

## Memorandum

To George Meservey, Director of Planning & Community Development

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Subject **Town of Orleans, MA  
Water Quality and Wastewater Planning  
Task Number 11.1.B.2 – NT Demonstration Projects  
Task 11.1.B.2.A - Technical Memorandum for Eldredge Park Permeable Reactive  
Barrier Demonstration Project – Q-4 January 2018 Groundwater Monitoring  
Quarterly Report - Final**

Project Number 60476644

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

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Approvals	Date	Signature / Initials
George Meservey, Orleans, MA Director of Planning & Community Development		

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### 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). 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 in groundwater derived from the injected PRB substrate, and reductions in nitrate concentration, the PRB is performing well in the monitored area downgradient of the PRB to the east northeast.

A portion of the area originally targeted for assessment of PRB performance further to the north of the PRB has been found to be potentially 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 is recommended that includes extending the PRB treatment line to the north to intercept and treat nitrate in groundwater along this untreated flow path.

## 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.

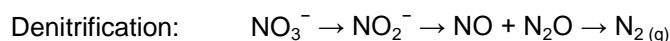
#### 4. Demonstration Test Location

- 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).
- 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 current PRB Demonstration test line is oriented northwest to southeast (perpendicular) to the northeasterly regional groundwater flow direction and is approximately 110 feet long. Future full-scale PRBs or sections of 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 vertical treatment interval from the top of the groundwater table to approximately 35 feet into the saturated soils was selected for this Demonstration Test PRB.

##### 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 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 will also maximize the persistence of the carbon substrate within the PRB. For this demonstration test, 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” in order to reduce migration after injection and increase persistence. Injecting EVO diluted with water enhances the distribution of EVO in the subsurface. The 60 percent EVO was mixed with water making a 15.5 percent solution for injection.

For in-situ remediation technologies, delivery of an appropriate amount of injected amendments is a primary factor to achieving successful treatment. Sufficient carbon substrate/electron donor material must be applied to establish nitrate reducing conditions in the PRB. The Substrate Estimating Tool for Enhanced Anaerobic Bioremediation of Chlorinated Solvents developed for the Environmental Security Technology Certification Program (ESTCP) was used to support EVO quantities for the PRB Demonstration Tests. This tool estimates quantities of various carbon substrates to provide sufficient amendment for the sum of electron donor demand from electron acceptors (dissolved oxygen, nitrate, and sulfate) as well as dissolved volatile organic compounds if present. For the Demonstration Test, the EVO dosage was determined primarily to meet the electron donor demand based on site conditions including expected nitrate concentrations. Actual quantities of EVO used to establish the Demonstration Test treatment zone are summarized in Table 4-1.

The metabolism of added carbon substrate by soil microbes can result in a decrease in groundwater pH, and a neutralization agent (i.e., sodium bicarbonate) is sometimes injected with the carbon substrate to counteract changes in pH. Groundwater pH is typically between pH 5.5 and pH 6 across Cape Cod. Denitrifying bacteria are most active in circumneutral groundwater (pH 6 to 8). Based on groundwater data indicating a lower pH (5.5-6.5) at the site, sodium bicarbonate was used as a pH buffer with the EVO. Approximately 10.3 pounds of sodium bicarbonate was added per 300-gallons of EVO solution.

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

Parameter	Demonstration Test Site
Area Description	Parking lot between the playing fields off Eldredge Park
Depth to Ground Water	30 to 40 feet below grade
Demonstration Test PRB Length	110 feet
Injection Interval	38 to 68 feet below grade
Injection Point Spacing	10 feet
Injection Points	17
Injection Pore Volume	12 percent (assumed effective porosity of 25 percent)
Total Injection Volume (gal)	10,800
Injection Volume Per Point (gal)	600 (Three points received 720, 820, 860 gal in order to use the remainder of the EVO.)
EVO Dilution	15.5 percent (~3.9:1 dilution from 60 percent EVO delivered)
Total EVO (gal)	2,620 (60 percent soy bean oil)

### **E. Substrate Delivery Record**

ISOTEC, Inc. performed the injections on November 15, 2016 through November 18, 2016 with oversight by the AECOM PRB Team. Injection of carbon substrate was performed directly through direct-push (i.e., GeoProbe®) rods, configured in 4-foot or 8-foot intervals with thin, laser cut injection holes. During the Demonstration Test, there were few geological limitations observed. The majority of the EVO was injected successfully with wellhead/injection pressure reading of 0 psi indicating no measureable resistance to injection. Several wells had higher wellhead pressures, close to 20 psi, particularly at their deepest intervals (56 to 68 feet). The higher pressure may indicate injection into lower permeability material such as finer sand and silt. The 17 injection points were spaced approximately 10 feet apart. In order to assess the effect of injection point density and injection volume, the eastern side of the PRB consisted of 10 points configured in two parallel, offset lines of five points each. The five points were spaced approximately 10 feet from each other. The second line was five feet downgradient and off-set by five feet. The western side of the PRB consisted of a single line with seven points, spaced 10 feet apart. Injection locations are depicted on Figure 1.

### **F. Field Injection Activities**

The system for preparation, mixing, and injection of substrate solutions consisted of mixing tanks, mixers, pumps, piping, meters, valves, and fittings. All components were selected from materials that are compatible for use with the selected amendments. Injection batches were prepared in 300-gallon plastic tanks by adding appropriate quantities of water to achieve the selected dilution concentration. Mobile above-ground pumps and hoses were used to convey EVO directly to the injection points. Flow totalizers, pressure gauges, and shut-off valves were used to monitor injection pressure, flow rates, and total volume added to each injection interval at each injection point.

At each injection point, a direct-push drill rig advanced injection tooling to a targeted depth of 68 feet below grade. Seventy-five gallons of the diluted EVO solution were injected per four-foot interval. Both 4-foot and 8-foot injection points were used for injection. The injection rods were lifted up four (or eight) feet to the subsequent injection target depth and the process was repeated. This method of direct-push injection is referred to as bottom-up injection. To minimize mounding and improve delivery, injection was generally not performed at adjacent points at the same time. A field log was maintained to record the solution composition, volume of solution delivered to each injection interval at injection point, length of time required for injection, and the injection pressure. Electricity to power remediation equipment was provided by a gasoline-powered generator. Potable water for batching and injection was collected from a nearby hydrant. More installation detail can be found in the Technical Memorandum for Eldredge Park Permeable Reactive Barriers Demonstration Overview of Baseline Sampling, Injection Activities and Post-Injection Groundwater Monitoring – Final (AECOM, March 2017).

## **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 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.

## 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. It is anticipated that the monitoring program will be frequently evaluated 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 includes 31 monitoring wells screens, including multi-level monitoring wells and single monitoring wells upgradient and downgradient of the PRB within the regional flow system. These wells are aligned in two transects oriented from southwest to northeast. There are additional monitoring wells located cross gradient and more regional monitoring wells around the PRB area. The monitoring network plan view is presented on Figure 1 and PRB monitoring well transect cross sections Transect 1 (A-A') and Transect 2 (B-B') shown on Figure 2 and Figure 3 respectively. 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, 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 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.

During injection activities, select groundwater wells were monitored for field parameters (pH, temperature, dissolved oxygen, oxidation-reduction potential, and conductivity). Additionally, the EVO vendor Terra Systems monitored the 10 foot and 20 foot downgradient monitoring wells using an in-well probe for these same parameters in order to observe any potential changes during injection. During the third full day of injections, select wells were sampled and analyzed for dissolved organic carbon (DOC) and alkalinity to estimate whether there had been any EVO migration. Generally DOC and alkalinity test results did not indicate EVO migration. Visual monitoring at test wells located 10 foot and 20 foot downgradient of injection points indicated sporadic observation of higher turbidity and what may have been dilute EVO during injection.

The first post-injection sampling event 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. Laboratory analysis of select metals will be conducted as part of performance monitoring in select wells. 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 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 <sub>3</sub> 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

### 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 Injection Activities

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

#### 1) 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 Figure 4 and Figure 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.

## 2) 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 PRB treatment line is 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 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 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.

### 3) 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 PRB does not likely 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. 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 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 now affected by the PRB. MW-2020B also saw a significant decrease in nitrate concentration from 22.4 mg/L in Q-2 to 6.0 mg/L in Q-3. Nitrate concentrations saw 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. 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-2 and Q-3 sampling at other locations where analyzed. No migration of EVO material was indicated by sampling observations or test results.

#### 4) 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 post-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. Additionally, water levels were 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 (Figure 6, Figure 7, and Figure 8). 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

Groundwater quality at sample locations closest to the PRB, including MW-B1010C on Transect 1 (A-A') and MW-B2010C on Transect 2 (B to B'), appear to be significantly improved by the PRB. Graphs of nitrate and DOC concentrations show generally decreasing nitrate concentration trends and increasing DOC concentration trends (Chart 1 and Chart 2). 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 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 (Chart 3, Chart 4, Chart 5, and Chart 6). 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. Dissolved manganese increased from 2.1 mg/L at Q-3 to 5.1 mg/L at Q-4 in MW-B2020C, however, dissolved iron decreased from 13.1 mg/L at Q-3 to 1.8 mg/L at Q-4. No significant changes for dissolved iron and manganese were noted between the Q-3 (or Q-2 when Q-3 unavailable) and Q-4 sampling at other locations where this was analyzed. No migration of EVO material was indicated by sampling observations or test results.

Nitrate concentrations also decreased at all monitoring wells located in an 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 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 (Chart 7 and Chart 8). 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 PRB.

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

## 9. Summary, Schedule, and Coordination

These monitoring data indicated the PRB is functioning as expected, increasing DOC and reducing nitrogen concentrations within the area affected by the PRB. The treated area is where the flow is from the southwest to northeast, through the PRB line to downgradient wells. Monitoring has also indicated the groundwater flow from the west to east, not passing through the PRB, is more prevalent approximately 50 feet north of the PRB. 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 (Figure 9).

A modification of the PRB system is necessary to improve the demonstration. This modification will require additional monitoring well installation to verify flow directions north of the PRB and establish an additional PRB injection zone starting at the west end of the current PRB injection zone and extending to the north up to 110 feet, roughly along the edge of the field and parking lot areas. The monitoring wells are necessary to verify groundwater contours for orientation of the new section of PRB perpendicular to the direction of groundwater flow. This modification of the PRB is being coordinated with Nauset Public Schools Superintendent's office and planned for the Spring of 2018.

In summary the completed PRB Demonstration Test milestones include:

- PRB groundwater monitoring network installation;
- Baseline groundwater quality data collection and analysis;
- PRB construction with injection of EVO as planned;
- Initial post-injection water quality data collection and analysis; and

- First four post-injection quarterly monitoring data collection and analysis.

The current plan includes collecting quarterly samples for a period of three years. 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 April 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.

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 – Monitoring Well Coordinates

Appendix B – Analytical Laboratory Reports

**Tables**

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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-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 <sup>1</sup>	N/A	N/A	55.0	45.0	55.0	N/A	N/A	N/A	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	45.7	45.37	50.0	40.0	50.0	5.70	-4.30	0.70	10.0	March 2017	Eldredge Park

Notes:

N/A = Not Available

1. MW-BC2C has not yet been surveyed.

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-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-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-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-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

## Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
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) <sup>1</sup>	Eldredge Park	2/23/2017	46.61	36.30	10.31
MW-12C (Existing) <sup>1</sup>	Eldredge Park	4/25/2017	46.61	34.95	11.66
MW-12C (Existing) <sup>1</sup>	Eldredge Park	6/29/2017	46.61	34.79	11.82
MW-12C (Existing) <sup>1</sup>	Eldredge Park	9/13/2017	46.61	13.00	33.61
MW-12C (Existing) <sup>1</sup>	Eldredge Park	1/8/2018	46.61	26.50	20.11
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-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-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-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

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
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		44.18		
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-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-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-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

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
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-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-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-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-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

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-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-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-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-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-BC2C <sup>2</sup>	Eldredge Park	6/29/2017	N/A	31.61	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	11/3/2016	N/A	32.84	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	11/14/2016	N/A	N/A	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	1/18/2017	N/A	33.22	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	1/27/2017	N/A	33.08	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	2/24/2017	N/A	32.63	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	4/25/2017	N/A	31.93	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	9/13/2017	N/A	31.26	N/A
MW-BC2C <sup>2</sup>	Eldredge Park	1/10/2018	N/A	31.70	N/A

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
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-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-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-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-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

## Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
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-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-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

Notes:

N/A = Not Available

1. MW-12C (Existing) was damaged during winter 2017. Water elevations taken since then may be affected.
2. MW-BC2C has not yet been surveyed.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-4 <sup>3</sup>				MW-8 <sup>3</sup>				MW-12A			
	10/4/2016	10/4/2016	10/4/2016	10/4/2016	11/03/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018		
Top of Screen Elevation (ft)	4.50	19.70						-24.4				
Bottom of Screen Elevation (ft)	-5.50	9.70						-34.4				
Sampling Date	10/4/2016	10/4/2016	10/4/2016	10/4/2016	11/03/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018		
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample		
Field Measurements												
pH (SU)	5.52	5.23	5.23	5.23	6.94	5.46	5.53	5.58	5.59	4.89		
Temperature (°C)	15.54	15.87	15.87	15.87	14.38	11.78	13.81	13.91	14.02	13.62		
Dissolved Oxygen (DO, mg/L)	7.89	9.58	9.58	9.58	1.13	3.69	7.03	14.81	6.92	7.65		
Redox Potential (ORP; mV)	57.90	135.00	135.00	135.00	70.90	197.60	183.10	173.60	146.50	288.30		
Specific Conductivity (µS/cm) <sup>c</sup>	171.00	190.00	190.00	190.00	667.00	572.00	550.00	537.00	518.00	563.00		
Turbidity (NTU)	-	-	-	-	17.70	5.50	5.31	5.13	7.68	3.58		
Laboratory Analyses												
Nitrogen												
Nitrate as N (mg/L)	2.45	9.24	9.24	9.24	0.783	0.669	0.849	0.786	0.794	0.242		
Nitrite as N (mg/L)	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.074		
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) (mg/L)	0.71	1.7	1.7	1.7	-	<0.2	0.4	-	-	0.22		
Total Nitrogen (mg/L)	3.15	10.9	10.9	10.9	1	0.669	1.25	0.79	1.11	0.533		
Anions												
Chloride (mg/L)	27.2	18.3	18.3	18.3	190	230	141	154	146	160		
Sulfate (mg/L)	12.8	10.1	10.1	10.1	10	16.1	13.4	12.6	12.3	12.2		
Elements												
Dissolved Iron (mg/L)	-	-	-	-	0.7	-	<0.1	<0.1	-	<0.1		
Dissolved Manganese (mg/L)	-	-	-	-	0.325	-	0.033	<0.02	-	<0.02		
Boron (mg/L)	-	-	-	-	<0.05	-	<0.05	-	-	-		
Sodium (mg/L)	-	-	-	-	-	-	98.3	-	-	-		
Other												
DOC (mg/L)	<0.5	<0.5	<0.5	<0.5	0.55	-	<0.5	2.16	0.792	1.7		
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-		
Alkalinity as CaCO3 (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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-12B										MW-12C <sup>1-3</sup>		
	-9.4										8.60		
Top of Screen Elevation (ft)											-1.40		
Bottom of Screen Elevation (ft)											-1.40		
Sampling Date	11/03/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	10/4/2016	11/03/2016 <sup>1</sup>	11/17/2016	1/5/2017	2/23/2017		
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Sample	Sample	Q1 Sample <sup>4</sup>		
Field Measurements													
pH (SU)	6.90	5.43	5.40	5.39	5.45	4.78	4.98	6.45	5.23	5.09	NS		
Temperature (°C)	14.50	11.82	14.18	14.37	14.56	13.80	17.50	14.08	14.42	12.60	NS		
Dissolved Oxygen (DO, mg/L)	1.05	1.16	6.39	12.40	5.51	5.67	6.93	0.83	0.68	1.61	NS		
Redox Potential (ORP; mV)	20.30	212.80	263.10	225.20	170.30	275.70	167.80	246.00	279.70	205.60	NS		
Specific Conductivity (µS/cm) <sup>c</sup>	231.00	243.00	235.00	253.00	257.00	249.00	178.00	216.00	156.00	199.00	NS		
Turbidity (NTU)	8.73	1.89	0.91	2.62	1.52	1.48	-	0.60	2.58	0.84	NS		
Laboratory Analyses													
Nitrogen													
Nitrate as N (mg/L)	6.17	5.08	5.33	6.19	4.9	1.91	6.74	6.51	-	6.03	NS		
Nitrite as N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	NS		
Ammonia (mg/L)	<0.1	0.19	<0.1	0.12	0.26	<0.1	<0.1	0.11	-	0.12	NS		
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	0.79	1.18	-	0.26	<0.2	1.34	-	-	1.24	NS		
Total Nitrogen (mg/L)	6.44	5.87	6.52	6.83	4.9	1.91	8.08	6.51	-	7.27	NS		
Anions													
Chloride (mg/L)	34.1	24.2	41.6	48.9	50.5	47.3	24.1	-	-	22.4	NS		
Sulfate (mg/L)	9.8	13.6	9.7	9.2	12.1	11.2	8.7	9.3	-	8.6	NS		
Elements													
Dissolved Iron (mg/L)	0.36	-	<0.05	<0.1	-	<0.1	-	<0.05	-	-	NS		
Dissolved Manganese (mg/L)	0.228	-	0.046	<0.02	-	<0.02	-	0.02	-	-	NS		
Boron (mg/L)	<0.05	-	<0.05	-	-	-	-	<0.05	-	-	NS		
Sodium (mg/L)	-	-	18.7	-	-	-	-	-	-	-	-		
Other													
DOC (mg/L)	1.82	-	<0.5	1.02	1.1	2.29	<0.5	0.87	0.674	-	NS		
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	NS		
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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MA-BU1A			MW-BU1C			MW-BU2A			
	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	Sampling Date	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample
	-26.3	-36.3	10/4/2016	5.44	5.27	6.73	5.72	5.68	5.72	5.23
				13.75	13.95	14.15	13.71	14.00	14.47	13.86
				7.60	8.75	1.18	6.82	15.26	6.87	7.63
				70.90	130.90	37.50	149.50	225.20	172.00	211.40
	1464.00			406.00	351.00	406.00	427.00	439.00	442.00	421.00
	-			44.50	-	44.50	378.00	2.55	4.02	20.90
Laboratory Analyses										
Nitrogen										
Nitrate as N (mg/L)	0.443			0.426	1.97	0.357	0.452	0.408	0.61	0.467
Nitrite as N (mg/L)	-			<0.01	-	<0.01	<0.01	<0.01	<0.01	0.065
Ammonia (mg/L)	0.24			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN) (mg/L)	0.38			<0.2	0.4	-	0.3	-	-	<0.2
Total Nitrogen (mg/L)	0.827			0.426	2.37	0.357	0.76	0.408	0.834	0.532
Anions										
Chloride (mg/L)	458			118	96.1	103	117	120	123	114
Sulfate (mg/L)	6.9			5.2	9.1	7.2	5.3	<5	<5	5.3
Elements										
Dissolved Iron (mg/L)	0.799			-	0.099	1.09	0.477	<0.1	-	<0.1
Dissolved Manganese (mg/L)	0.185			-	0.047	0.18	0.03	<0.02	-	<0.02
Boron (mg/L)	<0.05			-	<0.05	<0.05	<0.05	-	-	-
Sodium (mg/L)	-			-	-	-	63	-	-	-
Other										
DOC (mg/L)	<0.5			<0.5	<0.5	<0.5	0.53	<0.5	0.707	1.14
Methane (µg/L)	<2			<2	<2	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-			11	-	-	10	-	-	-

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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BU2B										MW-BU2C			
	-9.9										5.10			
	-19.9										-4.90			
Top of Screen Elevation (ft)														
Bottom of Screen Elevation (ft)														
Sampling Date	11/03/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/29/2017	9/12/2017	1/10/2018	11/03/2016 <sup>1</sup>	11/17/2016	1/10/2017	2/23/2017	6/29/2017	9/12/2017	1/10/2018	
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	
Field Measurements														
pH (SU)	7.11	5.94	5.73	5.68	5.75	5.24	7.14	5.46	5.49	5.62	5.27	5.26	4.85	
Temperature (°C)	14.70	12.07	14.18	14.70	15.21	14.53	15.20	14.89	12.78	14.78	15.22	15.67	14.76	
Dissolved Oxygen (DO, mg/L)	1.30	1.07	6.25	13.80	6.19	6.42	1.31	2.17	2.40	5.96	11.94	5.59	6.22	
Redox Potential (ORP; mV)	20.20	136.30	177.60	221.40	156.50	213.20	203.00	51.20	194.10	227.50	249.50	208.60	243.90	
Specific Conductivity (µS/cm) <sup>c</sup>	379.00	362.00	343.00	336.00	350.00	410.00	535.00	516.00	569.00	367.00	579.00	658.00	630.00	
Turbidity (NTU)	102.00	146.00	32.60	4.16	8.58	26.40	11.40	14.20	5.55	7.33	2.08	11.35	3.86	
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	1.06	0.826	1.01	0.768	1.07	2.78	5.39	-	7.42	1.78	5.39	6.35	8.03	
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	<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	
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	<0.2	0.43	-	-	<0.2	-	-	<0.2	0.55	-	<0.1	<0.2	
Total Nitrogen (mg/L)	1.06	0.826	1.44	0.768	1.07	2.78	5.39	-	-	2.32	5.39	6.35	8.03	
Anions														
Chloride (mg/L)	97.3	92.2	90.7	88.3	93.2	106	134	-	143	96.8	146	174	165	
Sulfate (mg/L)	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	<5	<5	
Elements														
Dissolved Iron (mg/L)	0.667	-	0.138	<0.1	-	<0.1	0.817	-	-	<0.1	<0.1	-	<0.1	
Dissolved Manganese (mg/L)	0.088	-	<0.02	<0.02	-	<0.02	0.26	-	-	0.077	0.081	-	0.076	
Boron (mg/L)	<0.05	-	<0.05	-	-	-	<0.05	-	-	<0.05	-	-	-	
Sodium (mg/L)	-	-	37.2	-	-	-	-	-	-	44.9	-	-	-	
Other														
DOC (mg/L)	0.612	-	<0.5	0.579	0.856	2.26	0.684	0.728	<0.5	<0.5	0.599	1.35	2.2	
Methane (µg/L)	<2	-	-	-	-	-	<2	-	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	18	16	-	-	-	-	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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BC1C				MW-BC2C				MW-BC3B			
	10/4/2016	11/04/2016	11/17/2016	1/10/2017	2/24/2017	6/29/2017	9/13/2017	1/10/2018	3/27/2017	6/29/2017	9/13/2017	1/10/2018
Top of Screen Elevation (ft)	2.5				N/A						-10.80	
Bottom of Screen Elevation (ft)	-7.5				N/A						-20.80	
Sampling Date	10/4/2016	11/04/2016	11/17/2016	1/10/2017	2/24/2017	6/29/2017	9/13/2017	1/10/2018	3/27/2017	6/29/2017	9/13/2017	1/10/2018
Type of Sample	Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample
Field Measurements												
pH (SU)	5.48	7.05	5.40	5.55	5.17	5.28	5.30	5.01	5.38	5.31	5.41	5.09
Temperature (°C)	13.37	15.25	14.54	12.65	15.10	15.07	15.49	14.62	14.19	14.13	14.24	14.22
Dissolved Oxygen (DO, mg/L)	7.75	1.65	1.67	1.87	5.73	12.16	4.94	5.20	2.50	6.98	3.29	3.27
Redox Potential (ORP; mV)	70.10	74.80	100.70	169.00	259.10	239.90	256.70	184.90	113.80	251.90	238.30	137.40
Specific Conductivity (µS/cm) <sup>c</sup>	1029.00	368.00	340.00	363.00	332.00	361.00	416.00	391.00	518.00	611.00	630.00	559.00
Turbidity (NTU)	-	6.00	19.20	16.60	20.40	3.76	2.62	2.40	5.69	16.40	5.82	4.65
Laboratory Analyses												
Nitrogen												
Nitrate as N (mg/L)	0.481	4.16	-	5.91	3.32	3.42	3.13	4.25	2.2	4.59	3.45	4.26
Nitrite as N (mg/L)	-	-	-	<0.01	<0.01	<0.01	<0.01	0.08	0.032	<0.01	<0.01	<0.01
Ammonia (mg/L)	-	<0.1	-	<0.1	<0.1	<0.1	0.12	<0.1	0.91	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	<0.2	0.92	-	-	<0.2	-	-	-	<0.2
Total Nitrogen (mg/L)	0.481	4.43	-	4.24	3.42	3.42	3.13	4.33	2.59	4.59	3.45	4.26
Anions												
Chloride (mg/L)	438	83.8	-	85.4	83.3	86.5	92.5	96	143	161	153	140
Sulfate (mg/L)	11.5	6.4	-	<5	6.3	<5	<5	5.3	8.3	6.8	9.1	13.6
Elements												
Dissolved Iron (mg/L)	-	-	-	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	<0.1
Dissolved Manganese (mg/L)	-	-	-	-	0.092	0.062	-	0.063	0.298	0.077	-	0.078
Boron (mg/L)	-	-	-	-	<0.05	-	-	-	-	-	-	-
Sodium (mg/L)	-	-	-	-	41.8	-	-	-	-	-	-	-
Other												
DOC (mg/L)	<0.5	0.764	0.576	<0.5	1.54	1.68	3.32	1.67	1.86	1.02	3.79	2.36
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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-BX1B				MW-BX1C			
	3/27/2017	6/28/2017	9/12/2017	1/8/2018	3/27/2017	6/28/2017	9/12/2017	1/8/2018
Top of Screen Elevation (ft)			-9.40				5.70	
Bottom of Screen Elevation (ft)			-19.40				-4.30	
Sampling Date	3/27/2017	6/28/2017	9/12/2017	1/8/2018	3/27/2017	6/28/2017	9/12/2017	1/8/2018
Type of Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample
Field Measurements								
pH (SU)	4.67	5.05	5.03	4.04	4.44	4.70	4.80	3.89
Temperature (°C)	13.76	14.28	14.50	13.33	13.87	14.32	14.44	13.44
Dissolved Oxygen (DO, mg/L)	1.73	1.87	0.07	0.09	0.63	2.30	0.79	1.56
Redox Potential (ORP; mV)	153.70	283.60	202.90	302.90	199.90	315.80	232.40	328.60
Specific Conductivity (µS/cm) <sup>c</sup>	367.00	446.00	470.00	468.00	521.00	473.00	447.00	499.00
Turbidity (NTU)	29.80	326.00	19.44	68.80	0.98	55.80	7.11	5.93
Laboratory Analyses								
Nitrogen								
Nitrate as N (mg/L)	11.4	34.4	39	10	0.25	38.7	37.8	11.1
Nitrite as N (mg/L)	0.018	<0.01	<0.01	<0.01	0.012	<0.01	<0.01	0.074
Ammonia (mg/L)	0.4	0.7	0.39	0.51	1.09	0.5	0.22	0.18
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	<0.2	-	-	-	<0.2
Total Nitrogen (mg/L)	12.9	37	39	10	1.52	42	37.8	11.2
Anions								
Chloride (mg/L)	43.1	41	37.9	33.4	49.6	40.8	37.3	34.5
Sulfate (mg/L)	7.6	<5	<5	<5	<5	<5	<5	<5
Elements								
Dissolved Iron (mg/L)	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	<0.1
Dissolved Manganese (mg/L)	0.335	0.478	-	0.631	0.566	0.517	-	0.553
Boron (mg/L)	-	-	-	0.052	-	-	-	0.052
Sodium (mg/L)	-	-	-	-	-	-	-	-
Other								
DOC (mg/L)	2.97	1.55	2.31	5.16	2.7	2.02	2.69	4.53
Methane (µg/L)	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	-	-	-	-	-	-	-

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

- DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2satur.html>
- MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 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.
- MW-12C (existing) was damaged during snow removal at the site. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1010C										MW-B1020B			
	-0.10										-10.4			
Top of Screen Elevation (ft)														
Bottom of Screen Elevation (ft)														
Sampling Date	11/03/2016 <sup>1</sup>	11/17/2016	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/9/2018	11/04/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	
Field Measurements														
pH (SU)	6.90	5.18	5.61	5.32	5.36	5.68	5.23	6.78	5.20	5.01	5.00	5.12	4.54	
Temperature (°C)	14.60	14.28	12.22	14.69	15.04	15.97	13.43	13.70	11.94	14.13	14.71	15.69	13.82	
Dissolved Oxygen (DO, mg/L)	0.87	0.71	0.49	1.07	1.39	0.12	2.11	1.03	0.60	2.77	1.44	0.20	0.16	
Redox Potential (ORP; mV)	110.70	231.60	190.80	252.20	204.80	2.70	86.20	45.00	190.70	251.30	276.30	160.30	166.20	
Specific Conductivity (µS/cm) <sup>c</sup>	262.00	230.00	289.00	258.00	269.00	238.00	249.00	465.00	355.00	353.00	352.00	332.00	288.00	
Turbidity (NTU)	16.00	5.97	10.60	5.62	2.73	2.99	5.15	67.90	321.00	11.00	14.60	2.50	2.84	
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	13.6	-	6.74	9.94	13.8	2.49	2.76	28.4	17.9	20.1	24.9	19.7	4.71	
Nitrite as N (mg/L)	-	-	0.509	0.474	0.171	0.185	0.052	-	<0.01	<0.01	0.158	0.076	0.091	
Ammonia (mg/L)	<0.1	-	<0.1	0.18	<0.1	<0.1	0.13	0.53	0.11	<0.1	<0.1	<0.1	0.14	
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	1.36	1.95	-	-	0.88	-	1.79	2.92	-	-	<0.2	
Total Nitrogen (mg/L)	13.9	-	8.61	12.4	15.7	4.22	3.69	28.5	19.6	23	27.1	19.7	4.8	
Anions														
Chloride (mg/L)	27.5	-	24.3	25.2	24.2	23.6	22.6	49.8	33.6	34	32.3	30	25.1	
Sulfate (mg/L)	-	-	23.7	16.5	11	22.6	10.8	-	<5	<5	<5	<5	6.8	
Elements														
Dissolved Iron (mg/L)	-	-	-	<0.1	0.143	3.88	9.69	2.52	-	0.153	<0.1	<0.1	<0.1	
Dissolved Manganese (mg/L)	-	-	-	0.234	0.324	0.996	0.531	0.948	-	0.293	0.333	0.32	0.307	
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	-	-	1.11	3.24	3.67	6.02	
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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1020C										MW-B1050A			
	4.50										-26.1			
Top of Screen Elevation (ft)														
Bottom of Screen Elevation (ft)	-5.50													
Sampling Date	11/04/2016 <sup>1</sup>	11/17/2016	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/8/2018	11/04/2016 <sup>1</sup>	1/5/2017	2/23/2017	6/28/2017	9/12/2017	1/9/2018	
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	
Field Measurements														
pH (SU)	6.88	5.27	5.38	5.17	5.16	5.22	4.54	7.15	5.60	5.50	5.00	5.27	5.06	
Temperature (°C)	14.24	14.66	12.73	15.06	15.26	15.97	13.97	13.77	11.87	14.05	14.27	15.87	14.11	
Dissolved Oxygen (DO, mg/L)	1.44	0.56	0.31	2.69	3.72	1.81	3.78	1.34	0.26	4.24	1.75	0.06	0.75	
Redox Potential (ORP; mV)	50.30	106.70	194.80	292.20	277.20	161.90	204.20	43.00	142.20	226.20	264.40	174.20	129.60	
Specific Conductivity (µS/cm) <sup>c</sup>	242.00	227.00	269.00	253.00	247.00	161.90	201.00	612.00	505.00	1648.00	508.00	422.00	1486.00	
Turbidity (NTU)	321.00	15.60	6.31	18.00	8.87	243.00	14.60	962.00	297.00	76.60	4.10	3.10	9.57	
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	10.6	-	11.1	12.6	13.9	12.4	2.97	37	26.6	11.8	26.8	26.7	4.89	
Nitrite as N (mg/L)	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.105	<0.01	0.038	0.048	0.141	
Ammonia (mg/L)	<0.1	-	0.19	<0.1	<0.1	<0.1	0.14	1.93	1.72	0.54	0.57	1.24	0.38	
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	1.99	2.25	-	-	<0.2	-	3.75	1.83	-	-	<0.2	
Total Nitrogen (mg/L)	10.6	-	13.1	14.9	15	12.4	2.97	37.2	30.5	13.7	26.8	26.7	5.03	
Anions														
Chloride (mg/L)	25.5	-	25.6	25.6	24.8	24.1	18.7	54.8	48.9	399	48.9	41.4	429	
Sulfate (mg/L)	-	-	5.6	6.1	5.8	5.8	6.7	-	6.1	<5	<5	<5	<5	
Elements														
Dissolved Iron (mg/L)	2.23	-	-	<0.1	<0.1	<0.1	<0.1	4.29	-	<0.1	<0.1	-	<0.1	
Dissolved Manganese (mg/L)	0.249	-	-	0.076	0.057	0.042	0.054	0.655	-	0.18	0.654	-	0.236	
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	-	-	0.808	1.85	3.72	2.83	
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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1050B					MW-B1050C				
	-11.1 -21.1					4.9 -5.1				
Top of Screen Elevation (ft)										
Bottom of Screen Elevation (ft)										
Sampling Date	11/04/2016 <sup>1</sup>	2/23/2017	6/28/2017	9/12/2017	1/9/2018	11/04/2016 <sup>1</sup>	2/23/2017	6/28/2017	9/12/2017	1/9/2018
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample
Field Measurements										
pH (SU)	7.06	5.13	5.10	5.22	4.74	7.20	5.43	5.34	5.38	4.96
Temperature (°C)	14.08	14.27	14.70	15.48	14.19	14.55	14.95	15.06	15.77	14.51
Dissolved Oxygen (DO, mg/L)	1.17	2.12	4.53	1.06	2.17	1.34	1.83	5.39	1.85	1.64
Redox Potential (ORP; mV)	80.30	304.40	260.10	203.80	160.40	48.60	205.90	230.20	176.50	167.20
Specific Conductivity (µS/cm) <sup>c</sup>	446.00	463.00	387.00	340.00	392.00	571.00	511.00	542.00	478.00	413.00
Turbidity (NTU)	3.97	7.20	0.72	2.75	5.06	8.21	2.27	0.98	3.23	1.90
Laboratory Analyses										
Nitrogen										
Nitrate as N (mg/L)	25.7	28.7	18.2	18	10.8	3.83	3.96	3.26	4.18	2
Nitrite as N (mg/L)	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	0.088
Ammonia (mg/L)	0.19	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	1.85	-	<0.2	<0.2	-	1.28	-	<0.1	<0.2
Total Nitrogen (mg/L)	26	30.5	18.2	18	10.8	4.05	5.24	3.26	4.4	2.08
Anions										
Chloride (mg/L)	48.2	50.7	41.7	38.2	36.7	141	123	134	120	85.7
Sulfate (mg/L)	-	<5	<5	<5	<5	-	20.1	15.2	14.6	17.9
Elements										
Dissolved Iron (mg/L)	0.734	<0.1	<0.1	-	<0.1	0.493	<0.1	<0.1	-	<0.1
Dissolved Manganese (mg/L)	0.332	0.142	0.101	-	0.115	0.146	0.042	0.057	-	0.034
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	-	0.592	1.62	2.19	3.26
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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B1075B										MW-B2010C			
	-11.5					-21.5					0			
Top of Screen Elevation (ft)														
Bottom of Screen Elevation (ft)														
Sampling Date	11/04/2016 <sup>1</sup>	2/23/2017	6/28/2017	9/13/2017	1/9/2018	11/03/2016 <sup>1</sup>	11/17/2016	2/24/2017	6/28/2017	9/13/2017	1/10/2018			
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample			
Field Measurements														
pH (SU)	7.19	5.59	5.66	5.83	5.53	7.04	5.32	5.70	6.11	6.29	6.20			
Temperature (°C)	15.20	14.20	14.74	14.93	14.13	15.12	14.58	14.81	15.39	15.69	14.71			
Dissolved Oxygen (DO, mg/L)	0.71	1.50	1.95	0.12	0.11	0.67	0.61	3.38	1.78	0.10	0.10			
Redox Potential (ORP; mV)	82.20	157.90	223.10	99.00	135.00	12.40	213.80	103.30	-41.60	-119.80	-102.10			
Specific Conductivity (µS/cm) <sup>c</sup>	631.00	1755.00	736.00	719.00	2688.00	333.00	304.00	302.00	431.00	689.00	862.00			
Turbidity (NTU)	13.00	126.00	1.87	24.23	173.00	149.00	44.40	19.90	6.89	5.10	3.32			
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	1.93	1	0.553	0.751	0.609	15.7	-	5.06	5.74	0.182	<0.03			
Nitrite as N (mg/L)	-	0.048	0.05	0.064	0.201	-	-	0.499	0.128	0.081	0.027			
Ammonia (mg/L)	3.73	5.26	11	12.2	14.3	0.14	-	<0.1	0.24	<0.1	0.17			
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	7.2	-	-	14.4	-	-	14.7	-	-	1.75			
Total Nitrogen (mg/L)	6.36	8.25	13.6	15.1	15.3	16.1	-	20.3	7.69	2.26	1.75			
Anions														
Chloride (mg/L)	96.3	440	170	147	764	38.6	-	27.5	30	37.4	35.5			
Sulfate (mg/L)	-	25.6	28.9	26.8	31.6	11	-	24.3	39.8	73.5	57			
Elements														
Dissolved Iron (mg/L)	-	0.342	<0.1	-	0.886	-	-	1.84	24.2	46.2	88.2			
Dissolved Manganese (mg/L)	-	0.119	0.111	-	0.142	-	-	0.189	1.62	2.56	5.15			
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	2.18	0.852	19.4	83.3	69.4	94.3			
Methane (µg/L)	-	-	-	-	-	-	-	-	11.3	-	-			
Alkalinity as CaCO3 (mg/L)	-	46	-	-	-	-	16	48	-	-	-			

Notes:

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D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2020B										MW-B2020C			
	-10.1										4.8			
Top of Screen Elevation (ft)														
Bottom of Screen Elevation (ft)	-5.2													
Sampling Date	11/03/2016 <sup>1</sup>	11/17/2016	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	11/03/2016 <sup>1</sup>	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	
Type of Sample	Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	
Field Measurements														
pH (SU)	7.00	5.22	5.05	5.10	5.04	5.45	4.95	7.00	5.12	5.09	5.60	5.76	5.16	
Temperature (°C)	14.91	14.39	12.23	14.53	14.86	15.14	14.28	15.20	12.90	15.42	15.57	15.80	14.72	
Dissolved Oxygen (DO, mg/L)	1.15	0.63	0.85	2.03	3.88	0.08	0.08	1.31	1.30	3.96	1.70	0.13	0.06	
Redox Potential (ORP; mV)	90.80	182.60	170.50	308.10	285.90	120.70	173.60	29.80	201.50	316.20	73.80	-15.70	8.50	
Specific Conductivity (µS/cm) <sup>c</sup>	321.00	307.00	344.00	338.00	354.00	323.00	370.00	249.00	251.00	225.00	264.00	248.00	250.00	
Turbidity (NTU)	14.30	17.40	6.95	6.11	8.12	5.91	10.00	28.00	5.81	5.17	6.23	1.30	6.09	
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	16.9	-	25.6	14.8	22.4	5.96	3.26	8.71	12.6	6.95	0.457	<0.03	<0.03	
Nitrite as N (mg/L)	0.022	-	<0.01	<0.01	<0.01	0.54	2.98	0.016	<0.01	<0.01	0.072	0.01	0.083	
Ammonia (mg/L)	0.1	-	<0.1	<0.1	<0.1	<0.1	0.23	0.24	<0.1	<0.1	<0.1	<0.1	0.14	
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	<0.2	3.86	-	-	4.32	-	<0.2	2.33	-	-	1.04	
Total Nitrogen (mg/L)	17.2	-	-	18.7	24.2	7.84	10.6	9.02	-	9.28	0.85	0.424	1.1	
Anions														
Chloride (mg/L)	32.5	-	34.9	32.7	39.3	38	51.4	26.8	31	28.4	32.2	31.2	33	
Sulfate (mg/L)	7.7	-	6	7.1	6.4	29.7	19.3	11.6	9.7	11.9	36.8	20.9	29	
Elements														
Dissolved Iron (mg/L)	1.2	-	-	<0.1	<0.1	<0.1	<0.1	1.42	-	<0.1	7.97	13.1	1.83	
Dissolved Manganese (mg/L)	0.126	-	-	0.028	0.029	0.187	0.374	1.14	-	0.067	0.964	2.08	5.09	
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	1.17	<0.5	2.04	23.3	14.2	11.8	
Methane (µg/L)	<2	-	-	-	-	-	-	<2	-	-	-	-	-	
Alkalinity as CaCO3 (mg/L)	-	20	12	8	-	-	-	-	10	7	-	-	-	

Notes:

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D - Duplicate

1. DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2050A										MW-B2050B				
	-25.4					-35.4					-10.4				
Top of Screen Elevation (ft)															
Bottom of Screen Elevation (ft)															
Sampling Date	11/03/2016 <sup>1</sup>	1/10/2017	2/24/2017	6/28/2017	9/13/2017	1/9/2018	11/03/2016 <sup>1</sup>	2/24/2017	6/28/2017	9/13/2017	1/9/2018	2/24/2017	6/28/2017	9/13/2017	1/9/2018
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample
Field Measurements															
pH (SU)	7.11	5.39	5.29	5.27	5.34	4.85	7.06	5.22	5.29	5.30	4.79	5.22	5.29	5.30	4.79
Temperature (°C)	14.44	11.96	14.06	14.47	14.58	14.05	14.95	14.64	15.27	15.31	14.32	14.64	15.27	15.31	14.32
Dissolved Oxygen (DO, mg/L)	0.60	0.09	0.83	1.66	0.06	0.07	1.29	3.75	5.97	1.27	1.43	3.75	5.97	1.27	1.43
Redox Potential (ORP; mV)	0.80	182.80	251.80	217.00	98.90	147.00	80.50	304.60	242.20	169.70	156.90	304.60	242.20	169.70	156.90
Specific Conductivity (µS/cm) <sup>c</sup>	540.00	520.00	550.00	505.00	509.00	660.00	512.00	645.00	502.00	510.00	495.00	645.00	502.00	510.00	495.00
Turbidity (NTU)	50.70	8.10	14.10	26.70	5.04	4.16	123.00	4.67	5.78	0.61	1.54	4.67	5.78	0.61	1.54
Laboratory Analyses															
Nitrogen															
Nitrate as N (mg/L)	35	39.3	27	32.8	25.5	11.6	4.75	3.64	5.27	3.94	1.72	3.64	5.27	3.94	1.72
Nitrite as N (mg/L)	-	0.025	<0.010	<0.01	0.166	0.04	-	<0.010	<0.01	<0.01	0.046	<0.010	<0.01	<0.01	0.046
Ammonia (mg/L)	1.05	0.87	0.89	1	0.63	0.78	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	3.32	3.5	-	-	<0.2	-	1.22	-	-	<0.2	1.22	-	-	<0.2
Total Nitrogen (mg/L)	35.3	-	30.5	35.4	25.6	11.6	5.15	4.86	5.91	3.94	1.76	4.86	5.91	3.94	1.76
Anions															
Chloride (mg/L)	49.9	64.5	63.3	66.8	65.8	114	123	173	124	119	121	173	124	119	121
Sulfate (mg/L)	5.6	5.6	6.2	7.5	5.3	6.1	11.5	11.5	11	8.7	11.4	11.5	11	8.7	11.4
Elements															
Dissolved Iron (mg/L)	3.2	-	<0.1	<0.1	-	<0.1	0.551	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	<0.1
Dissolved Manganese (mg/L)	0.407	-	0.293	0.26	-	0.258	0.258	0.297	0.258	-	0.315	0.297	0.258	-	0.315
Boron (mg/L)	<0.05	-	<0.05	-	-	-	<0.05	<0.05	-	-	-	<0.05	-	-	-
Sodium (mg/L)	-	-	40	-	-	-	-	81.7	-	-	-	81.7	-	-	-
Other															
DOC (mg/L)	1.61	-	1.08	1.37	5.63	2.76	1.15	1.08	0.754	5.01	4.25	1.08	0.754	5.01	4.25
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (mg/L)	-	17	13	-	-	-	-	11	-	-	-	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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2050C						MW-B2075A			
	4.6						-20.40			
Top of Screen Elevation (ft)										
Bottom of Screen Elevation (ft)	-30.40									
Sampling Date	11/03/2016 <sup>1</sup>	2/24/2017	6/28/2017	9/13/2017	1/9/2018	3/27/2017	6/28/2017	9/12/2017	1/10/2018	
Type of Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample	Sample	Q2 Sample	Q3 Sample	Q4 Sample	Q4 Sample
Field Measurements										
pH (SU)	7.22	5.49	5.38	5.40	5.11	5.21	5.50	5.53	5.27	5.27
Temperature (°C)	16.72	16.56	16.90	17.37	14.40	14.42	14.98	15.40	14.53	14.53
Dissolved Oxygen (DO, mg/L)	1.09	5.76	8.95	4.51	5.82	4.08	7.83	7.02	5.27	5.27
Redox Potential (ORP; mV)	82.50	179.50	236.30	177.90	171.50	130.70	234.90	205.30	173.40	173.40
Specific Conductivity (µS/cm) <sup>c</sup>	658.00	932.00	896.00	970.00	903.00	744.00	748.00	883.00	856.00	856.00
Turbidity (NTU)	212.00	36.10	9.68	20.03	16.10	159.00	3.85	43.20	333.00	333.00
Laboratory Analyses										
Nitrogen										
Nitrate as N (mg/L)	3.01	1.68	3.05	2.19	1.41	0.348	0.539	0.676	0.762	0.762
Nitrite as N (mg/L)	-	<0.010	<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
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	0.66	-	-	<0.2	-	-	-	0.31	0.31
Total Nitrogen (mg/L)	3.3	2.34	3.75	2.53	1.41	0.35	0.779	1.09	1.07	1.07
Anions										
Chloride (mg/L)	-	251	253	278	257	246	214	261	257	257
Sulfate (mg/L)	11.9	11.1	10.1	8.9	9.6	5.7	<5	5.4	6.5	6.5
Elements										
Dissolved Iron (mg/L)	-	0.308	<0.1	-	<0.1	0.119	<0.1	-	<0.1	<0.1
Dissolved Manganese (mg/L)	-	0.254	0.13	-	0.102	0.529	0.062	-	0.069	0.069
Boron (mg/L)	-	<0.05	-	-	-	-	-	-	-	-
Sodium (mg/L)	-	120	-	-	-	-	-	-	-	-
Other										
DOC (mg/L)	1.13	0.87	0.639	3.73	2.75	1.08	0.668	0.722	2.26	2.26
Methane (µg/L)	-	-	-	-	-	-	-	-	-	-
Alkalinity as CaCO3 (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/O2satur.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. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	MW-B2100C									
Top of Screen Elevation (ft)	9.6									
Bottom of Screen Elevation (ft)	-0.4									
Sampling Date	10/4/2016	11/03/2016 <sup>1</sup>	2/24/2017	6/28/2017	9/12/2017	1/10/2018				
Type of Sample	Sample	Sample	Q1 Sample	Q2 Sample	Q3 Sample	Q4 Sample				
Field Measurements										
pH (SU)	5.26	6.98	5.46	5.27	5.41	4.93				
Temperature (°C)	14.42	14.95	16.84	14.44	14.43	14.55				
Dissolved Oxygen (DO, mg/L)	5.90	1.50	7.37	10.84	5.09	4.99				
Redox Potential (ORP; mV)	110.50	124.70	189.80	217.40	216.7	206				
Specific Conductivity (µS/cm) <sup>c</sup>	272.00	297.00	346.00	364.00	377	378				
Turbidity (NTU)	-	8.44	OVER	5.71	2.97	2.87				
Laboratory Analyses										
Nitrogen										
Nitrate as N (mg/L)	1.29	1.29	0.959	0.724	0.903	1.13				
Nitrite as N (mg/L)	-	-	<0.010	<0.01	<0.01	<0.01				
Ammonia (mg/L)	<0.1	<0.1	<0.1	<0.1	0.1	<0.1				
Total Kjeldahl Nitrogen (TKN) (mg/L)	0.72	-	0.54	-	-	0.21				
Total Nitrogen (mg/L)	2.01	1.29	1.5	0.724	1.31	1.33				
Anions										
Chloride (mg/L)	65.4	67.8	83.2	96.4	97.3	97.8				
Sulfate (mg/L)	14.1	16.2	12.1	10	8.3	10.8				
Elements										
Dissolved Iron (mg/L)	0.115	-	0.147	<0.1	-	<0.1				
Dissolved Manganese (mg/L)	0.126	-	0.196	0.114	-	0.102				
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				
Methane (µg/L)	<2	-	-	-	-	-				
Alkalinity as CaCO3 (mg/L)	-	-	14	-	-	-				

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

D - Duplicate

- DO was measured in the field as DO(%) and was converted using the online tool at: <http://www.hbuehrer.ch/Rechner/O2satur.html>
- MW-12C references "MW-12" that was installed as part of the Nauset Regional Middle School monitoring well network.
- 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.
- MW-12C (existing) was damaged during snow removal at the site. A sample was unable to be taken during the Quarter 1 and 2 Sampling Events.

**Figures**

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Chart 1  
 Nitrate and DOC Concentrations at Eldredge Park Way PRB  
 Demonstration  
 MW-B1010C

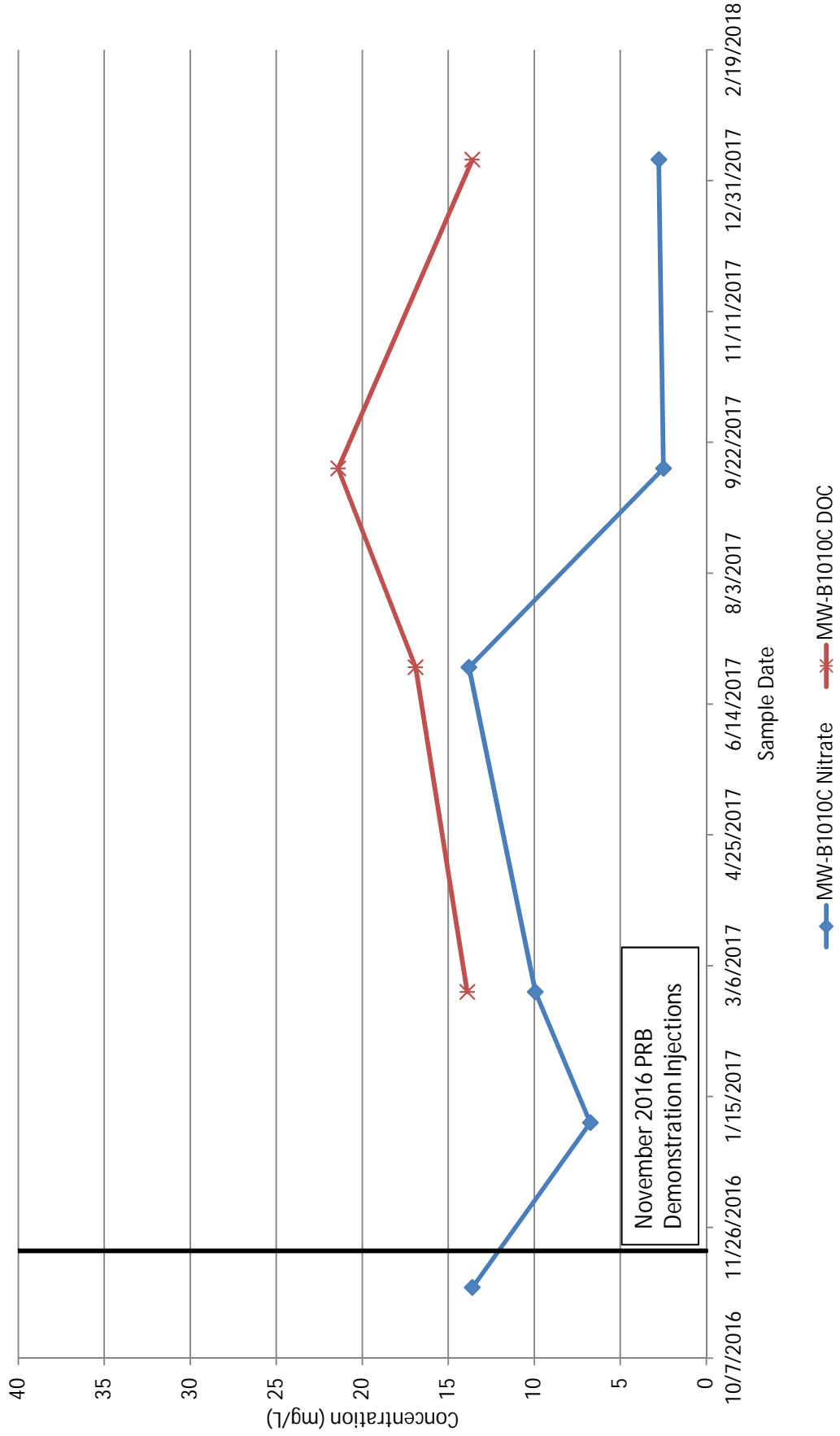


Chart 2  
 Nitrate Concentrations at Eldredge Park Way PRB Demonstration  
 MW-B2010C

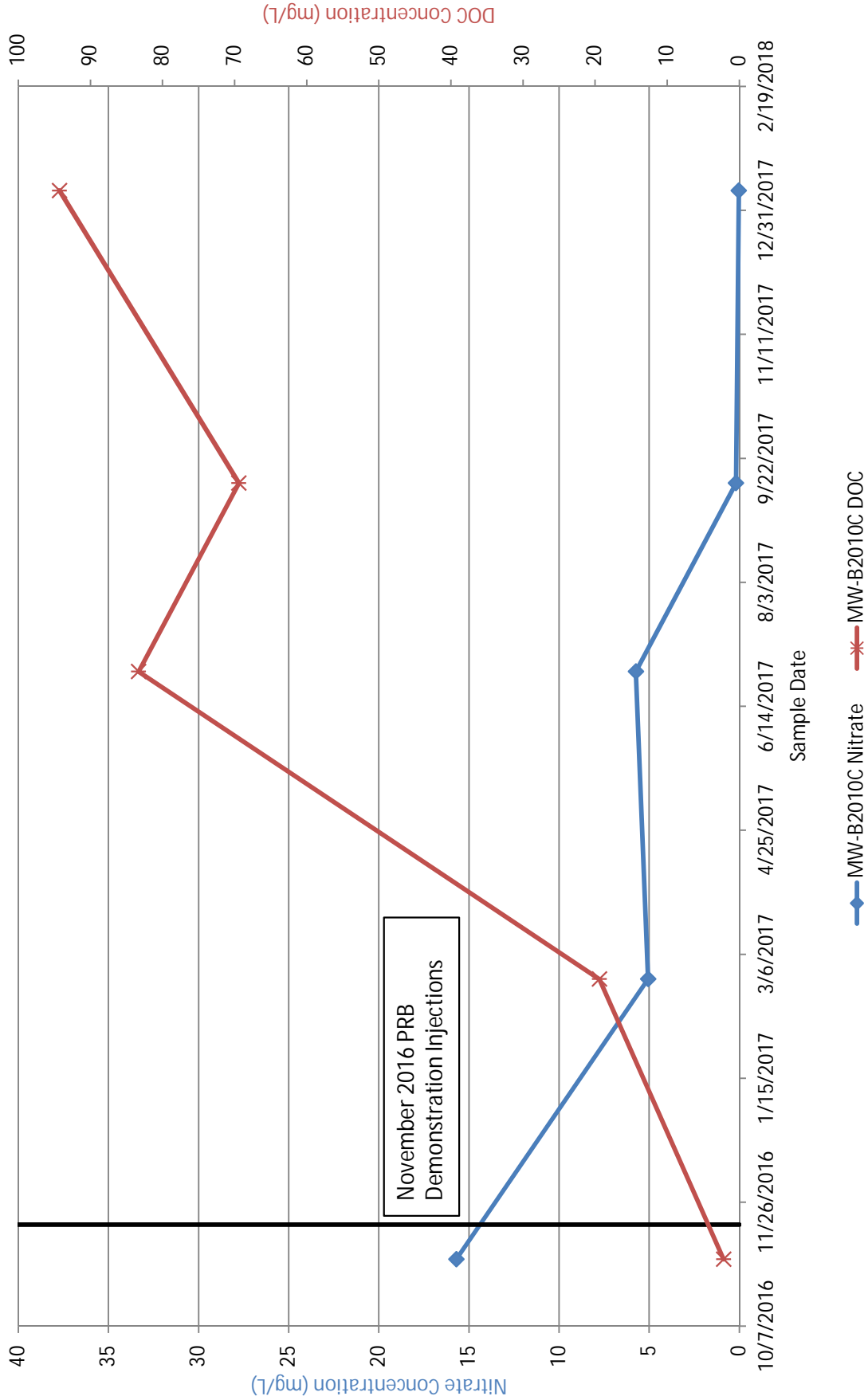


Chart 3  
Nitrate and DOC Concentrations at Eldredge Park Way PRB  
Demonstration  
MW-B1020B

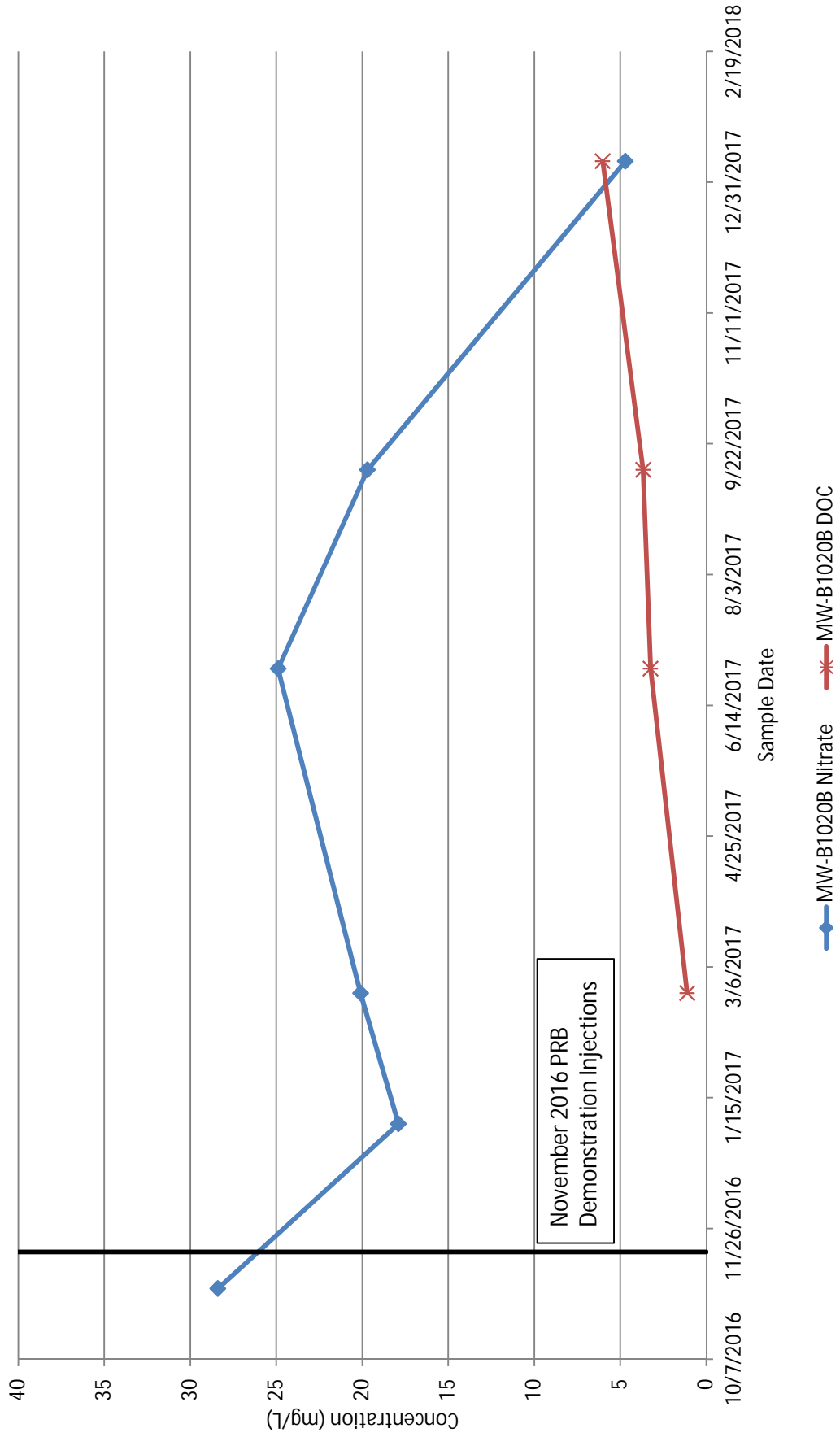


Chart 4  
 Nitrate and DOC Concentrations at Eldredge Park Way PRB  
 Demonstration  
 MW-B1020C

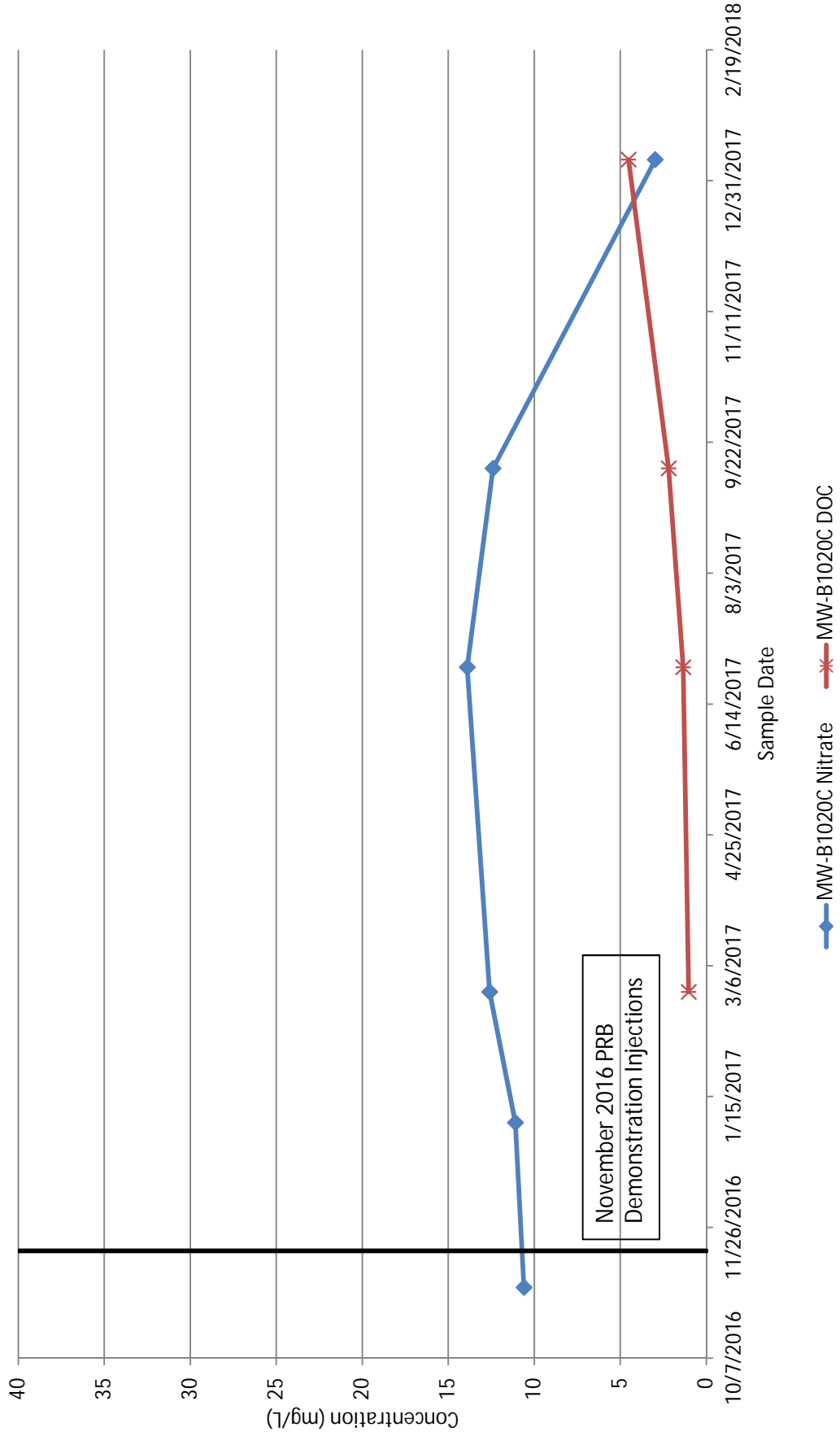


Chart 5  
Nitrate Concentrations at Eldredge Park Way PRB Demonstration  
MW-B2020B

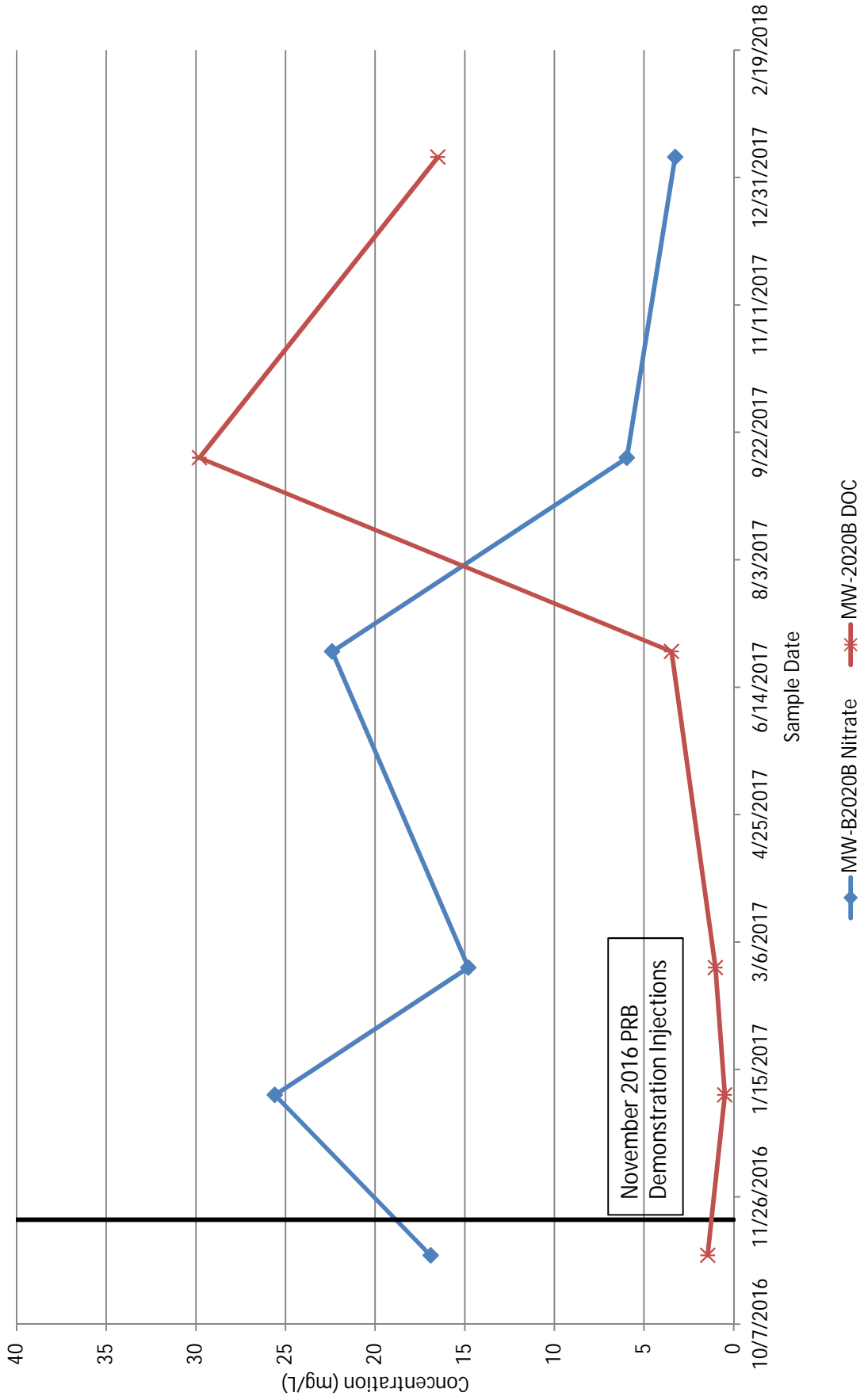


Chart 6  
 Nitrate Concentrations at Eldredge Park Way PRB Demonstration  
 MW-B2020C

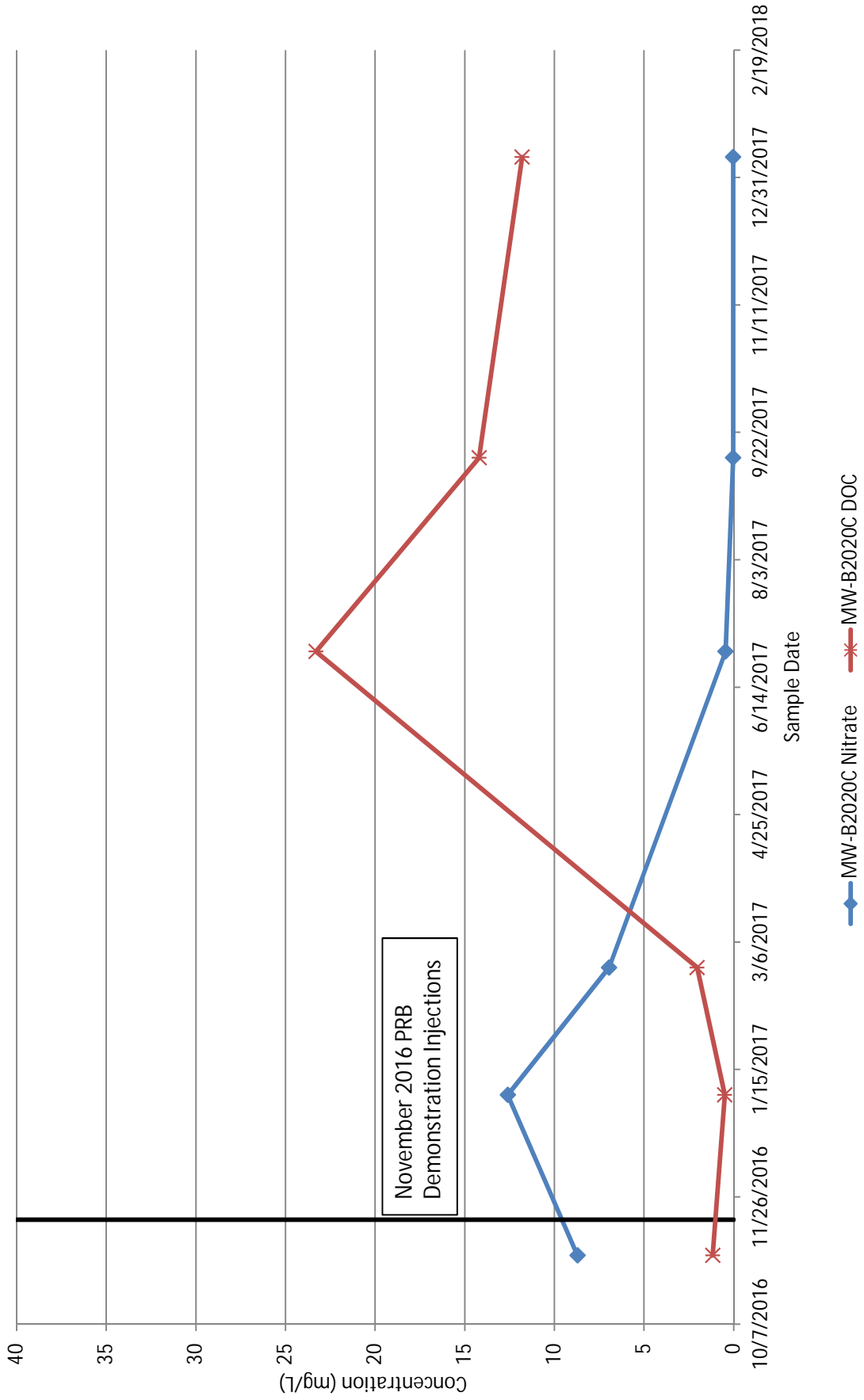


Chart 7  
Nitrate Concentrations at Eldredge Park Way PRB Demonstration  
MW-B1050A

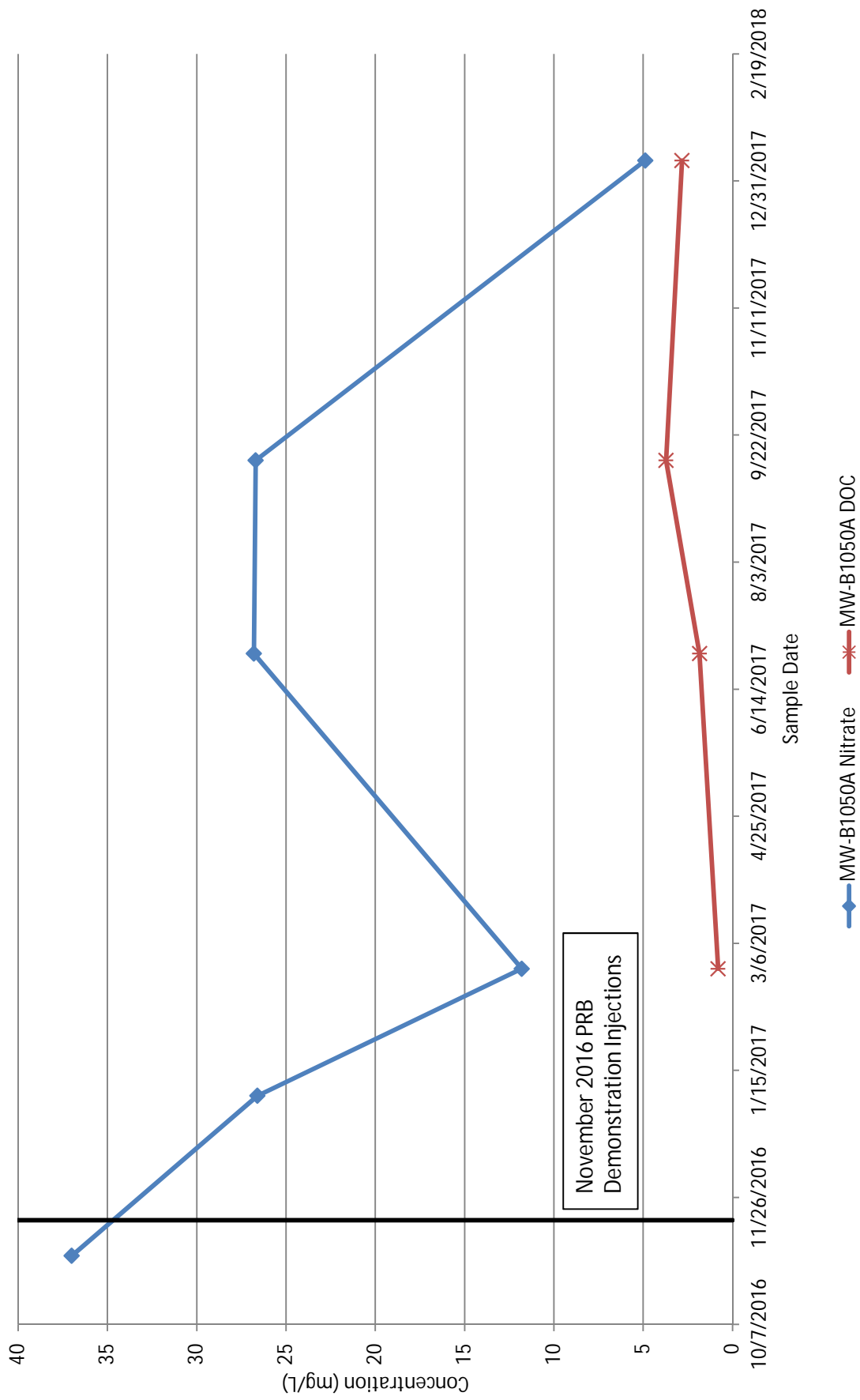
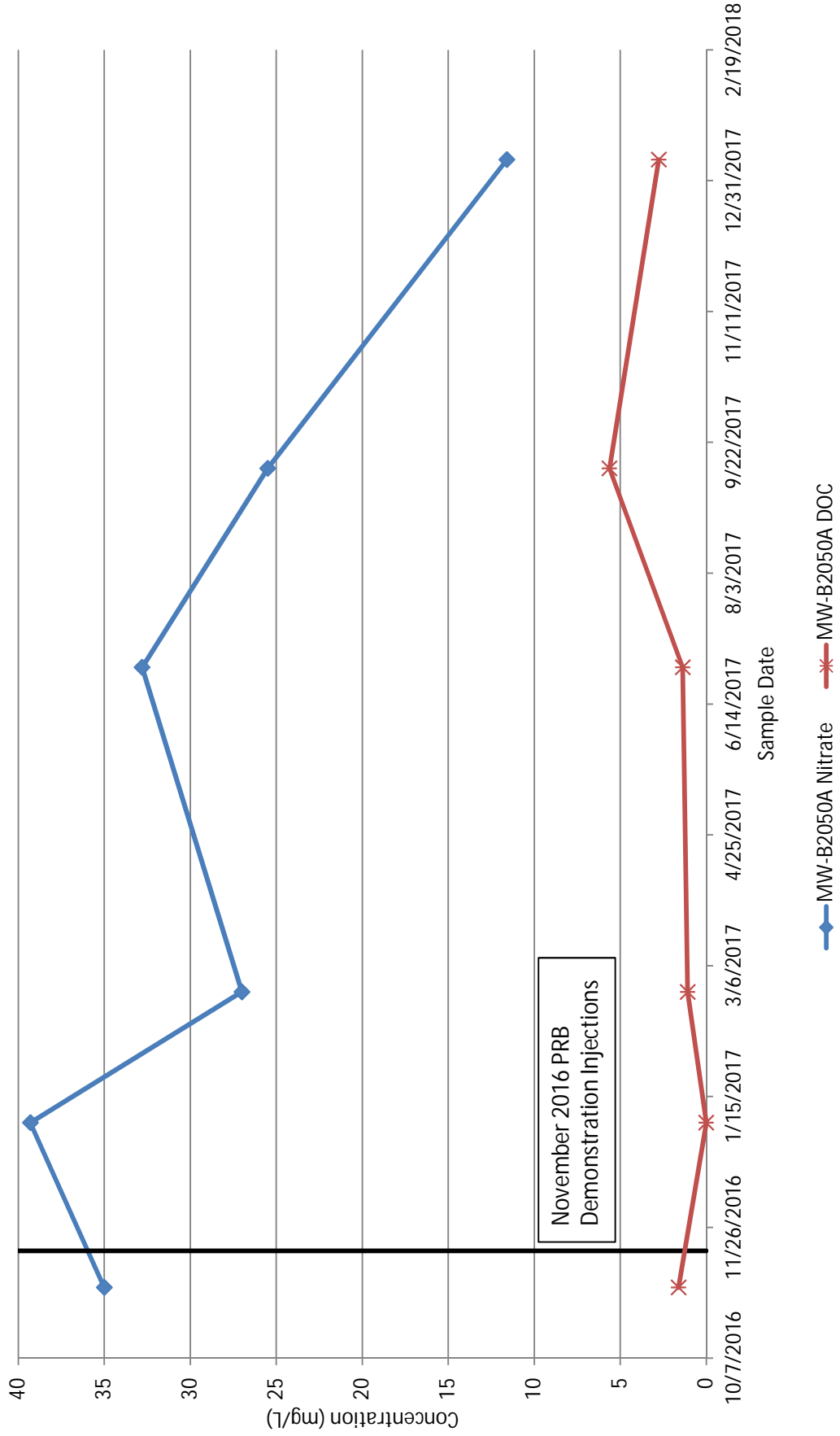


Chart 8  
 Nitrate and DOC Concentrations at Eldredge Park Way PRB  
 Demonstration  
 MW-B2050A



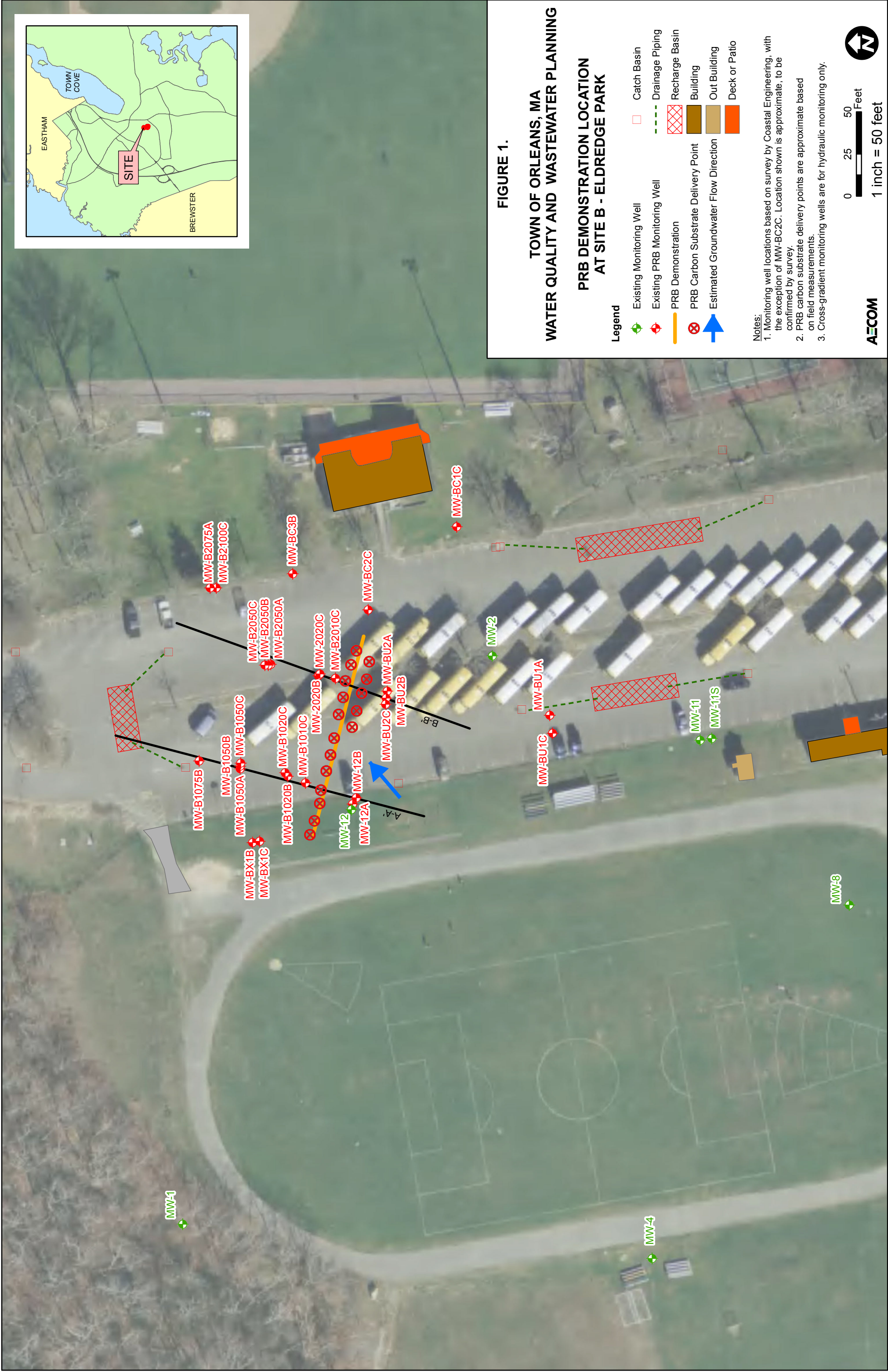


FIGURE 1.

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

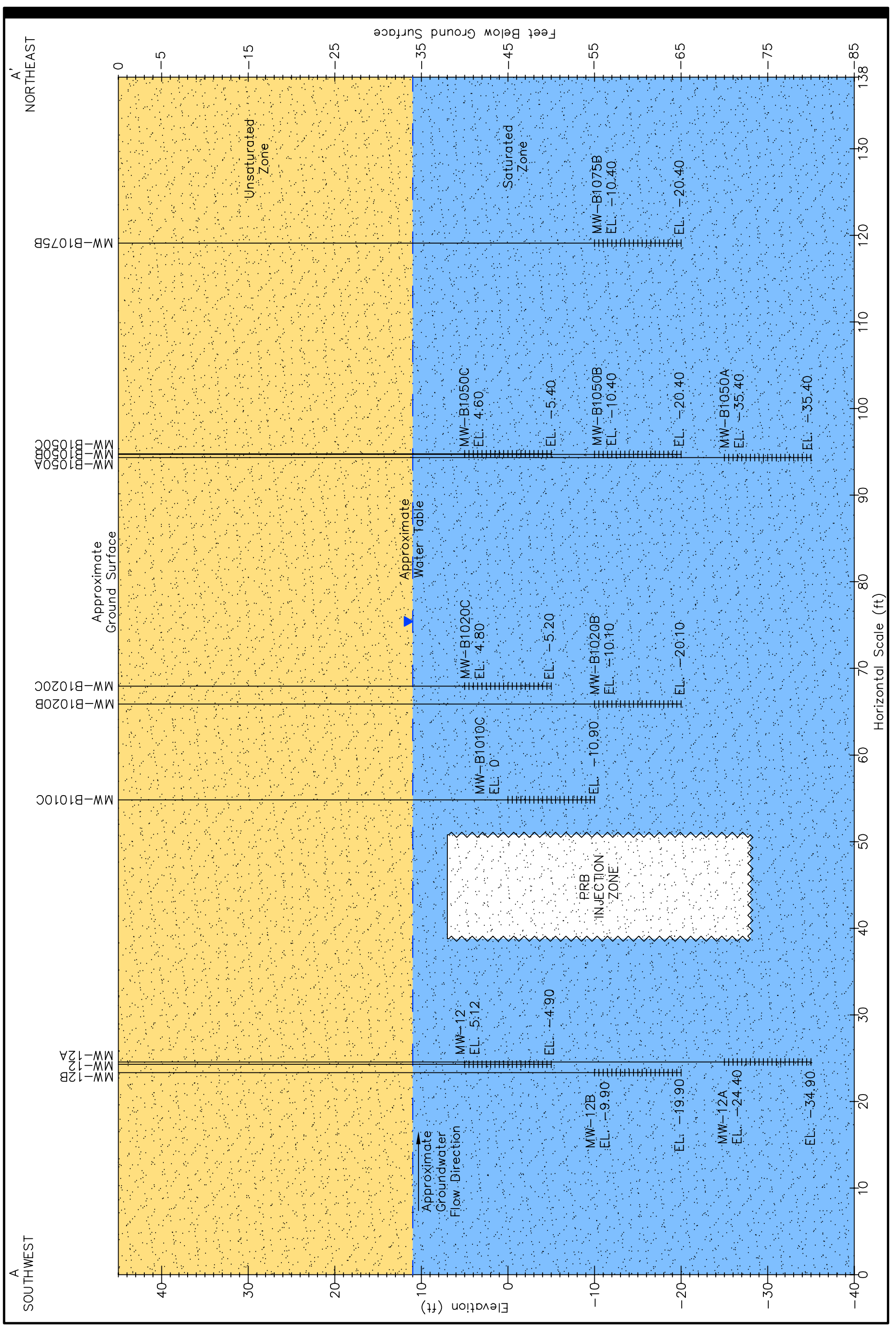
**Legend**

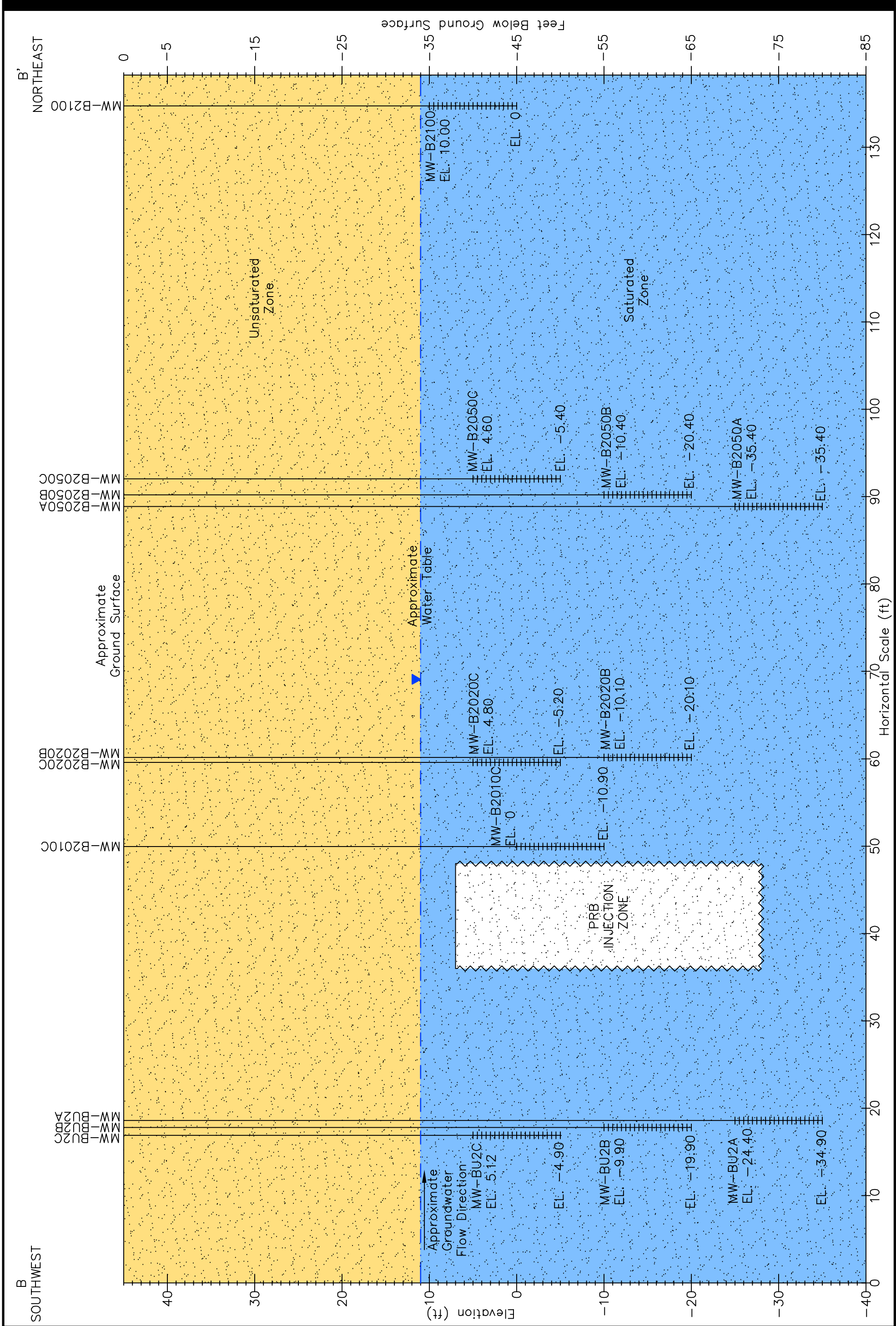
- Existing Monitoring Well
- Existing PRB Monitoring Well
- PRB Demonstration
- PRB Carbon Substrate Delivery Point
- Estimated Groundwater Flow Direction
- Catch Basin
- Drainage Piping
- Recharge Basin
- Building
- Out Building
- Deck or Patio

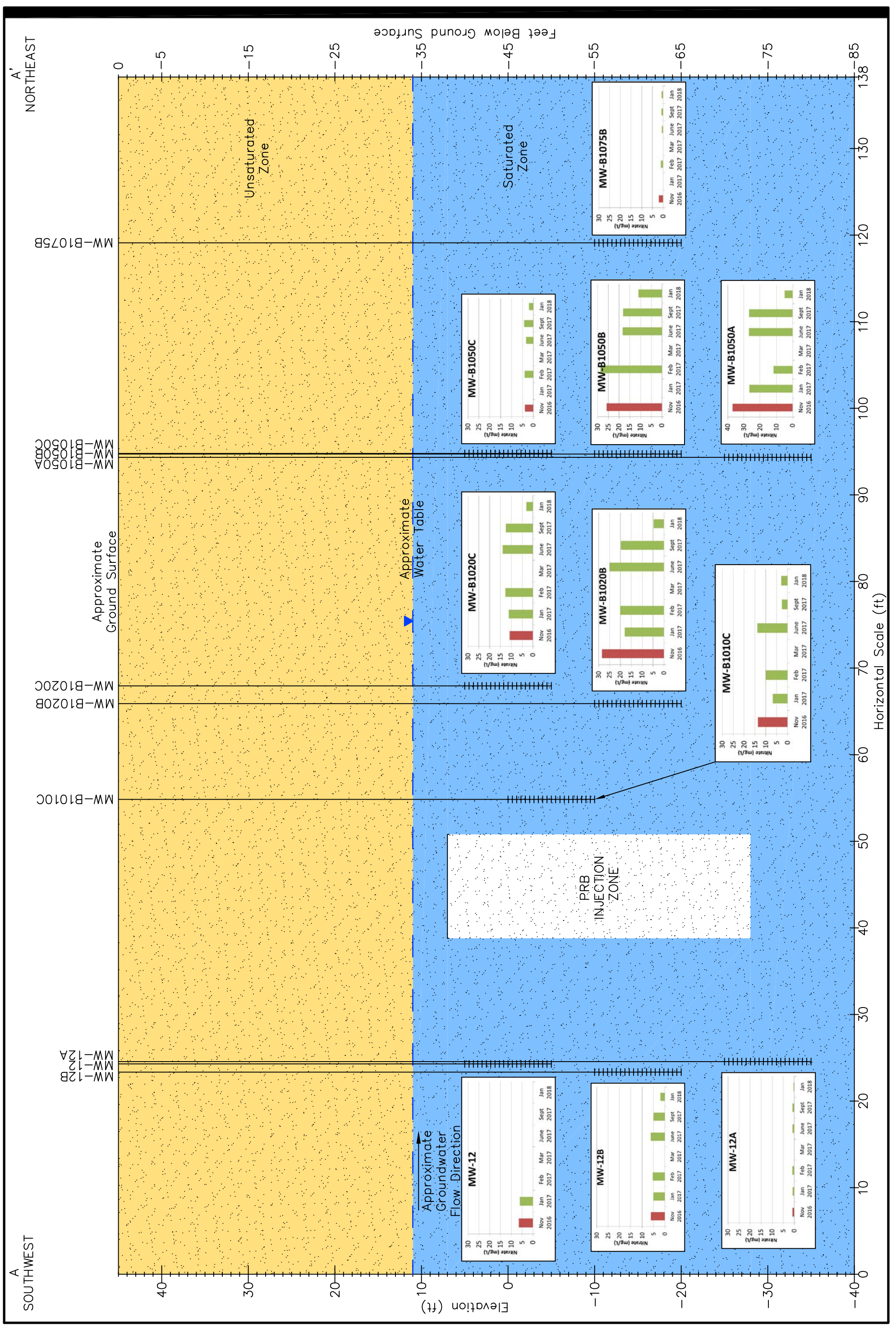
**Notes:**

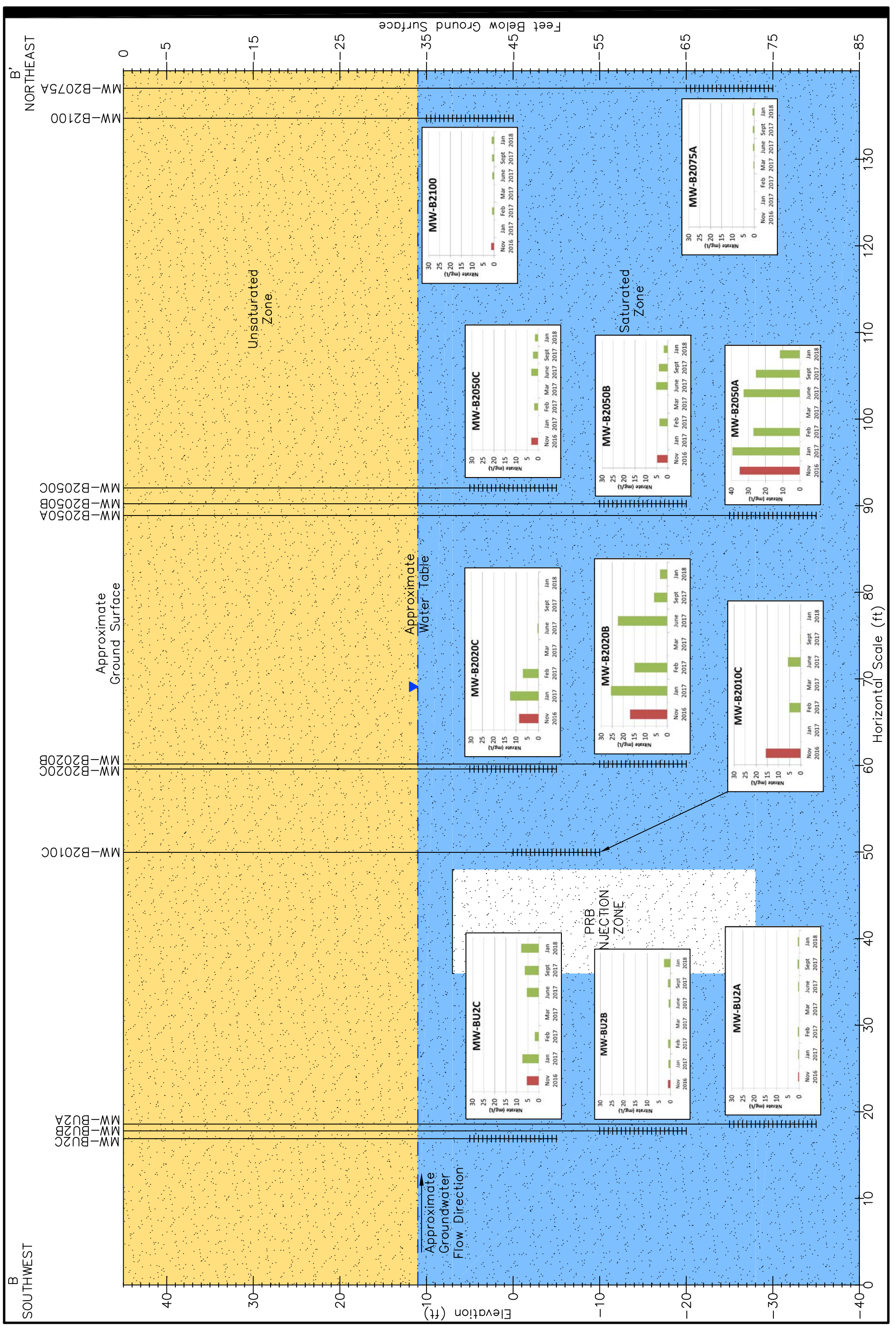
1. Monitoring well locations based on survey by Coastal Engineering, with the exception of MW-BC2C. Location shown is approximate, to be confirmed by survey.
2. PRB carbon substrate delivery points are approximate based on field measurements.
3. Cross-gradient monitoring wells are for hydraulic monitoring only.











CROSS SECTION B-B' WITH NITRATE CONCENTRATION DATA  
 TOWN OF ORLEANS, MA  
 Project No.: 60476644 Date: 2018-02-26

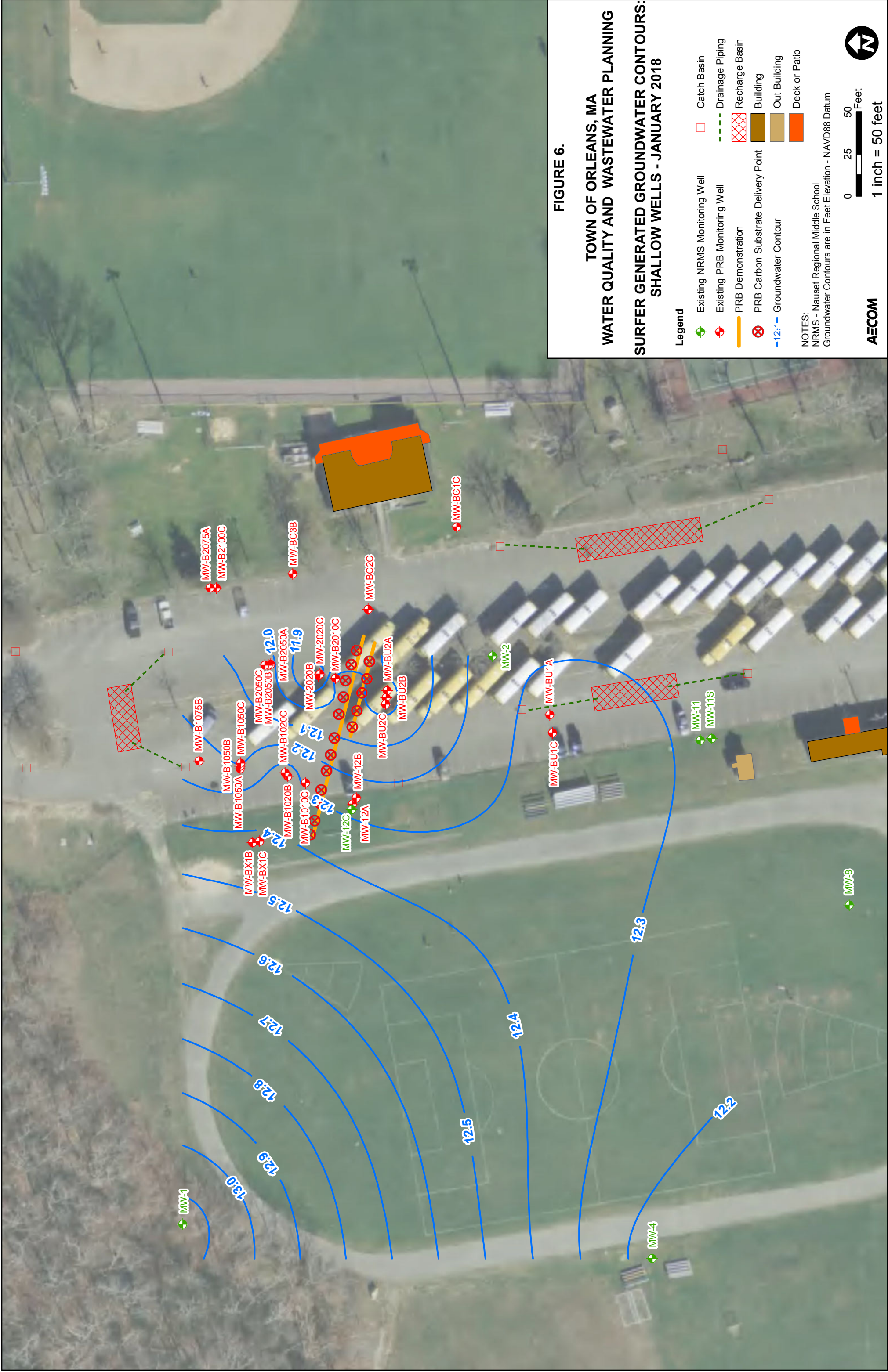
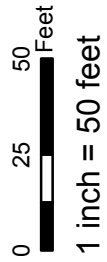


FIGURE 6.

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

- Legend**
- + Existing NRMS Monitoring Well
  - + Existing PRB Monitoring Well
  - + PRB Demonstration
  - + PRB Carbon Substrate Delivery Point
  - 12:1- Groundwater Contour
  - Catch Basin
  - Drainage Piping
  - Recharge Basin
  - Building
  - Out Building
  - Deck or Patio

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



**AECOM**





FIGURE 8.

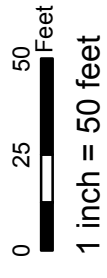
**TOWN OF ORLEANS, MA  
WATER QUALITY AND WASTEWATER PLANNING**

**SURFER GENERATED GROUNDWATER  
CONTOURS: DEEP WELLS - JANUARY 2018**

**Legend**

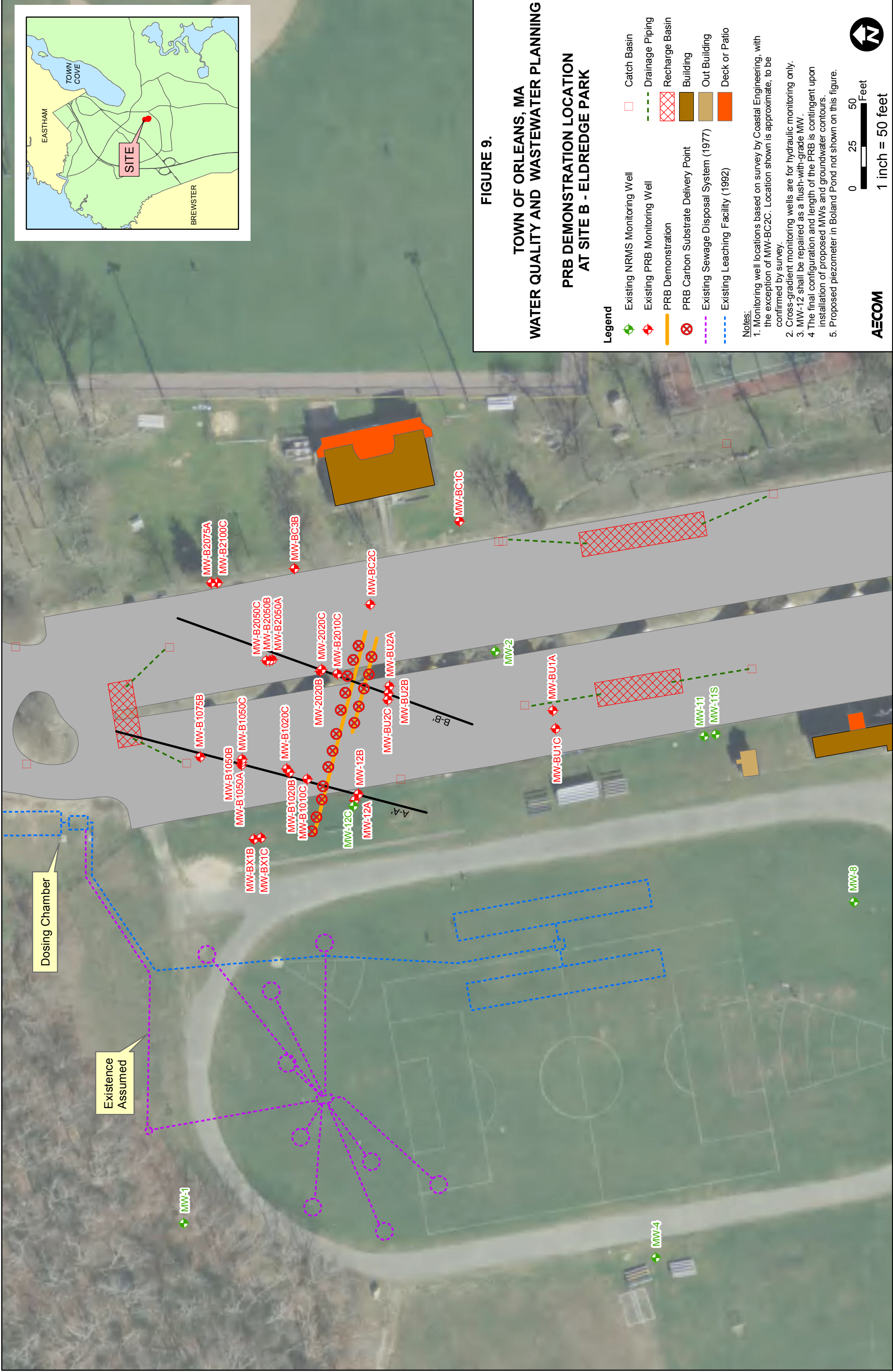
- + Existing NRMS Monitoring Well
- + Existing PRB Monitoring Well
- + PRB Demonstration
- + PRB Carbon Substrate Delivery Point
- Groundwater Contour
- Catch Basin
- Drainage Piping
- Recharge Basin
- Building
- Out Building
- Deck or Patio

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



**AECOM**





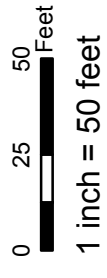
**FIGURE 9.**

**TOWN OF ORLEANS, MA  
WATER QUALITY AND WASTEWATER PLANNING**

**PRB DEMONSTRATION LOCATION  
AT SITE B - ELDRIDGE PARK**

- Legend**
- Existing NRMS Monitoring Well
  - Existing PRB Monitoring Well
  - PRB Demonstration
  - PRB Carbon Substrate Delivery Point
  - Existing Sewage Disposal System (1977)
  - Existing Leaching Facility (1992)
  - Catch Basin
  - Drainage Piping
  - Recharge Basin
  - Building
  - Out Building
  - Deck or Patio

- Notes:**
1. Monitoring well locations based on survey by Coastal Engineering, with the exception of MW-BC2C. Location shown is approximate, to be confirmed by survey.
  2. Cross-gradient monitoring wells are for hydraulic monitoring only.
  3. MW-12 shall be repaired as a flush-with-grade MW.
  4. The final configuration and length of the PRB is contingent upon installation of proposed MWs and groundwater contours.
  5. Proposed piezometer in Boland Pond not shown on this figure.



**AECOM**



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**Appendix A**  
**Monitoring Well Coordinates**

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NO.	DATE	REVISION	BY

PROJECT: NAUSET REGIONAL MIDDLE SCHOOL - OFF ELDRIDGE PARK WAY ORLEANS, MA

SHEET TITLE: WELL PLAN OF LAND SHOWING MONITOR WELL LOCATIONS

SCALE: AS NOTED

DRAWING FILE: C18470-C3D-NRMS.dwg

DATE: REV 4/20/2017 #264044

DRAWN BY: BPM

CHECKED BY: \_\_\_\_\_

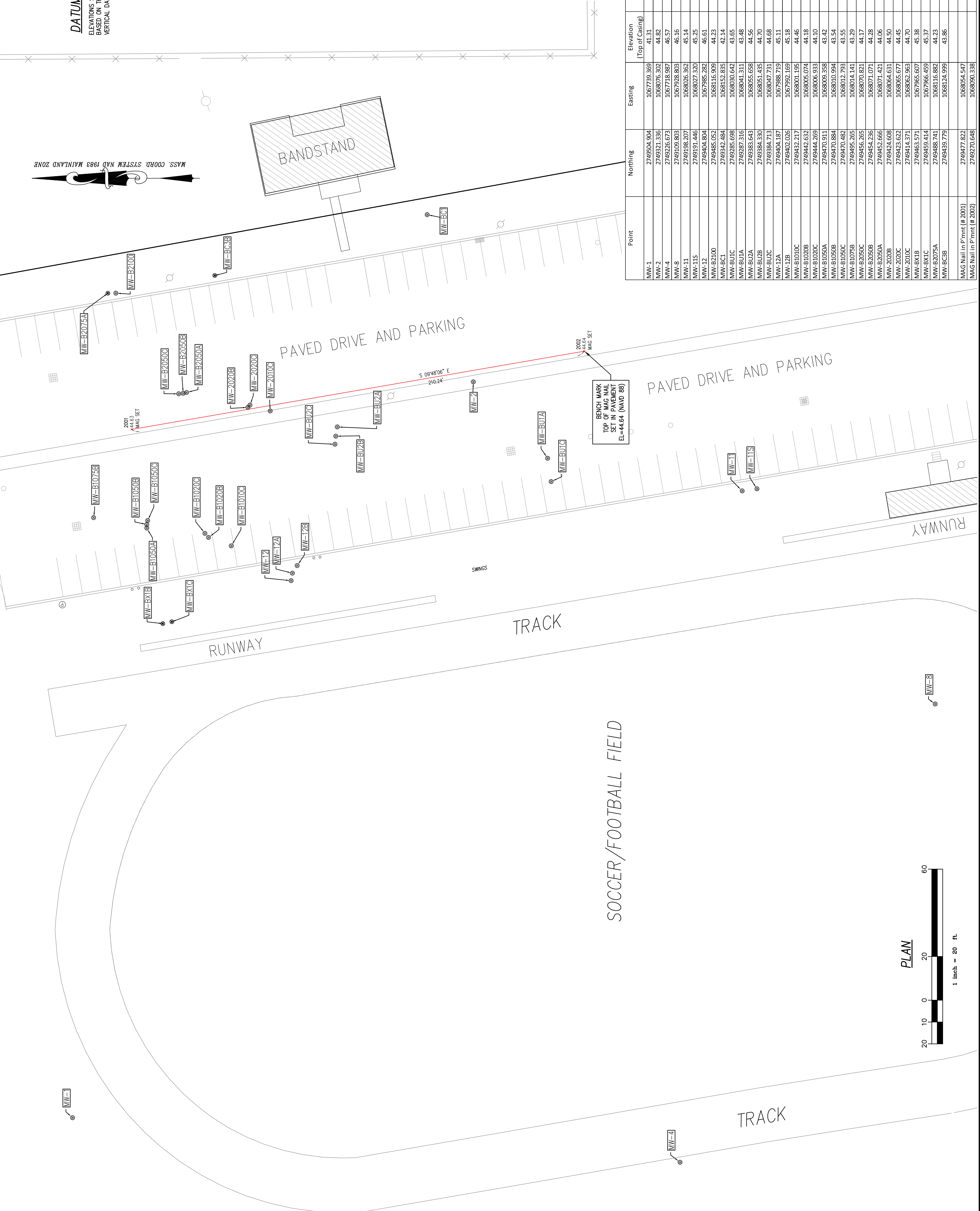
**SKC-5**

PROJECT NO. C18470.00

1 OF 1 SHEETS

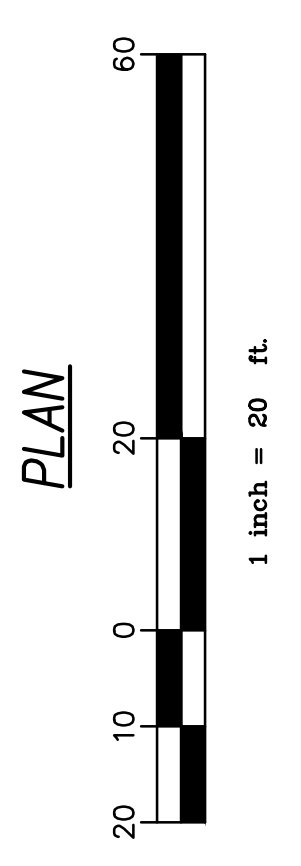
**DATUM NOTE:**  
ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 1988)

**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	1068076.302	44.82	44.82	44.6
MW-4	1067718.987	46.57	46.57	46.1
MW-8	1067928.803	46.16	46.16	46.9
MW-11	1068026.362	45.14	45.14	45.4
MW-12	1068027.320	45.25	45.25	45.4
MW-12A	1068116.909	44.23	44.23	44.6
MW-12B	1068116.909	44.23	44.23	44.6
MW-12C	1068116.909	44.23	44.23	44.6
MW-12D	1068116.909	44.23	44.23	44.6
MW-12E	1068116.909	44.23	44.23	44.6
MW-12F	1068116.909	44.23	44.23	44.6
MW-12G	1068116.909	44.23	44.23	44.6
MW-12H	1068116.909	44.23	44.23	44.6
MW-12I	1068116.909	44.23	44.23	44.6
MW-12J	1068116.909	44.23	44.23	44.6
MW-12K	1068116.909	44.23	44.23	44.6
MW-12L	1068116.909	44.23	44.23	44.6
MW-12M	1068116.909	44.23	44.23	44.6
MW-12N	1068116.909	44.23	44.23	44.6
MW-12O	1068116.909	44.23	44.23	44.6
MW-12P	1068116.909	44.23	44.23	44.6
MW-12Q	1068116.909	44.23	44.23	44.6
MW-12R	1068116.909	44.23	44.23	44.6
MW-12S	1068116.909	44.23	44.23	44.6
MW-12T	1068116.909	44.23	44.23	44.6
MW-12U	1068116.909	44.23	44.23	44.6
MW-12V	1068116.909	44.23	44.23	44.6
MW-12W	1068116.909	44.23	44.23	44.6
MW-12X	1068116.909	44.23	44.23	44.6
MW-12Y	1068116.909	44.23	44.23	44.6
MW-12Z	1068116.909	44.23	44.23	44.6
MW-13	1068001.195	44.46	44.46	44.9
MW-14	1068001.195	44.46	44.46	44.9
MW-15	1068001.195	44.46	44.46	44.9
MW-16	1068001.195	44.46	44.46	44.9
MW-17	1068001.195	44.46	44.46	44.9
MW-18	1068001.195	44.46	44.46	44.9
MW-19	1068001.195	44.46	44.46	44.9
MW-20	1068001.195	44.46	44.46	44.9
MW-21	1068001.195	44.46	44.46	44.9
MW-22	1068001.195	44.46	44.46	44.9
MW-23	1068001.195	44.46	44.46	44.9
MW-24	1068001.195	44.46	44.46	44.9
MW-25	1068001.195	44.46	44.46	44.9
MW-26	1068001.195	44.46	44.46	44.9
MW-27	1068001.195	44.46	44.46	44.9
MW-28	1068001.195	44.46	44.46	44.9
MW-29	1068001.195	44.46	44.46	44.9
MW-30	1068001.195	44.46	44.46	44.9

BENCH MARK  
TOP OF MAG NAIL  
SET IN PAVEMENT  
EL=44.64 (NAVD 88)



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**Appendix B**  
**Analytical Laboratory Reports**

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## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1801083**

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 9:45 am, Jan 17, 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: 1801083

**SAMPLE RECEIPT**

The following samples were received on January 08, 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.

**Revision 1 January 17, 2018: This report has been revised to include Nitrate and Nitrite.**

<b>Lab Number</b>	<b>Sample Name</b>	<b>Matrix</b>	<b>Analysis</b>
1801083-01	MW-B1020B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801083-02	MW-B1020C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801083-03	MW-BX1B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801083-04	MW-BX1C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801083-05	MW-12A	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801083-06	MW-12B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801083

**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](http://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: 1801083

**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 / 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-B1020B  
Date Sampled: 01/08/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-01  
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	01/09/18 16:47	10	10	CA80926
Manganese	<b>0.307</b> (0.020)		200.7		1	KJK	01/09/18 16:47	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1020B  
Date Sampled: 01/08/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-01  
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	0.14 (0.10)		350.1		1	JLK	01/10/18 18:57	mg/L	CA81004
Chloride	25.1 (3.0)		9250		1	EEM	01/11/18 14:46	mg/L	CA81114
Dissolved Organic Carbon (Average)	6.02 (0.250)		5310B		1	CCP	01/10/18 22:14	mg/L	[CALC]
Nitrate as N	4.71 (0.210)		353.2		10	JLK	01/09/18 18:21	mg/L	[CALC]
Nitrate/Nitrite as N	4.80 (0.200)		353.2		10	JLK	01/09/18 18:21	mg/L	CA80918
Nitrite as N	0.091 (0.010)		353.2		1	JLK	01/09/18 17:17	mg/L	CA80917
Sulfate	6.8 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 11:56	mg/L	CA81022
Total Nitrogen	4.80 (0.400)		4500N		10	EEM	01/11/18 11:56	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1020C  
Date Sampled: 01/08/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-02  
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	01/09/18 17:04	10	10	CA80926
Manganese	<b>0.054</b> (0.020)		200.7		1	KJK	01/09/18 17:04	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1020C  
Date Sampled: 01/08/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-02  
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	0.14 (0.10)		350.1		1	JLK	01/10/18 19:00	mg/L	CA81004
Chloride	18.7 (3.0)		9250		1	EEM	01/11/18 14:47	mg/L	CA81114
Dissolved Organic Carbon (Average)	4.52 (0.250)		5310B		1	CCP	01/10/18 22:26	mg/L	[CALC]
Nitrate as N	2.97 (0.210)		353.2		10	JLK	01/09/18 18:22	mg/L	[CALC]
Nitrate/Nitrite as N	2.97 (0.200)		353.2		10	JLK	01/09/18 18:22	mg/L	CA80918
Nitrite as N	ND (0.010)		353.2		1	JLK	01/09/18 17:18	mg/L	CA80917
Sulfate	6.7 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 11:59	mg/L	CA81022
Total Nitrogen	2.97 (0.400)		4500N		10	EEM	01/11/18 11:59	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1B  
Date Sampled: 01/08/18 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-03  
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	01/09/18 17:08	10	10	CA80926
Manganese	<b>0.631</b> (0.020)		200.7		1	KJK	01/09/18 17:08	10	10	CA80926



## CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1B  
Date Sampled: 01/08/18 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-03  
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>
Boron	0.052 (0.050)		200.7		1	KJK	01/10/18 14:31	50	25	CA80935



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1B  
Date Sampled: 01/08/18 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-03  
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	0.51 (0.10)		350.1		1	JLK	01/10/18 19:08	mg/L	CA81004
Chloride	33.4 (3.0)		9250		1	EEM	01/11/18 14:48	mg/L	CA81114
Dissolved Organic Carbon (Average)	5.16 (0.250)		5310B		1	CCP	01/10/18 22:38	mg/L	[CALC]
Nitrate as N	10.0 (0.410)		353.2		20	JLK	01/09/18 18:23	mg/L	[CALC]
Nitrate/Nitrite as N	10.0 (0.400)		353.2		20	JLK	01/09/18 18:23	mg/L	CA80918
Nitrite as N	ND (0.010)		353.2		1	JLK	01/09/18 17:19	mg/L	CA80917
Sulfate	ND (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:00	mg/L	CA81022
<b>Total Nitrogen</b>	<b>10.0 (0.600)</b>		4500N		20	EEM	01/11/18 12:00	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1C  
Date Sampled: 01/08/18 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-04  
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	ND (0.100)		200.7		1	KJK	01/09/18 17:12	10	10	CA80926
Manganese	0.553 (0.020)		200.7		1	KJK	01/09/18 17:12	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1C  
Date Sampled: 01/08/18 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-04  
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>
Boron	0.052 (0.050)		200.7		1	KJK	01/10/18 14:35	50	25	CA80935



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BX1C  
Date Sampled: 01/08/18 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-04  
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	0.18 (0.10)		350.1		1	JLK	01/10/18 19:11	mg/L	CA81004
Chloride	34.5 (3.0)		9250		1	EEM	01/11/18 14:49	mg/L	CA81114
Dissolved Organic Carbon (Average)	4.53 (0.250)		5310B		1	CCP	01/10/18 23:16	mg/L	[CALC]
Nitrate as N	11.1 (0.410)		353.2		20	JLK	01/09/18 18:24	mg/L	[CALC]
Nitrate/Nitrite as N	11.2 (0.400)		353.2		20	JLK	01/09/18 18:24	mg/L	CA80918
Nitrite as N	0.074 (0.010)		353.2		1	JLK	01/09/18 17:20	mg/L	CA80917
Sulfate	ND (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:00	mg/L	CA81022
<b>Total Nitrogen</b>	<b>11.2 (0.600)</b>		<b>4500N</b>		<b>20</b>	<b>EEM</b>	<b>01/11/18 12:00</b>	<b>mg/L</b>	<b>[CALC]</b>



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-12A  
Date Sampled: 01/08/18 15:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-05  
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	01/09/18 17:16	10	10	CA80926
Manganese	ND (0.020)		200.7		1	KJK	01/09/18 17:16	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-12A  
Date Sampled: 01/08/18 15:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-05  
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	01/10/18 19:12	mg/L	CA81004
Chloride	160 (30.0)		9250		10	EEM	01/11/18 15:13	mg/L	CA81114
Dissolved Organic Carbon (Average)	1.70 (0.250)		5310B		1	CCP	01/10/18 23:28	mg/L	[CALC]
Nitrate as N	0.242 (0.030)		353.2		1	JLK	01/09/18 18:09	mg/L	[CALC]
Nitrate/Nitrite as N	0.316 (0.020)		353.2		1	JLK	01/09/18 18:09	mg/L	CA80918
Nitrite as N	0.074 (0.010)		353.2		1	JLK	01/09/18 17:21	mg/L	CA80917
Sulfate	12.2 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	0.22 (0.20)		351.2		1	EEM	01/11/18 12:01	mg/L	CA81022
Total Nitrogen	0.533 (0.220)		4500N		1	EEM	01/11/18 12:01	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-12B  
Date Sampled: 01/08/18 15:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-06  
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	01/09/18 17:20	10	10	CA80926
Manganese	ND (0.020)		200.7		1	KJK	01/09/18 17:20	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-12B  
Date Sampled: 01/08/18 15:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801083  
ESS Laboratory Sample ID: 1801083-06  
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	01/10/18 19:13	mg/L	CA81004
<b>Chloride</b>	<b>47.3 (3.0)</b>		9250		1	EEM	01/11/18 14:55	mg/L	CA81114
<b>Dissolved Organic Carbon (Average)</b>	<b>2.29 (0.250)</b>		5310B		1	CCP	01/10/18 23:40	mg/L	[CALC]
<b>Nitrate as N</b>	<b>1.91 (0.110)</b>		353.2		5	JLK	01/09/18 18:30	mg/L	[CALC]
<b>Nitrate/Nitrite as N</b>	<b>1.91 (0.100)</b>		353.2		5	JLK	01/09/18 18:30	mg/L	CA80918
Nitrite as N	ND (0.010)		353.2		1	JLK	01/09/18 17:26	mg/L	CA80917
<b>Sulfate</b>	<b>11.2 (5.0)</b>		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:02	mg/L	CA81022
<b>Total Nitrogen</b>	<b>1.91 (0.300)</b>		4500N		5	EEM	01/11/18 12:02	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1801083

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Dissolved Metals</b>										
<b>Batch CA80926 - 200.7/6010BNoDigest</b>										
<b>Blank</b>										
Iron	ND	0.100	mg/L							
<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>LCS</b>										
Iron	2.47		mg/L	2.500		99	80-120			
Manganese	0.480		mg/L	0.5000		96	80-120			
<b>Total Metals</b>										
<b>Batch CA80935 - 3005A/200.7</b>										
<b>Blank</b>										
Boron	ND	0.050	mg/L							
<b>LCS</b>										
Boron	0.245	0.050	mg/L	0.2500		98	85-115			
<b>Classical Chemistry</b>										
<b>Batch CA80917 - [CALC]</b>										
<b>Blank</b>										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
<b>LCS</b>										
Nitrate as N	ND		mg/L							
Nitrite as N	0.265		mg/L	0.2497		106	90-110			
Nitrite as N	0.265		mg/L	0.2497		106	90-110			
<b>Batch CA80918 - [CALC]</b>										
<b>Blank</b>										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
<b>LCS</b>										
Nitrate as N	0.524		mg/L							
Nitrate/Nitrite as N	0.524		mg/L	0.5000		105	90-110			
Nitrate/Nitrite as N	0.524		mg/L	0.5000		105	90-110			
Total Nitrogen	0.524		mg/L							
<b>Batch CA81004 - NH4 Prep</b>										
<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801083

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CA81004 - NH4 Prep</b>										
Ammonia as N	0.09	0.10	mg/L	0.09994		86	80-120			
<b>LCS</b>										
Ammonia as N	1.11	0.10	mg/L	0.9994		111	80-120			
<b>Batch CA81022 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
<b>LCS</b>										
Total Kjeldahl Nitrogen as N	13.6	2.00	mg/L	13.80		99	80-120			
Total Nitrogen	13.6	2.00	mg/L							
<b>Batch CA81023 - General Preparation</b>										
<b>Blank</b>										
Sulfate	ND	5.0	mg/L							
<b>LCS</b>										
Sulfate	9.6		mg/L	9.988		96	85-115			
<b>Batch CA81027 - General Preparation</b>										
<b>Blank</b>										
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							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.74	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.83	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.250	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.74	0.500	mg/L	5.000		95	80-120	0.02	200	
Dissolved Organic Carbon (2)	4.76	0.500	mg/L	5.000		95	80-120	1	200	
Dissolved Organic Carbon (Average)	4.75	0.250	mg/L							
<b>Batch CA81114 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							
<b>LCS</b>										
Chloride	29.2		mg/L	30.00		97	90-110			



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801083

**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: 1801083

**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](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/mecdc/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](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  
 Shipped/Delivered Via: ESS Courier

ESS Project ID: 1801083  
 Date Received: 1/8/2018  
 Project Due Date: 1/15/2018  
 Days for Project: 5 Day

- |   |   |
|---|---|
| 1. Air bill manifest present? <input type="checkbox"/> No           | 6. Does COC match bottles? <input type="checkbox"/> Yes   |
| Air No.: <u>NA</u>  |   |
| 2. Were custody seals present? <input type="checkbox"/> No          | 7. Is COC complete and correct? <input type="checkbox"/> Yes  |
| 3. Is radiation count <100 CPM? <input type="checkbox"/> Yes        | 8. Were samples received intact? <input type="checkbox"/> Yes   |
| 4. Is a Cooler Present? <input type="checkbox"/> Yes                | 9. Were labs informed about <b>short holds &amp; rushes</b> ? <input checked="" type="checkbox"/> Yes / No / NA |
| Temp: <u>0.5</u> Iced with: <u>Ice</u>                              |   |
| 5. Was COC signed and dated by client? <input type="checkbox"/> Yes | 10. Were any analyses received outside of hold time? <input checked="" type="checkbox"/> Yes / No               |

- |  |   |
|--|---|
| 11. Any Subcontracting needed? Yes / <input checked="" type="checkbox"/> No          | 12. Were VOAs received? Yes / No  |
| ESS Sample IDs: _____  | a. Air bubbles in aqueous VOAs? Yes / No  |
| Analysis: _____  | b. Does methanol cover soil completely? Yes / No <input checked="" type="checkbox"/> NA |
| TAT: _____   |   |
| 13. Are the samples properly preserved? <input checked="" type="checkbox"/> 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	194528	Yes	NA	Yes	1L Poly - Unpres	NP	
01	194534	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	194546	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	194559	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	194560	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	194566	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	194527	Yes	NA	Yes	1L Poly - Unpres	NP	
02	194533	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	194545	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	194557	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	194558	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	194565	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	194526	Yes	NA	Yes	1L Poly - Unpres	NP	
03	194532	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	194544	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	194548	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
03	194555	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	194556	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	194564	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	194525	Yes	NA	Yes	1L Poly - Unpres	NP	
04	194531	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	194543	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	194547	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
04	194553	Yes	NA	Yes	VOA Vial - HCl	HCl	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KP/BB ESS Project ID: 1801083  
 Date Received: 1/8/2018

04	194554	Yes	NA	Yes	VOA Vial - HCl	HCl
04	194563	Yes	NA	Yes	250 mL Amber - Unpres	NP
05	194524	Yes	NA	Yes	1L Poly - Unpres	NP
05	194530	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
05	194542	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	194551	Yes	NA	Yes	VOA Vial - HCl	HCl
05	194552	Yes	NA	Yes	VOA Vial - HCl	HCl
05	194562	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	194523	Yes	NA	Yes	1L Poly - Unpres	NP
06	194529	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
06	194541	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	194549	Yes	NA	Yes	VOA Vial - HCl	HCl
06	194550	Yes	NA	Yes	VOA Vial - HCl	HCl
06	194561	Yes	NA	Yes	250 mL Amber - Unpres	NP

2nd Review

Are barcode labels on correct containers?

Yes  No

Completed

By:

Date & Time:

1/8/18 1952

Reviewed

By:

Date & Time:

1/8/18 2013

Delivered

By:

1/8/18 2013

ESS Laboratory

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

CHAIN OF CUSTODY

Turn Time 5-Day Rush  
 Regulatory State  
 Is this project for any of the following:  
 OCT RCP  OMA MCP  ORCP

ESS Lab # 1801083

Reporting Limits  
 Electronic Deliverables  Limit Checker  Standard Excel  
 Other (Please Specify ->)

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Project #		Address		PO #	Analysis	Limit Checker	Other (Please Specify ->)
						City	State	Zip Code	Email Address				
Company Name: AECOM Contact Person: JULIANNE MAMON City: Cheimsford MA State: MA Address: 250 Apollo Drive Zip Code: 01824 Email Address: Julianne.Mamon@aecom.com Project Name: O'HEANS PRB 04													
1	01/08/18	1030	G	GW	MW-1020B						X		
2	01/08/18	1110	G	GW	MW-1020C						X		
3	01/08/18	1345	G	GW	MW-1020B						X		
4	01/08/18	1420	G	GW	MW-1020C						X		
5	01/08/18	1510	G	GW	MW-12A						X		
6	01/08/18	1540	G	GW	MW-12B						X		

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 10-8 oz 10-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-Other

Number of Containers per Sample: 1 1 1 1 1 1

Sampled by: BRILEY MORRILL  
 Comments: Please specify "Other" preservative and containers types in this space

Cooler Present: Yes  
 Seals Intact: NA  
 Cooler Temperature: °C Ice Temp: 0.5

Relinquished by: (Signature, Date & Time) 1/8/18  
 Relinquished by: (Signature, Date & Time) 1/8/18 14:34  
 Relinquished by: (Signature, Date & Time) 1/8/18 14:34  
 Relinquished by: (Signature, Date & Time) 1/8/18 14:34

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1801106**

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 12:14 pm, Jan 24, 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: 1801106

**SAMPLE RECEIPT**

The following samples were received on January 09, 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.**

Ammonia and TKN results for samples 1801106-02 and -06 are not in agreement. The TKN analysis was repeated at a dilution to address a possible sample matrix issue. Results obtained from the diluted runs were similar to those of the original analysis, the original results are reported.

<b>Lab Number</b>	<b>Sample Name</b>	<b>Matrix</b>	<b>Analysis</b>
1801106-01	MW-B1010C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-02	MW-B1050A	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-03	MW-B1050B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-04	MW-B1050C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-05	MW-B1075B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-06	MW-B2050A	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-07	MW-B2050B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-08	MW-B2050C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-09	MW-B2020B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801106-10	MW-B2020C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801106

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

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[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: 1801106

**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 / 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-B1010C  
Date Sampled: 01/09/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-01  
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	9.69 (0.100)		200.7		1	KJK	01/10/18 13:07	10	10	CA80926
Manganese	0.531 (0.020)		200.7		1	KJK	01/11/18 11:12	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1010C  
Date Sampled: 01/09/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-01  
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	0.13 (0.10)		350.1		1	JLK	01/10/18 19:14	mg/L	CA81004
Chloride	22.6 (3.0)		9250		1	EEM	01/11/18 14:58	mg/L	CA81114
Dissolved Organic Carbon (Average)	13.6 (0.250)		5310B		1	CCP	01/10/18 23:54	mg/L	[CALC]
Nitrate as N	2.76 (0.110)		353.2		5	JLK	01/09/18 20:52	mg/L	[CALC]
Nitrite as N	0.052 (0.010)		353.2		1	JLK	01/09/18 20:03	mg/L	CA80917
Sulfate	10.8 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	0.88 (0.20)		351.2		1	EEM	01/11/18 12:10	mg/L	CA81022
Total Nitrogen	3.69 (0.300)		4500N		5	EEM	01/11/18 12:10	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050A  
Date Sampled: 01/09/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-02  
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	01/10/18 13:36	10	10	CA80926
Manganese	<b>0.236</b> (0.020)		200.7		1	KJK	01/11/18 11:29	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050A  
Date Sampled: 01/09/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-02  
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	0.38 (0.10)		350.1		1	JLK	01/10/18 19:14	mg/L	CA81004
Chloride	429 (30.0)		9250		10	EEM	01/11/18 15:14	mg/L	CA81114
Dissolved Organic Carbon (Average)	2.83 (0.250)		5310B		1	CCP	01/11/18 0:06	mg/L	[CALC]
Nitrate as N	4.89 (0.210)		353.2		10	JLK	01/09/18 20:53	mg/L	[CALC]
Nitrite as N	0.141 (0.010)		353.2		1	JLK	01/09/18 20:04	mg/L	CA80917
Sulfate	ND (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:11	mg/L	CA81022
<b>Total Nitrogen</b>	<b>5.03 (0.400)</b>		<b>4500N</b>		<b>10</b>	<b>EEM</b>	<b>01/11/18 12:11</b>	<b>mg/L</b>	<b>[CALC]</b>



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050B  
Date Sampled: 01/09/18 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-03  
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	01/10/18 13:40	10	10	CA80926
Manganese	0.115 (0.020)		200.7		1	KJK	01/11/18 11:33	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050B  
Date Sampled: 01/09/18 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-03  
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	01/10/18 19:15	mg/L	CA81004
<b>Chloride</b>	<b>36.7</b> (3.0)		9250		1	EEM	01/11/18 15:00	mg/L	CA81114
<b>Dissolved Organic Carbon (Average)</b>	<b>3.21</b> (0.250)		5310B		1	CCP	01/11/18 0:44	mg/L	[CALC]
<b>Nitrate as N</b>	<b>10.8</b> (0.410)		353.2		20	JLK	01/09/18 20:54	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/09/18 20:05	mg/L	CA80917
Sulfate	ND (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:12	mg/L	CA81022
<b>Total Nitrogen</b>	<b>10.8</b> (0.600)		4500N		20	EEM	01/11/18 12:12	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050C  
Date Sampled: 01/09/18 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-04  
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	ND (0.100)		200.7		1	KJK	01/10/18 13:44	10	10	CA80926
Manganese	<b>0.034</b> (0.020)		200.7		1	KJK	01/11/18 11:37	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1050C  
Date Sampled: 01/09/18 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-04  
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	01/10/18 19:16	mg/L	CA81004
<b>Chloride</b>	<b>85.7</b> (3.0)		9250		1	EEM	01/11/18 15:02	mg/L	CA81114
<b>Dissolved Organic Carbon (Average)</b>	<b>3.26</b> (0.250)		5310B		1	CCP	01/11/18 0:56	mg/L	[CALC]
<b>Nitrate as N</b>	<b>2.00</b> (0.110)		353.2		5	JLK	01/09/18 20:55	mg/L	[CALC]
<b>Nitrite as N</b>	<b>0.088</b> (0.010)		353.2		1	JLK	01/09/18 20:06	mg/L	CA80917
<b>Sulfate</b>	<b>17.9</b> (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:13	mg/L	CA81022
<b>Total Nitrogen</b>	<b>2.08</b> (0.300)		4500N		5	EEM	01/11/18 12:13	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1075B  
Date Sampled: 01/09/18 12:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-05  
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	0.886 (0.100)		200.7		1	KJK	01/10/18 13:48	10	10	CA80926
Manganese	0.142 (0.020)		200.7		1	KJK	01/11/18 11:41	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B1075B  
Date Sampled: 01/09/18 12:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-05  
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	14.3 (0.50)		350.1		5	JLK	01/10/18 19:34	mg/L	CA81004
Chloride	764 (30.0)		9250		10	EEM	01/11/18 15:15	mg/L	CA81114
Dissolved Organic Carbon (Average)	8.77 (0.250)		5310B		1	CCP	01/11/18 1:09	mg/L	[CALC]
Nitrate as N	0.609 (0.030)		353.2		1	JLK	01/09/18 20:38	mg/L	[CALC]
Nitrite as N	0.201 (0.010)		353.2		1	JLK	01/09/18 20:07	mg/L	CA80917
Sulfate	31.6 (10.0)		9038		2	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	14.4 (2.00)		351.2		10	EEM	01/11/18 12:25	mg/L	CA81022
Total Nitrogen	15.3 (2.02)		4500N		10	EEM	01/11/18 12:25	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050A  
Date Sampled: 01/09/18 14:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-06  
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	01/10/18 13:53	10	10	CA80926
Manganese	<b>0.258</b> (0.020)		200.7		1	KJK	01/11/18 11:45	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050A  
Date Sampled: 01/09/18 14:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-06  
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	0.78 (0.10)		350.1		1	JLK	01/10/18 19:25	mg/L	CA81004
Chloride	114 (30.0)		9250		10	EEM	01/11/18 15:17	mg/L	CA81114
Dissolved Organic Carbon (Average)	2.76 (0.250)		5310B		1	CCP	01/11/18 1:21	mg/L	[CALC]
Nitrate as N	11.6 (0.410)		353.2		20	JLK	01/09/18 20:56	mg/L	[CALC]
Nitrite as N	0.040 (0.010)		353.2		1	JLK	01/09/18 20:08	mg/L	CA80917
Sulfate	6.1 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:14	mg/L	CA81022
<b>Total Nitrogen</b>	<b>11.6 (0.600)</b>		<b>4500N</b>		<b>20</b>	<b>EEM</b>	<b>01/11/18 12:14</b>	<b>mg/L</b>	<b>[CALC]</b>



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050B  
Date Sampled: 01/09/18 14:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-07  
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	01/10/18 13:58	10	10	CA80926
Manganese	<b>0.315</b> (0.020)		200.7		1	KJK	01/11/18 11:49	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050B  
Date Sampled: 01/09/18 14:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-07  
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	01/10/18 19:26	mg/L	CA81004
<b>Chloride</b>	<b>121</b> (30.0)		9250		10	EEM	01/11/18 15:18	mg/L	CA81114
<b>Dissolved Organic Carbon (Average)</b>	<b>4.25</b> (0.250)		5310B		1	CCP	01/11/18 1:33	mg/L	[CALC]
<b>Nitrate as N</b>	<b>1.72</b> (0.110)		353.2		5	JLK	01/09/18 20:57	mg/L	[CALC]
<b>Nitrite as N</b>	<b>0.046</b> (0.010)		353.2		1	JLK	01/09/18 20:09	mg/L	CA80917
<b>Sulfate</b>	<b>11.4</b> (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:15	mg/L	CA81022
<b>Total Nitrogen</b>	<b>1.76</b> (0.300)		4500N		5	EEM	01/11/18 12:15	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050C  
Date Sampled: 01/09/18 14:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-08  
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	01/10/18 14:02	10	10	CA80926
Manganese	<b>0.102</b> (0.020)		200.7		1	KJK	01/11/18 12:06	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2050C  
Date Sampled: 01/09/18 14:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-08  
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	01/10/18 19:27	mg/L	CA81004
<b>Chloride</b>	<b>257 (30.0)</b>		9250		10	EEM	01/11/18 15:19	mg/L	CA81114
<b>Dissolved Organic Carbon (Average)</b>	<b>2.75 (0.250)</b>		5310B		1	CCP	01/11/18 2:11	mg/L	[CALC]
<b>Nitrate as N</b>	<b>1.41 (0.110)</b>		353.2		5	JLK	01/09/18 20:58	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/09/18 20:10	mg/L	CA80917
<b>Sulfate</b>	<b>9.6 (5.0)</b>		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/11/18 12:16	mg/L	CA81022
<b>Total Nitrogen</b>	<b>1.41 (0.300)</b>		4500N		5	EEM	01/11/18 12:16	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2020B  
Date Sampled: 01/09/18 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-09  
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	01/10/18 14:18	10	10	CA80926
Manganese	<b>0.374</b> (0.020)		200.7		1	KJK	01/11/18 12:11	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2020B  
Date Sampled: 01/09/18 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-09  
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	0.23 (0.10)		350.1		1	JLK	01/10/18 19:28	mg/L	CA81004
Chloride	51.4 (3.0)		9250		1	EEM	01/11/18 15:11	mg/L	CA81114
Dissolved Organic Carbon (Average)	16.5 (0.500)		5310B		2	CCP	01/11/18 16:44	mg/L	[CALC]
Nitrate as N	3.26 (0.300)		353.2		10	JLK	01/09/18 20:42	mg/L	[CALC]
Nitrite as N	2.98 (0.100)		353.2		10	JLK	01/09/18 20:21	mg/L	CA80917
Sulfate	19.3 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	4.32 (0.20)		351.2		1	EEM	01/11/18 12:22	mg/L	CA81022
Total Nitrogen	10.6 (0.400)		4500N		10	EEM	01/11/18 12:22	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2020C  
Date Sampled: 01/09/18 15:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-10  
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	1.83 (0.100)		200.7		1	KJK	01/10/18 14:23	10	10	CA80926
Manganese	5.09 (0.020)		200.7		1	KJK	01/11/18 12:15	10	10	CA80926



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2020C  
Date Sampled: 01/09/18 15:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801106  
ESS Laboratory Sample ID: 1801106-10  
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	0.14 (0.10)		350.1		1	JLK	01/10/18 19:29	mg/L	CA81004
Chloride	33.0 (3.0)		9250		1	EEM	01/11/18 15:12	mg/L	CA81114
Dissolved Organic Carbon (Average)	11.8 (0.500)		5310B		2	CCP	01/11/18 16:57	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	01/09/18 20:43	mg/L	[CALC]
Nitrite as N	0.083 (0.010)		353.2		1	JLK	01/09/18 20:12	mg/L	CA80917
Sulfate	29.0 (5.0)		9038		1	JLK	01/10/18 16:33	mg/L	CA81023
Total Kjeldahl Nitrogen as N	1.04 (0.20)		351.2		1	EEM	01/11/18 12:23	mg/L	CA81022
Total Nitrogen	1.10 (0.220)		4500N		1	EEM	01/11/18 12:23	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1801106

**Quality Control Data**

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

**Batch CA80926 - 200.7/6010BNoDigest**

<b>Blank</b>										
Iron	ND	0.100	mg/L							
<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>LCS</b>										
Iron	2.47		mg/L	2.500		99	80-120			
Manganese	0.480		mg/L	0.5000		96	80-120			

Classical Chemistry

**Batch CA80917 - [CALC]**

<b>Blank</b>										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
<b>LCS</b>										
Nitrate as N	ND		mg/L							
Nitrite as N	0.265		mg/L	0.2497		106	90-110			
Nitrite as N	0.265		mg/L	0.2497		106	90-110			

**Batch CA80918 - [CALC]**

<b>Blank</b>										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
<b>LCS</b>										
Nitrate as N	0.524		mg/L							
Nitrate/Nitrite as N	0.524		mg/L	0.5000		105	90-110			
Nitrate/Nitrite as N	0.524		mg/L	0.5000		105	90-110			
Total Nitrogen	0.524		mg/L							

**Batch CA81004 - NH4 Prep**

<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.09	0.10	mg/L	0.09994		86	80-120			
<b>LCS</b>										
Ammonia as N	1.11	0.10	mg/L	0.9994		111	80-120			

**Batch CA81022 - TKN Prep**

<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							

**LCS**



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1801106

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CA81022 - TKN Prep</b>										
Total Kjeldahl Nitrogen as N	13.6	2.00	mg/L	13.80		99	80-120			
Total Nitrogen	13.6	2.00	mg/L							
<b>Batch CA81023 - General Preparation</b>										
<b>Blank</b>										
Sulfate	ND	5.0	mg/L							
<b>LCS</b>										
Sulfate	9.6		mg/L	9.988		96	85-115			
<b>Batch CA81027 - General Preparation</b>										
<b>Blank</b>										
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							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.74	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.83	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.250	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.74	0.500	mg/L	5.000		95	80-120	0.02	200	
Dissolved Organic Carbon (2)	4.76	0.500	mg/L	5.000		95	80-120	1	200	
Dissolved Organic Carbon (Average)	4.75	0.250	mg/L							
<b>Batch CA81114 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							
<b>LCS</b>										
Chloride	29.2		mg/L	30.00		97	90-110			



## CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR

Client Project ID: Orleans MA

ESS Laboratory Work Order: 1801106

### 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: 1801106

**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](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/mecdc/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](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: 1801106

Shipped/Delivered Via: ESS Courier

Date Received: 1/9/2018

Project Due Date: 1/16/2018

Days for Project: 5 Day

- |   |  |
|---|--|
| <p>1. Air bill manifest present? <input type="checkbox"/> No<br/>Air No.: <u>NA</u></p> <p>2. Were custody seals present? <input type="checkbox"/> No</p> <p>3. Is radiation count &lt;100 CPM? <input type="checkbox"/> Yes</p> <p>4. Is a Cooler Present? <input type="checkbox"/> Yes<br/>Temp: <u>14.1.8</u> Iced with: <u>Ice</u></p> <p>5. Was COC signed and dated by client? <input type="checkbox"/> Yes</p> | <p>6. Does COC match bottles? <input type="checkbox"/> Yes</p> <p>7. Is COC complete and correct? <input type="checkbox"/> Yes</p> <p>8. Were samples received intact? <input type="checkbox"/> Yes</p> <p>9. Were labs informed about <u>short holds &amp; rushes</u>? <input checked="" type="checkbox"/> Yes / No / NA</p> <p>10. Were any analyses received outside of hold time? Yes <input checked="" type="checkbox"/> No</p> |
|---|--|

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

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	194709	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	194710	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	194720	Yes	NA	Yes	250 mL Amber - Unpres	NP	
01	194730	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	194740	Yes	NA	Yes	1L Poly - Unpres	NP	
01	194750	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	194707	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	194708	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	194719	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	194729	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	194739	Yes	NA	Yes	1L Poly - Unpres	NP	
02	194749	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	194705	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	194706	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	194718	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	194728	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	194738	Yes	NA	Yes	1L Poly - Unpres	NP	
03	194748	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	194703	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	194704	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	194717	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	194727	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	194737	Yes	NA	Yes	1L Poly - Unpres	NP	
04	194747	Yes	NA	Yes	250 mL Poly - Unpres	NP	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1801106

Date Received: 1/9/2018

05	194701	Yes	NA	Yes	VOA Vial - HCl	HCl
05	194702	Yes	NA	Yes	VOA Vial - HCl	HCl
05	194716	Yes	NA	Yes	250 mL Amber - Unpres	NP
05	194726	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
05	194736	Yes	NA	Yes	1L Poly - Unpres	NP
05	194746	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	194699	Yes	NA	Yes	VOA Vial - HCl	HCl
06	194700	Yes	NA	Yes	VOA Vial - HCl	HCl
06	194715	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	194725	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
06	194735	Yes	NA	Yes	1L Poly - Unpres	NP
06	194745	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	194697	Yes	NA	Yes	VOA Vial - HCl	HCl
07	194698	Yes	NA	Yes	VOA Vial - HCl	HCl
07	194714	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	194724	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
07	194734	Yes	NA	Yes	1L Poly - Unpres	NP
07	194744	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	194695	Yes	NA	Yes	VOA Vial - HCl	HCl
08	194696	Yes	NA	Yes	VOA Vial - HCl	HCl
08	194713	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	194723	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
08	194733	Yes	NA	Yes	1L Poly - Unpres	NP
08	194743	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	194693	Yes	NA	Yes	VOA Vial - HCl	HCl
09	194694	Yes	NA	Yes	VOA Vial - HCl	HCl
09	194712	Yes	NA	Yes	250 mL Amber - Unpres	NP
09	194722	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
09	194732	Yes	NA	Yes	1L Poly - Unpres	NP
09	194742	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	194691	Yes	NA	Yes	VOA Vial - HCl	HCl
10	194692	Yes	NA	Yes	VOA Vial - HCl	HCl
10	194711	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	194721	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
10	194731	Yes	NA	Yes	1L Poly - Unpres	NP
10	194741	Yes	NA	Yes	250 mL Poly - Unpres	NP

2nd Review

Are barcode labels on correct containers?

Yes  No

Completed

By: [Signature]

Date & Time: 1/9/18 1930

Reviewed

By: [Signature]

Date & Time: 1/9/18 1935

Delivered

By: [Signature]

Date & Time: 1/9/18 1935



## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1801156**

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 12:35 pm, Jan 24, 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: 1801156

**SAMPLE RECEIPT**

The following samples were received on January 10, 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>
1801156-01	MW-BC2C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-02	MW-B2010C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-03	MW-BC3B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-04	MW-B2075A	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-05	MW-B2100C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-06	MW-BU2A	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-07	MW-BU2B	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250
1801156-08	MW-BU2C	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801156

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

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[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: 1801156

**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 / 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-BC2C  
Date Sampled: 01/10/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-01  
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	01/11/18 12:36	10	10	CA81118
Manganese	<b>0.063</b> (0.020)		200.7		1	KJK	01/11/18 12:36	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BC2C  
Date Sampled: 01/10/18 10:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-01  
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	01/16/18 17:13	mg/L	CA81527
<b>Chloride</b>	<b>96.0</b> (3.0)		9250		1	EEM	01/11/18 16:27	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>1.67</b> (0.250)		5310B		1	CCP	01/12/18 18:02	mg/L	[CALC]
<b>Nitrate as N</b>	<b>4.25</b> (0.210)		353.2		10	JLK	01/11/18 23:01	mg/L	[CALC]
<b>Nitrite as N</b>	<b>0.080</b> (0.010)		353.2		1	JLK	01/11/18 22:01	mg/L	CA81129
<b>Sulfate</b>	<b>5.3</b> (5.0)		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/15/18 14:38	mg/L	CA81221
<b>Total Nitrogen</b>	<b>4.33</b> (0.400)		4500N		10	EEM	01/15/18 14:38	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2010C  
Date Sampled: 01/10/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-02  
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	88.2 (0.100)		200.7		1	KJK	01/11/18 13:25	10	10	CA81118
Manganese	5.15 (0.020)		200.7		1	KJK	01/11/18 13:25	10	10	CA81118

*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2010C  
Date Sampled: 01/10/18 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-02  
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	0.17 (0.10)		350.1		1	JLK	01/16/18 17:14	mg/L	CA81527
Chloride	35.5 (3.0)		9250		1	EEM	01/11/18 16:28	mg/L	CA81115
Dissolved Organic Carbon (Average)	94.3 (2.50)		5310B		10	CCP	01/12/18 21:48	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	01/11/18 22:40	mg/L	[CALC]
Nitrite as N	0.027 (0.010)		353.2		1	JLK	01/11/18 22:02	mg/L	CA81129
Sulfate	57.0 (50.0)		9038		10	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	1.75 (0.20)		351.2		1	EEM	01/15/18 14:40	mg/L	CA81221
Total Nitrogen	1.75 (0.220)		4500N		1	EEM	01/15/18 14:40	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BC3B  
Date Sampled: 01/10/18 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-03  
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	01/11/18 13:29	10	10	CA81118
Manganese	<b>0.078</b> (0.020)		200.7		1	KJK	01/11/18 13:29	10	10	CA81118



## CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BC3B  
Date Sampled: 01/10/18 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-03  
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	01/16/18 17:15	mg/L	CA81527
<b>Chloride</b>	<b>140</b> (30.0)		9250		10	EEM	01/11/18 16:47	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>2.36</b> (0.500)		5310B		2	CCP	01/15/18 15:51	mg/L	[CALC]
<b>Nitrate as N</b>	<b>4.26</b> (0.210)		353.2		10	JLK	01/11/18 23:02	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/11/18 22:08	mg/L	CA81129
<b>Sulfate</b>	<b>13.6</b> (5.0)		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/15/18 14:41	mg/L	CA81221
<b>Total Nitrogen</b>	<b>4.26</b> (0.400)		4500N		10	EEM	01/15/18 14:41	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2075A  
Date Sampled: 01/10/18 12:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-04  
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	ND (0.100)		200.7		1	KJK	01/11/18 13:33	10	10	CA81118
Manganese	<b>0.069</b> (0.020)		200.7		1	KJK	01/11/18 13:33	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2075A  
Date Sampled: 01/10/18 12:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-04  
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	01/16/18 17:16	mg/L	CA81527
<b>Chloride</b>	<b>257 (30.0)</b>		9250		10	EEM	01/11/18 16:48	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>2.26 (0.250)</b>		5310B		1	CCP	01/12/18 19:29	mg/L	[CALC]
<b>Nitrate as N</b>	<b>0.762 (0.030)</b>		353.2		1	JLK	01/11/18 22:47	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/11/18 22:09	mg/L	CA81129
<b>Sulfate</b>	<b>6.5 (5.0)</b>		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.31 (0.20)</b>		351.2		1	EEM	01/15/18 14:42	mg/L	CA81221
<b>Total Nitrogen</b>	<b>1.07 (0.220)</b>		4500N		1	EEM	01/15/18 14:42	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2100C  
Date Sampled: 01/10/18 12:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-05  
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	01/11/18 13:38	10	10	CA81118
Manganese	<b>0.102</b> (0.020)		200.7		1	KJK	01/11/18 13:38	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-B2100C  
Date Sampled: 01/10/18 12:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-05  
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	01/16/18 17:19	mg/L	CA81527
<b>Chloride</b>	<b>97.8 (3.0)</b>		9250		1	EEM	01/11/18 16:32	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>2.28 (0.250)</b>		5310B		1	CCP	01/12/18 20:07	mg/L	[CALC]
<b>Nitrate as N</b>	<b>1.13 (0.050)</b>		353.2		2	JLK	01/11/18 23:03	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/11/18 22:10	mg/L	CA81129
<b>Sulfate</b>	<b>10.8 (5.0)</b>		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.21 (0.20)</b>		351.2		1	EEM	01/15/18 14:43	mg/L	CA81221
<b>Total Nitrogen</b>	<b>1.33 (0.240)</b>		4500N		2	EEM	01/15/18 14:43	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2A  
Date Sampled: 01/10/18 13:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-06  
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	01/11/18 13:42	10	10	CA81118
Manganese	ND (0.020)		200.7		1	KJK	01/11/18 13:42	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2A  
Date Sampled: 01/10/18 13:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-06  
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	01/16/18 17:26	mg/L	CA81527
<b>Chloride</b>	<b>114</b> (30.0)		9250		10	EEM	01/11/18 16:49	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>1.14</b> (0.250)		5310B		1	CCP	01/12/18 20:19	mg/L	[CALC]
<b>Nitrate as N</b>	<b>0.467</b> (0.030)		353.2		1	JLK	01/11/18 22:48	mg/L	[CALC]
<b>Nitrite as N</b>	<b>0.065</b> (0.010)		353.2		1	JLK	01/11/18 22:11	mg/L	CA81129
<b>Sulfate</b>	<b>5.3</b> (5.0)		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/15/18 14:44	mg/L	CA81221
<b>Total Nitrogen</b>	<b>0.532</b> (0.220)		4500N		1	EEM	01/15/18 14:44	mg/L	[CALC]



## CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2B  
Date Sampled: 01/10/18 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-07  
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	01/11/18 13:46	10	10	CA81118
Manganese	ND (0.020)		200.7		1	KJK	01/11/18 13:46	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2B  
Date Sampled: 01/10/18 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-07  
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	01/16/18 17:27	mg/L	CA81527
<b>Chloride</b>	<b>106</b> (30.0)		9250		10	EEM	01/11/18 16:50	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>2.26</b> (0.250)		5310B		1	CCP	01/12/18 20:31	mg/L	[CALC]
<b>Nitrate as N</b>	<b>2.78</b> (0.110)		353.2		5	JLK	01/11/18 23:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/11/18 22:12	mg/L	CA81129
Sulfate	ND (5.0)		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/15/18 14:50	mg/L	CA81221
<b>Total Nitrogen</b>	<b>2.78</b> (0.300)		4500N		5	EEM	01/15/18 14:50	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2C  
Date Sampled: 01/10/18 14:50  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-08  
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	01/11/18 13:50	10	10	CA81118
Manganese	0.076 (0.020)		200.7		1	KJK	01/11/18 13:50	10	10	CA81118



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-BU2C  
Date Sampled: 01/10/18 14:50  
Percent Solids: N/A

ESS Laboratory Work Order: 1801156  
ESS Laboratory Sample ID: 1801156-08  
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	01/16/18 17:28	mg/L	CA81527
<b>Chloride</b>	<b>165</b> (30.0)		9250		10	EEM	01/11/18 16:55	mg/L	CA81115
<b>Dissolved Organic Carbon (Average)</b>	<b>2.20</b> (0.250)		5310B		1	CCP	01/12/18 20:44	mg/L	[CALC]
<b>Nitrate as N</b>	<b>8.03</b> (0.410)		353.2		20	JLK	01/11/18 23:05	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	01/11/18 22:13	mg/L	CA81129
Sulfate	ND (5.0)		9038		1	EEM	01/12/18 13:55	mg/L	CA81205
Total Kjeldahl Nitrogen as N	ND (0.20)		351.2		1	EEM	01/15/18 14:51	mg/L	CA81221
<b>Total Nitrogen</b>	<b>8.03</b> (0.600)		4500N		20	EEM	01/15/18 14:51	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1801156

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Dissolved Metals</b>										
<b>Batch CA81118 - 200.7/6010BNoDigest</b>										
<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>LCS</b>										
Iron	2.39		mg/L	2.500		96	80-120			
Manganese	0.480		mg/L	0.5000		96	80-120			
<b>Classical Chemistry</b>										
<b>Batch CA81115 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							
<b>LCS</b>										
Chloride	29.6		mg/L	30.00		99	90-110			
<b>Batch CA81129 - [CALC]</b>										
<b>Blank</b>										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
<b>LCS</b>										
Nitrate as N	ND		mg/L							
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
<b>Batch CA81130 - [CALC]</b>										
<b>Blank</b>										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
<b>LCS</b>										
Nitrate as N	0.518		mg/L							
Nitrate/Nitrite as N	0.518		mg/L	0.5000		104	90-110			
Total Nitrogen	0.518		mg/L							
<b>Batch CA81205 - General Preparation</b>										
<b>Blank</b>										
Sulfate	ND	5.0	mg/L							
<b>LCS</b>										
Sulfate	9.5		mg/L	9.988		95	85-115			
<b>Batch CA81221 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
<b>LCS</b>										



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801156

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CA81221 - TKN Prep</b>										
Total Kjeldahl Nitrogen as N	13.8	2.00	mg/L	13.80		100	80-120			
Total Nitrogen	13.8	2.00	mg/L							
<b>Batch CA81225 - General Preparation</b>										
<b>Blank</b>										
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							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.81	0.500	mg/L	5.000		96	80-120			
Dissolved Organic Carbon (2)	4.92	0.500	mg/L	5.000		98	80-120			
Dissolved Organic Carbon (Average)	4.87	0.250	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.71	0.500	mg/L	5.000		94	80-120	2	200	
Dissolved Organic Carbon (2)	4.74	0.500	mg/L	5.000		95	80-120	4	200	
Dissolved Organic Carbon (Average)	4.73	0.250	mg/L							
<b>Batch CA81527 - NH4 Prep</b>										
<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.12	0.10	mg/L	0.09994		116	80-120			
<b>LCS</b>										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			
<b>Batch CA81542 - General Preparation</b>										
<b>Blank</b>										
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							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.72	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.82	0.500	mg/L	5.000		96	80-120			
Dissolved Organic Carbon (Average)	4.77	0.250	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.73	0.500	mg/L	5.000		95	80-120	0.3	200	
Dissolved Organic Carbon (2)	4.74	0.500	mg/L	5.000		95	80-120	2	200	
Dissolved Organic Carbon (Average)	4.74	0.250	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1801156

**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: 1801156

**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](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](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 - KP/MM

ESS Project ID: 1801156

Shipped/Delivered Via: ESS Courier

Date Received: 1/10/2018

Project Due Date: 1/17/2018

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: 0.3 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	195136	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	195137	Yes	NA	Yes	VOA Vial - HCl	HCl	
01	195145	Yes	NA	Yes	250 mL Amber - Unpres	NP	
01	195153	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	195161	Yes	NA	Yes	1L Poly - Unpres	NP	
01	195169	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	195134	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	195135	Yes	NA	Yes	VOA Vial - HCl	HCl	
02	195144	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	195152	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	195160	Yes	NA	Yes	1L Poly - Unpres	NP	
02	195168	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	195132	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	195133	Yes	NA	Yes	VOA Vial - HCl	HCl	
03	195143	Yes	NA	Yes	250 mL Amber - Unpres	NP	
03	195151	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	195159	Yes	NA	Yes	1L Poly - Unpres	NP	
03	195167	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	195130	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	195131	Yes	NA	Yes	VOA Vial - HCl	HCl	
04	195142	Yes	NA	Yes	250 mL Amber - Unpres	NP	
04	195150	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	195158	Yes	NA	Yes	1L Poly - Unpres	NP	
04	195166	Yes	NA	Yes	250 mL Poly - Unpres	NP	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1801156

Date Received: 1/10/2018

05	195128	Yes	NA	Yes	VOA Vial - HCl	HCl
05	195129	Yes	NA	Yes	VOA Vial - HCl	HCl
05	195141	Yes	NA	Yes	250 mL Amber - Unpres	NP
05	195149	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
05	195157	Yes	NA	Yes	1L Poly - Unpres	NP
05	195165	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	195126	Yes	NA	Yes	VOA Vial - HCl	HCl
06	195127	Yes	NA	Yes	VOA Vial - HCl	HCl
06	195140	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	195148	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
06	195156	Yes	NA	Yes	1L Poly - Unpres	NP
06	195164	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	195124	Yes	NA	Yes	VOA Vial - HCl	HCl
07	195125	Yes	NA	Yes	VOA Vial - HCl	HCl
07	195139	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	195147	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
07	195155	Yes	NA	Yes	1L Poly - Unpres	NP
07	195163	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	195122	Yes	NA	Yes	VOA Vial - HCl	HCl
08	195123	Yes	NA	Yes	VOA Vial - HCl	HCl
08	195138	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	195146	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
08	195154	Yes	NA	Yes	1L Poly - Unpres	NP
08	195162	Yes	NA	Yes	250 mL Poly - Unpres	NP

**2nd Review**

Are barcode labels on correct containers?

Yes /  No

Completed

By: [Signature]

Date & Time: 1/10/18 1958

Reviewed

By: [Signature]

Date & Time: 1/10/18 2004

Delivered

By: [Signature]

1/10/18

2004



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