	CI82111
Manganese	4.54 (0.020)		200.7		1	KJK	09/21/18 22:12	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2010C
Date Sampled: 09/20/18 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	0.0599 (0.0125)		3113B		5	KJK	09/22/18 18:35	50	25	CI82041



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-B2010C
 Date Sampled: 09/20/18 12:00
 Percent Solids: N/A

ESS Laboratory Work Order: 1809553
 ESS Laboratory Sample ID: 1809553-04
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.86 (0.10)		350.1		1	JLK	09/26/18 16:37	mg/L	CI82502
Chloride	33.9 (3.0)		9250		1	EEM	09/24/18 13:58	mg/L	CI82425
Dissolved Organic Carbon (Average)	19.7 (1.25)		5310B		5	CCP	09/24/18 23:47	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	09/21/18 20:59	mg/L	[CALC]
Nitrite as N	0.058 (0.010)		353.2		1	JLK	09/21/18 19:51	mg/L	CI82146
Sulfate	17.8 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	1.93 (0.20)		351.2		1	JLK	09/25/18 17:41	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2C
Date Sampled: 09/20/18 13:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.164 (0.100)		200.7		1	KJK	09/21/18 22:16	10	10	CI82111
Manganese	0.728 (0.020)		200.7		1	KJK	09/21/18 22:16	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2C
Date Sampled: 09/20/18 13:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	ND (0.0025)		3113B		1	KJK	09/22/18 18:41	50	25	CI82041



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2C
Date Sampled: 09/20/18 13:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:38	mg/L	CI82502
Chloride	34.0 (3.0)		9250		1	EEM	09/24/18 13:59	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.36 (0.250)		5310B		1	CCP	09/24/18 20:50	mg/L	[CALC]
Nitrate as N	42.8 (2.01)		353.2		100	JLK	09/21/18 21:29	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 19:52	mg/L	CI82146
Sulfate	7.2 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	09/25/18 17:42	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2A
Date Sampled: 09/20/18 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.159 (0.100)		200.7		1	KJK	09/21/18 22:33	10	10	CI82111
Manganese	0.143 (0.020)		200.7		1	KJK	09/21/18 22:33	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2A
Date Sampled: 09/20/18 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	ND (0.0025)		3113B		1	KJK	09/22/18 18:58	50	25	CI82041



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2A
Date Sampled: 09/20/18 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:39	mg/L	CI82502
Chloride	26.5 (3.0)		9250		1	EEM	09/24/18 14:00	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.41 (0.250)		5310B		1	CCP	09/24/18 21:02	mg/L	[CALC]
Nitrate as N	10.8 (0.410)		353.2		20	JLK	09/21/18 21:30	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 19:53	mg/L	CI82146
Sulfate	9.8 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.32 (0.20)		351.2		1	JLK	09/25/18 17:43	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4A
Date Sampled: 09/20/18 09:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:37	10	10	CI82111
Manganese	0.075 (0.020)		200.7		1	KJK	09/21/18 22:37	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC4A
Date Sampled: 09/20/18 09:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:40	mg/L	CI82502
Chloride	60.2 (3.0)		9250		1	EEM	09/24/18 14:01	mg/L	CI82425
Dissolved Organic Carbon (Average)	11.4 (0.250)		5310B		1	CCP	09/24/18 21:15	mg/L	[CALC]
Nitrate as N	1.72 (0.110)		353.2		5	JLK	09/21/18 21:35	mg/L	[CALC]
Nitrite as N	0.164 (0.010)		353.2		1	JLK	09/21/18 19:59	mg/L	CI82146
Sulfate	27.5 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.46 (0.20)		351.2		1	JLK	09/25/18 17:45	mg/L	CI82444



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC3B
Date Sampled: 09/20/18 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:41	10	10	CI82111
Manganese	0.046 (0.020)		200.7		1	KJK	09/21/18 22:41	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BC3B
Date Sampled: 09/20/18 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:41	mg/L	CI82502
Chloride	154 (15.0)		9250		5	EEM	09/24/18 14:25	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.65 (0.250)		5310B		1	CCP	09/24/18 21:27	mg/L	[CALC]
Nitrate as N	4.96 (0.210)		353.2		10	JLK	09/21/18 21:36	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:00	mg/L	CI82146
Sulfate	10.4 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.31 (0.20)		351.2		1	JLK	09/25/18 18:07	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2A
Date Sampled: 09/20/18 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:46	10	10	CI82111
Manganese	ND (0.020)		200.7		1	KJK	09/21/18 22:46	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2A
Date Sampled: 09/20/18 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:42	mg/L	CI82502
Chloride	112 (15.0)		9250		5	EEM	09/24/18 14:26	mg/L	CI82425
Dissolved Organic Carbon (Average)	0.258 (0.250)		5310B		1	CCP	09/24/18 22:05	mg/L	[CALC]
Nitrate as N	0.617 (0.030)		353.2		1	JLK	09/21/18 21:09	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:01	mg/L	CI82146
Sulfate	5.1 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.43 (0.20)		351.2		1	JLK	09/25/18 18:07	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2B
Date Sampled: 09/20/18 11:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:50	10	10	CI82111
Manganese	ND (0.020)		200.7		1	KJK	09/21/18 22:50	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2B
Date Sampled: 09/20/18 11:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:43	mg/L	CI82502
Chloride	125 (15.0)		9250		5	EEM	09/24/18 14:27	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.21 (0.250)		5310B		1	CCP	09/24/18 22:18	mg/L	[CALC]
Nitrate as N	4.46 (0.410)		353.2		20	JLK	09/21/18 21:37	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:02	mg/L	CI82146
Sulfate	ND (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.32 (0.20)		351.2		1	JLK	09/25/18 18:08	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2C
Date Sampled: 09/20/18 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:54	10	10	CI82111
Manganese	0.078 (0.020)		200.7		1	KJK	09/21/18 22:54	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BU2C
Date Sampled: 09/20/18 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:44	mg/L	CI82502
Chloride	169 (15.0)		9250		5	EEM	09/24/18 14:31	mg/L	CI82425
Dissolved Organic Carbon (Average)	0.847 (0.250)		5310B		1	CCP	09/25/18 14:58	mg/L	[CALC]
Nitrate as N	7.35 (0.410)		353.2		20	JLK	09/21/18 21:38	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:02	mg/L	CI82146
Sulfate	ND (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.22 (0.20)		351.2		1	JLK	09/25/18 18:09	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1C
Date Sampled: 09/20/18 14:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-12
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 22:58	10	10	CI82111
Manganese	0.360 (0.020)		200.7		1	KJK	09/21/18 22:58	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1C
Date Sampled: 09/20/18 14:05
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-12
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	9.97 (0.50)		350.1		5	JLK	09/26/18 17:02	mg/L	CI82502
Chloride	109 (15.0)		9250		5	EEM	09/24/18 14:32	mg/L	CI82425
Dissolved Organic Carbon (Average)	4.16 (0.250)		5310B		1	CCP	09/25/18 16:01	mg/L	[CALC]
Nitrate as N	9.66 (0.410)		353.2		20	JLK	09/21/18 21:39	mg/L	[CALC]
Nitrite as N	0.128 (0.010)		353.2		1	JLK	09/21/18 20:03	mg/L	CI82146
Sulfate	28.1 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	11.4 (1.00)		351.2		5	JLK	09/25/18 18:36	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1B
Date Sampled: 09/20/18 14:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-13
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 23:02	10	10	CI82111
Manganese	0.042 (0.020)		200.7		1	KJK	09/21/18 23:02	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1B
Date Sampled: 09/20/18 14:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-13
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	1.26 (0.10)		350.1		1	JLK	09/26/18 16:46	mg/L	CI82502
Chloride	52.3 (3.0)		9250		1	EEM	09/24/18 14:14	mg/L	CI82425
Dissolved Organic Carbon (Average)	3.66 (0.250)		5310B		1	CCP	09/25/18 16:14	mg/L	[CALC]
Nitrate as N	10.6 (0.410)		353.2		20	JLK	09/21/18 21:40	mg/L	[CALC]
Nitrite as N	0.046 (0.010)		353.2		1	JLK	09/21/18 20:04	mg/L	CI82146
Sulfate	24.7 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	1.16 (0.20)		351.2		1	JLK	09/25/18 18:16	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1A
Date Sampled: 09/20/18 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-14
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.248 (0.100)		200.7		1	KJK	09/21/18 23:17	10	10	CI82111
Manganese	0.232 (0.020)		200.7		1	KJK	09/21/18 23:17	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN1A
Date Sampled: 09/20/18 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-14
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	1.13 (0.10)		350.1		1	JLK	09/26/18 16:53	mg/L	CI82502
Chloride	28.2 (3.0)		9250		1	EEM	09/24/18 14:15	mg/L	CI82425
Dissolved Organic Carbon (Average)	2.83 (0.250)		5310B		1	CCP	09/25/18 16:26	mg/L	[CALC]
Nitrate as N	11.1 (0.410)		353.2		20	JLK	09/21/18 21:41	mg/L	[CALC]
Nitrite as N	0.019 (0.010)		353.2		1	JLK	09/21/18 20:05	mg/L	CI82146
Sulfate	16.7 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	1.32 (0.20)		351.2		1	JLK	09/25/18 18:17	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BM050C
Date Sampled: 09/20/18 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-15
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 23:21	10	10	CI82111
Manganese	0.041 (0.020)		200.7		1	KJK	09/21/18 23:21	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-BM050C
 Date Sampled: 09/20/18 16:15
 Percent Solids: N/A

ESS Laboratory Work Order: 1809553
 ESS Laboratory Sample ID: 1809553-15
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:54	mg/L	CI82502
Chloride	193 (15.0)		9250		5	EEM	09/24/18 14:37	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.38 (0.250)		5310B		1	CCP	09/25/18 17:04	mg/L	[CALC]
Nitrate as N	1.05 (0.110)		353.2		5	JLK	09/21/18 21:42	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:06	mg/L	CI82146
Sulfate	ND (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.40 (0.20)		351.2		1	JLK	09/25/18 18:18	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BM050B
Date Sampled: 09/20/18 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-16
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/21/18 23:38	10	10	CI82111
Manganese	0.060 (0.020)		200.7		1	KJK	09/21/18 23:38	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BM050B
Date Sampled: 09/20/18 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-16
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	1.52 (0.10)		350.1		1	JLK	09/26/18 16:55	mg/L	CI82502
Chloride	238 (15.0)		9250		5	EEM	09/24/18 14:38	mg/L	CI82425
Dissolved Organic Carbon (Average)	2.26 (0.250)		5310B		1	CCP	09/25/18 17:16	mg/L	[CALC]
Nitrate as N	6.39 (0.410)		353.2		20	JLK	09/21/18 21:43	mg/L	[CALC]
Nitrite as N	0.016 (0.010)		353.2		1	JLK	09/21/18 20:07	mg/L	CI82146
Sulfate	17.3 (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	2.15 (0.20)		351.2		1	JLK	09/25/18 18:19	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BM050A
Date Sampled: 09/20/18 17:25
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-17
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.143 (0.100)		200.7		1	KJK	09/21/18 23:42	10	10	CI82111
Manganese	0.163 (0.020)		200.7		1	KJK	09/21/18 23:42	10	10	CI82111



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BM050A
Date Sampled: 09/20/18 17:25
Percent Solids: N/A

ESS Laboratory Work Order: 1809553
ESS Laboratory Sample ID: 1809553-17
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/26/18 16:56	mg/L	CI82502
Chloride	153 (15.0)		9250		5	EEM	09/24/18 14:39	mg/L	CI82425
Dissolved Organic Carbon (Average)	1.33 (0.250)		5310B		1	CCP	09/25/18 17:28	mg/L	[CALC]
Nitrate as N	2.23 (0.110)		353.2		5	JLK	09/21/18 21:44	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/21/18 20:13	mg/L	CI82146
Sulfate	ND (5.0)		9038		1	EEM	09/24/18 15:15	mg/L	CI82428
Total Kjeldahl Nitrogen as N	0.45 (0.20)		351.2		1	JLK	09/25/18 18:20	mg/L	CI82520



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
---------	--------	-----	-------	-------------	---------------	------	-------------	-----	-----------	-----------

Dissolved Metals

Batch CI82111 - 200.7/6010BNoDigest

Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.45		mg/L	2.501		98	80-120			
Manganese	0.484		mg/L	0.5000		97	80-120			

Total Metals

Batch CI82041 - 3005A/200.7

Blank										
Arsenic	ND	0.0025	mg/L							
LCS										
Arsenic	0.251	0.0625	mg/L	0.2500		101	85-115			
LCS Dup										
Arsenic	0.246	0.0625	mg/L	0.2500		98	85-115	2	20	

Classical Chemistry

Batch CI82146 - [CALC]

Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.254		mg/L	0.2497		102	90-110			
Nitrite as N	0.254		mg/L	0.2497		102	90-110			

Batch CI82147 - [CALC]

Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate as N	0.519		mg/L							
Nitrate/Nitrite as N	0.519		mg/L	0.5000		104	90-110			

Batch CI82425 - General Preparation

Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	30.2		mg/L	30.00		101	90-110			

Batch CI82428 - General Preparation

Blank										
Sulfate	ND	5.0	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CI82428 - General Preparation										
LCS										
Sulfate	9.6		mg/L	9.988		96	85-115			
Batch CI82444 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.0	2.00	mg/L	20.00		110	80-120			
Batch CI82447 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.250	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.32	0.500	mg/L	5.000		106	80-120			
Dissolved Organic Carbon (2)	5.27	0.500	mg/L	5.000		105	80-120			
Dissolved Organic Carbon (Average)	5.29	0.250	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	5.25	0.500	mg/L	5.000		105	80-120	1	200	
Dissolved Organic Carbon (2)	5.18	0.500	mg/L	5.000		104	80-120	2	200	
Dissolved Organic Carbon (Average)	5.21	0.250	mg/L							
Batch CI82502 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		112	80-120			
LCS										
Ammonia as N	1.05	0.10	mg/L	0.9994		105	80-120			
Batch CI82520 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.6	2.00	mg/L	20.00		103	80-120			
Batch CI82534 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.250	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.94	0.500	mg/L	5.000		99	80-120			
Dissolved Organic Carbon (2)	4.94	0.500	mg/L	5.000		99	80-120			
Dissolved Organic Carbon (Average)	4.94	0.250	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
---------	--------	-----	-------	-------------	---------------	------	-------------	-----	-----------	-----------

Classical Chemistry

Batch CI82534 - General Preparation

LCS Dup

Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	3	200	
Dissolved Organic Carbon (2)	4.76	0.500	mg/L	5.000		95	80-120	4	200	
Dissolved Organic Carbon (Average)	4.78	0.250	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

Notes and Definitions

- U Analyte included in the analysis, but not detected
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809553

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179

<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750

http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002

<http://www.maine.gov/dhhs/meecd/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002

<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424

<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313

<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006

http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752

<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809553

Date Received: 9/20/2018

Shipped/Delivered Via: ESS Courier

Project Due Date: 9/27/2018

Days for Project: 5 Day

1. Air bill manifest present? No
Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
Temp: 1.8 Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. Were labs informed about short holds & rushes? Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes No
ESS Sample IDs: _____
Analysis: _____
TAT: _____

12. Were VOAs received? Yes / No
a. Air bubbles in aqueous VOAs? Yes / No
b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
a. If metals preserved upon receipt: Date: _____ Time: _____ By: _____
b. Low Level VOA vials frozen: Date: _____ Time: _____ By: _____

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
a. Was there a need to contact the client? Yes / No
Who was contacted? _____ Date: _____ Time: _____ By: _____

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	269182	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	269183	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	269200	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	269233	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	269234	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	269251	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	269180	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	269181	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	269199	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	269231	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	269232	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	269250	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	269178	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	269179	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	269198	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
03	269229	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	269230	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	269249	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	269176	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	269177	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	269197	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
04	269227	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	269228	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	269248	Yes	NA	Yes	250 mL Amber - Unpres	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809553
Date Received: 9/20/2018

04	269254	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
05	269174	Yes	NA	Yes	VOA Vial - HCl	HCl
05	269175	Yes	NA	Yes	VOA Vial - HCl	HCl
05	269196	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
05	269225	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	269226	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	269247	Yes	NA	Yes	250 mL Amber - Unpres	NP
05	269253	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
06	269172	Yes	NA	Yes	VOA Vial - HCl	HCl
06	269173	Yes	NA	Yes	VOA Vial - HCl	HCl
06	269195	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
06	269223	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	269224	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	269246	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	269252	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
07	269170	Yes	NA	Yes	VOA Vial - HCl	HCl
07	269171	Yes	NA	Yes	VOA Vial - HCl	HCl
07	269194	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
07	269221	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	269222	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	269245	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	269168	Yes	NA	Yes	VOA Vial - HCl	HCl
08	269169	Yes	NA	Yes	VOA Vial - HCl	HCl
08	269193	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
08	269219	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	269220	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	269244	Yes	NA	Yes	250 mL Amber - Unpres	NP
09	269166	Yes	NA	Yes	VOA Vial - HCl	HCl
09	269167	Yes	NA	Yes	VOA Vial - HCl	HCl
09	269192	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
09	269217	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	269218	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	269243	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	269164	Yes	NA	Yes	VOA Vial - HCl	HCl
10	269165	Yes	NA	Yes	VOA Vial - HCl	HCl
10	269191	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
10	269215	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	269216	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	269242	Yes	NA	Yes	250 mL Amber - Unpres	NP
11	269162	Yes	NA	Yes	VOA Vial - HCl	HCl
11	269163	Yes	NA	Yes	VOA Vial - HCl	HCl
11	269190	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
11	269213	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	269214	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	269241	Yes	NA	Yes	250 mL Amber - Unpres	NP
12	269160	Yes	NA	Yes	VOA Vial - HCl	HCl
12	269161	Yes	NA	Yes	VOA Vial - HCl	HCl
12	269189	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
12	269211	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	269212	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	269240	Yes	NA	Yes	250 mL Amber - Unpres	NP
13	269158	Yes	NA	Yes	VOA Vial - HCl	HCl
13	269159	Yes	NA	Yes	VOA Vial - HCl	HCl
13	269188	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
13	269209	Yes	NA	Yes	250 mL Poly - Unpres	NP
13	269210	Yes	NA	Yes	250 mL Poly - Unpres	NP
13	269239	Yes	NA	Yes	250 mL Amber - Unpres	NP
14	269156	Yes	NA	Yes	VOA Vial - HCl	HCl
14	269157	Yes	NA	Yes	VOA Vial - HCl	HCl
14	269187	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
14	269207	Yes	NA	Yes	250 mL Poly - Unpres	NP
14	269208	Yes	NA	Yes	250 mL Poly - Unpres	NP
14	269238	Yes	NA	Yes	250 mL Amber - Unpres	NP
15	269154	Yes	NA	Yes	VOA Vial - HCl	HCl
15	269155	Yes	NA	Yes	VOA Vial - HCl	HCl
15	269186	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
15	269205	Yes	NA	Yes	250 mL Poly - Unpres	NP
15	269206	Yes	NA	Yes	250 mL Poly - Unpres	NP
15	269237	Yes	NA	Yes	250 mL Amber - Unpres	NP
16	269152	Yes	NA	Yes	VOA Vial - HCl	HCl

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809553

Date Received: 9/20/2018

16	269153	Yes	NA	Yes	VOA Vial - HCl	HCl
16	269185	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
16	269203	Yes	NA	Yes	250 mL Poly - Unpres	NP
16	269204	Yes	NA	Yes	250 mL Poly - Unpres	NP
16	269236	Yes	NA	Yes	250 mL Amber - Unpres	NP
17	269150	Yes	NA	Yes	VOA Vial - HCl	HCl
17	269151	Yes	NA	Yes	VOA Vial - HCl	HCl
17	269184	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
17	269201	Yes	NA	Yes	250 mL Poly - Unpres	NP
17	269202	Yes	NA	Yes	250 mL Poly - Unpres	NP
17	269235	Yes	NA	Yes	250 mL Amber - Unpres	NP

2nd Review

Are barcode labels on correct containers?

Yes / No
 Yes No

Are all necessary stickers attached?

Yes / No
 Yes No

Completed

By: [Signature]

Date & Time: 9/20/18 2223

Reviewed

By: [Signature]

Date & Time: 9/20/18 2300

Delivered

By: [Signature]

Date & Time: 9/20/18 2300



CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1809652

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:08 pm, Oct 02, 2018

Analytical Summary

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

SAMPLE RECEIPT

The following samples were received on September 25, 2018 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

<u>Lab Number</u>	<u>Sample Name</u>	<u>Matrix</u>	<u>Analysis</u>
1809652-01	MW-BX1B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-02	MW-BX1C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-03	MW-B1050B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-04	MW-B1050A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-05	MW-B1075B	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-06	MW-B1050C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-07	MW-4	Ground Water	3113B, 353.2
1809652-08	MW-BX2B	Ground Water	200.7, 3113B, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-09	MW-BN2C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-10	MW-B2100C	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-11	MW-B2075A	Ground Water	200.7, 350.1, 351.2, 353.2, 5310B, 9038, 9250
1809652-12	MW-B2020B	Ground Water	200.7, 3113B, 350.1, 351.2, 353.2, 5310B, 9038, 9250



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

- 1010A - Flashpoint
- 6010C - ICP
- 6020A - ICP MS
- 7010 - Graphite Furnace
- 7196A - Hexavalent Chromium
- 7470A - Aqueous Mercury
- 7471B - Solid Mercury
- 8011 - EDB/DBCP/TCP
- 8015C - GRO/DRO
- 8081B - Pesticides
- 8082A - PCB
- 8100M - TPH
- 8151A - Herbicides
- 8260B - VOA
- 8270D - SVOA
- 8270D SIM - SVOA Low Level
- 9014 - Cyanide
- 9038 - Sulfate
- 9040C - Aqueous pH
- 9045D - Solid pH (Corrosivity)
- 9050A - Specific Conductance
- 9056A - Anions (IC)
- 9060A - TOC
- 9095B - Paint Filter
- MADEP 04-1.1 - EPH
- MADEP 04-2.1 - VPH

Prep Methods

- 3005A - Aqueous ICP Digestion
- 3020A - Aqueous Graphite Furnace / ICP MS Digestion
- 3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
- 3060A - Solid Hexavalent Chromium Digestion
- 3510C - Separatory Funnel Extraction
- 3520C - Liquid / Liquid Extraction
- 3540C - Manual Soxhlet Extraction
- 3541 - Automated Soxhlet Extraction
- 3546 - Microwave Extraction
- 3580A - Waste Dilution
- 5030B - Aqueous Purge and Trap
- 5030C - Aqueous Purge and Trap
- 5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX1B
Date Sampled: 09/25/18 07:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	67.6 (0.100)		200.7		1	KJK	09/26/18 13:18	10	10	CI82602
Manganese	5.03 (0.020)		200.7		1	KJK	09/26/18 13:18	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX1B
Date Sampled: 09/25/18 07:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:43	mg/L	CI82713
Chloride	38.5 (3.0)		9250		1	EEM	10/01/18 14:10	mg/L	CJ80119
Dissolved Organic Carbon (Average)	80.7 (2.50)		5310B		10	ZZZ	09/26/18 0:00	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	09/25/18 22:50	mg/L	[CALC]
Nitrite as N	0.049 (0.010)		353.2		1	JLK	09/25/18 22:14	mg/L	CI82559
Sulfate	44.0 (25.0)		9038		5	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	2.14 (0.20)		351.2		1	JLK	10/01/18 17:45	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX1C
Date Sampled: 09/25/18 07:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	24.2 (0.100)		200.7		1	KJK	09/26/18 13:47	10	10	CI82602
Manganese	1.98 (0.020)		200.7		1	KJK	09/26/18 13:47	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX1C
Date Sampled: 09/25/18 07:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.16 (0.10)		350.1		1	JLK	09/28/18 16:44	mg/L	CI82713
Chloride	45.9 (3.0)		9250		1	EEM	10/01/18 14:12	mg/L	CJ80119
Dissolved Organic Carbon (Average)	78.7 (2.50)		5310B		10	ZZZ	09/26/18 0:13	mg/L	[CALC]
Nitrate as N	5.77 (0.210)		353.2		10	JLK	09/25/18 23:19	mg/L	[CALC]
Nitrite as N	0.118 (0.010)		353.2		1	JLK	09/25/18 22:17	mg/L	CI82559
Sulfate	18.1 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	2.90 (0.20)		351.2		1	JLK	10/01/18 17:48	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050B
Date Sampled: 09/25/18 08:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 13:51	10	10	CI82602
Manganese	0.147 (0.020)		200.7		1	KJK	09/26/18 13:51	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050B
Date Sampled: 09/25/18 08:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:45	mg/L	CI82713
Chloride	36.8 (3.0)		9250		1	EEM	10/01/18 14:13	mg/L	CJ80119
Dissolved Organic Carbon (Average)	9.71 (0.250)		5310B		1	ZZZ	09/25/18 20:56	mg/L	[CALC]
Nitrate as N	24.3 (2.01)		353.2		100	JLK	09/25/18 23:34	mg/L	[CALC]
Nitrite as N	0.049 (0.010)		353.2		1	JLK	09/25/18 22:18	mg/L	CI82559
Sulfate	ND (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	10/01/18 17:49	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050A
Date Sampled: 09/25/18 08:10
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	41.4 (0.100)		200.7		1	KJK	09/26/18 13:55	10	10	CI82602
Manganese	1.95 (0.020)		200.7		1	KJK	09/26/18 13:55	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050A
Date Sampled: 09/25/18 08:10
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.28 (0.10)		350.1		1	JLK	09/28/18 16:46	mg/L	CI82713
Chloride	63.7 (3.0)		9250		1	EEM	10/01/18 14:14	mg/L	CJ80119
Dissolved Organic Carbon (Average)	28.0 (1.25)		5310B		5	ZZZ	09/26/18 0:26	mg/L	[CALC]
Nitrate as N	11.7 (0.410)		353.2		20	JLK	09/25/18 23:35	mg/L	[CALC]
Nitrite as N	0.196 (0.010)		353.2		1	JLK	09/25/18 22:18	mg/L	CI82559
Sulfate	27.1 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	1.85 (0.20)		351.2		1	JLK	10/01/18 17:49	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1075B
Date Sampled: 09/25/18 08:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 13:59	10	10	CI82602
Manganese	0.083 (0.020)		200.7		1	KJK	09/26/18 13:59	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1075B
Date Sampled: 09/25/18 08:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	9.56 (0.50)		350.1		5	JLK	09/28/18 17:14	mg/L	CI82713
Chloride	159 (30.0)		9250		10	EEM	10/01/18 14:45	mg/L	CJ80119
Dissolved Organic Carbon (Average)	4.63 (0.250)		5310B		1	ZZZ	09/25/18 22:05	mg/L	[CALC]
Nitrate as N	8.18 (0.210)		353.2		10	JLK	09/25/18 23:22	mg/L	[CALC]
Nitrite as N	0.062 (0.010)		353.2		1	JLK	09/25/18 22:19	mg/L	CI82559
Sulfate	15.8 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	10.5 (1.00)		351.2		5	JLK	10/01/18 18:17	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050C
Date Sampled: 09/25/18 09:20
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 14:04	10	10	CI82602
Manganese	0.021 (0.020)		200.7		1	KJK	09/26/18 14:04	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-B1050C
 Date Sampled: 09/25/18 09:20
 Percent Solids: N/A

ESS Laboratory Work Order: 1809652
 ESS Laboratory Sample ID: 1809652-06
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:48	mg/L	CI82713
Chloride	32.8 (3.0)		9250		1	EEM	10/01/18 14:16	mg/L	CJ80119
Dissolved Organic Carbon (Average)	3.74 (0.250)		5310B		1	ZZZ	09/25/18 22:18	mg/L	[CALC]
Nitrate as N	8.43 (0.210)		353.2		10	JLK	09/25/18 23:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/25/18 22:20	mg/L	CI82559
Sulfate	15.3 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	JLK	10/01/18 17:51	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-4
Date Sampled: 09/25/18 09:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	ND (0.0025)		3113B		1	KJK	09/26/18 22:41	50	25	CI82644



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-4
Date Sampled: 09/25/18 09:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Nitrate as N	3.51 (0.210)		353.2		10	JLK	09/25/18 23:25	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2B
Date Sampled: 09/25/18 09:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 14:08	10	10	CI82602
Manganese	0.324 (0.020)		200.7		1	KJK	09/26/18 14:08	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2B
Date Sampled: 09/25/18 09:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	ND (0.0025)		3113B		1	KJK	09/26/18 22:52	50	25	CI82644



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-BX2B
 Date Sampled: 09/25/18 09:30
 Percent Solids: N/A

ESS Laboratory Work Order: 1809652
 ESS Laboratory Sample ID: 1809652-08
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.11 (0.10)		350.1		1	JLK	09/28/18 16:55	mg/L	CI82713
Chloride	29.7 (3.0)		9250		1	EEM	10/01/18 14:17	mg/L	CJ80119
Dissolved Organic Carbon (Average)	27.7 (0.750)		5310B		3	ZZZ	09/26/18 14:15	mg/L	[CALC]
Nitrate as N	9.55 (0.410)		353.2		20	JLK	09/25/18 23:26	mg/L	[CALC]
Nitrite as N	0.198 (0.010)		353.2		1	JLK	09/25/18 22:27	mg/L	CI82559
Sulfate	16.9 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	0.42 (0.20)		351.2		1	JLK	10/01/18 17:58	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN2C
Date Sampled: 09/25/18 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 14:12	10	10	CI82602
Manganese	0.158 (0.020)		200.7		1	KJK	09/26/18 14:12	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BN2C
Date Sampled: 09/25/18 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:56	mg/L	CI82713
Chloride	1000 (60.0)		9250		20	EEM	10/01/18 14:46	mg/L	CJ80119
Dissolved Organic Carbon (Average)	1.01 (0.250)		5310B		1	ZZZ	09/26/18 14:28	mg/L	[CALC]
Nitrate as N	0.942 (0.030)		353.2		1	JLK	09/25/18 23:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/25/18 22:28	mg/L	CI82559
Sulfate	5.7 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	0.61 (0.20)		351.2		1	JLK	10/01/18 17:59	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2100C
Date Sampled: 09/25/18 10:15
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 14:17	10	10	CI82602
Manganese	0.119 (0.020)		200.7		1	KJK	09/26/18 14:17	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
 Client Project ID: Orleans MA
 Client Sample ID: MW-B2100C
 Date Sampled: 09/25/18 10:15
 Percent Solids: N/A

ESS Laboratory Work Order: 1809652
 ESS Laboratory Sample ID: 1809652-10
 Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:57	mg/L	CI82713
Chloride	116 (30.0)		9250		10	EEM	10/01/18 14:47	mg/L	CJ80119
Dissolved Organic Carbon (Average)	1.17 (0.250)		5310B		1	ZZZ	09/25/18 22:56	mg/L	[CALC]
Nitrate as N	2.43 (0.110)		353.2		5	JLK	09/25/18 23:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/25/18 22:29	mg/L	CI82559
Sulfate	9.4 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	0.39 (0.20)		351.2		1	JLK	10/01/18 18:00	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2075A
Date Sampled: 09/25/18 10:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	ND (0.100)		200.7		1	KJK	09/26/18 14:21	10	10	CI82602
Manganese	0.028 (0.020)		200.7		1	KJK	09/26/18 14:21	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2075A
Date Sampled: 09/25/18 10:50
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	JLK	09/28/18 16:58	mg/L	CI82713
Chloride	308 (30.0)		9250		10	EEM	10/01/18 14:48	mg/L	CJ80119
Dissolved Organic Carbon (Average)	1.31 (0.250)		5310B		1	ZZZ	09/25/18 23:34	mg/L	[CALC]
Nitrate as N	0.810 (0.030)		353.2		1	JLK	09/25/18 23:06	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	09/25/18 22:30	mg/L	CI82559
Sulfate	7.7 (5.0)		9038		1	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	0.45 (0.20)		351.2		1	JLK	10/01/18 18:01	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2020B
Date Sampled: 09/25/18 12:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-12
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	17.6 (0.100)		200.7		1	KJK	09/26/18 14:25	10	10	CI82602
Manganese	3.54 (0.020)		200.7		1	KJK	09/26/18 14:25	10	10	CI82602



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2020B
Date Sampled: 09/25/18 12:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-12
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A/200.7

All methods used are in accordance with 40 CFR 136.

Total Metals

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Arsenic	ND (0.0025)		3113B		1	KJK	09/26/18 22:58	50	25	CI82644



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B2020B
Date Sampled: 09/25/18 12:30
Percent Solids: N/A

ESS Laboratory Work Order: 1809652
ESS Laboratory Sample ID: 1809652-12
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.11 (0.10)		350.1		1	JLK	09/28/18 16:59	mg/L	CI82713
Chloride	46.9 (3.0)		9250		1	EEM	10/01/18 14:25	mg/L	CJ80119
Dissolved Organic Carbon (Average)	17.3 (0.250)		5310B		1	ZZZ	09/25/18 23:47	mg/L	[CALC]
Nitrate as N	3.06 (0.110)		353.2		5	JLK	09/25/18 23:33	mg/L	[CALC]
Nitrite as N	0.314 (0.010)		353.2		1	JLK	09/25/18 22:31	mg/L	CI82559
Sulfate	42.5 (25.0)		9038		5	EEM	09/26/18 16:30	mg/L	CI82618
Total Kjeldahl Nitrogen as N	0.91 (0.20)		351.2		1	JLK	10/01/18 18:02	mg/L	CI82834



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
---------	--------	-----	-------	-------------	---------------	------	-------------	-----	-----------	-----------

Dissolved Metals

Batch CI82602 - 200.7/6010BNoDigest

Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.40		mg/L	2.501		96	80-120			
Manganese	0.482		mg/L	0.5000		96	80-120			

Total Metals

Batch CI82644 - 3005A/200.7

Blank										
Arsenic	ND	0.0025	mg/L							
LCS										
Arsenic	0.233	0.0625	mg/L	0.2500		93	85-115			

Classical Chemistry

Batch CI82534 - General Preparation

Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.250	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.94	0.500	mg/L	5.000		99	80-120			
Dissolved Organic Carbon (2)	4.94	0.500	mg/L	5.000		99	80-120			
Dissolved Organic Carbon (Average)	4.94	0.250	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	3	200	
Dissolved Organic Carbon (2)	4.76	0.500	mg/L	5.000		95	80-120	4	200	
Dissolved Organic Carbon (Average)	4.78	0.250	mg/L							

Batch CI82559 - [CALC]

Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.254		mg/L	0.2497		102	90-110			
Nitrite as N	0.254		mg/L	0.2497		102	90-110			

Batch CI82560 - [CALC]

Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CI82560 - [CALC]										
LCS										
Nitrate as N	0.534		mg/L							
Nitrate/Nitrite as N	0.534		mg/L	0.5000		107	90-110			
Batch CI82618 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.6		mg/L	9.988		96	85-115			
Batch CI82713 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.08	0.10	mg/L	0.09994		82	80-120			
LCS										
Ammonia as N	0.95	0.10	mg/L	0.9994		95	80-120			
Batch CI82834 - General Preparation										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.0	2.00	mg/L	20.00		110	80-120			
Batch CJ80119 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	31.7		mg/L	30.00		106	90-110			



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

Notes and Definitions

- U Analyte included in the analysis, but not detected
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1809652

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179

<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750

http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutOfStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002

<http://www.maine.gov/dhhs/meecd/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002

<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424

<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313

<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006

http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752

<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPBM/MM

ESS Project ID: 1809652

Date Received: 9/25/2018

Shipped/Delivered Via: ESS Courier

Project Due Date: 10/2/2018

Days for Project: 5 Day

1. Air bill manifest present? No
Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
Temp: 1.0 Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. Were labs informed about short holds & rushes? Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes No
ESS Sample IDs: _____
Analysis: _____
TAT: _____

12. Were VOAs received? Yes No
a. Air bubbles in aqueous VOAs? Yes / No / NA
b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes No
a. If metals preserved upon receipt: Date: _____ Time: _____ By: _____
b. Low Level VOA vials frozen: Date: _____ Time: _____ By: _____

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes No
a. Was there a need to contact the client? Yes No
Who was contacted? _____ Date: _____ Time: _____ By: _____

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	270812	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	270813	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	270824	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	270845	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	270846	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	270857	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	270810	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	270811	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	270823	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	270843	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	270844	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	270856	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	270808	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	270809	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	270822	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
03	270841	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	270842	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	270855	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	270806	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	270807	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	270821	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
04	270839	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	270840	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	270854	Yes	NA	Yes	250 mL Amber - Unpres	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1809652
Date Received: 9/25/2018

05	270804	Yes	NA	Yes	VOA Vial - HCl	HCl
05	270805	Yes	NA	Yes	VOA Vial - HCl	HCl
05	270820	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
05	270837	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	270838	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	270853	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	270802	Yes	NA	Yes	VOA Vial - HCl	HCl
06	270803	Yes	NA	Yes	VOA Vial - HCl	HCl
06	270819	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
06	270835	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	270836	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	270852	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	270858	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	270859	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
08	270800	Yes	NA	Yes	VOA Vial - HCl	HCl
08	270801	Yes	NA	Yes	VOA Vial - HCl	HCl
08	270818	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
08	270833	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	270834	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	270851	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	270927	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
09	270798	Yes	NA	Yes	VOA Vial - HCl	HCl
09	270799	Yes	NA	Yes	VOA Vial - HCl	HCl
09	270817	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
09	270831	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	270832	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	270850	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	270796	Yes	NA	Yes	VOA Vial - HCl	HCl
10	270797	Yes	NA	Yes	VOA Vial - HCl	HCl
10	270816	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
10	270829	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	270830	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	270849	Yes	NA	Yes	250 mL Amber - Unpres	NP
11	270794	Yes	NA	Yes	VOA Vial - HCl	HCl
11	270795	Yes	NA	Yes	VOA Vial - HCl	HCl
11	270815	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
11	270827	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	270828	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	270848	Yes	NA	Yes	250 mL Amber - Unpres	NP
12	270792	Yes	NA	Yes	VOA Vial - HCl	HCl
12	270793	Yes	NA	Yes	VOA Vial - HCl	HCl
12	270814	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
12	270825	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	270826	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	270847	Yes	NA	Yes	Other Glass - Unpres	NP
12	270926	Yes	NA	Yes	250 mL Poly - HNO3	HNO3

2nd Review

Are barcode labels on correct containers?
Are all necessary stickers attached?

Yes / No
Yes / No

Completed By: [Signature]
Reviewed By: [Signature]
Delivered By: [Signature]

Date & Time: 9/25/18 1915
Date & Time: 9/25/18 1922
Date & Time: 9/25/18 1922

ESS Laboratory

Division of Thielsch Engineering, Inc.
 185 Frances Avenue, Cranston RI 02910
 Tel. (401) 461-7181 Fax (401) 461-4486
 www.esslaboratory.com

CHAIN OF CUSTODY

Turn Time _____ Rush _____
 Regulatory State _____
 Is this project for any of the following?:
 OCT RCP OMA MCP ORGP

ESS Lab # 1807652

Reporting Limits _____
 Limit Checker Standard Excel
 Electronic Deliverables Other (Please Specify →)

Company Name AECOM
 Contact Person Briely Momi
 City Prossett State MA
 Telephone Number _____ FAX Number _____
 Project # _____ Project Name 9 Jonathan Bourne Dr
 Address 9 Jonathan Bourne Dr PO # _____
 Zip Code 02559 Email Address briely.momi@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
11	09/25/18	1050	G	GW	MN-B2075A	X NO ₂ , NO ₃ , SO ₄ , Cl X TKN, HMM X Diss Metals X DOC X Hrschic
12	09/25/18	1230	G	GW	MN-B2020B*	X NO ₂ , NO ₃ , SO ₄ , Cl X TKN, HMM X Diss Metals X DOC X Hrschic

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	G-Glass	O-Other	P-Poly	S-Sterile	V-Vial			
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAcAc, NaOH	9-NH4Cl	10-DI H2O	11-Ascorbic Acid	12-Other*
Number of Containers per Sample:												

Laboratory Use Only

Cooler Present: _____
 Seals Intact: _____
 Cooler Temperature: 1.0 °C ICE RC

Sampled by: _____
 Comments: *MN-B2020B DOC is mason jar, was short 1 250ml AG

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)
<u>[Signature]</u> 9/25/18 15:15	<u>[Signature]</u> 9/25/18 1709
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)
<u>[Signature]</u> 9/25/18 15:15	<u>[Signature]</u> 9/25/18 1910